Java Tutorial

JAVA TUTORIAL

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ABOUT THE TUTORIAL

Java Tutorial

Java is a high-level programming language originally developed by Sun Microsystems and released in 1995. Java runs on a variety of platforms, such as Windows, Mac OS, and the various versions of UNIX. This tutorial gives a complete understanding ofJava.

This reference will take you through simple and practical approach while learning Java Programming language.

Audience

This reference has been prepared for the beginners to help them understand the basic to advanced concepts related to Java Programming language.

Prerequisites

Before you start doing practice with various types of examples given in this reference, I'm making an assumption that you are already aware about what is a computer program and what is a computer programming language?

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CHAPTER

1

Java Overview

Java programming language was originally developed by Sun Microsystems which was initiated by James Gosling and released in 1995 as core component of Sun Microsystems' Java platform (Java 1.0 [J2SE]).

As of December 2008, the latest release of the Java Standard Edition is 6 (J2SE). With the advancement of Java and its widespread popularity, multiple configurations were built to suite various types of platforms. Ex: J2EE for Enterprise Applications, J2ME for Mobile Applications.

Sun Microsystems has renamed the new J2 versions as Java SE, Java EE and Java ME, respectively. Java is guaranteed to be **Write Once, Run Anywhere.**

Java is:

- **Object Oriented**: In Java, everything is an Object. Java can be easily extended since it is based on the Object model.
- **Platform independent**: Unlike many other programming languages including C and C++, when Java is compiled, it is not compiled into platform specific machine, rather into platform independent byte code. This byte code is distributed over the web and interpreted by virtual Machine (JVM) on whichever platform it is being run.
- **Simple**:Java is designed to be easy to learn. If you understand the basic concept of OOP,Java would be easy to master.
- **Secure**: With Java's secure feature, it enables to develop virus-free, tamper-free systems. Authentication techniques are based on public-key encryption.
- **Architectural-neutral**:Java compiler generates an architecture-neutral object file format, which makes the compiled code to be executable on many processors, with the presence of Java runtime system.
- **Portable**: Being architectural-neutral and having no implementation dependent aspects of the specification makes Java portable. Compiler inJava is written in ANSI C with a clean portability boundary which is a POSIX subset.
- **Robust**:Java makes an effort to eliminate error prone situations by emphasizing mainly on compile time error checking and runtime checking.
- **Multithreaded**: With Java's multithreaded feature, it is possible to write programs that can do many tasks simultaneously. This design feature allows developers to construct smoothly running interactive applications.

- **Interpreted**:Java byte code is translated on the fly to native machine instructions and is not stored anywhere. The development process is more rapid and analytical since the linking is an incremental and lightweight process.

- **High Performance**: With the use of Just-In-Time compilers, Java enables high performance.

- **Distributed**:Java is designed for the distributed environment of the internet.

- **Dynamic**: Java is considered to be more dynamic than C or C++ since it is designed to adapt to an evolving environment. Java programs can carry extensive amount of run-time information that can be used to verify and resolve accesses to objects on run-time.

History of Java:

James Gosling initiated the Java language project in June 1991 for use in one of his many set-top box projects. The language, initially called Oak after an oak tree that stood outside Gosling's office, also went by the name Green and ended up later being renamed as Java, from a list of random words.

Sun released the first public implementation as Java 1.0 in 1995. It promised **Write Once, Run Anywhere** (WORA), providing no-cost run-times on popular platforms.

On 13 November 2006, Sun released much of Java as free and open source software under the terms of the GNU General Public License (GPL).

On 8 May 2007, Sun finished the process, making all of Java's core code free and open-source, aside from a small portion of code to which Sun did not hold the copyright.

Tools you will need:

For performing the examples discussed in this tutorial, you will need a Pentium 200-MHz computer with a minimum of 64 MB of RAM (128 MB of RAM recommended).

You also will need the following softwares:

- Linux 7.1 or Windows 95/98/2000/XP operating system.

- Java JDK 5

- Microsoft Notepad or any other text editor

This tutorial will provide the necessary skills to create GUI, networking, and Web applications using Java.

What is Next?

Next chapter will guide you to where you can obtain Java and its documentation. Finally, it instructs you on how to install Java and prepare an environment to develop Java applications.

CHAPTER

2

Java Environment Setup

Before we proceed further, it is important that we set up the Java environment correctly. This section guides you on how to download and set up Java on your machine. Please follow the following steps to set up the environment.

Java SE is freely available from the link Download Java. So you download a version based on your operating system.

Follow the instructions to download Java and run the **.exe** to install Java on your machine. Once you installed Java on your machine, you would need to set environment variables to point to correct installation directories:

Setting up the path for windows 2000/XP:

Assuming you have installed Java in *c:\Program Files\java\jdk* directory:

- Right-click on 'My Computer' and select 'Properties'.
- Click on the 'Environment variables' button under the 'Advanced' tab.
- Now, alter the 'Path' variable so that it also contains the path to the Java executable. Example, if the path is currently set to 'C:\WINDOWS\SYSTEM32', then change your path to read 'C:\WINDOWS\SYSTEM32;c:\Program Files\java\jdk\bin'.

Setting up the path for windows 95/98/ME:

Assuming you have installed Java in *c:\Program Files\java\jdk* directory:

- Edit the 'C:\autoexec.bat' file and add the following line at the end: 'SET PATH=%PATH%;C:\Program Files\java\jdk\bin'

Setting up the path for Linux, UNIX, Solaris, FreeBSD:

Environment variable PATH should be set to point to where the Java binaries have been installed. Refer to your shell documentation if you have trouble doing this.

Example, if you use *bash* as your shell, then you would add the following line to the end of your '.bashrc: export PATH=/path/to/java:$PATH'

Popular Java Editors:

To write your Java programs, you will need a text editor. There are even more sophisticated IDEs available in the market. But for now, you can consider one of the following:

- **Notepad:** On Windows machine, you can use any simple text editor like Notepad (Recommended for this tutorial), TextPad.
- **Netbeans:**Is a Java IDE that is open-source and free which can be downloaded fromhttp://www.netbeans.org/index.html.
- **Eclipse:** Is also a Java IDE developed by the eclipse open-source community and can be downloaded from http://www.eclipse.org/.

What is Next?

Next chapter will teach you how to write and run your first Java program and some of the important basic syntaxes in Java needed for developing applications.

CHAPTER

3

Java Basic Syntax

When we consider a Java program, it can be defined as a collection of objects that communicate via invoking each other's methods. Let us now briefly look into what do class, object, methods and instance variables mean.

- **Object -** Objects have states and behaviors. Example: A dog has states-color, name, breed as well as behaviors -wagging, barking, eating. An object is an instance of a class.
- **Class -** A class can be defined as a template/blue print that describes the behaviors/states that object of its type support.
- **Methods -** A method is basically a behavior. A class can contain many methods. It is in methods where the logics are written, data is manipulated and all the actions are executed.
- **Instance Variables -** Each object has its unique set of instance variables. An object's state is created by the values assigned to these instance variables.

First Java Program:

Let us look at a simple code that would print the words *Hello World*.

```
public class MyFirstJavaProgram{

   /* This is my first java program.
    * This will print 'Hello World' as the output
    */

  public static void main(String[]args){
    System.out.println("Hello World");// prints Hello World
  }
}
```

Let's look at how to save the file, compile and run the program. Please follow the steps given below:

- Open notepad and add the code as above.
- Save the file as: MyFirstJavaProgram.java.
- Open a command prompt window and go o the directory where you saved the class. Assume it's C:\.
- Type ' javac MyFirstJavaProgram.java ' and press enter to compile your code. If there are no errors in your code, the command prompt will take you to the next line(Assumption : The path variable is set).

- Now, type ' java MyFirstJavaProgram ' to run your program.
- You will be able to see ' Hello World ' printed on the window.

```
C :> javac MyFirstJavaProgram.java
C :> java MyFirstJavaProgram
HelloWorld
```

Basic Syntax:

About Java programs, it is very important to keep in mind the following points.

- **Case Sensitivity -** Java is case sensitive, which means identifier **Hello** and **hello** would have different meaning in Java.
- **Class Names -** For all class names, the first letter should be in Upper Case.

  If several words are used to form a name of the class, each inner word's first letter should be in Upper Case.

  Example *class MyFirstJavaClass*
- **Method Names -** All method names should start with a Lower Case letter.

  If several words are used to form the name of the method, then each inner word's first letter should be in Upper Case.

  Example *public void myMethodName()*
- **Program File Name -** Name of the program file should exactly match the class name.

  When saving the file, you should save it using the class name (Remember Java is case sensitive) and append '.java' to the end of the name (if the file name and the class name do not match your program will not compile).

  Example : Assume 'MyFirstJavaProgram' is the class name, then the file should be saved as*'MyFirstJavaProgram.java'*
- **public static void main(String args[]) -** Java program processing starts from the main() method, which is a mandatory part of every Java program.

Java Identifiers:

All Java components require names. Names used for classes, variables and methods are called identifiers.

In Java, there are several points to remember about identifiers. They are as follows:

- All identifiers should begin with a letter (A to Z or a to z), currency character ($) or an underscore (_).
- After the first character, identifiers can have any combination of characters.
- A keyword cannot be used as an identifier.
- Most importantly identifiers are case sensitive.
- Examples of legal identifiers:age, $salary, _value, __1_value
- Examples of illegal identifiers: 123abc, -salary

Java Modifiers:

Like other languages, it is possible to modify classes, methods, etc., by using modifiers. There are two categories of modifiers:

- **Access Modifiers:** default, public, protected, private
- **Non-access Modifiers:** final, abstract, strictfp

We will be looking into more details about modifiers in the next section.

Java Variables:

We would see following type of variables in Java:

- Local Variables
- Class Variables (Static Variables)
- Instance Variables (Non-static variables)

Java Arrays:

Arrays are objects that store multiple variables of the same type. However, an array itself is an object on the heap. We will look into how to declare, construct and initialize in the upcoming chapters.

Java Enums:

Enums were introduced in java 5.0. Enums restrict a variable to have one of only a few predefined values. The values in this enumerated list are called enums.

With the use of enums, it is possible to reduce the number of bugs in your code.

For example, if we consider an application for a fresh juice shop, it would be possible to restrict the glass size to small, medium and large. This would make sure that it would not allow anyone to order any size other than the small, medium or large.

Example:

```
Class FreshJuice {

enum FreshJuiceSize{ SMALL, MEDUIM, LARGE }
   FreshJuiceSize size;
}

public class FreshJuiceTest {

  public static void main(String args[]) {
    FreshJuice juice =newFreshJuice();
    juice.size =FreshJuice.FreshJuiceSize.MEDUIM ;
  }
}
```

Note: enums can be declared as their own or inside a class. Methods, variables, constructors can be defined inside enums as well.

Java Keywords:

The following list shows the reserved words in Java. These reserved words may not be used as constant or variable or any other identifier names.

abstract	assert	boolean	break
byte	case	catch	char
class	const	continue	default
do	double	else	enum
extends	final	finally	float
for	goto	if	implements
import	instanceof	int	interface
long	native	new	package
private	protected	public	return
short	static	strictfp	super
switch	synchronized	this	throw
throws	transient	try	void
volatile	while		

Comments in Java

Java supports single-line and multi-line comments very similar to c and c++. All characters available inside any comment are ignored by Java compiler.

```
public class MyFirstJavaProgram {

   /* This is my first java program.
    * This will print 'Hello World' as the output
    * This is an example of multi-line comments.
    */

   public static void main(String[]args) {
     // This is an example of single line comment
     /* This is also an example of single line comment. */
     System.out.println("Hello World");
   }
}
```

Using Blank Lines:

A line containing only whitespace, possibly with a comment, is known as a blank line, and Java totally ignores it.

Inheritance:

Java classes can be derived from classes. Basically, if you need to create a new class and here is already a class that has some of the code you require, then it is possible to derive your new class from the already existing code.

This concept allows you to reuse the fields and methods of the existing class without having to rewrite the code in a new class. In this scenario, the existing class is called the superclass and the derived class is called the subclass.

Interfaces:

In Java language, an interface can be defined as a contract between objects on how to communicate with each other. Interfaces play a vital role when it comes to the concept of inheritance.

An interface defines the methods, a deriving class(subclass) should use. But the implementation of the methods is totally up to the subclass.

What is Next?

The next section explains about Objects and classes in Java programming. At the end of the session, you will be able to get a clear picture as to what are objects and what are classes in Java.

CHAPTER

4

Java Object & Classes

Java is an Object-Oriented Language. As a language that has the Object Oriented feature, Java supports the following fundamental concepts:

- Polymorphism
- Inheritance
- Encapsulation
- Abstraction
- Classes
- Objects
- Instance
- Method
- Message Parsing

In this chapter, we will look into the concepts Classes and Objects.

- **Object -** Objects have states and behaviors. Example: A dog has states-color, name, breed as well as behaviors -wagging, barking, eating. An object is an instance of a class.
- **Class -** A class can be defined as a template/blue print that describes the behaviors/states that object of its type support.

Objects in Java:

Let us now look deep into what are objects. If we consider the real-world we can find many objects around us, Cars, Dogs, Humans, etc. All these objects have a state and behavior.

If we consider a dog, then its state is - name, breed, color, and the behavior is - barking, wagging, running

If you compare the software object with a real world object, they have very similar characteristics.

Software objects also have a state and behavior. A software object's state is stored in fields and behavior is shown via methods.

So in software development, methods operate on the internal state of an object and the object-to-object communication is done via methods.

Classes in Java:

A class is a blue print from which individual objects are created.

A sample of a class is given below:

```
public class Dog {
  String breed;
  int age;
  String color;

  void barking() {
  }

  void hungry() {
  }

  void sleeping() {
  }
}
```

A class can contain any of the following variable types.

- **Local variables:** Variables defined inside methods, constructors or blocks are called local variables. The variable will be declared and initialized within the method and the variable will be destroyed when the method has completed.
- **Instance variables:** Instance variables are variables within a class but outside any method. These variables are instantiated when the class is loaded. Instance variables can be accessed from inside any method, constructor or blocks of that particular class.
- **Class variables:** Class variables are variables declared within a class, outside any method, with the static keyword.

A class can have any number of methods to access the value of various kinds of methods. In the above example, barking(), hungry() and sleeping() are methods.

Below mentioned are some of the important topics that need to be discussed when looking into classes of the Java Language.

Constructors:

When discussing about classes, one of the most important subtopic would be constructors. Every class has a constructor. If we do not explicitly write a constructor for a class the Java compiler builds a default constructor for that class.

Each time a new object is created, at least one constructor will be invoked. The main rule of constructors is that they should have the same name as the class. A class can have more than one constructor.

Example of a constructor is given below:

```
public class Puppy {
  public puppy(){
  }

  public puppy(String name) {
    // This constructor has one parameter, name.
  }
}
```

Java also supports Singleton Classes where you would be able to create only one instance of a class.

Singleton Classes

The Singleton's purpose is to control object creation, limiting the number to one but allowing the flexibility to create more objects if the situation changes.

Since there is only one Singleton instance, any instance fields of a Singleton will occur only once per class, just like static fields. Singletons often control access to resources such as database connections or sockets.

For example, if you have a license for only one connection for your database or your JDBC driver has trouble with multithreading, the Singleton makes sure that only one connection is made or that only one thread can access the connection at a time.

Implementing Singletons:

Example 1:

The easiest implementation consists of a private constructor and a field to hold its result, and a static accessor method with a name like getInstance().

The private field can be assigned from within a static initializer block or, more simply, using an initializer. The getInstance( ) method (which must be public) then simply returns this instance:

```
// File Name: Singleton.java
public class Singleton {

   private static Singleton singleton = new Singleton( );

   /* A private Constructor prevents any other
    * class from instantiating.
    */
   private Singleton(){ }

   /* Static 'instance' method */
   public static Singleton getInstance( ) {
      return singleton;
   }
   /* Other methods protected by singleton-ness */
   protected static void demoMethod( ) {
      System.out.println("demoMethod for singleton");
   }
}

// File Name: SingletonDemo.java
public class SingletonDemo {
   public static void main(String[] args) {
      Singleton tmp = Singleton.getInstance( );
      tmp.demoMethod( );
   }
}
```

This would produce the following result:

```
demoMethod for singleton
```

Example 2:

Following implementation shows a classic Singleton design pattern:

```
public class ClassicSingleton {

   private static ClassicSingleton instance = null;
   protected ClassicSingleton() {
      // Exists only to defeat instantiation.
   }
   public static ClassicSingleton getInstance() {
      if(instance == null) {
         instance = new ClassicSingleton();
      }
      return instance;
   }
}
```

The ClassicSingleton class maintains a static reference to the lone singleton instance and returns that reference from the static getInstance() method.

Here ClassicSingleton class employs a technique known as lazy instantiation to create the singleton; as a result, the singleton instance is not created until the getInstance() method is called for the first time. This technique ensures that singleton instances are created only when needed.

Creating an Object:

As mentioned previously, a class provides the blueprints for objects. So basically an object is created from a class. In Java the new keyword is used to create new objects.

There are three steps when creating an object from a class:

- **Declaration:** A variable declaration with a variable name with an object type.
- **Instantiation:** The 'new' keyword is used to create the object.
- **Initialization:** The 'new' keyword is followed by a call to a constructor. This call initializes the new object.

Example of creating an object is given below:

```
public class Puppy {

  publicPuppy(String name) {
    // This constructor has one parameter, name.
    System.out.println("Passed Name is :"+ name );
  }
  public static void main(String[]args) {
    // Following statement would create an object myPuppy
    Puppy myPuppy =newPuppy("tommy");
  }
}
```

If we compile and run the above program, then it would produce the following result:

```
PassedName is:tommy
```

Accessing Instance Variables and Methods:

Instance variables and methods are accessed via created objects. To access an instance variable the fully qualified path should be as follows:

```
/* First create an object */
ObjectReference = new Constructor();

/* Now call a variable as follows */
ObjectReference.variableName;

/* Now you can call a class method as follows */
ObjectReference.MethodName();
```

Example:

This example explains how to access instance variables and methods of a class:

```
public class Puppy{

  int puppyAge;

  public Puppy(String name){
    // This constructor has one parameter, name.
    System.out.println("Passed Name is :"+ name );
  }
  publicvoid setAge(int age ){
    puppyAge = age;
  }

  publicint getAge(){
    System.out.println("Puppy's age is :"+ puppyAge );
    return puppyAge;
  }
  public static void main(String[]args){
    /* Object creation */
    Puppy myPuppy =newPuppy("tommy");

    /* Call class method to set puppy's age */
    myPuppy.setAge(2);

    /* Call another class method to get puppy's age */
    myPuppy.getAge();

    /* You can access instance variable as follows as well */
    System.out.println("Variable Value :"+ myPuppy.puppyAge );
  }
}
```

If we compile and run the above program, then it would produce the following result:

```
PassedName is:tommy
Puppy's age is :2
Variable Value :2
```

Source file declaration rules:

As the last part of this section, let's now look into the source file declaration rules. These rules are essential when declaring classes, *import* statements and *package* statements in a source file.

- There can be only one public class per source file.
- A source file can have multiple non public classes.

- The public class name should be the name of the source file as well which should be appended by **.java** at the end. For example : The class name is . *public class Employee{}* Then the source file should be as Employee.java.

- If the class is defined inside a package, then the package statement should be the first statement in the source file.

- If import statements are present then they must be written between the package statement and the class declaration. If there are no package statements then the import statement should be the first line in the source file.

- Import and package statements will imply to all the classes present in the source file. It is not possible to declare different import and/or package statements to different classes in the source file.

Classes have several access levels and there are different types of classes; abstract classes, final classes, etc. I will be explaining about all these in the access modifiers chapter.

Apart from the above mentioned types of classes, Java also has some special classes called Inner classes and Anonymous classes.

Java Package:

In simple, it is a way of categorizing the classes and interfaces. When developing applications in Java, hundreds of classes and interfaces will be written, therefore categorizing these classes is a must as well as makes life much easier.

Import statements:

In Java if a fully qualified name, which includes the package and the class name, is given, then the compiler can easily locate the source code or classes. Import statement is a way of giving the proper location for the compiler to find that particular class.

For example,the following line would ask compiler to load all the classes available in directory java_installation/java/io

```
import java.io.*;
```

A Simple Case Study:

For our case study, we will be creating two classes. They are Employee and EmployeeTest.

First open notepad and add the following code. Remember this is the Employee class and the class is a public class. Now, save this source file with the name Employee.java.

The Employee class has four instance variables name, age, designation and salary. The class has one explicitly defined constructor, which takes a parameter.

```
import java.io.*;
public class Employee {
  String name;
  int age;
  String designation;
  double salary;

  // This is the constructor of the class Employee
  public Employee(String name) {
    this.name = name;
```

```
  }
  // Assign the age of the Employee  to the variable age.
  public void empAge(int empAge){
    age =  empAge;
  }
  /* Assign the designation to the variable designation.*/
  public void empDesignation(String empDesig){
    designation = empDesig;
  }
  /* Assign the salary to the variable salary.*/
  public void empSalary(double empSalary){
      salary = empSalary;
  }
  /* Print the Employee details */
  publicvoid printEmployee(){
    System.out.println("Name:"+ name );
    System.out.println("Age:"+ age );
    System.out.println("Designation:"+ designation );
    System.out.println("Salary:"+ salary);
  }
}
```

As mentioned previously in this tutorial, processing starts from the main method. Therefore in-order for us to run this Employee class there should be main method and objects should be created. We will be creating a separate class for these tasks.

Given below is the *EmployeeTest* class, which creates two instances of the class Employee and invokes the methods for each object to assign values for each variable.

Save the following code in EmployeeTest.java file

```
import java.io.*;
public class EmployeeTest{

  public static void main(String args[]){
    /* Create two objects using constructor */
    Employee empOne =newEmployee("James Smith");
    Employee empTwo =newEmployee("Mary Anne");

    // Invoking methods for each object created
    empOne.empAge(26);
    empOne.empDesignation("Senior Software Engineer");
    empOne.empSalary(1000);
    empOne.printEmployee();

    empTwo.empAge(21);
    empTwo.empDesignation("Software Engineer");
    empTwo.empSalary(500);
    empTwo.printEmployee();
  }
}
```

Now, compile both the classes and then run *EmployeeTest* to see the result as follows:

```
C :> javac Employee.java
C :> vi EmployeeTest.java
C :> javac  EmployeeTest.java
C :> java EmployeeTest
Name:JamesSmith
Age:26
Designation:SeniorSoftwareEngineer
Salary:1000.0
```

```
Name:MaryAnne
Age:21
Designation:SoftwareEngineer
Salary:500.0
```

What is Next?

Next session will discuss basic data types in Java and how they can be used when developing Java applications.

CHAPTER

5

Java Basic Data Types

Variables are nothing but reserved memory locations to store values. This means that when you create a variable you reserve some space in memory.

Based on the data type of a variable, the operating system allocates memory and decides what can be stored in the reserved memory. Therefore, by assigning different data types to variables, you can store integers, decimals, or characters in these variables.

There are two data types available in Java:

- Primitive Data Types
- Reference/Object Data Types

Primitive Data Types:

There are eight primitive data types supported by Java. Primitive data types are predefined by the language and named by a keyword. Let us now look into detail about the eight primitive data types.

byte:

- Byte data type is an 8-bit signed two's complement integer.
- Minimum value is -128 (-2^7)
- Maximum value is 127 (inclusive)(2^7 -1)
- Default value is 0
- Byte data type is used to save space in large arrays, mainly in place of integers, since a byte is four times smaller than an int.
- Example: byte a = 100, byte b = -50

short:

- Short data type is a 16-bit signed two's complement integer.

- Minimum value is -32,768 (-2^15)
- Maximum value is 32,767(inclusive) (2^15 -1)
- Short data type can also be used to save memory as byte data type. A short is 2 times smaller than an int
- Default value is 0.
- Example: short s= 10000, short r = -20000

int:

- int data type is a 32-bit signed two's complement integer.
- Minimum value is - 2,147,483,648.(-2^31)
- Maximum value is 2,147,483,647(inclusive).(2^31 -1)
- Int is generally used as the default data type for integral values unless there is a concern about memory.
- The default value is 0.
- Example: int a = 100000, int b = -200000

long:

- Long data type is a 64-bit signed two's complement integer.
- Minimum value is -9,223,372,036,854,775,808.(-2^63)
- Maximum value is 9,223,372,036,854,775,807 (inclusive). (2^63 -1)
- This type is used when a wider range than int is needed.
- Default value is 0L.
- Example: int a = 100000L, int b = -200000L

float:

- Float data type is a single-precision 32-bit IEEE 754 floating point.
- Float is mainly used to save memory in large arrays of floating point numbers.
- Default value is 0.0f.
- Float data type is never used for precise values such as currency.
- Example: float f1 = 234.5f

double:

- double data type is a double-precision 64-bit IEEE 754 floating point.
- This data type is generally used as the default data type for decimal values, generally the default choice.
- Double data type should never be used for precise values such as currency.
- Default value is 0.0d.
- Example: double d1 = 123.4

boolean:

- boolean data type represents one bit of information.
- There are only two possible values: true and false.
- This data type is used for simple flags that track true/false conditions.
- Default value is false.
- Example: boolean one = true

char:

- char data type is a single 16-bit Unicode character.
- Minimum value is '\u0000' (or 0).
- Maximum value is '\uffff' (or 65,535 inclusive).
- Char data type is used to store any character.
- Example: char letterA ='A'

Reference Data Types:

- Reference variables are created using defined constructors of the classes. They are used to access objects. These variables are declared to be of a specific type that cannot be changed. For example, Employee, Puppy, etc.
- Class objects and various types of array variables come under reference data type.
- Default value of any reference variable is null.
- A reference variable can be used to refer to any object of the declared type or any compatible type.
- Example: Animal animal = new Animal("giraffe");

Java Literals:

A literal is a source code representation of a fixed value. They are represented directly in the code without any computation.

Literals can be assigned to any primitive type variable. For example:

```
byte a =68;
char a ='A'
```

byte, int, long, and short can be expressed in decimal(base 10),hexadecimal(base 16) or octal(base 8) number systems as well.

Prefix 0 is used to indicate octal and prefix 0x indicates hexadecimal when using these number systems for literals. For example:

```
int decimal=100;
int octal =0144;
int hexa =0x64;
```

String literals in Java are specified like they are in most other languages by enclosing a sequence of characters between a pair of double quotes. Examples of string literals are:

```
"Hello World"
"two\nlines"
"\"This is in quotes\""
```

String and char types of literals can contain any Unicode characters. For example:

```
char a ='\u0001';
String a ="\u0001";
```

Java language supports few special escape sequences for String and char literals as well. They are:

Notation	Character represented
\n	Newline (0x0a)
\r	Carriage return (0x0d)
\f	Formfeed (0x0c)
\b	Backspace (0x08)
\s	Space (0x20)
\t	Tab
\"	Double quote
\'	Single quote
\\	Backslash
\ddd	Octal character (ddd)
\uxxxx	Hexadecimal UNICODE character (xxxx)

What is Next?

This chapter explained you various data types, next topic explains different variable types and their usage. This will give you a good understanding about how they can be used in the Java classes, interfaces, etc.

CHAPTER

6

Java Variable Types

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 datatypes. The *identifier* is the name of the variable. 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, initializing
// d and f.
byte z =22;// initializes z.
double pi =3.14159;// declares an approximation of pi.
char x ='x';// the variable x has the value 'x'.
```

This chapter will explain various variable types available in Java Language. There are three kinds of variables in Java:

- Local variables
- Instance variables
- Class/static variables

Local variables:

- Local variables are declared in methods, constructors, or blocks.
- Local variables are created when the method, constructor or block is entered and the variable will be destroyed once it exits the method, constructor or block..
- Access modifiers cannot be used for local variables.
- Local variables are visible only within the declared method, constructor or block.

- Local variables are implemented at stack level internally.
- There is no default value for local variables so local variables should be declared and an initial value should be assigned before the first use.

Example:

Here, *age* is a local variable. This is defined inside *pupAge()* method and its scope is limited to this method only.

```
public class Test{
  public void pupAge(){
    int age =0;
    age = age +7;
    System.out.println("Puppy age is : "+ age);
  }

  public static void main(String args[]){
    Test test =newTest();
    test.pupAge();
  }
}
```

This would produce the following result:

```
Puppy age is:7
```

Example:

Following example uses *age* without initializing it, so it would give an error at the time of compilation.

```
public classTest{
  public void pupAge(){
    int age;
    age = age +7;
    System.out.println("Puppy age is : "+ age);
  }

  public static void main(String args[]){
    Test test =newTest();
    test.pupAge();
  }
}
```

This would produce the following error while compiling it:

```
Test.java:4:variable number might not have been initialized
age = age +7;
^
1 error
```

Instance variables:

- Instance variables are declared in a class, but outside a method, constructor or any block.
- When a space is allocated for an object in the heap, a slot for each instance variable value is created.

- Instance variables are created when an object is created with the use of the keyword 'new' and destroyed when the object is destroyed.
- Instance variables hold values that must be referenced by more than one method, constructor or block, or essential parts of an object's state that must be present throughout the class.
- Instance variables can be declared in class level before or after use.
- Access modifiers can be given for instance variables.
- The instance variables are visible for all methods, constructors and block in the class. Normally, it is recommended to make these variables private (access level).However visibility for subclasses can be given for these variables with the use of access modifiers.
- Instance variables have default values. For numbers, the default value is 0; for Booleans, it is false; and for object references, it is null. Values can be assigned during the declaration or within the constructor.
- Instance variables can be accessed directly by calling the variable name inside the class. However within static methods and different class (when instance variables are given accessibility) should be called using the fully qualified name *.ObjectReference.VariableName*.

Example:

```
import java.io.*;

public class Employee{
  // this instance variable is visible for any child class.
  public String name;

  // salary  variable is visible in Employee class only.
  private double salary;

  // The name variable is assigned in the constructor.
  public Employee(String empName){
    name = empName;
  }

  // The salary variable is assigned a value.
  public void setSalary(double empSal){
    salary = empSal;
  }

  // This method prints the employee details.
  public void printEmp(){
    System.out.println("name  : "+ name );
    System.out.println("salary :"+ salary);
  }

  public static void main(String args[]){
     Employee empOne = new Employee("Ransika");
     empOne.setSalary(1000);
     empOne.printEmp();
  }
}
```

This would produce the following result:

```
name  :Ransika
```

```
salary :1000.0
```

Class/static variables:

- Class variables also known as static variables are declared with the *static* keyword in a class, but outside a method, constructor or a block.
- There would only be one copy of each class variable per class, regardless of how many objects are created from it.
- Static variables are rarely used other than being declared as constants. Constants are variables that are declared as public/private, final and static. Constant variables never change from their initial value.
- Static variables are stored in static memory. It is rare to use static variables other than declared final and used as either public or private constants.
- Static variables are created when the program starts and destroyed when the program stops.
- Visibility is similar to instance variables. However, most static variables are declared public since they must be available for users of the class.
- Default values are same as instance variables. For numbers, the default value is 0; for Booleans, it is false; and for object references, it is null. Values can be assigned during the declaration or within the constructor. Additionally values can be assigned in special static initializer blocks.
- Static variables can be accessed by calling with the class name . *ClassName.VariableName*.
- When declaring class variables as public static final, then variables names (constants) are all in upper case. If the static variables are not public and final the naming syntax is the same as instance and local variables.

Example:

```
import java.io.*;

public class Employee{
  // salary variable is a private static variable
  private static double salary;

  // DEPARTMENT is a constant
  public static final String DEPARTMENT ="Development ";

  public static void main(String args[]){
    salary =1000;
    System.out.println(DEPARTMENT+"average salary:"+salary);
  }
}
```

This would produce the following result:

```
Development average salary:1000
```

Note: If the variables are access from an outside class the constant should be accessed as Employee.DEPARTMENT

What is Next?

You already have used access modifiers (public & private) in this chapter. The next chapter will explain you Access Modifiers and NonAccess Modifiers in detail.

CHAPTER

7

Java Modifier Types

Modifiers arekeywords that you add to those definitions to change their meanings. The Java language has a wide variety of modifiers, including the following:

1. Java Access Modifiers

Java provides a number of access modifiers to set access levels for classes, variables, methods and constructors. The four access levels are:

- Visible to the package, the default. No modifiers are needed.
- Visible to the class only (private).
- Visible to the world (public).
- Visible to the package and all subclasses (protected).

Default Access Modifier - No keyword:

Default access modifier means we do not explicitly declare an access modifier for a class, field, method, etc.

A variable or method declared without any access control modifier is available to any other class in the same package. The fields in an interface are implicitly public static final and the methods in an interface are by default public

Example:

Variables and methods can be declared without any modifiers, as in the following examples:

```
String version ="1.5.1";

boolean processOrder(){
  return true;
}
```

Private Access Modifier - private:

Methods, Variables and Constructors that are declared private can only be accessed within the declared class itself.

Private access modifier is the most restrictive access level. Class and interfaces cannot be private.

Variables that are declared private can be accessed outside the class if public getter methods are present in the class.

Using the private modifier is the main way that an object encapsulates itself and hide data from the outside world.

Example:

The following class uses private access control:

```
public classLogger{
  private String format;
  public String getFormat(){
    return this.format;
  }
  public void setFormat(String format){
    this.format = format;
  }
}
```

Here, the *format* variable of the Logger class is private, so there's no way for other classes to retrieve or set its value directly.

So to make this variable available to the outside world, we defined two public methods: *getFormat()*, which returns the value of format, and *setFormat(String)*, which sets its value.

Public Access Modifier - public:

A class, method, constructor, interface etc declared public can be accessed from any other class. Therefore fields, methods, blocks declared inside a public class can be accessed from any class belonging to the Java Universe.

However if the public class we are trying to access is in a different package, then the public class still need to be imported.

Because of class inheritance, all public methods and variables of a class are inherited by its subclasses.

Example:

The following function uses public access control:

```
public static void main(String[] arguments){
  // ...
}
```

The main() method of an application has to be public. Otherwise, it could not be called by a Java interpreter (such as java) to run the class.

Protected Access Modifier - protected:

Variables, methods and constructors which are declared protected in a superclass can be accessed only by the subclasses in other package or any class within the package of the protected members' class.

The protected access modifier cannot be applied to class and interfaces. Methods, fields can be declared protected, however methods and fields in a interface cannot be declared protected.

Protected access gives the subclass a chance to use the helper method or variable, while preventing a nonrelated class from trying to use it.

Example:

The following parent class uses protected access control, to allow its child class override*openSpeaker()* method:

```
class AudioPlayer{
  protected boolean openSpeaker(Speaker sp){
    // implementation details
  }
}

class StreamingAudioPlayer{
  boolean openSpeaker(Speaker sp){
    // implementation details
  }
}
```

Here, if we define *openSpeaker()* method as private, then it would not be accessible from any other class other than *AudioPlayer*. If we define it as public, then it would become accessible to all the outside world. But our intension is to expose this method to its subclass only, thats why we used*protected* modifier.

Access Control and Inheritance:

The following rules for inherited methods are enforced:

- Methods declared public in a superclass also must be public in all subclasses.
- Methods declared protected in a superclass must either be protected or public in subclasses; they cannot be private.
- Methods declared without access control (no modifier was used) can be declared more private in subclasses.
- Methods declared private are not inherited at all, so there is no rule for them.

2. Non Access Modifiers

To use a modifier, you include its keyword in the definition of a class, method, or variable. The modifier precedes the rest of the statement, as in the following examples (Italic ones):

```
public class className {
  // ...
}
private boolean myFlag;
static final double weeks =9.5;
protected static final int BOXWIDTH =42;
public static void main(String[] arguments){
  // body of method
}
```

Access Control Modifiers:

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Non Access Modifiers:

Java provides a number of non-access modifiers to achieve many other functionality.

- The *static* modifier for creating class methods and variables
- The *final* modifier for finalizing the implementations of classes, methods, and variables.
- The *abstract* modifier for creating abstract classes and methods.
- The *synchronized* and *volatile* modifiers, which are used for threads.

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   // ...
}
private boolean myFlag;
static final double weeks =9.5;
protected static final int BOXWIDTH =42;
public static void main(String[] arguments){
   // body of method
}
```

Access Control Modifiers:

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Non Access Modifiers:

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- The *abstract* modifier for creating abstract classes and methods.

- The *synchronized* and *volatile* modifiers, which are used for threads.

What is Next?

In the next section, I will be discussing about Basic Operators used in the Java Language. The chapter will give you an overview of how these operators can be used during application development.

CHAPTER

8

Java Basic Operators

Java provides a rich set of operators to manipulate variables. We can divide all the Java operators into the following groups:

- Arithmetic Operators
- Relational Operators
- Bitwise Operators
- Logical Operators
- Assignment Operators
- Misc Operators

The Arithmetic Operators:

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

Assume integer variable A holds 10 and variable B holds 20, then:

Operator	Description	Example
+	Addition - Adds values on either side of the operator	A + B will give 30
-	Subtraction - Subtracts right hand operand from left hand operand	A - B will give -10
*	Multiplication - Multiplies values on either side of the operator	A * B will give 200
/	Division - Divides left hand operand by right hand operand	B / A will give 2
%	Modulus - Divides left hand operand by right hand operand and returns remainder	B % A will give 0
++	Increment - Increases the value of operand by 1	B++ gives 21
--	Decrement - Decreases the value of operand by 1	B-- gives 19

Example

The following simple example program demonstrates the arithmetic operators. Copy and paste the following Java program in Test.java file and compile and run this program:

```
public class Test{

  public static void main(String args[]){
    int a =10;
    int b =20;
    int c =25;
    int d =25;
    System.out.println("a + b = "+(a + b));
    System.out.println("a - b = "+(a - b));
    System.out.println("a * b = "+(a * b));
    System.out.println("b / a = "+(b / a));
    System.out.println("b % a = "+(b % a));
    System.out.println("c % a = "+(c % a));
    System.out.println("a++   = "+(a++));
    System.out.println("b--   = "+(a--));
    // Check the difference in d++ and ++d
    System.out.println("d++   = "+(d++));
    System.out.println("++d   = "+(++d));
 }
}
```

This would produce the following result:

```
a + b =30
a - b =-10
a * b =200
b / a =2
b % a =0
c % a =5
a++=10
b--=11
d++=25
++d   =27
```

The Relational Operators:

There are following relational operators supported by Java language:

Assume variable A holds 10 and variable B holds 20, then:

Operator	Description	Example
==	Checks if the values of two operands are equal or not, if yes then condition becomes true.	(A == B) is not true.
!=	Checks if the values of two operands are equal or not, if values are not equal then condition becomes true.	(A != B) is true.
>	Checks if the value of left operand is greater than the value of right operand, if yes then condition becomes true.	(A > B) is not true.
<	Checks if the value of left operand is less than the value of right operand, if yes then condition becomes true.	(A < B) is true.
>=	Checks if the value of left operand is greater than or equal to the value of right operand, if yes then condition becomes true.	(A >= B) is not true.

<=	Checks if the value of left operand is less than or equal to the value of right operand, if yes then condition becomes true.	(A <= B) is true.

Example

The following simple example program demonstrates the relational operators. Copy and paste the following Java program in Test.java file and compile and run this program. :

```
public class Test{

  public static void main(String args[]){
    int a =10;
    int b =20;
    System.out.println("a == b = "+(a == b));
    System.out.println("a != b = "+(a != b));
    System.out.println("a > b = "+(a > b));
    System.out.println("a < b = "+(a < b));
    System.out.println("b >= a = "+(b >= a));
    System.out.println("b <= a = "+(b <= a));
  }
}
```

This would produce the following result:

```
a == b =false
a != b =true
a > b =false
a < b =true
b >= a =true
b <= a =false
```

The Bitwise Operators:

Java defines several bitwise operators, which can be applied to the integer types, long, int, short, char, and byte.

Bitwise operator works on bits and performsbit-by-bit operation. Assume if a = 60; and b = 13; now in binary format they will be as follows:

a = 0011 1100

b = 0000 1101

---

a&b = 0000 1100

a|b = 0011 1101

a^b = 0011 0001

~a = 1100 0011

The following table lists the bitwise operators:

Assume integer variable A holds 60 and variable B holds 13, then:

Operator	Description	Example
&	Binary AND Operator copies a bit to the result if it exists in both operands.	(A & B) will give 12 which is 0000 1100
|	Binary OR Operator copies a bit if it exists in either operand.	(A | B) will give 61 which is 0011 1101
^	Binary XOR Operator copies the bit if it is set in one operand but not both.	(A ^ B) will give 49 which is 0011 0001
~	Binary Ones Complement Operator is unary and has the effect of 'flipping' bits.	(~A) will give -60 which is 1100 0011
<<	Binary Left Shift Operator. The left operands value is moved left by the number of bits specified by the right operand.	A << 2 will give 240 which is 1111 0000
>>	Binary Right Shift Operator. The left operands value is moved right by the number of bits specified by the right operand.	A >> 2 will give 15 which is 1111
>>>	Shift right zero fill operator. The left operands value is moved right by the number of bits specified by the right operand and shifted values are filled up with zeros.	A >>>2 will give 15 which is 0000 1111

Example

The following simple example program demonstrates the bitwise operators. Copy and paste the following Java program in Test.java file and compile and run this program:

```
public class Test{

  public static void main(String args[]){
    int a =60;   /* 60 = 0011 1100 */
    int b =13;   /* 13 = 0000 1101 */
    int c =0;

     c = a & b;/* 12 = 0000 1100 */
     System.out.println("a & b = "+ c );

     c = a | b;/* 61 = 0011 1101 */
     System.out.println("a | b = "+ c );

     c = a ^ b;/* 49 = 0011 0001 */
     System.out.println("a ^ b = "+ c );

     c =~a;/*-61 = 1100 0011 */
     System.out.println("~a = "+ c );

     c = a <<2;/* 240 = 1111 0000 */
     System.out.println("a << 2 = "+ c );

     c = a >>2;/* 215 = 1111 */
     System.out.println("a >> 2  = "+ c );

     c = a >>>2;/* 215 = 0000 1111 */
     System.out.println("a >>> 2 = "+ c );
  }
}
```

This would produce the following result:

```
a & b =12
a | b =61
a ^ b =49
~a =-61
a <<2=240
a >>15
a >>>15
```

The Logical Operators:

The following table lists the logical operators:

Assume Boolean variables A holds true and variable B holds false, then:

Operator	Description	Example
&&	Called Logical AND operator. If both the operands are non-zero, then the condition becomes true.	(A && B) is false.
||	Called Logical OR Operator. If any of the two operands are non-zero, then the condition becomes true.	(A || B) is true.
!	Called Logical NOT Operator. Use to reverses the logical state of its operand. If a condition is true then Logical NOT operator will make false.	!(A && B) is true.

Example

The following simple example program demonstrates the logical operators. Copy and paste the following Java program in Test.java file and compile and run this program:

```
public class Test{

  public static void main(String args[]){
    boolean a = true;
    boolean b = false;

    System.out.println("a && b = "+(a&&b));

    System.out.println("a || b = "+(a||b));

    System.out.println("!(a && b) = "+!(a && b));
  }
}
```

This would produce the following result:

```
a && b = false
a || b = true
!(a && b)= true
```

The Assignment Operators:

There are following assignment operators supported by Java language:

Operator	Description	Example

=	Simple assignment operator, Assigns values from right side operands to left side operand	C = A + B will assign value of A + B into C
+=	Add AND assignment operator, It adds right operand to the left operand and assign the result to left operand	C += A is equivalent to C = C + A
-=	Subtract AND assignment operator, It subtracts right operand from the left operand and assign the result to left operand	C -= A is equivalent to C = C - A
*=	Multiply AND assignment operator, It multiplies right operand with the left operand and assign the result to left operand	C *= A is equivalent to C = C * A
/=	Divide AND assignment operator, It divides left operand with the right operand and assign the result to left operand	C /= A is equivalent to C = C / A
%=	Modulus AND assignment operator, It takes modulus using two operands and assign the result to left operand	C %= A is equivalent to C = C % A
<<=	Left shift AND assignment operator	C <<= 2 is same as C = C << 2
>>=	Right shift AND assignment operator	C >>= 2 is same as C = C >> 2
&=	Bitwise AND assignment operator	C &= 2 is same as C = C & 2
^=	bitwise exclusive OR and assignment operator	C ^= 2 is same as C = C ^ 2
|=	bitwise inclusive OR and assignment operator	C |= 2 is same as C = C | 2

Example:

The following simple example program demonstrates the assignment operators. Copy and paste the following Java program in Test.java file and compile and run this program:

```
public class Test {

  public static void main(String args[]){
    int a =10;
    int b =20;
    int c =0;

     c = a + b;
     System.out.println("c = a + b = "+ c );

     c += a ;
     System.out.println("c += a  = "+ c );

     c -= a ;
     System.out.println("c -= a = "+ c );

     c *= a ;
     System.out.println("c *= a = "+ c );

     a =10;
     c =15;
     c /= a ;
     System.out.println("c /= a = "+ c );
```

```
      a =10;
      c =15;
      c %= a ;
      System.out.println("c %= a  = "+ c );

      c <<=2;
      System.out.println("c <<= 2 = "+ c );

      c >>=2;
      System.out.println("c >>= 2 = "+ c );

      c >>=2;
      System.out.println("c >>= a = "+ c );

      c &= a ;
      System.out.println("c &= 2  = "+ c );

      c ^= a ;
      System.out.println("c ^= a   = "+ c );

      c |= a ;
      System.out.println("c |= a   = "+ c );
   }
}
```

This would produce the following result:

```
c = a + b =30
c += a  =40
c -= a =30
c *= a =300
c /= a =1
c %= a  =5
c <<=2=20
c >>=2=5
c >>=2=1
c &= a  =0
c ^= a   =10
c |= a   =10
```

Misc Operators

There are few other operators supported by Java Language.

Conditional Operator (?:):

Conditional operator is also known as the ternary operator. This operator consists of three operands and is used to evaluate Boolean expressions. The goal of the operator is to decide which value should be assigned to the variable. The operator is written as:

```
variable x =(expression)? value iftrue: value iffalse
```

Following is the example:

```
public class Test{

   public static void main(String args[]){
      int a , b;
```

```
      a =10;
      b =(a ==1)?20:30;
      System.out.println("Value of b is : "+  b );

      b =(a ==10)?20:30;
      System.out.println("Value of b is : "+ b );
   }
}
```

This would produce the following result:

```
Value of b is:30
Value of b is:20
```

instanceOf Operator:

This operator is used only for object reference variables. The operator checks whether the object is of a particular type(class type or interface type). instanceOf operator is wriiten as:

```
(Object reference variable ) instanceOf  (class/interface type)
```

If the object referred by the variable on the left side of the operator passes the IS-A check for the class/interface type on the right side, then the result will be true. Following is the example:

```
String name ='James';
boolean result = name instanceOf String;
// This will return true since name is type of String
```

This operator will still return true if the object being compared is the assignment compatible with the type on the right. Following is one more example:

```
class Vehicle{}

   public class CarextendsVehicle{
      public static void main(String args[]){
      Vehicle a = new Car();
      boolean result =  a instanceofCar;
      System.out.println(result);
   }
}
```

This would produce the following result:

```
true
```

Precedence of Java Operators:

Operator precedence determines the grouping of terms in an expression. This affects how an expression is evaluated. Certain operators have higher precedence than others; for example, the multiplication operator has higher precedence than the addition operator:

For example, x = 7 + 3 * 2; here, x is assigned 13, not 20 because operator * has higher precedence than +, so it first gets multiplied with 3*2 and then adds into 7.

Here, operators with the highest precedence appear at the top of the table, those with the lowest appear at the bottom. Within an expression, higher precedence operators will be evaluated first.

Category	Operator	Associativity
Postfix	() [] . (dot operator)	Left to right
Unary	++ - - ! ~	Right to left
Multiplicative	* / %	Left to right
Additive	+ -	Left to right
Shift	>>>>><<	Left to right
Relational	>>= <<=	Left to right
Equality	== !=	Left to right
Bitwise AND	&	Left to right
Bitwise XOR	^	Left to right
Bitwise OR	|	Left to right
Logical AND	&&	Left to right
Logical OR	||	Left to right
Conditional	?:	Right to left
Assignment	= += -= *= /= %= >>= <<= &= ^= |=	Right to left
Comma	,	Left to right

What is Next?

Next chapter would explain about loop control in Java programming. The chapter will describe various types of loops and how these loops can be used in Java program development and for what purposes they are being used.

CHAPTER

9

Java Loop Control

There may be a situation when we need to execute a block of code several number of times and is often referred to as a loop.

Java has very flexible three looping mechanisms. You can use one of the following three loops:

- while Loop
- do...while Loop
- for Loop

As of Java 5, the *enhanced for loop* was introduced. This is mainly used for Arrays.

The while Loop:

A while loop is a control structure that allows you to repeat a task a certain number of times.

Syntax:

The syntax of a while loop is:

```
while(Boolean_expression)
{
  //Statements
}
```

When executing, if the *boolean_expression* result is true, then the actions inside the loop will be executed. This will continue as long as the expression result is true.
Here, key point of the *while* loop is that the loop might not ever run. When the expression is tested and the result is false, the loop body will be skipped and the first statement after the while loop will be executed.

Example:

```
public class Test{

  public static void main(String args[]){
    int x =10;

    while( x <20){
      System.out.print("value of x : "+ x );
```

```
      x++;
      System.out.print("\n");
    }
  }
}
```

This would produce the following result:

```
value of x :10
value of x :11
value of x :12
value of x :13
value of x :14
value of x :15
value of x :16
value of x :17
value of x :18
value of x :19
```

The do...while Loop:

A do...while loop is similar to a while loop, except that a do...while loop is guaranteed to execute at least one time.

Syntax:

The syntax of a do...while loop is:

```
do
{
  //Statements
}while(Boolean_expression);
```

Notice that the Boolean expression appears at the end of the loop, so the statements in the loop execute once before the Boolean is tested.

If the Boolean expression is true, the flow of control jumps back up to do, and the statements in the loop execute again. This process repeats until the Boolean expression is false.

Example:

```
public class Test{

  public static void main(String args[]){
    int x =10;

    do{
      System.out.print("value of x : "+ x );
      x++;
      System.out.print("\n");
    }while( x <20);
  }
}
```

This would produce the following result:

```
value of x :10
value of x :11
value of x :12
value of x :13
```

```
value of x :14
value of x :15
value of x :16
value of x :17
value of x :18
value of x :19
```

The for Loop:

A for loop is a repetition control structure that allows you to efficiently write a loop that needs to execute a specific number of times.

A for loop is useful when you know how many times a task is to be repeated.

Syntax:

The syntax of a for loop is:

```
for(initialization;Boolean_expression; update)
{
  //Statements
}
```

Here is the flow of control in a for loop:

- The initialization step is executed first, and only once. This step allows you to declare and initialize any loop control variables. You are not required to put a statement here, as long as a semicolon appears.
- Next, the Boolean expression is evaluated. If it is true, the body of the loop is executed. If it is false, the body of the loop does not execute and flow of control jumps to the next statement past the for loop.
- After the body of the for loop executes, the flow of control jumps back up to the update statement. This statement allows you to update any loop control variables. This statement can be left blank, as long as a semicolon appears after the Boolean expression.
- The Boolean expression is now evaluated again. If it is true, the loop executes and the process repeats itself (body of loop, then update step,then Boolean expression). After the Boolean expression is false, the for loop terminates.

Example:

```
public class Test{

  public static void main(String args[]){

    for(int x =10; x <20; x = x+1){
      System.out.print("value of x : "+ x );
      System.out.print("\n");
    }
  }
}
```

This would produce the following result:

```
value of x :10
value of x :11
value of x :12
value of x :13
```

```
value of x :14
value of x :15
value of x :16
value of x :17
value of x :18
value of x :19
```

Enhanced for loop in Java:

As of Java 5, the enhanced for loop was introduced. This is mainly used for Arrays.

Syntax:

The syntax of enhanced for loop is:

```
for(declaration : expression)
{
  //Statements
}
```

- **Declaration**: The newly declared block variable, which is of a type compatible with the elements of the array you are accessing. The variable will be available within the for block and its value would be the same as the current array element.
- **Expression**: This evaluates to the array you need to loop through. The expression can be an array variable or method call that returns an array.

Example:

```
public class Test{

  public static void main(String args[]){
    int[] numbers ={10,20,30,40,50};

    for(int x : numbers ){
      System.out.print(x);
      System.out.print(",");
    }
    System.out.print("\n");
    String[] names ={"James","Larry","Tom","Lacy"};
    for(String name : names ){
      System.out.print( name );
      System.out.print(",");
    }
  }
}
```

This would produce the following result:

```
10,20,30,40,50,
James,Larry,Tom,Lacy,
```

The break Keyword:

The *break* keyword is used to stop the entire loop. The break keyword must be used inside any loop or a switch statement.

The break keyword will stop the execution of the innermost loop and start executing the next line of code after the block.

Syntax:

The syntax of a break is a single statement inside any loop:

```
break;
```

Example:

```
public class Test{

  public static void main(String args[]){
    int[] numbers ={10,20,30,40,50};

    for(int x : numbers){
      if(x ==30){
        break;
      }
      System.out.print( x );
      System.out.print("\n");
    }
  }
}
```

This would produce the following result:

```
10
20
```

The continue Keyword:

The *continue* keyword can be used in any of the loop control structures. It causes the loop to immediately jump to the next iteration of the loop.

- In a for loop, the continue keyword causes flow of control to immediately jump to the update statement.
- In a while loop or do/while loop, flow of control immediately jumps to the Boolean expression.

Syntax:

The syntax of a continue is a single statement inside any loop:

```
continue;
```

Example:

```
public class Test{

  public static void main(String args[]){
    int[] numbers ={10,20,30,40,50};

    for(int x : numbers){
      if( x ==30){
        continue;
      }
      System.out.print( x );
      System.out.print("\n");
```

```
      }
   }
}
```

This would produce the following result:

```
10
20
40
50
```

What is Next?

In the following chapter, we will be learning about decision making statements in Java programming.

CHAPTER

10

Java Decision Making

There are two types of decision making statements in Java. They are:

- if statements
- switch statements

The if Statement:

An if statement consists of a Boolean expression followed by one or more statements.

Syntax:

The syntax of an if statement is:

```
if(Boolean_expression)
{
  //Statements will execute if the Boolean expression is true
}
```

If the Boolean expression evaluates to true, then the block of code inside the if statement will be executed. If not, the first set of code after the end of the if statement(after the closing curly brace) will be executed.

Example:

```
public class Test{

  public static void main(String args[]){
    int x =10;

    if( x <20){
      System.out.print("This is if statement");
    }
  }
}
```

This would produce the following result:

```
This is if statement
```

The if...else Statement:

An if statement can be followed by an optional *else* statement, which executes when the Boolean expression is false.

Syntax:

The syntax of an if...else is:

```
if(Boolean_expression){
  //Executes when the Boolean expression is true
}else{
  //Executes when the Boolean expression is false
}
```

Example:

```
public class Test{

  public static void main(String args[]){
    int x =30;

    if(x <20){
      System.out.print("This is if statement");
    }else{
      System.out.print("This is else statement");
    }
  }
}
```

This would produce the following result:

```
This is else statement
```

The if...else if...else Statement:

An if statement can be followed by an optional *else if...else* statement, which is very useful to test various conditions using single if...else if statement.

When using if, else if , else statements there are few points to keep in mind.

- An if can have zero or one else's and it must come after any else if's.
- An if can have zero to many else if's and they must come before the else.
- Once an else if succeeds, none of the remaining else if's or else's will be tested.

Syntax:

The syntax of an if...else is:

```
if(Boolean_expression1){
  //Executes when the Boolean expression 1 is true
}elseif(Boolean_expression2){
  //Executes when the Boolean expression 2 is true
}elseif(Boolean_expression3){
  //Executes when the Boolean expression 3 is true
}else{
```

```
  //Executes when the none of the above condition is true.
}
```

Example:

```
public class Test{

  public static void main(String args[]){
    int x =30;

    if( x ==10){
       System.out.print("Value of X is 10");
    }elseif( x ==20){
       System.out.print("Value of X is 20");
    }elseif( x ==30){
       System.out.print("Value of X is 30");
    }else{
       System.out.print("This is else statement");
    }
  }
}
```

This would produce the following result:

```
Value of X is30
```

Nested if...else Statement:

It is always legal to nest if-else statements which means you can use one if or else if statement inside another if or else if statement.

Syntax:

The syntax for a nested if...else is as follows:

```
if(Boolean_expression1){
//Executes when the Boolean expression 1 is true
if(Boolean_expression2){
//Executes when the Boolean expression 2 is true
}
}
```

You can nest *else if...else* in the similar way as we have nested *if* statement.

Example:

```
public class Test{

  public static void main(String args[]){
    int x =30;
    int y =10;

    if( x ==30){
      if( y ==10){
        System.out.print("X = 30 and Y = 10");
      }
    }
}
```

This would produce the following result:

```
X =30 and Y =10
```

The switch Statement:

A *switch* statement allows a variable to be tested for equality against a list of values. Each value is called a case, and the variable being switched on is checked for each case.

Syntax:

The syntax of enhanced for loop is:

```
switch(expression){
  case value :
  //Statements
  break;//optional
  case value :
  //Statements
  break;//optional
  //You can have any number of case statements.
  default://Optional
  //Statements
}
```

The following rules apply to a switch statement:

- The variable used in a switch statement can only be a byte, short, int, or char.
- You can have any number of case statements within a switch. Each case is followed by the value to be compared to and a colon.
- The value for a case must be the same data type as the variable in the switch and it must be a constant or a literal.
- When the variable being switched on is equal to a case, the statements following that case will execute until a *break* statement is reached.
- When a *break* statement is reached, the switch terminates, and the flow of control jumps to the next line following the switch statement.
- Not every case needs to contain a break. If no break appears, the flow of control will *fall through*to subsequent cases until a break is reached.
- A *switch* statement can have an optional default case, which must appear at the end of the switch. The default case can be used for performing a task when none of the cases is true. No break is needed in the default case.

Example:

```
public class Test{

  public static void main(String args[]){
    char grade = args[0].charAt(0);

    switch(grade)
    {
      case'A':
         System.out.println("Excellent!");
```

```
         break;
      case'B':
      case'C':
         System.out.println("Well done");
         break;
      case'D':
         System.out.println("You passed");
      case'F':
         System.out.println("Better try again");
         break;
      default:
         System.out.println("Invalid grade");
    }
   System.out.println("Your grade is "+ grade);
  }
}
```

Compile and run above program using various command line arguments. This would produce the following result:

```
$ java Test a
Invalid grade
Your grade is a a
$ java Test A
Excellent!
Your grade is a A
$ java Test C
Welldone
Your grade is a C
$
```

What is Next?

Next chapter discuses about the Number class (in the java.lang package) and its subclasses in Java Language.

We will be looking into some of the situations where you would use instantiations of these classes rather than the primitive data types, as well as classes such as formatting, mathematical functions that you need to know about when working with Numbers.

CHAPTER

11

Java Numbers

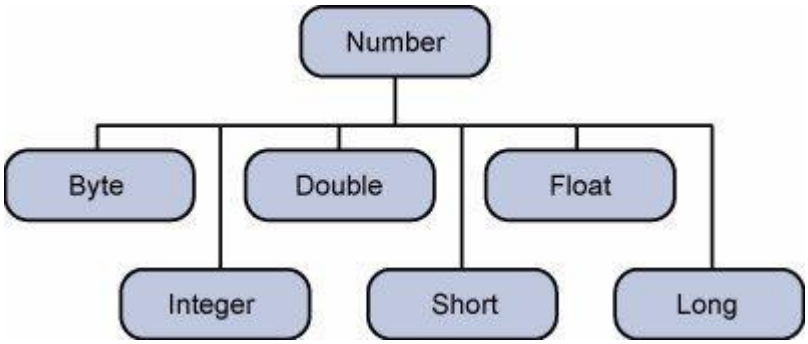
Normally, when we work with Numbers, we use primitive data types such as byte, int, long, double, etc.

Example:

```
int i =5000;
float gpa =13.65;
byte mask =0xaf;
```

However, in development, we come across situations where we need to use objects instead of primitive data types. In-order to achieve this, Java provides wrapper classes for each primitive data type.

All the wrapper classes (Integer, Long, Byte, Double, Float, Short) are subclasses of the abstract class Number.



This wrapping is taken care of by the compiler,the process is called boxing. So when a primitive is used when an object is required, the compiler boxes the primitive type in its wrapper class. Similarly, the compiler unboxes the object to a primitive as well. The **Number** is part of the java.lang package.

Here is an example of boxing and unboxing:

```
public class Test{

  public static void main(String args[]){
    Integer x =5;// boxes int to an Integer object
    x =  x +10;// unboxes the Integer to a int
    System.out.println(x);
  }
}
```

This would produce the following result:

```
15
```

When x is assigned integer values, the compiler boxes the integer because x is integer objects. Later, x is unboxed so that they can be added as integers.

Number Methods:

Here is the list of the instance methods that all the subclasses of the Number class implement:

SN	Methods with Description
1	xxxValue() Converts the value of *this* Number object to the xxx data type and returned it.
2	compareTo() Compares *this* Number object to the argument.
3	equals() Determines whether *this* number object is equal to the argument.
4	valueOf() Returns an Integer object holding the value of the specified primitive.
5	toString() Returns a String object representing the value of specified int or Integer.
6	parseInt() This method is used to get the primitive data type of a certain String.
7	abs() Returns the absolute value of the argument.
8	ceil() Returns the smallest integer that is greater than or equal to the argument. Returned as a double.
9	floor() Returns the largest integer that is less than or equal to the argument. Returned as a double.
10	rint() Returns the integer that is closest in value to the argument. Returned as a double.
11	round() Returns the closest long or int, as indicated by the method's return type, to the argument.
12	min() Returns the smaller of the two arguments.
13	max() Returns the larger of the two arguments.
14	exp() Returns the base of the natural logarithms, e, to the power of the argument.
15	log() Returns the natural logarithm of the argument.
16	pow() Returns the value of the first argument raised to the power of the second argument.
17	sqrt() Returns the square root of the argument.

18	sin() Returns the sine of the specified double value.
19	cos() Returns the cosine of the specified double value.
20	tan() Returns the tangent of the specified double value.
21	asin() Returns the arcsine of the specified double value.
22	acos() Returns the arccosine of the specified double value.
23	atan() Returns the arctangent of the specified double value.
24	atan2() Converts rectangular coordinates (x, y) to polar coordinate (r, theta) and returns theta.
25	toDegrees() Converts the argument to degrees
26	toRadians() Converts the argument to radians.
27	random() Returns a random number.

xxxValue()

Description:

The method converts the value of the Number Object that invokes the method to the primitive data type that is returned from the method.

Syntax:

Here is a separate method for each primitive data type:

```
byte byteValue()
short shortValue()
int intValue()
long longValue()
float floatValue()
double doubleValue()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- These method returns the primitive data type that is given in the signature.

Example:

```
public class Test{

public static void main(String args[]){
Integer x =5;
// Returns byte primitive data type
System.out.println( x.byteValue());

// Returns double primitive data type
System.out.println(x.doubleValue());

// Returns long primitive data type
System.out.println( x.longValue());
}
}
```

This produces the following result:

```
5
5.0
5
```

compareTo()

Description:

The method compares the Number object that invoked the method to the argument. It is possible to compare Byte, Long, Integer, etc.

However, two different types cannot be compared, both the argument and the Number object invoking the method should be of same type.

Syntax:

```
public int compareTo(NumberSubClass referenceName )
```

Parameters:

Here is the detail of parameters:

- **referenceName** -- This could be a Byte, Double, Integer, Float, Long or Short.

Return Value:

- If the Integer is equal to the argument then 0 is returned.
- If the Integer is less than the argument then -1 is returned.
- If the Integer is greater than the argument then 1 is returned.

Example:

```
public class Test{

public static void main(String args[]){
Integer x =5;
System.out.println(x.compareTo(3));
System.out.println(x.compareTo(5));
System.out.println(x.compareTo(8));
}
}
```

This produces the following result:

```
1
0
-1
```

equals()

Description:

The method determines whether the Number Object that invokes the method is equal to the argument.

Syntax:

```
public boolean equals(Object o)
```

Parameters:

Here is the detail of parameters:

- **o** -- Any object.

Return Value:

- The methods returns True if the argument is not null and is an object of the same type and with the same numeric value. There are some extra requirements for Double and Float objects that are described in the Java API documentation.

Example:

```
public class Test{

public static void main(String args[]){
Integer x =5;
Integer y =10;
Integer z =5;
Short a =5;

System.out.println(x.equals(y));
System.out.println(x.equals(z));
System.out.println(x.equals(a));
}
```

```
}
```

This produces the following result:

```
false
true
false
```

valueOf()

Description:

The valueOf method returns the relevant Number Object holding the value of the argument passed. The argument can be a primitive data type, String, etc.

This method is a static method. The method can take two arguments, where one is a String and the other is a radix.

Syntax:

All the variants of this method are given below:

```
static Integer valueOf(int i)
static Integer valueOf(String s)
static Integer valueOf(String s,int radix)
```

Parameters:

Here is the detail of parameters:

- **i** -- An int for which Integer representation would be returned.
- **s** -- A String for which Integer representation would be returned.
- **radix** -- This would be used to decide the value of returned Integer based on passed String.

Return Value:

- **valueOf(int i):** This returns an Integer object holding the value of the specified primitive.
- **valueOf(String s):** This returns an Integer object holding the value of the specified string representation.
- **valueOf(String s, int radix):** This returns an Integer object holding the integer value of the specified string representation, parsed with the value of radix.

```
public class Test{

public static void main(String args[]){

Integer x =Integer.valueOf(9);
Double c =Double.valueOf(5);
Float a =Float.valueOf("80");

Integer b =Integer.valueOf("444",16);

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

```
System.out.println(c);
System.out.println(a);
System.out.println(b);
}
}
```

This produces the following result:

```
9
5.0
80.0
1092
```

toString()

Description:

The method is used to get a String object representing the value of the Number Object.

If the method takes a primitive data type as an argument, then the String object representing the primitive data type value is return.

If the method takes two arguments, then a String representation of the first argument in the radix specified by the second argument will be returned.

Syntax:

All the variant of this method are given below:

```
String toString()
static String toString(int i)
```

Parameters:

Here is the detail of parameters:

- **i** -- An int for which string representation would be returned.

Return Value:

- **toString():** This returns a String object representing the value of **this** Integer.
- **toString(int i):** This returns a String object representing the specified integer.

Example:

```
public class Test{

public static void main(String args[]){
Integer x =5;

System.out.println(x.toString());
System.out.println(Integer.toString(12));
}
```

```
}
```

This produces the following result:

```
5
12
```

parseInt()

Description:

This method is used to get the primitive data type of a certain String. parseXxx() is a static method and can have one argument or two.

Syntax:

All the variant of this method are given below:

```
static int parseInt(String s)

static int parseInt(String s,int radix)
```

Parameters:

Here is the detail of parameters:

- **s** -- This is a string representation of decimal.
- **radix** -- This would be used to convert String s into integer.

Return Value:

- **parseInt(String s):** This returns an integer (decimal only).
- **parseInt(int i):** This returns an integer, given a string representation of decimal, binary, octal, or hexadecimal (radix equals 10, 2, 8, or 16 respectively) numbers as input.

Example:

```
public class Test{

public static void main(String args[]){
int x = Integer.parseInt("9");
double c = Double.parseDouble("5");
int b = Integer.parseInt("444",16);

System.out.println(x);
System.out.println(c);
System.out.println(b);
}
}
```

This produces the following result:

```
9
```

```
5.0
1092
```

abs()

Description:

The method gives the absolute value of the argument. The argument can be int, float, long, double, short, byte.

Syntax:

All the variant of this method are given below:

```
double abs(double d)
float abs(float f)
int abs(int i)
long abs(long lng)
```

Parameters:

Here is the detail of parameters:

- Any primitive data type

Return Value:

- This method Returns the absolute value of the argument.

Example:

```
public class Test{

public static void main(String args[]){
Integer a =-8;
double d =-100;
float f =-90;

System.out.println(Math.abs(a));
System.out.println(Math.abs(d));
System.out.println(Math.abs(f));
}
}
```

This produces the following result:

```
8
100.0
90.0
```

ceil()

Description:

The method ceil gives the smallest integer that is greater than or equal to the argument.

Syntax:

This method has following variants:

```
double ceil(double d)

double ceil(float f)
```

Parameters:

Here is the detail of parameters:

- A double or float primitive data type

Return Value:

- This method Returns the smallest integer that is greater than or equal to the argument. Returned as a double.

Example:

```
public class Test{

public static void main(String args[]){
double d =-100.675;
float f =-90;

System.out.println(Math.ceil(d));
System.out.println(Math.ceil(f));

System.out.println(Math.floor(d));
System.out.println(Math.floor(f));
}
}
```

This produces the following result:

```
-100.0
-90.0
-101.0
-90.0
```

floor()

Description:

The method floor gives the largest integer that is less than or equal to the argument.

Syntax:

This method has following variants:

```
double floor(double d)

double floor(float f)
```

Parameters:

Here is the detail of parameters:

- A double or float primitive data type

Return Value:

- This method Returns the largest integer that is less than or equal to the argument. Returned as a double.

Example:

```
public class Test{

public static void main(String args[]){
double d =-100.675;
float f =-90;

System.out.println(Math.floor(d));
System.out.println(Math.floor(f));

System.out.println(Math.ceil(d));
System.out.println(Math.ceil(f));
}
}
```

This produces the following result:

```
-101.0
-90.0
-100.0
-90.0
```

rint()

Description:

The method rint returns the integer that is closest in value to the argument.

Syntax:

```
double rint(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double primitive data type

Return Value:

- This method Returns the integer that is closest in value to the argument. Returned as a double.

Example:

```
public class Test{

public static void main(String args[]){
double d =100.675;
double e =100.500;
double f =100.200;

System.out.println(Math.rint(d));
System.out.println(Math.rint(e));
System.out.println(Math.rint(f));
}
}
```

This produces the following result:

```
101.0
100.0
100.0
```

round()

Description:

The method round returns the closest long or int, as given by the methods return type.

Syntax:

This method has following variants:

```
long round(double d)

int round(float f)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double or float primitive data type
- **f** -- A float primitive data type

Return Value:

- This method Returns the closest long or int, as indicated by the method's return type, to the argument.

Example:

```
public class Test{

public static void main(String args[]){
double d =100.675;
double e =100.500;
float f =100;
float g =90f;

System.out.println(Math.round(d));
System.out.println(Math.round(e));
System.out.println(Math.round(f));
System.out.println(Math.round(g));
}
}
```

This produces the following result:

```
101
101
100
90
```

min()

Description:

The method gives the smaller of the two arguments. The argument can be int, float, long, double.

Syntax:

This method has following variants:

```
double min(double arg1,double arg2)
float min(float arg1,float arg2)
int min(int arg1,int arg2)
long min(long arg1,long arg2)
```

Parameters:

Here is the detail of parameters:

- A primitive data types

Return Value:

- This method Returns the smaller of the two arguments.

Example:

```
public class Test{

public static void main(String args[]){
System.out.println(Math.min(12.123,12.456));
System.out.println(Math.min(23.12,23.0));
}
}
```

This produces the following result:

```
12.123
23.0
```

max()

Description:

The method gives the maximum of the two arguments. The argument can be int, float, long, double.

Syntax:

This method has following variants:

```
double max(double arg1,double arg2)
float max(float arg1,float arg2)
int max(int arg1,int arg2)
long max(long arg1,long arg2)
```

Parameters:

Here is the detail of parameters:

- A primitive data types

Return Value:

- This method returns the maximum of the two arguments.

Example:

```
public class Test{

public static void main(String args[]){
System.out.println(Math.max(12.123,12.456));
System.out.println(Math.max(23.12,23.0));
}
}
```

This produces the following result:

```
12.456
23.12
```

exp()

Description:

The method returns the base of the natural logarithms, e, to the power of the argument.

Syntax:

```
double exp(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A primitive data types

Return Value:

- This method Returns the base of the natural logarithms, e, to the power of the argument.

Example:

```
public class Test{

public static void main(String args[]){
double x =11.635;
double y =2.76;

System.out.printf("The value of e is %.4f%n",Math.E);
```

```
System.out.printf("exp(%.3f) is %.3f%n", x,Math.exp(x));
}
}
```

This produces the following result:

```
The value of e is 2.7183
exp(11.635) is 112983.831
```

log()

Description:

The method returns the natural logarithm of the argument.

Syntax:

```
double log(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A primitive data types

Return Value:

- This method Returns the natural logarithm of the argument.

Example:

```
public class Test{

public static void main(String args[]){
double x =11.635;
double y =2.76;

System.out.printf("The value of e is %.4f%n",Math.E);
System.out.printf("log(%.3f) is %.3f%n", x,Math.log(x));
}
}
```

This produces the following result:

```
The value of e is 2.7183
log(11.635) is 2.454
```

pow()

Description:

The method returns the value of the first argument raised to the power of the second argument.

Syntax:

```
double pow(doublebase,double exponent)
```

Parameters:

Here is the detail of parameters:

- **base** -- A primitive data type
- **exponenet** -- A primitive data type

Return Value:

- This method Returns the value of the first argument raised to the power of the second argument.

Example:

```
public class Test{

public static void main(String args[]){
double x = 11.635;
double y = 2.76;

System.out.printf("The value of e is %.4f%n",Math.E);
System.out.printf("pow(%.3f, %.3f) is %.3f%n",x, y,Math.pow(x, y));

}
}
```

This produces the following result:

```
The value of e is 2.7183
pow(11.635, 2.760) is 874.008
```

sqrt()

Description:

The method returns the square root of the argument.

Syntax:

```
double sqrt(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A primitive data type

Return Value:

- This method Returns the square root of the argument.

Example:

```
public class Test{

public static void main(String args[]){
double x =11.635;
double y =2.76;

System.out.printf("The value of e is %.4f%n",Math.E);
System.out.printf("sqrt(%.3f) is %.3f%n", x,Math.sqrt(x));
}
}
```

This produces the following result:

```
The value of e is 2.7183
sqrt(11.635) is 3.411
```

sin()

Description:

The method returns the sine of the specified double value.

Syntax:

```
double sin(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data types

Return Value:

- This method Returns the sine of the specified double value.

Example:

```
public class Test{

public static void main(String args[]){
double degrees =45.0;
```

```
double radians =Math.toRadians(degrees);

System.out.format("The value of pi is %.4f%n",Math.PI);
System.out.format("The sine of %.1f degrees is
%.4f%n",degrees,Math.sin(radians));

}
}
```

This produces the following result:

```
The value of pi is 3.1416
The sine of 45.0 degrees is 0.7071
```

cos()

Description:

The method returns the cosine of the specified double value.

Syntax:

```
double cos(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data types

Return Value:

- This method Returns the cosine of the specified double value.

Example:

```
public class Test{

public static void main(String args[]){
double degrees =45.0;
double radians =Math.toRadians(degrees);

System.out.format("The value of pi is %.4f%n",Math.PI);
System.out.format("The cosine of %.1f degrees is %.4f%n",
                        degrees,Math.cos(radians));

}
}
```

This produces the following result:

```
The value of pi is 3.1416
```

```
The cosine of 45.0 degrees is 0.7071
```

tan()

Description:

The method returns the tangent of the specified double value.

Syntax:

```
double tan(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data type

Return Value:

- This method returns the tangent of the specified double value.

Example:

```
public class Test{

public static void main(String args[]){
double degrees =45.0;
double radians =Math.toRadians(degrees);

System.out.format("The value of pi is %.4f%n",Math.PI);
System.out.format("The tangent of %.1f degrees is %.4f%n",
                        degrees,Math.tan(radians));

}
}
```

This produces the following result:

```
The value of pi is 3.1416
The tangent of 45.0 degrees is 1.0000
```

asin()

Description:

The method returns the arcsine of the specified double value.

Syntax:

```
double asin(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data types

Return Value:

- This method Returns the arcsine of the specified double value.

Example:

```
public class Test{

public static void main(String args[]){
double degrees =45.0;
double radians =Math.toRadians(degrees);

System.out.format("The value of pi is %.4f%n",Math.PI);
System.out.format("The arcsine of %.4f is %.4f degrees %n",
Math.sin(radians),
Math.toDegrees(Math.asin(Math.sin(radians))));


}
}
```

This produces the following result:

```
The value of pi is 3.1416
The arcsine of 0.7071 is 45.0000 degrees
```

acos()

Description:

The method returns the arccosine of the specified double value.

Syntax:

```
double acos(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data types

Return Value:

- This method Returns the arccosine of the specified double value.

Example:

```
public class Test{

public static void main(String args[]){
double degrees =45.0;
double radians =Math.toRadians(degrees);

System.out.format("The value of pi is %.4f%n",Math.PI);
System.out.format("The arccosine of %.4f is %.4f degrees %n",
Math.cos(radians),
Math.toDegrees(Math.acos(Math.sin(radians))));


}
}
```

This produces the following result:

```
The value of pi is 3.1416
The arccosine of 0.7071 is 45.0000 degrees
```

atan()

Description:

The method returns the arctangent of the specified double value.

Syntax:

```
double atan(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data types

Return Value :

- This method Returns the arctangent of the specified double value.

Example:

```
public class Test{

public static void main(String args[]){
double degrees =45.0;
double radians =Math.toRadians(degrees);

System.out.format("The value of pi is %.4f%n",Math.PI);
System.out.format("The arctangent of %.4f is %.4f degrees %n",
Math.cos(radians),
Math.toDegrees(Math.atan(Math.sin(radians))));


}
}
```

This produces the following result:

```
The value of pi is 3.1416
The arctangent of 1.0000 is 45.0000 degrees
```

atan2()

Description:

The method Converts rectangular coordinates (x, y) to polar coordinate (r, theta) and returns theta.

Syntax:

```
double atan2(double y,double x)
```

Parameters:

Here is the detail of parameters:

- **X** -- X co-ordinate in double data type
- **Y** -- Y co-ordinate in double data type

Return Value:

- This method Returns theta from polar coordinate (r, theta)

Example:

```
public class Test{

public static void main(String args[]){
double x =45.0;
double y =30.0;

System.out.println(Math.atan2(x, y));
}
```

```
}
```

This produces the following result:

```
0.982793723247329
```

toDegrees()

Description:

The method converts the argument value to degrees.

Syntax:

```
double toDegrees(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data type.

Return Value:

- This method returns a double value.

Example:

```
public class Test{

public static void main(String args[]){
double x =45.0;
double y =30.0;

System.out.println(Math.toDegrees(x));
System.out.println(Math.toDegrees(y));
}
}
```

This produces the following result:

```
2578.3100780887044
1718.8733853924698
```

toRadians()

Description:

The method converts the argument value to radians.

Syntax:

```
double toRadians(double d)
```

Parameters:

Here is the detail of parameters:

- **d** -- A double data type.

Return Value:

- This method returns a double value.

Example:

```
public class Test{

public static void main(String args[]){
double x =45.0;
double y =30.0;

System.out.println(Math.toRadians(x));
System.out.println(Math.toRadians(y));
}
}
```

This produces the following result:

```
0.7853981633974483
0.5235987755982988
```

random()

Description:

The method is used to generate a random number between 0.0 and 1.0. The range is: 0.0 =< Math.random < 1.0. Different ranges can be achieved by using arithmetic.

Syntax:

```
static double random()
```

Parameters:

Here is the detail of parameters:

- NA

Return Value:

- This method returns a double

Example:

```
public class Test{

public static void main(String args[]){
System.out.println(Math.random());
System.out.println(Math.random());
}
}
```

This produces the following result:

```
0.16763945061451657
0.400551253762343
```

Note: Above result would vary every time you would call random() method.

What is Next?

In the next section, we will be going through the Character class in Java. You will be learning how to use object Characters and primitive data type char in Java.

CHAPTER

12

Java Characters

Normally, when we work with characters, we use primitive data types char.

Example:

```
char ch ='a';

// Unicode for uppercase Greek omega character
char uniChar ='\u039A';

// an array of chars
char[] charArray = {'a','b','c','d','e'};
```

However in development, we come across situations where we need to use objects instead of primitive data types. Inorder to achieve this, Java provides wrapper class **Character** for primitive data type char.

The Character class offers a number of useful class (i.e., static) methods for manipulating characters. You can create a Character object with the Character constructor:

```
Character ch =newCharacter('a');
```

The Java compiler will also create a Character object for you under some circumstances. For example, if you pass a primitive char into a method that expects an object, the compiler automatically converts the char to a Character for you. This feature is called autoboxing or unboxing, if the conversion goes the other way.

Example:

```
// Here following primitive char 'a'
// is boxed into the Character object ch
Character ch ='a';

// Here primitive 'x' is boxed for method test,
// return is unboxed to char 'c'
char c = test('x');
```

Escape Sequences:

A character preceded by a backslash (\) is an escape sequence and has special meaning to the compiler.

The newline character (\n) has been used frequently in this tutorial in System.out.println() statements to advance to the next line after the string is printed.

Following table shows the Java escape sequences:

Escape Sequence	Description
\t	Inserts a tab in the text at this point.
\b	Inserts a backspace in the text at this point.
\n	Inserts a newline in the text at this point.
\r	Inserts a carriage return in the text at this point.
\f	Inserts a form feed in the text at this point.
\'	Inserts a single quote character in the text at this point.
\"	Inserts a double quote character in the text at this point.
\\	Inserts a backslash character in the text at this point.

When an escape sequence is encountered in a print statement, the compiler interprets it accordingly.

Example:

If you want to put quotes within quotes you must use the escape sequence, \", on the interior quotes:

```
public class Test{

  public static void main(String args[]){
    System.out.println("She said \"Hello!\" to me.");
  }
}
```

This would produce the following result:

```
She said "Hello!" to me.
```

Character Methods:

Here is the list of the important instance methods that all the subclasses of the Character class implement:

SN	Methods with Description
1	isLetter() Determines whether the specified char value is a letter.
2	isDigit() Determines whether the specified char value is a digit.
3	isWhitespace() Determines whether the specified char value is white space.
4	isUpperCase() Determines whether the specified char value is uppercase.
5	isLowerCase()

	Determines whether the specified char value is lowercase.
6	toUpperCase() Returns the uppercase form of the specified char value.
7	toLowerCase() Returns the lowercase form of the specified char value.
8	toString() Returns a String object representing the specified character valuethat is, a one-character string.

For a complete list of methods, please refer to the java.lang.Character API specification.

isLetter()

Description:

The method determines whether the specified char value is a letter.

Syntax:

```
boolean isLetter(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns true if passed character is really a character.

Example:

```
public class Test {

  public static void main(String args[]){
    System.out.println(Character.isLetter('c'));
    System.out.println(Character.isLetter('5'));
  }
}
```

This produces the following result:

```
true
false
```

isDigit()

Description:

The method determines whether the specified char value is a digit.

Syntax:

```
boolean isDigit(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns true if passed character is really a digit.

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.isDigit('c'));
    System.out.println(Character.isDigit('5'));
  }
}
```

This produces the following result:

```
false
true
```

isWhitespace()

Description:

The method determines whether the specified char value is a white space, which includes space, tab or new line.

Syntax:

```
boolean isWhitespace(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns true if passed character is really a white space.

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.isWhitespace('c'));
    System.out.println(Character.isWhitespace(' '));
    System.out.println(Character.isWhitespace('\n'));
    System.out.println(Character.isWhitespace('\t'));
  }
}
```

This produces the following result:

```
false
true
true
true
```

isUpperCase()

Description:

The method determines whether the specified char value is uppercase.

Syntax:

```
boolean isUpperCase(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns true if passed character is really an uppercase.

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.isUpperCase('c'));
    System.out.println(Character.isUpperCase('C'));
    System.out.println(Character.isUpperCase('\n'));
    System.out.println(Character.isUpperCase('\t'));
  }
}
```

This produces the following result:

```
false
true
false
false
```

isLowerCase()

Description:

The method determines whether the specified char value is lowercase.

Syntax:

```
boolean isLowerCase(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns true if passed character is really an lowercase.

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.isLowerCase('c'));
    System.out.println(Character.isLowerCase('C'));
    System.out.println(Character.isLowerCase('\n'));
    System.out.println(Character.isLowerCase('\t'));
  }
}
```

This produces the following result:

```
true
false
false
false
```

toUpperCase()

Description:

The method returns the uppercase form of the specified char value.

Syntax:

```
char toUpperCase(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value :

- This method Returns the uppercase form of the specified char value.

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.toUpperCase('c'));
    System.out.println(Character.toUpperCase('C'));
  }
}
```

This produces the following result:

```
C
C
```

toLowerCase()

Description:

The method returns the lowercase form of the specified char value.

Syntax:

```
char toLowerCase(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns the lowercase form of the specified char value.

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.toLowerCase('c'));
    System.out.println(Character.toLowerCase('C'));
  }
}
```

This produces the following result:

```
c
c
```

toString()

Description:

The method returns a String object representing the specified character value, that is, a one-character string.

Syntax:

```
String toString(char ch)
```

Parameters:

Here is the detail of parameters:

- **ch** -- Primitive character type

Return Value:

- This method Returns String object

Example:

```
public class Test{

  public static void main(String args[]){
    System.out.println(Character.toString('c'));
    System.out.println(Character.toString('C'));
  }
}
```

This produces the following result:

```
c
C
```

What is Next?

In the next section, we will be going through the String class in Java. You will be learning how to declare and use Strings efficiently as well as some of the important methods in the String class.

CHAPTER

13

Java Strings

Strings which are widely used in Java programming are a sequence of characters. In the Java programming language, strings are objects.

The Java platform provides the String class to create and manipulate strings.

Creating Strings:

The most direct way to create a string is to write:

```
String greeting ="Hello world!";
```

Whenever it encounters a string literal in your code, the compiler creates a String object with its value, in this case, "Hello world!'.

As with any other object, you can create String objects by using the new keyword and a constructor. The String class has eleven constructors that allow you to provide the initial value of the string using different sources, such as an array of characters:

```
public class StringDemo{

  public static void main(String args[]){
    char[] helloArray ={'h','e','l','l','o','.'};
    String helloString = new String(helloArray);
    System.out.println(helloString);
  }
}
```

This would produce the following result:

```
hello.
```

Note: The String class is immutable, so that once it is created a String object cannot be changed. If there is a necessity to make alot of modifications to Strings of characters, then you should use String Buffer & String Builder Classes.

String Length:

Methods used to obtain information about an object are known as accessor methods. One accessor method that you can use with strings is the length() method, which returns the number of characters contained in the string object.

After the following two lines of code have been executed, len equals 17:

```
public class StringDemo{

  public static void main(String args[]){
    String palindrome ="Dot saw I was Tod";
    int len = palindrome.length();
    System.out.println("String Length is : "+ len );
  }
}
```

This would produce the following result:

```
StringLengthis:17
```

Concatenating Strings:

The String class includes a method for concatenating two strings:

```
string1.concat(string2);
```

This returns a new string that is string1 with string2 added to it at the end. You can also use the concat() method with string literals, as in:

```
"My name is ".concat("Zara");
```

Strings are more commonly concatenated with the + operator, as in:

```
"Hello,"+" world"+"!"
```

which results in:

```
"Hello, world!"
```

Let us look at the following example:

```
public class StringDemo{

  public static void main(String args[]){
    String string1 ="saw I was ";
    System.out.println("Dot "+ string1 +"Tod");
  }
}
```

This would produce the following result:

```
Dot saw I was Tod
```

Creating Format Strings:

You have printf() and format() methods to print output with formatted numbers. The String class has an equivalent class method, format(), that returns a String object rather than a PrintStream object.

Using String's static format() method allows you to create a formatted string that you can reuse, as opposed to a one-time print statement. For example, instead of:

```
System.out.printf("The value of the float variable is "+
"%f, while the value of the integer "+
```

```
"variable is %d, and the string "+
"is %s", floatVar, intVar, stringVar);
```

you can write:

```
String fs;
fs = String.format("The value of the float variable is "+
"%f, while the value of the integer "+
"variable is %d, and the string "+
"is %s", floatVar, intVar, stringVar);
System.out.println(fs);
```

String Methods:

Here is the list of methods supported by String class:

SN	Methods with Description
1	char charAt(int index) Returns the character at the specified index.
2	int compareTo(Object o) Compares this String to another Object.
3	int compareTo(String anotherString) Compares two strings lexicographically.
4	int compareToIgnoreCase(String str) Compares two strings lexicographically, ignoring case differences.
5	String concat(String str) Concatenates the specified string to the end of this string.
6	boolean contentEquals(StringBuffer sb) Returns true if and only if this String represents the same sequence of characters as the specified StringBuffer.
7	static String copyValueOf(char[] data) Returns a String that represents the character sequence in the array specified.
8	static String copyValueOf(char[] data, int offset, int count) Returns a String that represents the character sequence in the array specified.
9	boolean endsWith(String suffix) Tests if this string ends with the specified suffix.
10	boolean equals(Object anObject) Compares this string to the specified object.
11	boolean equalsIgnoreCase(String anotherString) Compares this String to another String, ignoring case considerations.
12	byte getBytes() Encodes this String into a sequence of bytes using the platform's default charset, storing the result into a new byte array.
13	byte[] getBytes(String charsetName Encodes this String into a sequence of bytes using the named charset, storing the result into a new byte array.
14	void getChars(int srcBegin, int srcEnd, char[] dst, int dstBegin) Copies characters from this string into the destination character array.

15	int hashCode() Returns a hash code for this string.
16	int indexOf(int ch) Returns the index within this string of the first occurrence of the specified character.
17	int indexOf(int ch, int fromIndex) Returns the index within this string of the first occurrence of the specified character, starting the search at the specified index.
18	int indexOf(String str) Returns the index within this string of the first occurrence of the specified substring.
19	int indexOf(String str, int fromIndex) Returns the index within this string of the first occurrence of the specified substring, starting at the specified index.
20	String intern() Returns a canonical representation for the string object.
21	int lastIndexOf(int ch) Returns the index within this string of the last occurrence of the specified character.
22	int lastIndexOf(int ch, int fromIndex) Returns the index within this string of the last occurrence of the specified character, searching backward starting at the specified index.
23	int lastIndexOf(String str) Returns the index within this string of the rightmost occurrence of the specified substring.
24	int lastIndexOf(String str, int fromIndex) Returns the index within this string of the last occurrence of the specified substring, searching backward starting at the specified index.
25	int length() Returns the length of this string.
26	boolean matches(String regex) Tells whether or not this string matches the given regular expression.
27	boolean regionMatches(boolean ignoreCase, int toffset, String other, int ooffset, int len) Tests if two string regions are equal.
28	boolean regionMatches(int toffset, String other, int ooffset, int len) Tests if two string regions are equal.
29	String replace(char oldChar, char newChar) Returns a new string resulting from replacing all occurrences of oldChar in this string with newChar.
30	String replaceAll(String regex, String replacement Replaces each substring of this string that matches the given regular expression with the given replacement.
31	String replaceFirst(String regex, String replacement) Replaces the first substring of this string that matches the given regular expression with the given replacement.
32	String[] split(String regex) Splits this string around matches of the given regular expression.
33	String[] split(String regex, int limit) Splits this string around matches of the given regular expression.

34	boolean startsWith(String prefix) Tests if this string starts with the specified prefix.
35	boolean startsWith(String prefix, int toffset) Tests if this string starts with the specified prefix beginning a specified index.
36	CharSequence subSequence(int beginIndex, int endIndex) Returns a new character sequence that is a subsequence of this sequence.
37	String substring(int beginIndex) Returns a new string that is a substring of this string.
38	String substring(int beginIndex, int endIndex) Returns a new string that is a substring of this string.
39	char[] toCharArray() Converts this string to a new character array.
40	String toLowerCase() Converts all of the characters in this String to lower case using the rules of the default locale.
41	String toLowerCase(Locale locale) Converts all of the characters in this String to lower case using the rules of the given Locale.
42	String toString() This object (which is already a string!) is itself returned.
43	String toUpperCase() Converts all of the characters in this String to upper case using the rules of the default locale.
44	String toUpperCase(Locale locale) Converts all of the characters in this String to upper case using the rules of the given Locale.
45	String trim() Returns a copy of the string, with leading and trailing whitespace omitted.
46	static String valueOf(primitive data type x) Returns the string representation of the passed data type argument.

The above mentioned methods are explained here:

char charAt(int index)

Description:

This method returns the character located at the String's specified index. The string indexes start from zero.

Syntax:

Here is the syntax of this method:

```
public char charAt(int index)
```

Parameters:

Here is the detail of parameters:

- **index** -- Index of the character to be returned.

Return Value:

- This method Returns a char at the specified index.

Example:

```
public class Test{

  public static void main(String args[]){
    String s ="Strings are immutable";
    char result = s.charAt(8);
    System.out.println(result);
  }
}
```

This produces the following result:

```
a
```

int compareTo(Object o)

Description:

There are two variants of this method. First method compares this String to another Object and second method compares two strings lexicographically.

Syntax:

Here is the syntax of this method:

```
int compareTo(Object o)

or

int compareTo(String anotherString)
```

Parameters:

Here is the detail of parameters:

- **o** -- the Object to be compared.
- **anotherString** -- the String to be compared.

Return Value :

- The value 0 if the argument is a string lexicographically equal to this string; a value less than 0 if the argument is a string lexicographically greater than this string; and a value greater than 0 if the argument is a string lexicographically less than this string.

Example:

```
public class Test{

  public static void main(String args[]){
    String str1 ="Strings are immutable";
    String str2 ="Strings are immutable";
    String str3 ="Integers are not immutable";

    int result = str1.compareTo( str2 );
    System.out.println(result);

    result = str2.compareTo( str3 );
    System.out.println(result);

    result = str3.compareTo( str1 );
    System.out.println(result);
  }
}
```

This produces the following result:

```
0
10
-10
```

int compareTo(String anotherString)

Description:

There are two variants of this method. First method compares this String to another Object and second method compares two strings lexicographically.

Syntax:

Here is the syntax of this method:

```
int compareTo(Object o)

or

int compareTo(String anotherString)
```

Parameters:

Here is the detail of parameters:

- **o** -- the Object to be compared.
- **anotherString** -- the String to be compared.

Return Value :

- The value 0 if the argument is a string lexicographically equal to this string; a value less than 0 if the argument is a string lexicographically greater than this string; and a value greater than 0 if the argument is a string lexicographically less than this string.

Example:

```
public class Test{

  public static void main(String args[]){
    String str1 ="Strings are immutable";
    String str2 ="Strings are immutable";
    String str3 ="Integers are not immutable";

    int result = str1.compareTo( str2 );
    System.out.println(result);

    result = str2.compareTo( str3 );
    System.out.println(result);

    result = str3.compareTo( str1 );
    System.out.println(result);
  }
}
```

This produces the following result:

```
0
10
-10
```

int compareToIgnoreCase(String str)

Description:

This method compares two strings lexicographically, ignoring case differences.

Syntax:

Here is the syntax of this method:

```
int compareToIgnoreCase(String str)
```

Parameters:

Here is the detail of parameters:

- **str** -- the String to be compared.

Return Value:

- This method returns a negative integer, zero, or a positive integer as the specified String is greater than, equal to, or less than this String, ignoring case considerations.

Example:

```
public class Test{

  public static void main(String args[]){
    String str1 ="Strings are immutable";
    String str2 ="Strings are immutable";
    String str3 ="Integers are not immutable";

    int result = str1.compareToIgnoreCase( str2 );
    System.out.println(result);

    result = str2.compareToIgnoreCase( str3 );
    System.out.println(result);

    result = str3.compareToIgnoreCase( str1 );
    System.out.println(result);
  }
}
```

This produces the following result:

```
0
10
-10
```

String concat(String str)

Description:

This method appends one String to the end of another. The method returns a String with the value of the String passed in to the method appended to the end of the String used to invoke this method.

Syntax:

Here is the syntax of this method:

```
public String concat(String s)
```

Parameters:

Here is the detail of parameters:

- **s** -- the String that is concatenated to the end of this String.

Return Value :

- This methods returns a string that represents the concatenation of this object's characters followed by the string argument's characters.

Example:

```
public class Test{
```

```
  public static void main(String args[]){
    String s ="Strings are immutable";
    s = s.concat(" all the time");
    System.out.println(s);
  }
}
```

This produces the following result:

```
Strings are immutable all the time
```

boolean contentEquals(StringBuffer sb)

Description:

This method returns true if and only if this String represents the same sequence of characters as the specified in StringBuffer.

Syntax:

Here is the syntax of this method:

```
public boolean contentEquals(StringBuffer sb)
```

Parameters:

Here is the detail of parameters:

- **sb** -- the StringBuffer to compare.

Return Value:

- This method returns true if and only if this String represents the same sequence of characters as the specified in StringBuffer, otherwise false.

Example:

```
public class Test{

  public static void main(String args[]){
    String str1 = "Not immutable";
    String str2 = "Strings are immutable";
    StringBuffer str3 = new StringBuffer("Not immutable");

    boolean  result = str1.contentEquals( str3 );
    System.out.println(result);

    result = str2.contentEquals( str3 );
    System.out.println(result);
  }
}
```

This produces the following result:

```
true
false
```

static String copyValueOf(char[] data)

Description:

This method has two different forms:

- **public static String copyValueOf(char[] data):** Returns a String that represents the character sequence in the array specified.
- **public static String copyValueOf(char[] data, int offset, int count):** Returns a String that represents the character sequence in the array specified.

Syntax:

Here is the syntax of this method:

```
Public staticString copyValueOf(char[] data)

or

public staticString copyValueOf(char[] data,int offset,int count)
```

Parameters:

Here is the detail of parameters:

- **data** -- the character array.
- **offset** -- initial offset of the subarray.
- **count** -- length of the subarray.

Return Value :

- This method returns a String that contains the characters of the character array.

Example:

```
public class Test{
  public static void main(String args[]){
    char[]Str1={'h','e','l','l','o',' ','w','o','r','l','d'};
    StringStr2="";

    Str2=Str2.copyValueOf(Str1);
    System.out.println("Returned String: "+Str2);

    Str2=Str2.copyValueOf(Str1,2,6);
    System.out.println("Returned String: "+Str2);
  }
}
```

This produces the following result:

```
Returned String: hello world
Returned String: llo wo
```

boolean endsWith(String suffix)

Description:

This method tests if this string ends with the specified suffix.

Syntax:

Here is the syntax of this method:

```
public boolean endsWith(String suffix)
```

Parameters:

Here is the detail of parameters:

- **suffix** -- the suffix.

Return Value:

- This method returns true if the character sequence represented by the argument is a suffix of the character sequence represented by this object; false otherwise. Note that the result will be true if the argument is the empty string or is equal to this String object as determined by the equals(Object) method.

Example:

```
public class Test{

  public static void main(String args[]){
    StringStr = new String("This is really not immutable!!");
    boolean retVal;

    retVal = Str.endsWith("immutable!!");
    System.out.println("Returned Value = "+ retVal );

    retVal = Str.endsWith("immu");
    System.out.println("Returned Value = "+ retVal );
  }
}
```

This produces the following result:

```
Returned Value = true
Returned Value = false
```

boolean equals(Object anObject)

Description:

This method compares this string to the specified object. The result is true if and only if the argument is not null and is a String object that represents the same sequence of characters as this object.

Syntax:

Here is the syntax of this method:

```
public boolean equals(Object anObject)
```

Parameters:

Here is the detail of parameters:

- **anObject** -- the object to compare this String against.

Return Value :

- This method returns true if the String are equal; false otherwise.

Example:

```
public class Test{

  public static void main(String args[]){
    StringStr1=new String("This is really not immutable!!");
    StringStr2=Str1;
    StringStr3=new String("This is really not immutable!!");
    boolean retVal;

    retVal =Str1.equals(Str2);
    System.out.println("Returned Value = "+ retVal );

    retVal =Str1.equals(Str3);
    System.out.println("Returned Value = "+ retVal );
  }
}
```

This produces the following result:

```
Returned Value = true
Returned Value = true
```

boolean equalsIgnoreCase(String anotherString)

Description:

This method compares this String to another String, ignoring case considerations. Two strings are considered equal ignoring case if they are of the same length, and corresponding characters in the two strings are equal ignoring case.

Syntax:

Here is the syntax of this method:

```
public boolean equalsIgnoreCase(String anotherString)
```

Parameters:

Here is the detail of parameters:

- **anotherString** -- the String to compare this String against

Return Value:

- This method returns true if the argument is not null and the Strings are equal, ignoring case; false otherwise.

Example:

```
public class Test{

  public static void main(String args[]){
    StringStr1 = new String("This is really not immutable!!");
    StringStr2 = Str1;
    StringStr3 = new String("This is really not immutable!!");
    StringStr4 = new String("This IS REALLY NOT IMMUTABLE!!");
    boolean retVal;

    retVal = Str1.equals(Str2);
    System.out.println("Returned Value = "+ retVal );

    retVal = Str1.equals(Str3);
    System.out.println("Returned Value = "+ retVal );

    retVal = Str1.equalsIgnoreCase(Str4);
    System.out.println("Returned Value = "+ retVal );
  }
}
```

This produces the following result:

```
Returned Value = true
Returned Value = true
Returned Value = true
```

byte getBytes()

Description:

This method has following two forms:

- **getBytes(String charsetName):** Encodes this String into a sequence of bytes using the named charset, storing the result into a new byte array.
- **getBytes():** Encodes this String into a sequence of bytes using the platform's default charset, storing the result into a new byte array.

Syntax:

Here is the syntax of this method:

```
public byte[] getBytes(String charsetName)
throws UnsupportedEncodingException

or

public byte[] getBytes()
```

Parameters:

Here is the detail of parameters:

- **charsetName** -- the name of a supported charset.

Return Value:

- This method returns the resultant byte array

Example:

```
import java.io.*;

  public class Test{

    public static void main(String args[]){
      StringStr1 = new String("Welcome to Tutorialspoint.com");

      try{
         byte[]Str2=Str1.getBytes();
         System.out.println("Returned  Value "+Str2);

         Str2 = Str1.getBytes("UTF-8");
         System.out.println("Returned  Value "+Str2);

         Str2 = Str1.getBytes("ISO-8859-1");
         System.out.println("Returned  Value "+Str2);
      }catch(UnsupportedEncodingException e){
         System.out.println("Unsupported character set");
       }
    }
}
```

This produces the following result:

```
Returned  Value [B@192d342
```

```
Returned  Value [B@15ff48b
Returned  Value [B@1b90b39
```

byte[] getBytes(String charsetName)

Description:

This method has following two forms:

- **getBytes(String charsetName):** Encodes this String into a sequence of bytes using the named charset, storing the result into a new byte array.
- **getBytes():** Encodes this String into a sequence of bytes using the platform's default charset, storing the result into a new byte array.

Syntax:

Here is the syntax of this method:

```
publicbyte[] getBytes(String charsetName)
throws UnsupportedEncodingException

or

public byte[] getBytes()
```

Parameters:

Here is the detail of parameters:

- **charsetName** -- the name of a supported charset.

Return Value:

- This method returns the resultant byte array

Example:

```
import java.io.*;

  public class Test{

    public static void main(String args[]){
    StringStr1=new String("Welcome to Tutorialspoint.com");

    try{
       byte[]Str2 = Str1.getBytes();
       System.out.println("Returned  Value "+Str2);

       Str2 = Str1.getBytes("UTF-8");
       System.out.println("Returned  Value "+Str2);

       Str2 = Str1.getBytes("ISO-8859-1");
```

```
        System.out.println("Returned  Value "+Str2);
     }catch(UnsupportedEncodingException e){
        System.out.println("Unsupported character set");
     }
   }
}
```

This produces the following result:

```
Returned  Value [B@192d342
Returned  Value [B@15ff48b
Returned  Value [B@1b90b39
```

void getChars(int srcBegin, int srcEnd, char[] dst, int dstBegin)

Description:

This method copies characters from this string into the destination character array.

Syntax:

Here is the syntax of this method:

```
public void getChars(int srcBegin,
int srcEnd,
char[] dst,
int dstBegin)
```

Parameters:

Here is the detail of parameters:

- **srcBegin** -- index of the first character in the string to copy.
- **srcEnd** -- index after the last character in the string to copy.
- **dst** -- the destination array.
- **dstBegin** -- the start offset in the destination array.

Return Value:

- It does not return any value but throws IndexOutOfBoundsException.

Example:

```
import java.io.*;

  public class Test{
    public static void main(String args[]){
    StringStr1=new String("Welcome to Tutorialspoint.com");
    char[]Str2=newchar[7];
```

```
    try{
      Str1.getChars(2,9,Str2,0);
      System.out.print("Copied Value = ");
      System.out.println(Str2);

    }catch(Exception ex){
       System.out.println("Raised exception...");
    }
  }
}
```

This produces the following result:

```
Copied Value = lcome t
```

int hashCode()

Description:

This method returns a hash code for this string. The hash code for a String object is computed as:

```
s[0]*31^(n-1)+ s[1]*31^(n-2)+...+ s[n-1]
```

Using int arithmetic, where s[i] is the ith character of the string, n is the length of the string, and ^ indicates exponentiation. (The hash value of the empty string is zero.)

Syntax:

Here is the syntax of this method:

```
public int hashCode()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- This method returns a hash code value for this object.

Example:

```
import java.io.*;

  public class Test{
    public static void main(String args[]){
    StringStr=new String("Welcome to Tutorialspoint.com");
    System.out.println("Hashcode for Str :"+Str.hashCode());
```

```
   }
}
```

This produces the following result:

```
Hashcode for Str :1186874997
```

int indexOf(int ch)

Description:

This method has following different variants:

- **public int indexOf(int ch):** Returns the index within this string of the first occurrence of the specified character or -1 if the character does not occur.
- **public int indexOf(int ch, int fromIndex):** Returns the index within this string of the first occurrence of the specified character, starting the search at the specified index or -1 if the character does not occur.
- **int indexOf(String str):** Returns the index within this string of the first occurrence of the specified substring. If it does not occur as a substring, -1 is returned.
- **int indexOf(String str, int fromIndex):** Returns the index within this string of the first occurrence of the specified substring, starting at the specified index. If it does not occur, -1 is returned.

Syntax:

Here is the syntax of this method:

```
public int indexOf(int ch )

or

public int indexOf(int ch,int fromIndex)

or

int indexOf(String str)

or

int indexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- a string.

Return Value:

- See the description.

Example:

```
import java.io.*;

public class Test{

  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Index :");
    System.out.println(Str.indexOf('o'));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf('o',5));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr1));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr1,15));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr2));
  }
}
```

This produces the following result:

```
Found Index :4
Found Index :9
Found Index :11
Found Index :-1
Found Index :-1
```

int indexOf(int ch, int fromIndex)

Description:

This method has following different variants:

- **public int indexOf(int ch):** Returns the index within this string of the first occurrence of the specified character or -1 if the character does not occur.
- **public int indexOf(int ch, int fromIndex):** Returns the index within this string of the first occurrence of the specified character, starting the search at the specified index or -1 if the character does not occur.
- **int indexOf(String str):** Returns the index within this string of the first occurrence of the specified substring. If it does not occur as a substring, -1 is returned.
- **int indexOf(String str, int fromIndex):** Returns the index within this string of the first occurrence of the specified substring, starting at the specified index. If it does not occur, -1 is returned.

Syntax:

Here is the syntax of this method:

```
public int indexOf(int ch )

or
```

```
public int indexOf(int ch,int fromIndex)

or

int indexOf(String str)

or

int indexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- a string.

Return Value:

- See the description.

Example:

```
import java.io.*;

  public class Test{

    public static void main(String args[]){
      StringStr=new String("Welcome to Tutorialspoint.com");
      StringSubStr1=new String("Tutorials");
      StringSubStr2=new String("Sutorials");

      System.out.print("Found Index :");
      System.out.println(Str.indexOf('o'));
      System.out.print("Found Index :");
      System.out.println(Str.indexOf('o',5));
      System.out.print("Found Index :");
      System.out.println(Str.indexOf(SubStr1));
      System.out.print("Found Index :");
      System.out.println(Str.indexOf(SubStr1,15));
      System.out.print("Found Index :");
      System.out.println(Str.indexOf(SubStr2));
    }
}
```

This produces the following result:

```
Found Index :4
Found Index :9
Found Index :11
Found Index :-1
Found Index :-1
```

int indexOf(String str)

Description:

This method has following different variants:

- **public int indexOf(int ch):** Returns the index within this string of the first occurrence of the specified character or -1 if the character does not occur.
- **public int indexOf(int ch, int fromIndex):** Returns the index within this string of the first occurrence of the specified character, starting the search at the specified index or -1 if the character does not occur.
- **int indexOf(String str):** Returns the index within this string of the first occurrence of the specified substring. If it does not occur as a substring, -1 is returned.
- **int indexOf(String str, int fromIndex):** Returns the index within this string of the first occurrence of the specified substring, starting at the specified index. If it does not occur, -1 is returned.

Syntax:

Here is the syntax of this method:

```
public int indexOf(int ch )

or

public int indexOf(int ch,int fromIndex)

or

int indexOf(String str)

or

int indexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- a string.

Return Value:

- See the description.

Example:

```
import java.io.*;

public class Test{

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

```
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Index :");
    System.out.println(Str.indexOf('o'));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf('o',5));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr1));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr1,15));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr2));
  }
}
```

This produces the following result:

```
Found Index :4
Found Index :9
Found Index :11
Found Index :-1
Found Index :-1
```

int indexOf(String str, int fromIndex)

Description:

This method has following different variants:

- **public int indexOf(int ch):** Returns the index within this string of the first occurrence of the specified character or -1 if the character does not occur.
- **public int indexOf(int ch, int fromIndex):** Returns the index within this string of the first occurrence of the specified character, starting the search at the specified index or -1 if the character does not occur.
- **int indexOf(String str):** Returns the index within this string of the first occurrence of the specified substring. If it does not occur as a substring, -1 is returned.
- **int indexOf(String str, int fromIndex):** Returns the index within this string of the first occurrence of the specified substring, starting at the specified index. If it does not occur, -1 is returned.

Syntax:

Here is the syntax of this method:

```
public int indexOf(int ch )

or

public int indexOf(int ch,int fromIndex)

or

int indexOf(String str)

or
```

```
int indexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- a string.

Return Value:

- See the description.

Example:

```
import java.io.*;

public class Test{

  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Index :");
    System.out.println(Str.indexOf('o'));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf('o',5));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr1));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr1,15));
    System.out.print("Found Index :");
    System.out.println(Str.indexOf(SubStr2));
  }
}
```

This produces the following result:

```
Found Index :4
Found Index :9
Found Index :11
Found Index :-1
Found Index :-1
```

String intern()

Description:

This method returns a canonical representation for the string object. It follows that for any two strings s and t, s.intern() == t.intern() is true if and only if s.equals(t) is true.

Syntax:

Here is the syntax of this method:

```
publicString intern()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- This method returns a canonical representation for the string object.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr1 = new String("Welcome to Tutorialspoint.com");
    StringStr2 = new String("WELCOME TO SUTORIALSPOINT.COM");

    System.out.print("Canonical representation:");
    System.out.println(Str1.intern());

    System.out.print("Canonical representation:");
    System.out.println(Str2.intern());
  }
}
```

This produces the following result:

```
Canonical representation: Welcome to Tutorialspoint.com
Canonical representation: WELCOME TO SUTORIALSPOINT.COM
```

int lastIndexOf(int ch)

Description:

This method has the following variants:

- **int lastIndexOf(int ch):** Returns the index within this string of the last occurrence of the specified character or -1 if the character does not occur.
- **public int lastIndexOf(int ch, int fromIndex):** Returns the index of the last occurrence of the character in the character sequence represented by this object that is less than or equal to fromIndex, or -1 if the character does not occur before that point.
- **public int lastIndexOf(String str):** If the string argument occurs one or more times as a substring within this object, then it returns the index of the first character of the last such substring is returned. If it does not occur as a substring, -1 is returned.

- **public int lastIndexOf(String str, int fromIndex):** Returns the index within this string of the last occurrence of the specified substring, searching backward starting at the specified index.

Syntax:

Here is the syntax of this method:

```
int lastIndexOf(int ch)

or

public int lastIndexOf(int ch,int fromIndex)

or

public int lastIndexOf(String str)

or

public int lastIndexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- A string.

Return Value:

- This method returns the index.

Example:

```
import java.io.*;

public class Test{

  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o'));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o',5));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1,15));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr2));
  }
```

```
}
```

This produces the following result:

```
Found Last Index :27
Found Last Index :4
Found Last Index :11
Found Last Index :11
Found Last Index :-1
```

int lastIndexOf(int ch, int fromIndex)

Description:

This method has the following variants:

- **int lastIndexOf(int ch):** Returns the index within this string of the last occurrence of the specified character or -1 if the character does not occur.
- **public int lastIndexOf(int ch, int fromIndex):** Returns the index of the last occurrence of the character in the character sequence represented by this object that is less than or equal to fromIndex, or -1 if the character does not occur before that point.
- **public int lastIndexOf(String str):** If the string argument occurs one or more times as a substring within this object, then it returns the index of the first character of the last such substring is returned. If it does not occur as a substring, -1 is returned.
- **public int lastIndexOf(String str, int fromIndex):** Returns the index within this string of the last occurrence of the specified substring, searching backward starting at the specified index.

Syntax:

Here is the syntax of this method:

```
int lastIndexOf(int ch)

or

public int lastIndexOf(int ch,int fromIndex)

or

public int lastIndexOf(String str)

or

public int lastIndexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- A string.

Return Value:

- This method returns the index.

Example:

```
import java.io.*;

public class Test{

  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o'));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o',5));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1,15));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr2));
  }
}
```

This produces the following result:

```
Found Last Index :27
Found Last Index :4
Found Last Index :11
Found Last Index :11
Found Last Index :-1
```

int lastIndexOf(String str)

Description:

This method has the following variants:

- **int lastIndexOf(int ch):** Returns the index within this string of the last occurrence of the specified character or -1 if the character does not occur.
- **public int lastIndexOf(int ch, int fromIndex):** Returns the index of the last occurrence of the character in the character sequence represented by this object that is less than or equal to fromIndex, or -1 if the character does not occur before that point.
- **public int lastIndexOf(String str):** If the string argument occurs one or more times as a substring within this object, then it returns the index of the first character of the last such substring is returned. If it does not occur as a substring, -1 is returned.
- **public int lastIndexOf(String str, int fromIndex):** Returns the index within this string of the last occurrence of the specified substring, searching backward starting at the specified index.

Syntax:

Here is the syntax of this method:

```
int lastIndexOf(int ch)

or

public int lastIndexOf(int ch,int fromIndex)

or

public int lastIndexOf(String str)

or

public int lastIndexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- A string.

Return Value:

- This method returns the index.

Example:

```
import java.io.*;

public class Test{

  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o'));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o',5));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1,15));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr2));
  }
}
```

This produces the following result:

```
Found Last Index :27
Found Last Index :4
Found Last Index :11
Found Last Index :11
Found Last Index :-1
```

int lastIndexOf(String str, int fromIndex)

Description:

This method has the following variants:

- **int lastIndexOf(int ch):** Returns the index within this string of the last occurrence of the specified character or -1 if the character does not occur.
- **public int lastIndexOf(int ch, int fromIndex):** Returns the index of the last occurrence of the character in the character sequence represented by this object that is less than or equal to fromIndex, or -1 if the character does not occur before that point.
- **public int lastIndexOf(String str):** If the string argument occurs one or more times as a substring within this object, then it returns the index of the first character of the last such substring is returned. If it does not occur as a substring, -1 is returned.
- **public int lastIndexOf(String str, int fromIndex):** Returns the index within this string of the last occurrence of the specified substring, searching backward starting at the specified index.

Syntax:

Here is the syntax of this method:

```
int lastIndexOf(int ch)

or

public int lastIndexOf(int ch,int fromIndex)

or

public int lastIndexOf(String str)

or

public int lastIndexOf(String str,int fromIndex)
```

Parameters:

Here is the detail of parameters:

- **ch** -- a character.
- **fromIndex** -- the index to start the search from.
- **str** -- A string.

Return Value:

- This method returns the index.

Example:

```
import java.io.*;

public class Test{

  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");
    StringSubStr1 = new String("Tutorials");
    StringSubStr2 = new String("Sutorials");

    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o'));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf('o',5));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr1,15));
    System.out.print("Found Last Index :");
    System.out.println(Str.lastIndexOf(SubStr2));
  }
}
```

This produces the following result:

```
Found Last Index :27
Found Last Index :4
Found Last Index :11
Found Last Index :11
Found Last Index :-1
```

int length()

Description:

This method returns the length of this string. The length is equal to the number of 16-bit Unicode characters in the string.

Syntax:

Here is the syntax of this method:

```
public int length()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- This method returns the the length of the sequence of characters represented by this object.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr1 = new String("Welcome to Tutorialspoint.com");
    StringStr2 = new String("Tutorials");

    System.out.print("String Length :");
    System.out.println(Str1.length());

    System.out.print("String Length :");
   System.out.println(Str2.length());
  }
}
```

This produces the following result:

```
String Length :29
String Length :9
```

boolean matches(String regex)

Description:

This method tells whether or not this string matches the given regular expression. An invocation of this method of the form str.matches(regex) yields exactly the same result as the expression Pattern.matches(regex, str).

Syntax:

Here is the syntax of this method:

```
public boolean matches(String regex)
```

Parameters:

Here is the detail of parameters:

- **regex** -- the regular expression to which this string is to be matched.

Return Value:

- This method returns true if, and only if, this string matches the given regular expression.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.matches("(.*)Tutorials(.*)"));

    System.out.print("Return Value :");
    System.out.println(Str.matches("Tutorials"));

    System.out.print("Return Value :");
    System.out.println(Str.matches("Welcome(.*)"));
  }
}
```

This produces the following result:

```
Return Value :true
Return Value :false
Return Value :true
```

boolean regionMatches(boolean ignoreCase, int toffset, String other, int ooffset, int len)

Description:

This method has two variants which can be used to test if two string regions are equal.

Syntax:

Here is the syntax of this method:

```
public boolean regionMatches(int toffset,
String other,
int ooffset,
int len)

or

publicboolean regionMatches(boolean ignoreCase,
int toffset,
String other,
int ooffset,
int len)
```

Parameters:

Here is the detail of parameters:

- **toffset** -- the starting offset of the subregion in this string.
- **other** -- the string argument.
- **ooffset** -- the starting offset of the subregion in the string argument.
- **len** -- the number of characters to compare.
- **ignoreCase** -- if true, ignore case when comparing characters.

Return Value:

- It returns true if the specified subregion of this string matches the specified subregion of the string argument; false otherwise. Whether the matching is exact or case insensitive depends on the ignoreCase argument.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr1 = new String("Welcome to Tutorialspoint.com");
    StringStr2 = new String("Tutorials");
    StringStr3 = new String("TUTORIALS");

    System.out.print("Return Value :");
    System.out.println(Str1.regionMatches(11,Str2,0,9));

    System.out.print("Return Value :");
    System.out.println(Str1.regionMatches(11,Str3,0,9));

    System.out.print("Return Value :");
    System.out.println(Str1.regionMatches(true,11,Str3,0,9));
  }
}
```

This produces the following result:

```
Return Value :true
Return Value :false
Return Value :true
```

boolean regionMatches(int toffset, String other, int ooffset, int len)

Description:

This method has two variants which can be used to test if two string regions are equal.

Syntax:

Here is the syntax of this method:

```
public boolean regionMatches(int toffset,
String other,
```

```
int ooffset,
int len)

or

public boolean regionMatches(boolean ignoreCase,
int toffset,
String other,
int ooffset,
int len)
```

Parameters:

Here is the detail of parameters:

- **toffset** -- the starting offset of the subregion in this string.
- **other** -- the string argument.
- **ooffset** -- the starting offset of the subregion in the string argument.
- **len** -- the number of characters to compare.
- **ignoreCase** -- if true, ignore case when comparing characters.

Return Value:

- It returns true if the specified subregion of this string matches the specified subregion of the string argument; false otherwise. Whether the matching is exact or case insensitive depends on the ignoreCase argument.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr1 = new String("Welcome to Tutorialspoint.com");
    StringStr2 = new String("Tutorials");
    StringStr3 = new String("TUTORIALS");

    System.out.print("Return Value :");
    System.out.println(Str1.regionMatches(11,Str2,0,9));

    System.out.print("Return Value :");
    System.out.println(Str1.regionMatches(11,Str3,0,9));

    System.out.print("Return Value :");
    System.out.println(Str1.regionMatches(true,11,Str3,0,9));
  }
}
```

This produces the following result:

```
Return Value :true
Return Value :false
Return Value :true
```

String replace(char oldChar, char newChar)

Description:

This method returns a new string resulting from replacing all occurrences of oldChar in this string with newChar.

Syntax:

Here is the syntax of this method:

```
public String replace(char oldChar,char newChar)
```

Parameters:

Here is the detail of parameters:

- **oldChar** -- the old character.
- **newChar** -- the new character.

Return Value:

- It returns a string derived from this string by replacing every occurrence of oldChar with newChar.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.replace('o','T'));

    System.out.print("Return Value :");
    System.out.println(Str.replace('l','D'));
  }
}
```

This produces the following result:

```
Return Value :WelcTme tT TutTrialspTint.cTm
Return Value :WeDcome to TutoriaDspoint.com
```

String replaceAll(String regex, String replacement)

Description:

This method replaces each substring of this string that matches the given regular expression with the given replacement.

Syntax:

Here is the syntax of this method:

```
public String replaceAll(String regex,String replacement)
```

Parameters:

Here is the detail of parameters:

- **regex** -- the regular expression to which this string is to be matched.
- **replacement** -- the string which would replace found expression.

Return Value:

- This method returns the resulting String.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.replaceAll("(.*)Tutorials(.*)",
    "AMROOD"));
  }
}
```

This produces the following result:

```
Return Value :AMROOD
```

String replaceFirst(String regex, String replacement)

Description:

This method replaces the first substring of this string that matches the given regular expression with the given replacement.

Syntax:

Here is the syntax of this method:

```
public String replaceFirst(String regex,String replacement)
```

Parameters:

Here is the detail of parameters:

- **regex** -- the regular expression to which this string is to be matched.
- **replacement** -- the string which would replace found expression.

Return Value :

- This method returns a resulting String.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.replaceFirst("(.*)Tutorials(.*)",
    "AMROOD"));

    System.out.print("Return Value :");
    System.out.println(Str.replaceFirst("Tutorials","AMROOD"));
  }
}
```

This produces the following result:

```
Return Value :AMROOD
Return Value :Welcome to AMROODpoint.com
```

String[] split(String regex)

Description:

This method has two variants and splits this string around matches of the given regular expression.

Syntax:

Here is the syntax of this method:

```
public String[] split(String regex,int limit)

or

public String[] split(String regex)
```

Parameters:

Here is the detail of parameters:

- **regex** -- the delimiting regular expression.
- **limit** -- the result threshold which means how many strings to be returned.

Return Value:

- It returns the array of strings computed by splitting this string around matches of the given regular expression.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
  StringStr = new String("Welcome-to-Tutorialspoint.com");

  System.out.println("Return Value :");
  for(String retval:Str.split("-",2)){
    System.out.println(retval);
  }
  System.out.println("");
  System.out.println("Return Value :");
  for(String retval:Str.split("-",3)){
    System.out.println(retval);
  }
  System.out.println("");
  System.out.println("Return Value :");
  for(String retval:Str.split("-",0)){
    System.out.println(retval);
  }
  System.out.println("");
  System.out.println("Return Value :");
  for(String retval:Str.split("-")){
    System.out.println(retval);
  }
 }
}
```

This produces the following result:

```
Return Value :
Welcome
to-Tutorialspoint.com

Return Value :
Welcome
to
Tutorialspoint.com

Return Value:
Welcome
to
Tutorialspoint.com

Return Value :
Welcome
```

```
to
Tutorialspoint.com
```

String[] split(String regex, int limit)

Description:

This method has two variants and splits this string around matches of the given regular expression.

Syntax:

Here is the syntax of this method:

```
public String[] split(String regex,int limit)

or

public String[] split(String regex)
```

Parameters:

Here is the detail of parameters:

- **regex** -- the delimiting regular expression.
- **limit** -- the result threshold which means how many strings to be returned.

Return Value:

- It returns the array of strings computed by splitting this string around matches of the given regular expression.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome-to-Tutorialspoint.com");

    System.out.println("Return Value :");
    for(String retval:Str.split("-",2)){
      System.out.println(retval);
    }
    System.out.println("");
    System.out.println("Return Value :");
    for(String retval:Str.split("-",3)){
      System.out.println(retval);
    }
    System.out.println("");
    System.out.println("Return Value :");
    for(String retval:Str.split("-",0)){
      System.out.println(retval);
```

```
    }
    System.out.println("");
    System.out.println("Return Value :");
    for(String retval:Str.split("-")){
      System.out.println(retval);
    }
  }
}
```

This produces the following result:

```
Return Value :
Welcome
to-Tutorialspoint.com

Return Value :
Welcome
to
Tutorialspoint.com

Return Value:
Welcome
to
Tutorialspoint.com

Return Value :
Welcome
to
Tutorialspoint.com
```

boolean startsWith(String prefix)

Description:

This method has two variants and tests if a string starts with the specified prefix beginning a specified index or by default at the beginning.

Syntax:

Here is the syntax of this method:

```
public boolean startsWith(String prefix,int toffset)

or

public boolean startsWith(String prefix)
```

Parameters:

Here is the detail of parameters:

- **prefix** -- the prefix to be matched.
- **toffset** -- where to begin looking in the string.

Return Value:

- It returns true if the character sequence represented by the argument is a prefix of the character sequence represented by this string; false otherwise.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.startsWith("Welcome"));

    System.out.print("Return Value :");
    System.out.println(Str.startsWith("Tutorials"));

    System.out.print("Return Value :");
    System.out.println(Str.startsWith("Tutorials",11));
  }
}
```

This produces the following result:

```
Return Value :true
Return Value :false
Return Value :true
```

boolean startsWith(String prefix, int toffset)

Description:

This method has two variants and tests if a string starts with the specified prefix beginning a specified index or by default at the beginning.

Syntax:

Here is the syntax of this method:

```
public boolean startsWith(String prefix,int toffset)

or

public boolean startsWith(String prefix)
```

Parameters:

Here is the detail of parameters:

- **prefix** -- the prefix to be matched.

- **toffset** -- where to begin looking in the string.

Return Value:

- It returns true if the character sequence represented by the argument is a prefix of the character sequence represented by this string; false otherwise.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.startsWith("Welcome"));

    System.out.print("Return Value :");
    System.out.println(Str.startsWith("Tutorials"));

    System.out.print("Return Value :");
    System.out.println(Str.startsWith("Tutorials",11));
  }
}
```

This produces the following result:

```
Return Value :true
Return Value :false
Return Value :true
```

CharSequence subSequence(int beginIndex, int endIndex)

Description:

This method returns a new character sequence that is a subsequence of this sequence.

Syntax:

Here is the syntax of this method:

```
public CharSequence subSequence(int beginIndex,int endIndex)
```

Parameters:

Here is the detail of parameters:

- **beginIndex** -- the begin index, inclusive.
- **endIndex** -- the end index, exclusive.

Return Value:

- This method returns the specified subsequence.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.subSequence(0,10));

    System.out.print("Return Value :");
    System.out.println(Str.subSequence(10,15));
  }
}
```

This produces the following result:

```
Return Value :Welcome to
Return Value : Tuto
```

String substring(int beginIndex)

Description:

This method has two variants and returns a new string that is a substring of this string. The substring begins with the character at the specified index and extends to the end of this string or up to endIndex - 1 if second argument is given.

Syntax:

Here is the syntax of this method:

```
public String substring(int beginIndex)

or

public String substring(int beginIndex,int endIndex)
```

Parameters:

Here is the detail of parameters:

- **beginIndex** -- the begin index, inclusive.
- **endIndex** -- the end index, exclusive.

Return Value:

- The specified substring.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.substring(10));

    System.out.print("Return Value :");
    System.out.println(Str.substring(10,15));
}
}
```

This produces the following result:

```
Return Value : Tutorialspoint.com
Return Value : Tuto
```

String substring(int beginIndex, int endIndex)

Description:

This method has two variants and returns a new string that is a substring of this string. The substring begins with the character at the specified index and extends to the end of this string or up to endIndex - 1 if second argument is given.

Syntax:

Here is the syntax of this method:

```
public String substring(int beginIndex)

or

public String substring(int beginIndex,int endIndex)
```

Parameters:

Here is the detail of parameters:

- **beginIndex** -- the begin index, inclusive.
- **endIndex** -- the end index, exclusive.

Return Value:

- The specified substring.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.substring(10));

    System.out.print("Return Value :");
    System.out.println(Str.substring(10,15));
  }
}
```

This produces the following result:

```
Return Value : Tutorialspoint.com
Return Value : Tuto
```

char[] toCharArray()

Description:

This method converts this string to a new character array.

Syntax:

Here is the syntax of this method:

```
public char[] toCharArray()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- It returns a newly allocated character array, whose length is the length of this string and whose contents are initialized to contain the character sequence represented by this string.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
```

```
    System.out.println(Str.toCharArray());
  }
}
```

This produces the following result:

```
Return Value :Welcome to Tutorialspoint.com
```

String toLowerCase()

Description:

This method has two variants. First variant converts all of the characters in this String to lower case using the rules of the given Locale. This is equivalent to calling toLowerCase(Locale.getDefault()).

Second variant takes locale as an argument to be used while converting into lower case.

Syntax:

Here is the syntax of this method:

```
public String toLowerCase()

or

public String toLowerCase(Locale locale)
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- It returns the String, converted to lowercase.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.toLowerCase());
  }
}
```

This produces the following result:

```
Return Value :welcome to tutorialspoint.com
```

String toLowerCase(Locale locale)

Description:

This method has two variants. First variant converts all of the characters in this String to lower case using the rules of the given Locale. This is equivalent to calling toLowerCase(Locale.getDefault()).

Second variant takes locale as an argument to be used while converting into lower case.

Syntax:

Here is the syntax of this method:

```
public String toLowerCase()

or

public String toLowerCase(Locale locale)
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- It returns the String, converted to lowercase.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.toLowerCase());
}
}
```

This produces the following result:

```
Return Value :welcome to tutorialspoint.com
```

String toString()

Description:

This method returns itself a string

Syntax:

Here is the syntax of this method:

```
public String toString()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- This method returns the string itself.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.toString());
  }
}
```

This produces the following result:

```
Return Value :Welcome to Tutorialspoint.com
```

String toUpperCase()

Description:

This method has two variants. First variant converts all of the characters in this String to upper case using the rules of the given Locale. This is equivalent to calling toUpperCase(Locale.getDefault()).

Second variant takes locale as an argument to be used while converting into upper case.

Syntax:

Here is the syntax of this method:

```
public String toUpperCase()

or

public String toUpperCase(Locale locale)
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- It returns the String, converted to uppercase.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.toUpperCase());
  }
}
```

This produces the following result:

```
Return Value :WELCOME TO TUTORIALSPOINT.COM
```

String toUpperCase(Locale locale)

Description:

This method has two variants. First variant converts all of the characters in this String to upper case using the rules of the given Locale. This is equivalent to calling toUpperCase(Locale.getDefault()).

Second variant takes locale as an argument to be used while converting into upper case.

Syntax:

Here is the syntax of this method:

```
public String toUpperCase()

or
```

```
public String toUpperCase(Locale locale)
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- It returns the String, converted to uppercase.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("Welcome to Tutorialspoint.com");

    System.out.print("Return Value :");
    System.out.println(Str.toUpperCase());
  }
}
```

This produces the following result:

```
Return Value :WELCOME TO TUTORIALSPOINT.COM
```

String trim()

Description:

This method returns a copy of the string, with leading and trailing whitespace omitted.

Syntax:

Here is the syntax of this method:

```
public String trim()
```

Parameters:

Here is the detail of parameters:

- **NA**

Return Value:

- It returns a copy of this string with leading and trailing white space removed, or this string if it has no leading or trailing white space.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    StringStr = new String("   Welcome to Tutorialspoint.com   ");

    System.out.print("Return Value :");
    System.out.println(Str.trim());
  }
}
```

This produces the following result:

```
Return Value :Welcome to Tutorialspoint.com
```

static String valueOf(primitive data type x)

Description:

This method has followings variants, which depend on the passed parameters. This method returns the string representation of the passed argument.

- **valueOf(boolean b):** Returns the string representation of the boolean argument.
- **valueOf(char c):** Returns the string representation of the char argument.
- **valueOf(char[] data):** Returns the string representation of the char array argument.
- **valueOf(char[] data, int offset, int count):** Returns the string representation of a specific subarray of the char array argument.
- **valueOf(double d):** Returns the string representation of the double argument.
- **valueOf(float f):** Returns the string representation of the float argument.
- **valueOf(int i):** Returns the string representation of the int argument.
- **valueOf(long l):** Returns the string representation of the long argument.
- **valueOf(Object obj):** Returns the string representation of the Object argument.

Syntax:

Here is the syntax of this method:

```
Static String valueOf(boolean b)

or

static String valueOf(char c)

or

static String valueOf(char[] data)

or
```

```
static String valueOf(char[] data,int offset,int count)

or

static String valueOf(double d)

or

static String valueOf(float f)

or

static String valueOf(int i)

or

static String valueOf(long l)

or

staticString valueOf(Object obj)
```

Parameters:

Here is the detail of parameters:

- **See the description.**

Return Value :

- This method returns the string representation.

Example:

```
import java.io.*;

public class Test{
  public static void main(String args[]){
    double d = 102939939.939;
    boolean b = true;
    long l = 1232874;
    char[] arr = {'a','b','c','d','e','f','g'};

    System.out.println("Return Value : "+String.valueOf(d));
    System.out.println("Return Value : "+String.valueOf(b));
    System.out.println("Return Value : "+String.valueOf(l));
    System.out.println("Return Value : "+String.valueOf(arr));
  }
}
```

This produces the following result:

```
Return Value : 1.02939939939E8
Return Value : true
Return Value : 1232874
```

```
Return Value : abcdefg
```

CHAPTER

14

Java Arrays

Java provides a data structure, the **array**, which stores a fixed-size sequential collection of elements of the same type. An array is used to store a collection of data, but it is often more useful to think of an array as a collection of variables of the same type.

Instead of declaring individual variables, such as number0, number1, ..., and number99, you declare one array variable such as numbers and use numbers[0], numbers[1], and ..., numbers[99] to represent individual variables.

This tutorial introduces how to declare array variables, create arrays, and process arrays using indexed variables.

Declaring Array Variables:

To use an array in a program, you must declare a variable to reference the array, and you must specify the type of array the variable can reference. Here is the syntax for declaring an array variable:

```
dataType[] arrayRefVar;// preferred way.

or

dataType arrayRefVar[];//  works but not preferred way.
```

Note: The style **dataType[] arrayRefVar** is preferred. The style **dataType arrayRefVar[]** comes from the C/C++ language and was adopted in Java to accommodate C/C++ programmers.

Example:

The following code snippets are examples of this syntax:

```
double[] myList;// preferred way.

or

double myList[];//  works but not preferred way.
```

Creating Arrays:

You can create an array by using the new operator with the following syntax:

```
arrayRefVar   = new dataType[arraySize];
```

The above statement does two things:

- It creates an array using new dataType[arraySize];
- It assigns the reference of the newly created array to the variable arrayRefVar.

Declaring an array variable, creating an array, and assigning the reference of the array to the variable can be combined in one statement, as shown below:

```
dataType[] arrayRefVar = new dataType[arraySize];
```

Alternatively you can create arrays as follows:

```
dataType[] arrayRefVar = {value0, value1,..., valuek};
```

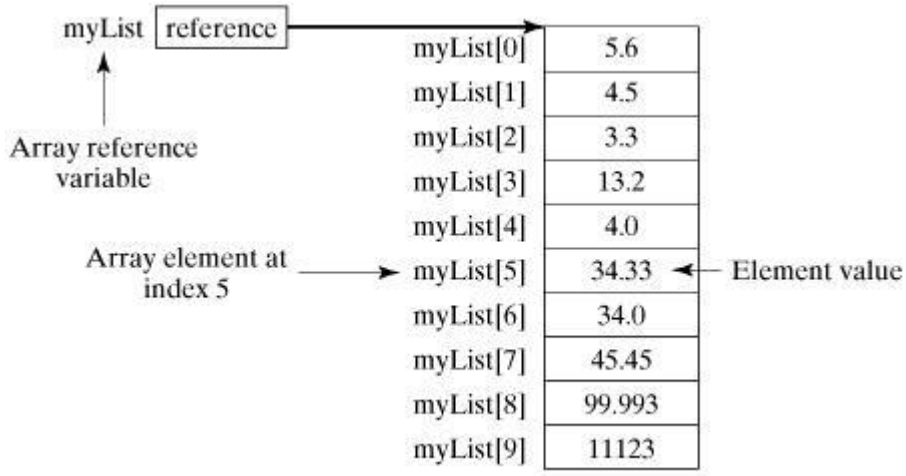
The array elements are accessed through the **index**. Array indices are 0-based; that is, they start from 0 to **arrayRefVar.length-1**.

Example:

Following statement declares an array variable, myList, creates an array of 10 elements of double type and assigns its reference to myList:

```
double[] myList = new double[10];
```

Following picture represents array myList. Here, myList holds ten double values and the indices are from 0 to 9.



Processing Arrays:

When processing array elements, we often use either for loop or foreach loop because all of the elements in an array are of the same type and the size of the array is known.

Example:

Here is a complete example of showing how to create, initialize and process arrays:

```
public class TestArray{

  public static void main(String[] args){
    double[] myList ={1.9,2.9,3.4,3.5};
    // Print all the array elements
    for(int i =0; i < myList.length; i++){
      System.out.println(myList[i]+" ");
```

```
    }
    // Summing all elements
    double total =0;
    for(int i =0; i < myList.length; i++){
      total += myList[i];
    }
    System.out.println("Total is "+ total);
    // Finding the largest element
    double max = myList[0];
    for(int i =1; i < myList.length; i++){
      if(myList[i]> max) max = myList[i];
    }
    System.out.println("Max is "+ max);
  }
}
```

This would produce the following result:

```
1.9
2.9
3.4
3.5
Totalis11.7
Maxis3.5
```

The foreach Loops:

JDK 1.5 introduced a new for loop known as foreach loop or enhanced for loop, which enables you to traverse the complete array sequentially without using an index variable.

Example:

The following code displays all the elements in the array myList:

```
public class TestArray{

  public static void main(String[] args){
    double[] myList ={1.9,2.9,3.4,3.5};

    // Print all the array elements
    for(double element: myList){
      System.out.println(element);
    }
  }
}
```

This would produce the following result:

```
1.9
2.9
3.4
3.5
```

Passing Arrays to Methods:

Just as you can pass primitive type values to methods, you can also pass arrays to methods. For example, the following method displays the elements in an int array:

```
public static void printArray(int[] array){
```

```
   for(int i =0; i < array.length; i++){
     System.out.print(array[i]+" ");
   }
}
```

You can invoke it by passing an array. For example, the following statement invokes the printArray method to display 3, 1, 2, 6, 4, and 2:

```
printArray(newint[]{3,1,2,6,4,2});
```

Returning an Array from a Method:

A method may also return an array. For example, the method shown below returns an array that is the reversal of another array:

```
publicstaticint[] reverse(int[] list){
   int[] result =newint[list.length];

   for(int i =0, j = result.length -1; i < list.length; i++, j--){
     result[j]= list[i];
   }
   return result;
}
```

The Arrays Class:

The java.util.Arrays class contains various static methods for sorting and searching arrays, comparing arrays, and filling array elements. These methods are overloaded for all primitive types.

SN	Methods with Description
1	**public static int binarySearch(Object[] a, Object key)** Searches the specified array of Object (Byte, Int , double, etc.) for the specified value using the binary search algorithm. The array must be sorted prior to making this call. This returns index of the search key, if it is contained in the list; otherwise, (-(insertion point + 1).
2	**public static boolean equals(long[] a, long[] a2)** Returns true if the two specified arrays of longs are equal to one another. Two arrays are considered equal if both arrays contain the same number of elements, and all corresponding pairs of elements in the two arrays are equal. This returns true if the two arrays are equal. Same method could be used by all other primitive data types (Byte, short, Int, etc.)
3	**public static void fill(int[] a, int val)** Assigns the specified int value to each element of the specified array of ints. Same method could be used by all other primitive data types (Byte, short, Int, etc.)
4	**public static void sort(Object[] a)** Sorts the specified array of objects into ascending order, according to the natural ordering of its elements. Same method could be used by all other primitive data types (Byte, short, Int, etc.)

CHAPTER

15

Java Date & Time

Java provides the **Date** class available in **java.util** package, this class encapsulates the current date and time.

The Date class supports two constructors. The first constructor initializes the object with the current date and time.

```
Date()
```

The following constructor accepts one argument that equals the number of milliseconds that have elapsed since midnight, January 1, 1970

```
Date(long millisec)
```

Once you have a Date object available, you can call any of the following support methods to play with dates:

SN	Methods with Description
1	**boolean after(Date date)** Returns true if the invoking Date object contains a date that is later than the one specified by date, otherwise, it returns false.
2	**boolean before(Date date)** Returns true if the invoking Date object contains a date that is earlier than the one specified by date, otherwise, it returns false.
3	**Object clone( )** Duplicates the invoking Date object.
4	**int compareTo(Date date)** Compares the value of the invoking object with that of date. Returns 0 if the values are equal. Returns a negative value if the invoking object is earlier than date. Returns a positive value if the invoking object is later than date.
5	**int compareTo(Object obj)** Operates identically to compareTo(Date) if obj is of class Date. Otherwise, it throws a ClassCastException.
6	**boolean equals(Object date)** Returns true if the invoking Date object contains the same time and date as the one specified by date, otherwise, it returns false.
7	**long getTime( )** Returns the number of milliseconds that have elapsed since January 1, 1970.
8	**int hashCode( )**

	Returns a hash code for the invoking object.
9	**void setTime(long time)** Sets the time and date as specified by time, which represents an elapsed time in milliseconds from midnight, January 1, 1970
10	**String toString( )** Converts the invoking Date object into a string and returns the result.

Getting Current Date & Time

This is very easy to get current date and time in Java. You can use a simple Date object with *toString()*method to print current date and time as follows:

```
import java.util.Date;

public class DateDemo{
  public static void main(String args[]){
    // Instantiate a Date object
    Date date = new Date();

    // display time and date using toString()
    System.out.println(date.toString());
  }
}
```

This would produce the following result:

```
MonMay0409:51:52 CDT 2009
```

Date Comparison:

There are following three ways to compare two dates:

- You can use getTime( ) to obtain the number of milliseconds that have elapsed since midnight, January 1, 1970, for both objects and then compare these two values.
- You can use the methods before( ), after( ), and equals( ). Because the 12th of the month comes before the 18th, for example, new Date(99, 2, 12).before(new Date (99, 2, 18)) returns true.
- You can use the compareTo( ) method, which is defined by the Comparable interface and implemented by Date.

Date Formatting using SimpleDateFormat:

SimpleDateFormat is a concrete class for formatting and parsing dates in a locale-sensitive manner. SimpleDateFormat allows you to start by choosing any user-defined patterns for date-time formatting. For example:

```
import java.util.*;
import java.text.*;

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

    Date dNow = new Date();
    SimpleDateFormat ft =
    newSimpleDateFormat("E yyyy.MM.dd 'at' hh:mm:ss a zzz");
```

```
    System.out.println("Current Date: "+ ft.format(dNow));
  }
}
```

This would produce the following result:

```
CurrentDate:Sun2004.07.18 at 04:14:09 PM PDT
```

Simple DateFormat format codes:

To specify the time format, use a time pattern string. In this pattern, all ASCII letters are reserved as pattern letters, which are defined as the following:

Character	Description	Example
G	Era designator	AD
Y	Year in four digits	2001
M	Month in year	July or 07
D	Day in month	10
H	Hour in A.M./P.M. (1~12)	12
H	Hour in day (0~23)	22
M	Minute in hour	30
S	Second in minute	55
S	Millisecond	234
E	Day in week	Tuesday
D	Day in year	360
F	Day of week in month	2 (second Wed. in July)
W	Week in year	40
W	Week in month	1
A	A.M./P.M. marker	PM
K	Hour in day (1~24)	24
K	Hour in A.M./P.M. (0~11)	10
Z	Time zone	Eastern Standard Time
'	Escape for text	Delimiter
"	Single quote	`

Date Formatting using printf:

Date and time formatting can be done very easily using **printf** method. You use a two-letter format, starting with **t** and ending in one of the letters of the table given below. For example:

```
import java.util.Date;
```

```
public class DateDemo{

  public static void main(String args[]){
    // Instantiate a Date object
    Date date = new Date();

    // display time and date using toString()
    String str = String.format("Current Date/Time : %tc", date );

    System.out.printf(str);
  }
}
```

This would produce the following result:

```
CurrentDate/Time:SatDec1516:37:57 MST 2012
```

It would be a bit silly if you had to supply the date multiple times to format each part. For that reason, a format string can indicate the index of the argument to be formatted.

The index must immediately follow the % and it must be terminated by a $. For example:

```
import java.util.Date;

public class DateDemo{

  public static void main(String args[]){
    // Instantiate a Date object
    Date date = new Date();

    // display time and date using toString()
    System.out.printf("%1$s %2$tB %2$td, %2$tY",
    "Due date:", date);
  }
}
```

This would produce the following result:

```
Due date:February09,2004
```

Alternatively, you can use the < flag. It indicates that the same argument as in the preceding format specification should be used again. For example:

```
import java.util.Date;

public class DateDemo{

  public static void main(String args[]){
    // Instantiate a Date object
    Date date = new Date();

    // display formatted date
    System.out.printf("%s %tB %<te, %<tY",
    "Due date:", date);
  }
}
```

This would produce the following result:

```
Due date:February09,2004
```

Date and Time Conversion Characters:

Character	Description	Example
c	Complete date and time	Mon May 04 09:51:52 CDT 2009
F	ISO 8601 date	2004-02-09
D	U.S. formatted date (month/day/year)	02/09/2004
T	24-hour time	18:05:19
r	12-hour time	06:05:19 pm
R	24-hour time, no seconds	18:05
Y	Four-digit year (with leading zeroes)	2004
y	Last two digits of the year (with leading zeroes)	04
C	First two digits of the year (with leading zeroes)	20
B	Full month name	February
b	Abbreviated month name	Feb
m	Two-digit month (with leading zeroes)	02
d	Two-digit day (with leading zeroes)	03
e	Two-digit day (without leading zeroes)	9
A	Full weekday name	Monday
a	Abbreviated weekday name	Mon
j	Three-digit day of year (with leading zeroes)	069
H	Two-digit hour (with leading zeroes), between 00 and 23	18
k	Two-digit hour (without leading zeroes), between 0 and 23	18
I	Two-digit hour (with leading zeroes), between 01 and 12	06
l	Two-digit hour (without leading zeroes), between 1 and 12	6
M	Two-digit minutes (with leading zeroes)	05
S	Two-digit seconds (with leading zeroes)	19
L	Three-digit milliseconds (with leading zeroes)	047
N	Nine-digit nanoseconds (with leading zeroes)	047000000
P	Uppercase morning or afternoon marker	PM
p	Lowercase morning or afternoon marker	pm
z	RFC 822 numeric offset from GMT	-0800
Z	Time zone	PST
s	Seconds since 1970-01-01 00:00:00 GMT	1078884319

Q	Milliseconds since 1970-01-01 00:00:00 GMT	1078884319047

There are other useful classes related to Date and time. For more details, you can refer to Java Standard documentation.

Parsing Strings into Dates:

The SimpleDateFormat class has some additional methods, notably parse( ) , which tries to parse a string according to the format stored in the given SimpleDateFormat object. For example:

```
import java.util.*;
import java.text.*;

public class DateDemo{

  public static void main(String args[]){
    SimpleDateFormat ft = new SimpleDateFormat("yyyy-MM-dd");

    String input = args.length ==0?"1818-11-11": args[0];

    System.out.print(input +" Parses as ");

    Date t;

    try{
       t = ft.parse(input);
       System.out.println(t);
    }catch(ParseException e){
       System.out.println("Unparseable using "+ ft);
    }
  }
}
```

A sample run of the above program would produce the following result:

```
$ java DateDemo
1818-11-11ParsesasWedNov1100:00:00 GMT 1818
$ java DateDemo2007-12-01
2007-12-01ParsesasSatDec0100:00:00 GMT 2007
```

Sleeping for a While:

You can sleep for any period of time from one millisecond up to the lifetime of your computer. For example, following program would sleep for 10 seconds:

```
import java.util.*;

public class SleepDemo{
  public static void main(String args[]){
    try{
      System.out.println(newDate()+"\n");
      Thread.sleep(5*60*10);
      System.out.println(newDate()+"\n");
    }catch(Exception e){
      System.out.println("Got an exception!");
    }
  }
}
```

This would produce the following result:

```
SunMay0318:04:41 GMT 2009

SunMay0318:04:51 GMT 2009
```

Measuring Elapsed Time:

Sometimes, you may need to measure point in time in milliseconds. So let's rewrite above example once again:

```
import java.util.*;

public class DiffDemo{

  public static void main(String args[]){
    try{
      long start = System.currentTimeMillis();
      System.out.println(newDate()+"\n");
      Thread.sleep(5*60*10);
      System.out.println(newDate()+"\n");
      long end = System.currentTimeMillis();
      long diff = end- start;
      System.out.println("Difference is : "+ diff);
    }catch(Exception e){
      System.out.println("Got an exception!");
    }
  }
}
```

This would produce the following result:

```
SunMay0318:16:51 GMT 2009

SunMay0318:16:57 GMT 2009

Differenceis:5993
```

GregorianCalendar Class:

GregorianCalendar is a concrete implementation of a Calendar class that implements the normal Gregorian calendar with which you are familiar. I did not discuss Calendar class in this tutorial, you can look standard Java documentation for this.

The **getInstance( )** method of Calendar returns a GregorianCalendar initialized with the current date and time in the default locale and time zone. GregorianCalendar defines two fields: AD and BC. These represent the two eras defined by the Gregorian calendar.

There are also several constructors for GregorianCalendar objects:

SN	Constructor with Description
1	**GregorianCalendar()** Constructs a default GregorianCalendar using the current time in the default time zone with the default locale.
2	**GregorianCalendar(int year, int month, int date)** Constructs a GregorianCalendar with the given date set in the default time zone with the default locale.
3	**GregorianCalendar(int year, int month, int date, int hour, int minute)** Constructs a GregorianCalendar with the given date and time set for the default time zone with the default locale.

4	**GregorianCalendar(int year, int month, int date, int hour, int minute, int second)** Constructs a GregorianCalendar with the given date and time set for the default time zone with the default locale.
5	**GregorianCalendar(Locale aLocale)** Constructs a GregorianCalendar based on the current time in the default time zone with the given locale.
6	**GregorianCalendar(TimeZone zone)** Constructs a GregorianCalendar based on the current time in the given time zone with the default locale.
7	**GregorianCalendar(TimeZone zone, Locale aLocale)** Constructs a GregorianCalendar based on the current time in the given time zone with the given locale.

Here is the list of few useful support methods provided by GregorianCalendar class:

SN	Methods with Description
1	**void add(int field, int amount)** Adds the specified (signed) amount of time to the given time field, based on the calendar's rules.
2	**protected void computeFields()** Converts UTC as milliseconds to time field values.
3	**protected void computeTime()** Overrides Calendar Converts time field values to UTC as milliseconds.
4	**boolean equals(Object obj)** Compares this GregorianCalendar to an object reference.
5	**int get(int field)** Gets the value for a given time field.
6	**int getActualMaximum(int field)** Return the maximum value that this field could have, given the current date.
7	**int getActualMinimum(int field)** Return the minimum value that this field could have, given the current date.
8	**int getGreatestMinimum(int field)** Returns highest minimum value for the given field if varies.
9	**Date getGregorianChange()** Gets the Gregorian Calendar change date.
10	**int getLeastMaximum(int field)** Returns lowest maximum value for the given field if varies.
11	**int getMaximum(int field)** Returns maximum value for the given field.
12	**Date getTime()** Gets this Calendar's current time.
13	**long getTimeInMillis()** Gets this Calendar's current time as a long.
14	**TimeZone getTimeZone()** Gets the time zone.
15	**int getMinimum(int field)** Returns minimum value for the given field.
16	**int hashCode()**

	Override hashCode.
17	**boolean isLeapYear(int year)** Determines if the given year is a leap year.
18	**void roll(int field, boolean up)** Adds or subtracts (up/down) a single unit of time on the given time field without changing larger fields.
19	**void set(int field, int value)** Sets the time field with the given value.
20	**void set(int year, int month, int date)** Sets the values for the fields year, month, and date.
21	**void set(int year, int month, int date, int hour, int minute)** Sets the values for the fields year, month, date, hour, and minute.
22	**void set(int year, int month, int date, int hour, int minute, int second)** Sets the values for the fields year, month, date, hour, minute, and second.
23	**void setGregorianChange(Date date)** Sets the GregorianCalendar change date.
24	**void setTime(Date date)** Sets this Calendar's current time with the given Date.
25	**void setTimeInMillis(long millis)** Sets this Calendar's current time from the given long value.
26	**void setTimeZone(TimeZone value)** Sets the time zone with the given time zone value.
27	**String toString()** Return a string representation of this calendar.

Example:

```
import java.util.*;

public class GregorianCalendarDemo{

  public static void main(String args[]){
    String months[]={
    "Jan","Feb","Mar","Apr",
    "May","Jun","Jul","Aug",
    "Sep","Oct","Nov","Dec"};

    int year;
    // Create a Gregorian calendar initialized
    // with the current date and time in the
    // default locale and timezone.
    GregorianCalendar gcalendar = newGregorianCalendar();
    // Display current time and date information.
    System.out.print("Date: ");
    System.out.print(months[gcalendar.get(Calendar.MONTH)]);
    System.out.print(" "+ gcalendar.get(Calendar.DATE)+" ");
    System.out.println(year = gcalendar.get(Calendar.YEAR));
    System.out.print("Time: ");
    System.out.print(gcalendar.get(Calendar.HOUR)+":");
    System.out.print(gcalendar.get(Calendar.MINUTE)+":");
    System.out.println(gcalendar.get(Calendar.SECOND));
```

```
   // Test if the current year is a leap year
   if(gcalendar.isLeapYear(year)){
     System.out.println("The current year is a leap year");
   }
   else{
     System.out.println("The current year is not a leap year");
   }
  }
}
```

This would produce the following result:

```
Date:Apr222009
Time:11:25:27
The current year isnot a leap year
```

For a complete list of constant available in Calendar class, you can refer to standard Java documentation.

CHAPTER

16

Java Regular Expressions

Java provides the java.util.regex package for pattern matching with regular expressions. Java regular expressions are very similar to the Perl programming language and very easy to learn.

A regular expression is a special sequence of characters that helps you match or find other strings or sets of strings, using a specialized syntax held in a pattern. They can be used to search, edit, or manipulate text and data.

The java.util.regex package primarily consists of the following three classes:

- **Pattern Class:** A Pattern object is a compiled representation of a regular expression. The Pattern class provides no public constructors. To create a pattern, you must first invoke one of its public static compile methods, which will then return a Pattern object. These methods accept a regular expression as the first argument.
- **Matcher Class:** A Matcher object is the engine that interprets the pattern and performs match operations against an input string. Like the Pattern class, Matcher defines no public constructors. You obtain a Matcher object by invoking the matcher method on a Pattern object.
- **PatternSyntaxException:** A PatternSyntaxException object is an unchecked exception that indicates a syntax error in a regular expression pattern.

Capturing Groups:

Capturing groups are a way to treat multiple characters as a single unit. They are created by placing the characters to be grouped inside a set of parentheses. For example, the regular expression (dog) creates a single group containing the letters "d", "o", and "g".

Capturing groups are numbered by counting their opening parentheses from left to right. In the expression ((A)(B(C))), for example, there are four such groups:

- ((A)(B(C)))
- (A)
- (B(C))
- (C)

To find out how many groups are present in the expression, call the groupCount method on a matcher object. The groupCount method returns an int showing the number of capturing groups present in the matcher's pattern.

There is also a special group, group 0, which always represents the entire expression. This group is not included in the total reported by groupCount.

Example:

Following example illustrates how to find a digit string from the given alphanumeric string:

```
import java.util.regex.Matcher;
import java.util.regex.Pattern;

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

    // String to be scanned to find the pattern.
    String line ="This order was places for QT3000! OK?";
    String pattern ="(.*)(\\d+)(.*)";

    // Create a Pattern object
    Pattern r =Pattern.compile(pattern);

    // Now create matcher object.
    Matcher m = r.matcher(line);
    if(m.find()){
      System.out.println("Found value: "+ m.group(0));
      System.out.println("Found value: "+ m.group(1));
      System.out.println("Found value: "+ m.group(2));
    }else{
      System.out.println("NO MATCH");
    }
  }
}
```

This would produce the following result:

```
Found value:This order was places for QT3000! OK?
Found value:This order was places for QT300
Found value:0
```

Regular Expression Syntax:

Here is the table listing down all the regular expression metacharacter syntax available in Java:

Subexpression	Matches
^	Matches beginning of line.
$	Matches end of line.
.	Matches any single character except newline. Using m option allows it to match newline as well.
[...]	Matches any single character in brackets.
[^...]	Matches any single character not in brackets
\A	Beginning of entire string
\z	End of entire string
\Z	End of entire string except allowable final line terminator.

re*	Matches 0 or more occurrences of preceding expression.
re+	Matches 1 or more of the previous thing
re?	Matches 0 or 1 occurrence of preceding expression.
re{ n}	Matches exactly n number of occurrences of preceding expression.
re{ n,}	Matches n or more occurrences of preceding expression.
re{ n, m}	Matches at least n and at most m occurrences of preceding expression.
a| b	Matches either a or b.
(re)	Groups regular expressions and remembers matched text.
(?: re)	Groups regular expressions without remembering matched text.
(?> re)	Matches independent pattern without backtracking.
\w	Matches word characters.
\W	Matches nonword characters.
\s	Matches whitespace. Equivalent to [\t\n\r\f].
\S	Matches nonwhitespace.
\d	Matches digits. Equivalent to [0-9].
\D	Matches nondigits.
\A	Matches beginning of string.
\Z	Matches end of string. If a newline exists, it matches just before newline.
\z	Matches end of string.
\G	Matches point where last match finished.
\n	Back-reference to capture group number "n"
\b	Matches word boundaries when outside brackets. Matches backspace (0x08) when inside brackets.
\B	Matches nonword boundaries.
\n, \t, etc.	Matches newlines, carriage returns, tabs, etc.
\Q	Escape (quote) all characters up to \E
\E	Ends quoting begun with \Q

Methods of the Matcher Class:

Here is a list of useful instance methods:

Index Methods:

Index methods provide useful index values that show precisely where the match was found in the input string:

SN	Methods with Description

1	**public int start()** Returns the start index of the previous match.
2	**public int start(int group)** Returns the start index of the subsequence captured by the given group during the previous match operation.
3	**public int end()** Returns the offset after the last character matched.
4	**public int end(int group)** Returns the offset after the last character of the subsequence captured by the given group during the previous match operation.

Study Methods:

Study methods review the input string and return a Boolean indicating whether or not the pattern is found:

SN	Methods with Description
1	**public boolean lookingAt()** Attempts to match the input sequence, starting at the beginning of the region, against the pattern.
2	**public boolean find()** Attempts to find the next subsequence of the input sequence that matches the pattern.
3	**public boolean find(int start** Resets this matcher and then attempts to find the next subsequence of the input sequence that matches the pattern, starting at the specified index.
4	**public boolean matches()** Attempts to match the entire region against the pattern.

Replacement Methods:

Replacement methods are useful methods for replacing text in an input string:

SN	Methods with Description
1	**public Matcher appendReplacement(StringBuffer sb, String replacement)** Implements a non-terminal append-and-replace step.
2	**public StringBuffer appendTail(StringBuffer sb)** Implements a terminal append-and-replace step.
3	**public String replaceAll(String replacement)** Replaces every subsequence of the input sequence that matches the pattern with the given replacement string.
4	**public String replaceFirst(String replacement)** Replaces the first subsequence of the input sequence that matches the pattern with the given replacement string.
5	**public static String quoteReplacement(String s)** Returns a literal replacement String for the specified String. This method produces a String that will work as a literal replacement s in the appendReplacement method of the Matcher class.

The start and end Methods:

Following is the example that counts the number of times the word "cats" appears in the input string:

```
import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class RegexMatches
{
   private static finalString REGEX = "\\bcat\\b";
   private static finalString INPUT = "cat cat cat cattie cat";

   public static void main(String args[]){
     Pattern p =Pattern.compile(REGEX);
     Matcher m = p.matcher(INPUT);// get a matcher object
     int count =0;

     while(m.find()){
       count++;
       System.out.println("Match number "+count);
       System.out.println("start(): "+m.start());
       System.out.println("end(): "+m.end());
     }
   }
}
```

This would produce the following result:

```
Match number 1
start():0
end():3
Match number 2
start():4
end():7
Match number 3
start():8
end():11
Match number 4
start():19
end():22
```

You can see that this example uses word boundaries to ensure that the letters "c" "a" "t" are not merely a substring in a longer word. It also gives some useful information about where in the input string the match has occurred.

The start method returns the start index of the subsequence captured by the given group during the previous match operation, and end returns the index of the last character matched, plus one.

The *matches* and *lookingAt* Methods:

The matches and lookingAt methods both attempt to match an input sequence against a pattern. The difference, however, is that matches requires the entire input sequence to be matched, while lookingAt does not.

Both methods always start at the beginning of the input string. Here is the example explaining the functionality:

```
import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class RegexMatches
{
   private static final String REGEX ="foo";
   private static final String INPUT ="fooooooooooooooooo";
   private static Pattern pattern;
   private static Matcher matcher;
```

```
   public static void main(String args[]){
     pattern = Pattern.compile(REGEX);
     matcher = pattern.matcher(INPUT);

     System.out.println("Current REGEX is: "+REGEX);
     System.out.println("Current INPUT is: "+INPUT);

     System.out.println("lookingAt(): "+matcher.lookingAt());
     System.out.println("matches(): "+matcher.matches());
  }
}
```

This would produce the following result:

```
Current REGEX is: foo
Current INPUT is: fooooooooooooooooo
lookingAt():true
matches():false
```

The *replaceFirst* and *replaceAll* Methods:

The replaceFirst and replaceAll methods replace text that matches a given regular expression. As their names indicate, replaceFirst replaces the first occurrence, and replaceAll replaces all occurrences.

Here is the example explaining the functionality:

```
import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class RegexMatches
{
  private staticString REGEX = "dog";
  private staticString INPUT = "The dog says meow. "+"All dogs say meow.";
  private staticString REPLACE = "cat";

  public static void main(String[] args){
    Pattern p =Pattern.compile(REGEX);
    // get a matcher object
    Matcher m = p.matcher(INPUT);
    INPUT = m.replaceAll(REPLACE);
    System.out.println(INPUT);
  }
}
```

This would produce the following result:

```
The cat says meow.All cats say meow.
```

The *appendReplacement* and *appendTail* Methods:

The Matcher class also provides appendReplacement and appendTail methods for text replacement.

Here is the example explaining the functionality:

```
import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class RegexMatches
{
   private staticString REGEX ="a*b";
```

```
   private staticString INPUT ="aabfooaabfooabfoob";
   private staticString REPLACE ="-";
   public static void main(String[] args){
     Pattern p = Pattern.compile(REGEX);
     // get a matcher object
     Matcher m = p.matcher(INPUT);
     StringBuffer sb =new StringBuffer();
     while(m.find()){
       m.appendReplacement(sb,REPLACE);
     }
     m.appendTail(sb);
     System.out.println(sb.toString());
   }
}
```

This would produce the following result:

```
-foo-foo-foo-
```

PatternSyntaxException Class Methods:

A PatternSyntaxException is an unchecked exception that indicates a syntax error in a regular expression pattern. The PatternSyntaxException class provides the following methods to help you determine what went wrong:

SN	Methods with Description
1	**public String getDescription()** Retrieves the description of the error.
2	**public int getIndex()** Retrieves the error index.
3	**public String getPattern()** Retrieves the erroneous regular expression pattern.
4	**public String getMessage()** Returns a multi-line string containing the description of the syntax error and its index, the erroneous regular expression pattern, and a visual indication of the error index within the pattern.

CHAPTER

17

Java Methods

A Javamethod is a collection of statements that are grouped together to perform an operation. When you call the System.out.println method, for example, the system actually executes several statements in order to display a message on the console.

Now you will learn how to create your own methods with or without return values, invoke a method with or without parameters, overload methods using the same names, and apply method abstraction in the program design.

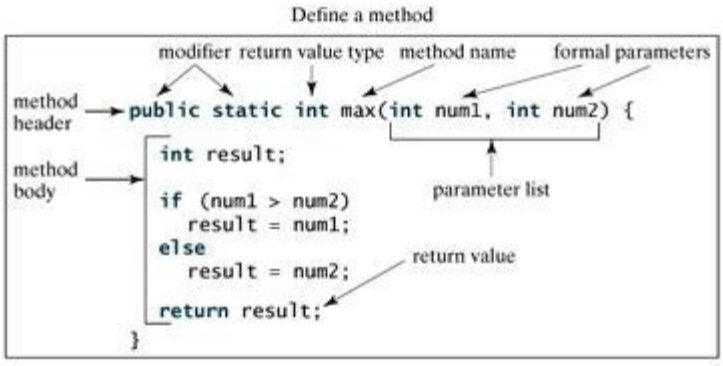
Creating a Method:

In general, a method has the following syntax:

```
modifier returnValueType methodName(list of parameters){
// Method body;
}
```

A method definition consists of a method header and a method body. Here are all the parts of a method:

- **Modifiers:** The modifier, which is optional, tells the compiler how to call the method. This defines the access type of the method.
- **Return Type:** A method may return a value. The returnValueType is the data type of the value the method returns. Some methods perform the desired operations without returning a value. In this case, the returnValueType is the keyword **void**.
- **Method Name:** This is the actual name of the method. The method name and the parameter list together constitute the method signature.
- **Parameters:** A parameter is like a placeholder. When a method is invoked, you pass a value to the parameter. This value is referred to as actual parameter or argument. The parameter list refers to the type, order, and number of the parameters of a method. Parameters are optional; that is, a method may contain no parameters.
- **Method Body:** The method body contains a collection of statements that define what the method does.



Note: In certain other languages, methods are referred to as procedures and functions. A method with a nonvoid return value type is called a function; a method with a void return value type is called a procedure.

Example:

Here is the source code of the above defined method called max(). This method takes two parameters num1 and num2 and returns the maximum between the two:

```
/** Return the max between two numbers */
public static int max(int num1,int num2){
int result;
if(num1 > num2)
    result = num1;
else
    result = num2;

return result;
}
```

Calling a Method:

In creating a method, you give a definition of what the method is to do. To use a method, you have to call or invoke it. There are two ways to call a method; the choice is based on whether the method returns a value or not.

When a program calls a method, program control is transferred to the called method. A called method returns control to the caller when its return statement is executed or when its method-ending closing brace is reached.

If the method returns a value, a call to the method is usually treated as a value. For example:

```
int larger = max(30,40);
```

If the method returns void, a call to the method must be a statement. For example, the method println returns void. The following call is a statement:

```
System.out.println("Welcome to Java!");
```

Example:

Following is the example to demonstrate how to define a method and how to call it:

```
public class TestMax{
/** Main method */
public static void main(String[] args){
int i =5;
```

```
int j =2;
int k = max(i, j);
System.out.println("The maximum between "+ i +
" and "+ j +" is "+ k);
}

/** Return the max between two numbers */
publicstaticint max(int num1,int num2){
int result;
if(num1 > num2)
     result = num1;
else
     result = num2;

return result;
}
}
```

This would produce the following result:

```
The maximum between 5and2is5
```

This program contains the main method and the max method. The main method is just like any other method except that it is invoked by the JVM.

The main method's header is always the same, like the one in this example, with the modifiers public and static, return value type void, method name main, and a parameter of the String[] type. String[] indicates that the parameter is an array of String.

The void Keyword:

This section shows how to declare and invoke a void method. Following example gives a program that declares a method named printGrade and invokes it to print the grade for a given score.

Example:

```
public class TestVoidMethod{

  public static void main(String[] args){
    printGrade(78.5);
  }

  public static void printGrade(double score){
    if(score >=90.0){
      System.out.println('A');
    }
    elseif(score >=80.0){
      System.out.println('B');
    }
    elseif(score >=70.0){
      System.out.println('C');
    }
    elseif(score >=60.0){
      System.out.println('D');
    }
    else{
      System.out.println('F');
    }
  }
```

```
}
```

This would produce the following result:

```
C
```

Here the printGrade method is a void method. It does not return any value. A call to a void method must be a statement. So, it is invoked as a statement in line 3 in the main method. This statement is like any Java statement terminated with a semicolon.

Passing Parameters by Values:

When calling a method, you need to provide arguments, which must be given in the same order as their respective parameters in the method specification. This is known as parameter order association.

For example, the following method prints a message n times:

```
public static void nPrintln(String message,int n){
  for(int i =0; i < n; i++)
    System.out.println(message);
}
```

Here, you can use nPrintln("Hello", 3) to print "Hello" three times. The nPrintln("Hello", 3) statement passes the actual string parameter, "Hello", to the parameter, message; passes 3 to n; and prints "Hello" three times. However, the statement nPrintln(3, "Hello") would be wrong.

When you invoke a method with a parameter, the value of the argument is passed to the parameter. This is referred to as pass-by-value. If the argument is a variable rather than a literal value, the value of the variable is passed to the parameter. The variable is not affected, regardless of the changes made to the parameter inside the method.

For simplicity, Java programmers often say passing an argument x to a parameter y, which actually means passing the value of x to y.

Example:

Following is a program that demonstrates the effect of passing by value. The program creates a method for swapping two variables. The swap method is invoked by passing two arguments. Interestingly, the values of the arguments are not changed after the method is invoked.

```
public class TestPassByValue{

  public static void main(String[] args){
    int num1 =1;
    int num2 =2;

    System.out.println("Before swap method, num1 is "+ num1 +" and num2 is "+ num2);

    // Invoke the swap method
    swap(num1, num2);
    System.out.println("After swap method, num1 is "+ num1 +" and num2 is "+ num2);
  }
  /** Method to swap two variables */
  public static void swap(int n1,int n2){
    System.out.println("\tInside the swap method");
    System.out.println("\t\tBefore swapping n1 is "+ n1 +" n2 is "+ n2);
    // Swap n1 with n2
    int temp = n1;
    n1 = n2;
    n2 = temp;
```

```
    System.out.println("\t\tAfter swapping n1 is "+ n1 +" n2 is "+ n2);
  }
}
```

This would produce the following result:

```
Before swap method, num1 is1and num2 is2
Inside the swap method
Before swapping n1 is1 n2 is2
After swapping n1 is2 n2 is1
After swap method, num1 is1and num2 is2
```

Overloading Methods:

The max method that was used earlier works only with the int data type. But what if you need to find which of two floating-point numbers has the maximum value? The solution is to create another method with the same name but different parameters, as shown in the following code:

```
public static double max(double num1,double num2){
  if(num1 > num2)
    return num1;
  else
    return num2;
}
```

If you call max with int parameters, the max method that expects int parameters will be invoked; if you call max with double parameters, the max method that expects double parameters will be invoked. This is referred to as **method overloading**; that is, two methods have the same name but different parameter lists within one class.

The Java compiler determines which method is used based on the method signature. Overloading methods can make programs clearer and more readable. Methods that perform closely related tasks should be given the same name.

Overloaded methods must have different parameter lists. You cannot overload methods based on different modifiers or return types. Sometimes there are two or more possible matches for an invocation of a method due to similar method signature, so the compiler cannot determine the most specific match. This is referred to as ambiguous invocation.

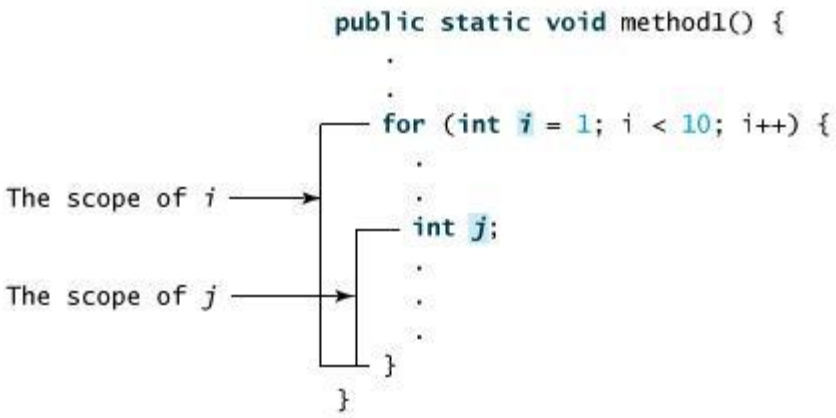
The Scope of Variables:

The scope of a variable is the part of the program where the variable can be referenced. A variable defined inside a method is referred to as a local variable.

The scope of a local variable starts from its declaration and continues to the end of the block that contains the variable. A local variable must be declared before it can be used.

A parameter is actually a local variable. The scope of a method parameter covers the entire method.

A variable declared in the initial action part of a for loop header has its scope in the entire loop. But a variable declared inside a for loop body has its scope limited in the loop body from its declaration to the end of the block that contains the variable as shown below:



You can declare a local variable with the same name multiple times in different non-nesting blocks in a method, but you cannot declare a local variable twice in nested blocks.

Using Command-Line Arguments:

Sometimes you will want to pass information into a program when you run it. This is accomplished by passing command-line arguments to main( ).

A command-line argument is the information that directly follows the program's name on the command line when it is executed. To access the command-line arguments inside a Java program is quite easy.they are stored as strings in the String array passed to main( ).

Example:

The following program displays all of the command-line arguments that it is called with:

```
public class CommandLine {

  public static void main(String args[]){
    for(int i=0; i<args.length; i++){
      System.out.println("args["+ i +"]: "+args[i]);
    }
  }
}
```

Try executing this program as shown here:

```
java CommandLine this is a command line 200-100
```

This would produce the following result:

```
args[0]:this
args[1]:is
args[2]: a
args[3]: command
args[4]: line
args[5]:200
args[6]:-100
```

The Constructors:

A constructor initializes an object when it is created. It has the same name as its class and is syntactically similar to a method. However, constructors have no explicit return type.

Typically, you will use a constructor to give initial values to the instance variables defined by the class, or to perform any other startup procedures required to create a fully formed object.

All classes have constructors, whether you define one or not, because Java automatically provides a default constructor that initializes all member variables to zero. However, once you define your own constructor, the default constructor is no longer used.

Example:

Here is a simple example that uses a constructor:

```
// A simple constructor.
class MyClass{
  int x;

  // Following is the constructor
  MyClass(){
     x =10;
  }
}
```

You would call constructor to initialize objects as follows:

```
public class ConsDemo{

  public static void main(String args[]){
    MyClass t1 =newMyClass();
    MyClass t2 =newMyClass();
    System.out.println(t1.x +" "+ t2.x);
  }
}
```

Most often, you will need a constructor that accepts one or more parameters. Parameters are added to a constructor in the same way that they are added to a method, just declare them inside the parentheses after the constructor's name.

Example:

Here is a simple example that uses a constructor:

```
// A simple constructor.
class MyClass{
  int x;

  // Following is the constructor
  MyClass(int i ){
     x = i;
  }
}
```

You would call constructor to initialize objects as follows:

```
public class ConsDemo{
```

```
public static void main(String args[]){
  MyClass t1 = new MyClass(10);
  MyClass t2 = new MyClass(20);
  System.out.println(t1.x +" "+ t2.x);
 }
}
```

This would produce the following result:

```
1020
```

Variable Arguments(var-args):

JDK 1.5 enables you to pass a variable number of arguments of the same type to a method. The parameter in the method is declared as follows:

```
typeName... parameterName
```

In the method declaration, you specify the type followed by an ellipsis (...) Only one variable-length parameter may be specified in a method, and this parameter must be the last parameter. Any regular parameters must precede it.

Example:

```
public class VarargsDemo{

  public static void main(String args[]){
    // Call method with variable args
    printMax(34,3,3,2,56.5);
    printMax(newdouble[]{1,2,3});
  }

  public static void printMax(double... numbers){
    if(numbers.length ==0){
      System.out.println("No argument passed");
      return;
    }

  double result = numbers[0];

  for(int i =1; i <  numbers.length; i++)
  if(numbers[i]>  result)
      result = numbers[i];
  System.out.println("The max value is "+ result);
 }
}
```

This would produce the following result:

```
The max value is56.5
The max value is3.0
```

The finalize( ) Method:

It is possible to define a method that will be called just before an object's final destruction by the garbage collector. This method is called **finalize( )**, and it can be used to ensure that an object terminates cleanly.

For example, you might use finalize( ) to make sure that an open file owned by that object is closed.

To add a finalizer to a class, you simply define the finalize( ) method. The Java runtime 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 finalize( ) method has this general form:

```
protectedvoid finalize()
{
// finalization code here
}
```

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

This means that you cannot know whenor even iffinalize( ) will be executed. For example, if your program ends before garbage collection occurs, finalize( ) will not execute.

CHAPTER

18

Java Files & I/O

The java.io package contains nearly every class you might ever need to perform input and output (I/O) in Java. All these streams represent an input source and an output destination. The stream in the java.io package supports many data such as primitives, Object, localized characters, etc.

A stream can be defined as a sequence of data. The InputStream is used to read data from a source and the OutputStream is used for writing data to a destination.

Java does provide strong, flexible support for I/O as it relates to files and networks but this tutorial covers very basic functionality related to streams and I/O. We would see most commonly used example one by one:

Reading Console Input:

Java input console is accomplished by reading from **System.in**. To obtain a character-based stream that is attached to the console, you wrap **System.in** in a **BufferedReader** object, to create a character stream. Here is most common syntax to obtain BufferedReader:

```
BufferedReader br = new BufferedReader(new InputStreamReader(System.in));
```

Once BufferedReader is obtained, we can use read( ) method to reach a character or readLine( ) method to read a string from the console.

Reading Characters from Console:

To read a character from a BufferedReader, we would read( ) method whose sytax is as follows:

```
int read()throwsIOException
```

Each time that read( ) is called, it reads a character from the input stream and returns it as an integer value. It returns .1 when the end of the stream is encountered. As you can see, it can throw an IOException.

The following program demonstrates read( ) by reading characters from the console until the user types a "q":

```
// Use a BufferedReader to read characters from the console.

import java.io.*;

public class BRRead{
public static void main(String args[])throwsIOException
{
  char c;
```

```
  // Create a BufferedReader using System.in
  BufferedReader br = new BufferedReader(new
  InputStreamReader(System.in));
  System.out.println("Enter characters, 'q' to quit.");
  // read characters
  do{
       c =(char) br.read();
       System.out.println(c);
  }while(c !='q');
 }
}
```

Here is a sample run:

```
Enter characters,'q' to quit.
123abcq
1
2
3
a
b
c
q
```

Reading Strings from Console:

To read a string from the keyboard, use the version of readLine( ) that is a member of the BufferedReader class. Its general form is shown here:

```
String readLine()throws IOException
```

The following program demonstrates BufferedReader and the readLine( ) method. The program reads and displays lines of text until you enter the word "end":

```
// Read a string from console using a BufferedReader.
import java.io.*;
public class BRReadLines{
public static void main(String args[])throws IOException
{
  // Create a BufferedReader using System.in
  BufferedReader br = new BufferedReader(new
  InputStreamReader(System.in));
  String str;
  System.out.println("Enter lines of text.");
  System.out.println("Enter 'end' to quit.");
  do{
     str = br.readLine();
     System.out.println(str);
  }while(!str.equals("end"));
  }
}
```

Here is a sample run:

```
Enter lines of text.
Enter'end' to quit.
Thisis line one
Thisis line one
Thisis line two
Thisis line two
```

```
end
end
```

Writing Console Output:

Console output is most easily accomplished with **print( )** and **println( )**, described earlier. These methods are defined by the class **PrintStream** which is the type of the object referenced by**System.out**. Even though System.out is a byte stream, using it for simple program output is still acceptable.

Because PrintStream is an output stream derived from OutputStream, it also implements the low-level method write( ). Thus, write( ) can be used to write to the console. The simplest form of write( ) defined by PrintStream is shown here:

```
void write(int byteval)
```

This method writes to the stream the byte specified by byteval. Although byteval is declared as an integer, only the low-order eight bits are written.

Example:

Here is a short example that uses write( ) to output the character "A" followed by a newline to the screen:

```
import java.io.*;

// Demonstrate System.out.write().
public class WriteDemo{
  public static void main(String args[]){
    int b;
    b ='A';
    System.out.write(b);
    System.out.write('\n');
  }
}
```

This would produce simply 'A' character on the output screen.

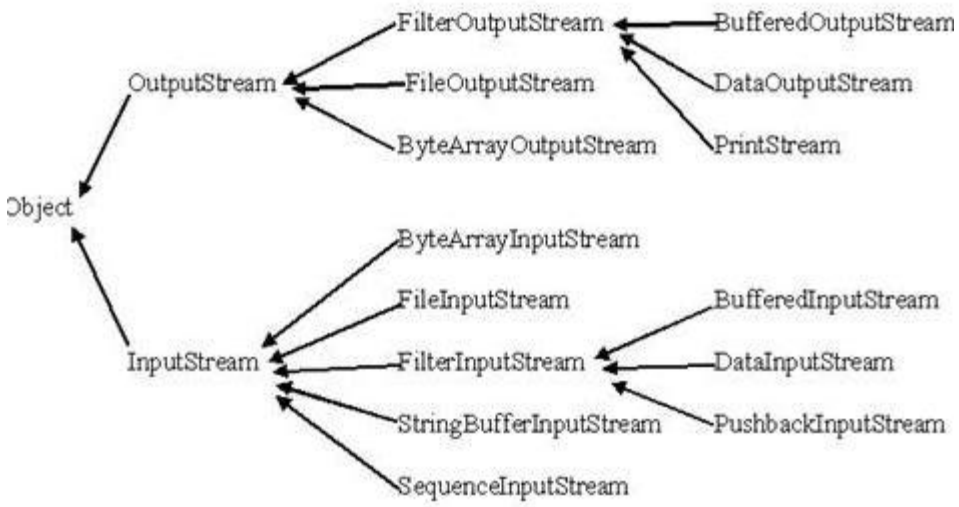
```
A
```

Note: You will not often use write( ) to perform console output because print( ) and println( ) are substantially easier to use.

Reading and Writing Files:

As described earlier, A stream can be defined as a sequence of data. The InputStream is used to read data from a source and the OutputStream is used for writing data to a destination.

Here is a hierarchy of classes to deal with Input and Output streams.



The two important streams are FileInputStream and FileOutputStream, which would be discussed in this tutorial:

FileInputStream:

This stream is used for reading data from the files. Objects can be created using the keyword new and there are several types of constructors available.

Following constructor takes a file name as a string to create an input stream object to read the file:

```
InputStream f = new FileInputStream("C:/java/hello");
```

Following constructor takes a file object to create an input stream object to read the file. First we create a file object using File() method as follows:

```
File f =new File("C:/java/hello");
InputStream f =new FileInputStream(f);
```

Once you have *InputStream* object in hand, then there is a list of helper methods which can be used to read to stream or to do other operations on the stream.

SN	Methods with Description
1	**public void close() throws IOException{}** This method closes the file output stream. Releases any system resources associated with the file. Throws an IOException.
2	**protected void finalize()throws IOException {}** This method cleans up the connection to the file. Ensures that the close method of this file output stream is called when there are no more references to this stream. Throws an IOException.
3	**public int read(int r)throws IOException{}** This method reads the specified byte of data from the InputStream. Returns an int. Returns the next byte of data and -1 will be returned if it's end of file.
4	**public int read(byte[] r) throws IOException{}** This method reads r.length bytes from the input stream into an array. Returns the total number of bytes read. If end of file -1 will be returned.
5	**public int available() throws IOException{}** Gives the number of bytes that can be read from this file input stream. Returns an int.

There are other important input streams available, for more detail you can refer to the following links:

ByteArrayInputStream

The ByteArrayInputStream class allows a buffer in the memory to be used as an InputStream. The input source is a byte array. There are following forms of constructors to create ByteArrayInputStream objects

Takes a byte array as the parameter:

```
ByteArrayInputStream bArray = new ByteArrayInputStream(byte[] a);
```

Another form takes an array of bytes, and two ints, where **off** is the first byte to be read and **len** is the number of bytes to be read.

```
ByteArrayInputStream bArray = new ByteArrayInputStream(byte[]a,
int off,
int len)
```

Once you have *ByteArrayInputStream* object in hand then there is a list of helper methods which can be used to read the stream or to do other operations on the stream.

SN	Methods with Description
1	**public int read()** This method reads the next byte of data from the InputStream. Returns an int as the next byte of data. If it is end of file then it returns -1.
2	**public int read(byte[] r, int off, int len)** This method reads upto **len** number of bytes starting from **off** from the input stream into an array. Returns the total number of bytes read. If end of file -1 will be returned.
3	**public int available()** Gives the number of bytes that can be read from this file input stream. Returns an int that gives the number of bytes to be read.
4	**public void mark(int read)** This sets the current marked position in the stream. The parameter gives the maximum limit of bytes that can be read before the marked position becomes invalid.
5	**public long skip(long n)** Skips n number of bytes from the stream. This returns the actual number of bytes skipped.

Example:

Following is the example to demonstrate ByteArrayInputStream and ByteArrayOutputStream

```
import java.io.*;

public class ByteStreamTest{

  public static void main(String args[])throws IOException{

    ByteArrayOutputStream bOutput = new ByteArrayOutputStream(12);

    while(bOutput.size()!=10){
      // Gets the inputs from the user
      bOutput.write(System.in.read());
    }

    byte b []= bOutput.toByteArray();
```

```
    System.out.println("Print the content");
    for(int x=0; x < b.length; x++){
      // printing the characters
      System.out.print((char)b[x]+"   ");
    }
    System.out.println("   ");

    int c;

    ByteArrayInputStream bInput = new ByteArrayInputStream(b);

    System.out.println("Converting characters to Upper case ");
    for(int y =0; y <1; y++){
    while(( c= bInput.read())!=-1){
      System.out.println(Character.toUpperCase((char)c));
    }
    bInput.reset();
  }
 }
}
```

Here is the sample run of the above program:

```
asdfghjkly
Print the content
a   s   d   f   g   h   j   k   l   y
Converting characters to Uppercase
A
S
D
F
G
H
J
K
L
Y
```

DataInputStream

The DataInputStream is used in the context of DataOutputStream and can be used to read primitives.

Following is the constructor to create an InputStream:

```
InputStream in = DataInputStream(InputStreamin);
```

Once you have *DataInputStream* object in hand, then there is a list of helper methods,s which can be used to read the stream or to do other operations on the stream.

SN	Methods with Description
1	**public final int read(byte[] r, int off, int len)throws IOException** Reads up to len bytes of data from the input stream into an array of bytes. Returns the total number of bytes read into the buffer otherwise -1 if it is end of file.
2	**Public final int read(byte [] b)throws IOException** Reads some bytes from the inputstream an stores in to the byte array. Returns the total number of bytes read into the buffer otherwise -1 if it is end of file.

3	**(a) public final Boolean readBooolean()throws IOException,** **(b) public final byte readByte()throws IOException,** **(c) public final short readShort()throws IOException** **(d) public final Int readInt()throws IOException** These methods will read the bytes from the contained InputStream. Returns the next two bytes of the InputStream as the specific primitive type.
4	**public String readLine() throws IOException** Reads the next line of text from the input stream. It reads successive bytes, converting each byte separately into a character, until it encounters a line terminator or end of file; the characters read are then returned as a String.

Example:

Following is the example to demonstrate DataInputStream and DataInputStream. This example reads 5 lines given in a file test.txt and convert those lines into capital letters and finally copies them into another file test1.txt.

```
import java.io.*;

public class Test{
  public static void main(String args[])throwsIOException{

    DataInputStream d = new DataInputStream(new
    FileInputStream("test.txt"));

    DataOutputStreamout= new DataOutputStream(new
    FileOutputStream("test1.txt"));

    String count;
    while((count = d.readLine())!=null){
      String u = count.toUpperCase();
      System.out.println(u);
      out.writeBytes(u +"  ,");
    }
    d.close();
    out.close();
  }
}
```

Here is the sample run of the above program:

```
THIS IS TEST 1,
THIS IS TEST 2,
THIS IS TEST 3,
THIS IS TEST 4,
THIS IS TEST 5,
```

FileOutputStream:

FileOutputStream is used to create a file and write data into it.The stream would create a file, if it doesn't already exist, before opening it for output.

Here are two constructors which can be used to create a FileOutputStream object.

Following constructor takes a file name as a string to create an input stream object to write the file:

```
OutputStream f = new FileOutputStream("C:/java/hello")
```

Following constructor takes a file object to create an output stream object to write the file. First, we create a file object using File() method as follows:

```
File f = new File("C:/java/hello");
OutputStream f = new FileOutputStream(f);
```

Once you have *OutputStream* object in hand, then there is a list of helper methods, which can be used to write to stream or to do other operations on the stream.

SN	Methods with Description
1	**public void close() throws IOException{}** This method closes the file output stream. Releases any system resources associated with the file. Throws an IOException.
2	**protected void finalize()throws IOException {}** This method cleans up the connection to the file. Ensures that the close method of this file output stream is called when there are no more references to this stream. Throws an IOException.
3	**public void write(int w)throws IOException{}** This methods writes the specified byte to the output stream.
4	**public void write(byte[] w)** Writes w.length bytes from the mentioned byte array to the OutputStream.

There are other important output streams available, for more detail you can refer to the following links:

ByteArrayOutputStream

The ByteArrayOutputStream class stream creates a buffer in memory and all the data sent to the stream is stored in the buffer. There are following forms of constructors to create ByteArrayOutputStream objects

Following constructor creates a buffer of 32 byte:

```
OutputStream bOut = new ByteArrayOutputStream()
```

Following constructor creates a buffer of size int a:

```
OutputStream bOut = new ByteArrayOutputStream(int a)
```

Once you have *ByteArrayOutputStream* object in hand then there is a list of helper methods which can be used to write the stream or to do other operations on the stream.

SN	Methods with Description
1	**public void reset()** This method resets the number of valid bytes of the byte array output stream to zero, so all the accumulated output in the stream will be discarded.
2	**public byte[] toByteArray()** This method creates a newly allocated Byte array. Its size would be the current size of the output stream and the contents of the buffer will be copied into it. Returns the current contents of the output stream as a byte array.
3	**public String toString()** Converts the buffer content into a string. Translation will be done according to the default character encoding. Returns the String translated from the buffer's content.
4	**public void write(int w)** Writes the specified array to the output stream.

5	**public void write(byte []b, int of, int len)** Writes len number of bytes starting from offset off to the stream.
6	**public void writeTo(OutputStream outSt)** Writes the entire content of this Stream to the specified stream argument.

Example:

Following is the example to demonstrate ByteArrayOutputStream and ByteArrayOutputStream

```
import java.io.*;

public class ByteStreamTest{

  public static void main(String args[])throws IOException{

    ByteArrayOutputStream bOutput = new ByteArrayOutputStream(12);

    while( bOutput.size()!=10){
      // Gets the inputs from the user
      bOutput.write(System.in.read());
    }

    byte b []= bOutput.toByteArray();
    System.out.println("Print the content");
    for(int x=0; x < b.length; x++){
      //printing the characters
      System.out.print((char)b[x]+"   ");
    }
    System.out.println("   ");

    int c;

    ByteArrayOutputStream bInput = new ByteArrayOutputStream(b);

    System.out.println("Converting characters to Upper case ");
    for(int y =0; y <1; y++){
      while(( c= bInput.read())!=-1){
        System.out.println(Character.toUpperCase((char)c));
      }
    bInput.reset();
  }
 }
}
```

Here is the sample run of the above program:

```
asdfghjkly
Print the content
a   s   d   f   g   h   j   k   l   y
Converting characters to Uppercase
A
S
D
F
G
H
J
K
L
```

```
Y
```

DataOutputStream

The DataOutputStream stream let you write the primitives to an output source.

Following is the constructor to create a DataOutputStream.

```
DataOutputStream out = DataOutputStream(OutputStream out);
```

Once you have *DataOutputStream* object in hand, then there is a list of helper methods, which can be used to write the stream or to do other operations on the stream.

SN	Methods with Description
1	**public final void write(byte[] w, int off, int len)throws IOException** Writes len bytes from the specified byte array starting at point off , to the underlying stream.
2	**Public final int write(byte [] b)throws IOException** Writes the current number of bytes written to this data output stream. Returns the total number of bytes write into the buffer.
3	**(a) public final void writeBooolean()throws IOException,** **(b) public final void writeByte()throws IOException,** **(c) public final void writeShort()throws IOException** **(d) public final void writeInt()throws IOException** These methods will write the specific primitive type data into the output stream as bytes.
4	**Public void flush()throws IOException** Flushes the data output stream.
5	**public final void writeBytes(String s) throws IOException** Writes out the string to the underlying output stream as a sequence of bytes. Each character in the string is written out, in sequence, by discarding its high eight bits.

Example:

Following is the example to demonstrate DataInputStream and DataInputStream. This example reads 5 lines given in a file test.txt and converts those lines into capital letters and finally copies them into another file test1.txt.

```
import java.io.*;

public class Test{
  public static void main(String args[])throws IOException{

    DataInputStream d = new DataInputStream(new
    FileInputStream("test.txt"));

    DataOutputStream out = new DataOutputStream(new
    FileOutputStream("test1.txt"));

    String count;
    while((count = d.readLine())!=null){
      String u = count.toUpperCase();
      System.out.println(u);
      out.writeBytes(u +"  ,");
    }
    d.close();
    out.close();
```

```
   }
}
```

Here is the sample run of the above program:

```
THIS IS TEST 1,
THIS IS TEST 2,
THIS IS TEST 3,
THIS IS TEST 4,
THIS IS TEST 5,
```

Example:

Following is the example to demonstrate InputStream and OutputStream:

```
import java.io.*;

public class fileStreamTest{

  public static void main(String args[]){

    try{
      byte bWrite []={11,21,3,40,5};
      OutputStream os = new FileOutputStream("C:/test.txt");
      for(int x=0; x < bWrite.length ; x++){
        os.write( bWrite[x]);// writes the bytes
      }
      os.close();

      InputStream is = new FileInputStream("C:/test.txt");
      int size = is.available();

      for(int i=0; i< size; i++){
        System.out.print((char)is.read()+"  ");
      }
      is.close();
    }catch(IOException e){
       System.out.print("Exception");
    }
  }
}
```

The above code would create file test.txt and would write given numbers in binary format. Same would be output on the stdout screen.

File Navigation and I/O:

There are several other classes that we would be going through to get to know the basics of File Navigation and I/O.

File Class

Java File class represents the files and directory pathnames in an abstract manner. This class is used for creation of files and directories, file searching, file deletion etc.

The File object represents the actual file/directory on the disk. There are following constructors to create a File object:

Following syntax creates a new File instance from a parent abstract pathname and a child pathname string.

```
File(File parent,String child);
```

Following syntax creates a new File instance by converting the given pathname string into an abstract pathname.

```
File(String pathname)
```

Following syntax creates a new File instance from a parent pathname string and a child pathname string.

```
File(String parent,String child)
```

Following syntax creates a new File instance by converting the given file: URI into an abstract pathname.

```
File(URI uri)
```

Once you have *File* object in hand then there is a list of helper methods which can be used manipulate the files.

SN	Methods with Description
1	**public String getName()** Returns the name of the file or directory denoted by this abstract pathname.
2	**public String getParent()** Returns the pathname string of this abstract pathname's parent, or null if this pathname does not name a parent directory.
3	**public File getParentFile()** Returns the abstract pathname of this abstract pathname's parent, or null if this pathname does not name a parent directory.
4	**public String getPath()** Converts this abstract pathname into a pathname string.
5	**public boolean isAbsolute()** Tests whether this abstract pathname is absolute. Returns true if this abstract pathname is absolute, false otherwise
6	**public String getAbsolutePath()** Returns the absolute pathname string of this abstract pathname.
7	**public boolean canRead()** Tests whether the application can read the file denoted by this abstract pathname. Returns true if and only if the file specified by this abstract pathname exists and can be read by the application; false otherwise.
8	**public boolean canWrite()** Tests whether the application can modify to the file denoted by this abstract pathname. Returns true if and only if the file system actually contains a file denoted by this abstract pathname and the application is allowed to write to the file; false otherwise.
9	**public boolean exists()** Tests whether the file or directory denoted by this abstract pathname exists. Returns true if and only if the file or directory denoted by this abstract pathname exists; false otherwise
10	**public boolean isDirectory()** Tests whether the file denoted by this abstract pathname is a directory. Returns true if and only if the file denoted by this abstract pathname exists and is a directory; false otherwise.
11	**public boolean isFile()** Tests whether the file denoted by this abstract pathname is a normal file. A file is normal if it is not a directory and, in addition, satisfies other system-dependent criteria. Any non-directory file created by a Java application is guaranteed to be a normal file. Returns true if and only if the file denoted by this abstract pathname exists and is a normal file; false otherwise.

12	**public long lastModified()** Returns the time that the file denoted by this abstract pathname was last modified. Returns a long value representing the time the file was last modified, measured in milliseconds since the epoch (00:00:00 GMT, January 1, 1970), or 0L if the file does not exist or if an I/O error occurs.
13	**public long length()** Returns the length of the file denoted by this abstract pathname. The return value is unspecified if this pathname denotes a directory.
14	**public boolean createNewFile() throws IOException** Atomically creates a new, empty file named by this abstract pathname if and only if a file with this name does not yet exist. Returns true if the named file does not exist and was successfully created; false if the named file already exists.
15	**public boolean delete()** Deletes the file or directory denoted by this abstract pathname. If this pathname denotes a directory, then the directory must be empty in order to be deleted. Returns true if and only if the file or directory is successfully deleted; false otherwise.
16	**public void deleteOnExit()** Requests that the file or directory denoted by this abstract pathname be deleted when the virtual machine terminates.
17	**public String[] list()** Returns an array of strings naming the files and directories in the directory denoted by this abstract pathname.
18	**public String[] list(FilenameFilter filter)** Returns an array of strings naming the files and directories in the directory denoted by this abstract pathname that satisfy the specified filter.
20	**public File[] listFiles()** Returns an array of abstract pathnames denoting the files in the directory denoted by this abstract pathname.
21	**public File[] listFiles(FileFilter filter)** Returns an array of abstract pathnames denoting the files and directories in the directory denoted by this abstract pathname that satisfy the specified filter.
22	**public boolean mkdir()** Creates the directory named by this abstract pathname. Returns true if and only if the directory was created; false otherwise.
23	**public boolean mkdirs()** Creates the directory named by this abstract pathname, including any necessary but nonexistent parent directories. Returns true if and only if the directory was created, along with all necessary parent directories; false otherwise.
24	**public boolean renameTo(File dest)** Renames the file denoted by this abstract pathname. Returns true if and only if the renaming succeeded; false otherwise.
25	**public boolean setLastModified(long time)** Sets the last-modified time of the file or directory named by this abstract pathname. Returns true if and only if the operation succeeded; false otherwise.
26	**public boolean setReadOnly()** Marks the file or directory named by this abstract pathname so that only read operations are allowed. Returns true if and only if the operation succeeded; false otherwise.
27	**public static File createTempFile(String prefix, String suffix, File directory) throws IOException** Creates a new empty file in the specified directory, using the given prefix and suffix strings to generate its name. Returns an abstract pathname denoting a newly-created empty file.
28	**public static File createTempFile(String prefix, String suffix) throws IOException**

	Creates an empty file in the default temporary-file directory, using the given prefix and suffix to generate its name. Invoking this method is equivalent to invoking createTempFile(prefix, suffix, null). Returns abstract pathname denoting a newly-created empty file.
29	**public int compareTo(File pathname)** Compares two abstract pathnames lexicographically. Returns zero if the argument is equal to this abstract pathname, a value less than zero if this abstract pathname is lexicographically less than the argument, or a value greater than zero if this abstract pathname is lexicographically greater than the argument.
30	**public int compareTo(Object o)** Compares this abstract pathname to another object. Returns zero if the argument is equal to this abstract pathname, a value less than zero if this abstract pathname is lexicographically less than the argument, or a value greater than zero if this abstract pathname is lexicographically greater than the argument.
31	**public boolean equals(Object obj)** Tests this abstract pathname for equality with the given object. Returns true if and only if the argument is not null and is an abstract pathname that denotes the same file or directory as this abstract pathname.
32	**public String toString()** Returns the pathname string of this abstract pathname. This is just the string returned by the getPath() method.

Example:

Following is the example to demonstrate File object:

```
import java.io.File;

public class DirList{
  public static void main(String args[]){
    String dirname ="/java";
    File f1 = new File(dirname);
    if(f1.isDirectory()){
      System.out.println("Directory of "+ dirname);
      String s[]= f1.list();
      for(int i=0; i < s.length; i++){
        File f = new File(dirname +"/"+ s[i]);
        if(f.isDirectory()){
          System.out.println(s[i]+" is a directory");
        }else{
          System.out.println(s[i]+" is a file");
        }
      }
    }else{
      System.out.println(dirname +" is not a directory");
    }
  }
}
```

This would produce the following result:

```
Directory of /mysql
bin is a directory
lib is a directory
demo is a directory
test.txt is a file
README is a file
index.html is a file
include is a directory
```

FileReader Class

This class inherits from the InputStreamReader class. FileReader is used for reading streams of characters.

This class has several constructors to create required objects.

Following syntax creates a new FileReader, given the File to read from.

```
FileReader(File file)
```

Following syntax creates a new FileReader, given the FileDescriptor to read from.

```
FileReader(FileDescriptor fd)
```

Following syntax creates a new FileReader, given the name of the file to read from.

```
FileReader(String fileName)
```

Once you have *FileReader* object in hand then there is a list of helper methods which can be used manipulate the files.

SN	Methods with Description
1	**public int read() throws IOException** Reads a single character. Returns an int, which represents the character read.
2	**public int read(char [] c, int offset, int len)** Reads characters into an array. Returns the number of characters read.

Example:

Following is the example to demonstrate class:

```
import java.io.*;

public class FileRead{

  public static void main(String args[])throwsIOException{

    File file = new File("Hello1.txt");
    // creates the file
    file.createNewFile();
    // creates a FileWriter Object
    FileWriter writer = new FileWriter(file);
    // Writes the content to the file
    writer.write("This\n is\n an\n example\n");
    writer.flush();
    writer.close();

    //Creates a FileReader Object
    FileReader fr = new FileReader(file);
    char[] a =newchar[50];
    fr.read(a);// reads the content to the array
    for(char c : a)
      System.out.print(c);//prints the characters one by one
    fr.close();
 }
}
```

This would produce the following result:

```
This
is
an
example
```

FileWriter Class

This class inherits from the OutputStreamWriter class. The class is used for writing streams of characters.

This class has several constructors to create required objects.

Following syntax creates a FileWriter object given a File object.

```
FileWriter(File file)
```

Following syntax creates a FileWriter object given a File object.

```
FileWriter(File file,boolean append)
```

Following syntax creates a FileWriter object associated with a file descriptor.

```
FileWriter(FileDescriptor fd)
```

Following syntax creates a FileWriter object given a file name.

```
FileWriter(String fileName)
```

Following syntax creates a FileWriter object given a file name with a boolean indicating whether or not to append the data written.

```
FileWriter(String fileName,boolean append)
```

Once you have *FileWriter* object in hand, then there is a list of helper methods, which can be used manipulate the files.

SN	Methods with Description
1	**public void write(int c) throws IOException** Writes a single character.
2	**public void write(char [] c, int offset, int len)** Writes a portion of an array of characters starting from offset and with a length of len.
3	**public void write(String s, int offset, int len)** Write a portion of a String starting from offset and with a length of len.

Example:

Following is the example to demonstrate class:

```
import java.io.*;

public class FileRead{

public static void main(String args[])throwsIOException{

  File file = new File("Hello1.txt");
```

```
  // creates the file
  file.createNewFile();
  // creates a FileWriter Object
  FileWriter writer =newFileWriter(file);
  // Writes the content to the file
  writer.write("This\n is\n an\n example\n");
  writer.flush();
  writer.close();

  // Creates a FileReader Object
   FileReader fr = new FileReader(file);
   char[] a = new char[50];
   fr.read(a);// reads the content to the array
   for(char c : a)
     System.out.print(c);//prints the characters one by one
   fr.close();
 }
}
```

This would produce the following result:

```
This
is
an
example
```

Directories in Java:

Creating Directories:

There are two useful **File** utility methods, which can be used to create directories:

- The **mkdir( )** method creates a directory, returning true on success and false on failure. Failure indicates that the path specified in the File object already exists, or that the directory cannot be created because the entire path does not exist yet.
- The **mkdirs()** method creates both a directory and all the parents of the directory.

Following example creates "/tmp/user/java/bin" directory:

```
import java.io.File;

public class CreateDir{
  public static void main(String args[]){
    String dirname ="/tmp/user/java/bin";
    File d = new File(dirname);
    // Create directory now.
    d.mkdirs();
  }
}
```

Compile and execute above code to create "/tmp/user/java/bin".

Note: Java automatically takes care of path separators on UNIX and Windows as per conventions. If you use a forward slash (/) on a Windows version of Java, the path will still resolve correctly.

Reading Directories:

A directory is a File that contains a list of other files and directories. When you create a File object and it is a directory, the isDirectory( ) method will return true.

You can call list( ) on that object to extract the list of other files and directories inside. The program shown here illustrates how to use list( ) to examine the contents of a directory:

```
import java.io.File;

public class DirList{
  public static void main(String args[]){
    String dirname ="/java";
    File f1 =newFile(dirname);
    if(f1.isDirectory()){
      System.out.println("Directory of "+ dirname);
      String s[]= f1.list();
      for(int i=0; i < s.length; i++){
        File f =newFile(dirname +"/"+ s[i]);
        if(f.isDirectory()){
          System.out.println(s[i]+" is a directory");
        }else{
          System.out.println(s[i]+" is a file");
        }
      }
    }else{
      System.out.println(dirname +" is not a directory");
    }
  }
}
```

This would produce the following result:

```
Directory of /mysql
bin is a directory
lib is a directory
demo is a directory
test.txt is a file
README is a file
index.html is a file
include is a directory
```

CHAPTER

19

Java Exceptions

An exception is a problem that arises during the execution of a program. An exception can occur for many different reasons, including the following:

- A user has entered invalid data.
- A file that needs to be opened cannot be found.
- A network connection has been lost in the middle of communications or the JVM has run out of memory.

Some of these exceptions are caused by user error, others by programmer error, and others by physical resources that have failed in some manner.

To understand how exception handling works in Java, you need to understand the three categories of exceptions:

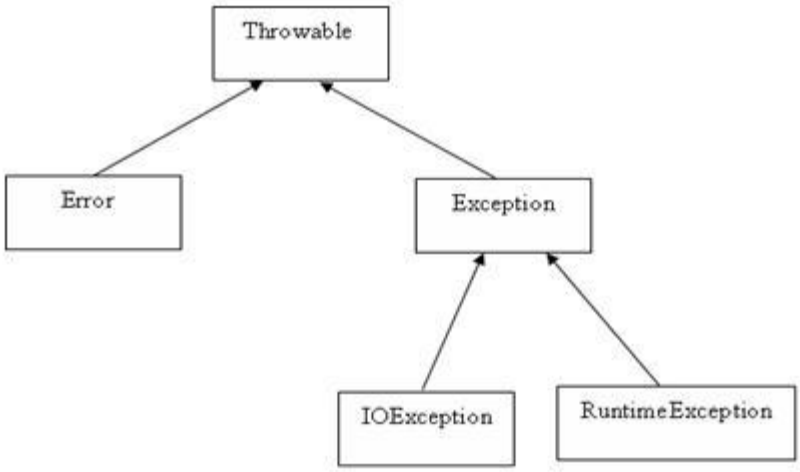
- **Checked exceptions:** A checked exception is an exception that is typically a user error or a problem that cannot be foreseen by the programmer. For example, if a file is to be opened, but the file cannot be found, an exception occurs. These exceptions cannot simply be ignored at the time of compilation.
- **Runtime exceptions:** A runtime exception is an exception that occurs that probably could have been avoided by the programmer. As opposed to checked exceptions, runtime exceptions are ignored at the time of compilation.
- **Errors:** These are not exceptions at all, but problems that arise beyond the control of the user or the programmer. Errors are typically ignored in your code because you can rarely do anything about an error. For example, if a stack overflow occurs, an error will arise. They are also ignored at the time of compilation.

Exception Hierarchy:

All exception classes are subtypes of the java.lang.Exception class. The exception class is a subclass of the Throwable class. Other than the exception class there is another subclass called Error which is derived from the Throwable class.

Errors are not normally trapped form the Java programs. These conditions normally happen in case of severe failures, which are not handled by the java programs. Errors are generated to indicate errors generated by the runtime environment. Example : JVM is out of Memory. Normally programs cannot recover from errors.

The Exception class has two main subclasses: IOException class and RuntimeException Class.



Here is a list of most common checked and unchecked **Java's Built-in Exceptions.**

Java's Built-in Exceptions

Java defines several exception classes inside the standard package **java.lang**.

The most general of these exceptions are subclasses of the standard type RuntimeException. Since java.lang is implicitly imported into all Java programs, most exceptions derived from RuntimeException are automatically available.

Java defines several other types of exceptions that relate to its various class libraries. Following is the list of Java Unchecked RuntimeException.

Exception	Description
ArithmeticException	Arithmetic error, such as divide-by-zero.
ArrayIndexOutOfBoundsException	Array index is out-of-bounds.
ArrayStoreException	Assignment to an array element of an incompatible type.
ClassCastException	Invalid cast.
IllegalArgumentException	Illegal argument used to invoke a method.
IllegalMonitorStateException	Illegal monitor operation, such as waiting on an unlocked thread.
IllegalStateException	Environment or application is in incorrect state.
IllegalThreadStateException	Requested operation not compatible with current thread state.
IndexOutOfBoundsException	Some type of index is out-of-bounds.
NegativeArraySizeException	Array created with a negative size.
NullPointerException	Invalid use of a null reference.
NumberFormatException	Invalid conversion of a string to a numeric format.
SecurityException	Attempt to violate security.
StringIndexOutOfBounds	Attempt to index outside the bounds of a string.

UnsupportedOperationException	An unsupported operation was encountered.

Following is the list of Java Checked Exceptions Defined in java.lang.

Exception	Description
ClassNotFoundException	Class not found.
CloneNotSupportedException	Attempt to clone an object that does not implement the Cloneable interface.
IllegalAccessException	Access to a class is denied.
InstantiationException	Attempt to create an object of an abstract class or interface.
InterruptedException	One thread has been interrupted by another thread.
NoSuchFieldException	A requested field does not exist.
NoSuchMethodException	A requested method does not exist.

Exceptions Methods:

Following is the list of important methods available in the Throwable class.

SN	Methods with Description
1	**public String getMessage()** Returns a detailed message about the exception that has occurred. This message is initialized in the Throwable constructor.
2	**public Throwable getCause()** Returns the cause of the exception as represented by a Throwable object.
3	**public String toString()** Returns the name of the class concatenated with the result of getMessage()
4	**public void printStackTrace()** Prints the result of toString() along with the stack trace to System.err, the error output stream.
5	**public StackTraceElement [] getStackTrace()** Returns an array containing each element on the stack trace. The element at index 0 represents the top of the call stack, and the last element in the array represents the method at the bottom of the call stack.
6	**public Throwable fillInStackTrace()** Fills the stack trace of this Throwable object with the current stack trace, adding to any previous information in the stack trace.

Catching Exceptions:

A method catches an exception using a combination of the **try** and **catch** keywords. A try/catch block is placed around the code that might generate an exception. Code within a try/catch block is referred to as protected code, and the syntax for using try/catch looks like the following:

```
try
{
  //Protected code
}catch(ExceptionName e1)
{
  //Catch block
```

```
}
```

A catch statement involves declaring the type of exception you are trying to catch. If an exception occurs in protected code, the catch block (or blocks) that follows the try is checked. If the type of exception that occurred is listed in a catch block, the exception is passed to the catch block much as an argument is passed into a method parameter.

Example:

The following is an array is declared with 2 elements. Then, the code tries to access the 3rd element of the array which throws an exception.

```
// File Name : ExcepTest.java
import java.io.*;
public class ExcepTest{

  public static void main(String args[]){
    try{
      int a[]=newint[2];
      System.out.println("Access element three :"+ a[3]);
   }catch(ArrayIndexOutOfBoundsException e){
      System.out.println("Exception thrown  :"+ e);
   }
   System.out.println("Out of the block");
  }
}
```

This would produce the following result:

```
Exception thrown  :java.lang.ArrayIndexOutOfBoundsException:3
Out of the block
```

Multiple catch Blocks:

A try block can be followed by multiple catch blocks. The syntax for multiple catch blocks looks like the following:

```
try
{
  //Protected code
}catch(ExceptionType1 e1)
{
  //Catch block
}catch(ExceptionType2 e2)
{
  //Catch block
}catch(ExceptionType3 e3)
{
  //Catch block
}
```

The previous statements demonstrate three catch blocks, but you can have any number of them after a single try. If an exception occurs in the protected code, the exception is thrown to the first catch block in the list. If the data type of the exception thrown matches ExceptionType1, it gets caught there. If not, the exception passes down to the second catch statement. This continues until the exception either is caught or falls through all catches, in which case the current method stops execution and the exception is thrown down to the previous method on the call stack.

Example:

Here is code segment showing how to use multiple try/catch statements.

```
try
{
   file =newFileInputStream(fileName);
   x =(byte) file.read();
}catch(IOException i)
{
   i.printStackTrace();
   return-1;
}catch(FileNotFoundException f)//Not valid!
{
   f.printStackTrace();
   return-1;
}
```

The throws/throw Keywords:

If a method does not handle a checked exception, the method must declare it using the **throws**keyword. The throws keyword appears at the end of a method's signature.
You can throw an exception, either a newly instantiated one or an exception that you just caught, by using the **throw** keyword. Try to understand the different in throws and throw keywords.

The following method declares that it throws a RemoteException:

```
import java.io.*;
public class className
{
  public void deposit(double amount)throwsRemoteException
  {
    // Method implementation
    throw new RemoteException();
  }
  //Remainder of class definition
}
```

A method can declare that it throws more than one exception, in which case the exceptions are declared in a list separated by commas. For example, the following method declares that it throws a RemoteException and an InsufficientFundsException:

```
import java.io.*;
public class className
{
  public void withdraw(double amount)throwsRemoteException,
  InsufficientFundsException
  {
    // Method implementation
  }
  //Remainder of class definition
}
```

The finally Keyword

The finally keyword is used to create a block of code that follows a try block. A finally block of code always executes, whether or not an exception has occurred.

Using a finally block allows you to run any cleanup-type statements that you want to execute, no matter what happens in the protected code.

A finally block appears at the end of the catch blocks and has the following syntax:

```
try
{
  //Protected code
}catch(ExceptionType1 e1)
{
  //Catch block
}catch(ExceptionType2 e2)
{
  //Catch block
}catch(ExceptionType3 e3)
{
  //Catch block
}finally
{
  //The finally block always executes.
}
```

Example:

```
public class ExcepTest{

public static void main(String args[]){
  int a[]=newint[2];
  try{
    System.out.println("Access element three :"+ a[3]);
  }catch(ArrayIndexOutOfBoundsException e){
    System.out.println("Exception thrown  :"+ e);
  }
  finally{
    a[0]=6;
    System.out.println("First element value: "+a[0]);
    System.out.println("The finally statement is executed");
  }
 }
}
```

This would produce the following result:

```
Exception thrown  :java.lang.ArrayIndexOutOfBoundsException:3
First element value:6
Thefinally statement is executed
```

Note the following:

- A catch clause cannot exist without a try statement.
- It is not compulsory to have finally clauses whenever a try/catch block is present.
- The try block cannot be present without either catch clause or finally clause.
- Any code cannot be present in between the try, catch, finally blocks.

Declaring you own Exception:

You can create your own exceptions in Java. Keep the following points in mind when writing your own exception classes:

- All exceptions must be a child of Throwable.
- If you want to write a checked exception that is automatically enforced by the Handle or Declare Rule, you need to extend the Exception class.
- If you want to write a runtime exception, you need to extend the RuntimeException class.

We can define our own Exception class as below:

```
class MyException extends Exception{
}
```

You just need to extend the Exception class to create your own Exception class. These are considered to be checked exceptions. The following InsufficientFundsException class is a user-defined exception that extends the Exception class, making it a checked exception. An exception class is like any other class, containing useful fields and methods.

Example:

```
// File Name InsufficientFundsException.java
import java.io.*;

public class InsufficientFundsException extends Exception
{
  private double amount;
  public InsufficientFundsException(double amount)
  {
    this.amount = amount;
  }
  public double getAmount()
  {
    return amount;
  }
}
```

To demonstrate using our user-defined exception, the following CheckingAccount class contains a withdraw() method that throws an InsufficientFundsException.

```
// File Name CheckingAccount.java
import java.io.*;

public class CheckingAccount
{
  private double balance;
  private int number;
  public CheckingAccount(int number)
  {
     this.number = number;
  }
  public void deposit(double amount)
  {
     balance += amount;
  }
  public void withdraw(double amount)throws InsufficientFundsException
  {
    if(amount <= balance)
    {
       balance -= amount;
    }
    else
```

```
    {
      double needs = amount - balance;
      throw new InsufficientFundsException(needs);
    }
  }
  public double getBalance()
  {
    return balance;
  }
  public int getNumber()
  {
    return number;
  }
}
```

The following BankDemo program demonstrates invoking the deposit() and withdraw() methods of CheckingAccount.

```
// File Name BankDemo.java
public class BankDemo
{
  public static void main(String[] args)
  {
    CheckingAccount c =newCheckingAccount(101);
    System.out.println("Depositing $500...");
    c.deposit(500.00);
    try
    {
      System.out.println("\nWithdrawing $100...");
      c.withdraw(100.00);
      System.out.println("\nWithdrawing $600...");
      c.withdraw(600.00);
    }catch(InsufficientFundsException e)
    {
      System.out.println("Sorry, but you are short $"
      + e.getAmount());
      e.printStackTrace();
    }
  }
}
```

Compile all the above three files and run BankDemo, this would produce the following result:

```
Depositing $500...

Withdrawing $100...

Withdrawing $600...
Sorry, but you are short $200.0
InsufficientFundsException
        at CheckingAccount.withdraw(CheckingAccount.java:25)
        at BankDemo.main(BankDemo.java:13)
```

Common Exceptions:

In Java, it is possible to define two categories of Exceptions and Errors.

- **JVM Exceptions:** - These are exceptions/errors that are exclusively or logically thrown by the JVM. Examples : NullPointerException, ArrayIndexOutOfBoundsException, ClassCastException,
- **Programmatic exceptions:**- These exceptions are thrown explicitly by the application or the API programmers. Examples: IllegalArgumentException, IllegalStateException.

CHAPTER

20

Java Inheritance

Inheritance can be defined as the process where one object acquires the properties of another. With the use of inheritance, the information is made manageable in a hierarchical order.

When we talk about inheritance, the most commonly used keyword would be **extends** and **implements**. These words would determine whether one object IS-A type of another. By using these keywords we can make one object acquire the properties of another object.

IS-A Relationship:

IS-A is a way of saying : This object is a type of that object. Let us see how the **extends** keyword is used to achieve inheritance.

```
public class Animal{
}

public class MammalextendsAnimal{
}

public class ReptileextendsAnimal{
}

public class DogextendsMammal{
}
```

Now, based on the above example, In Object Oriented terms the following are true:

- Animal is the superclass of Mammal class.
- Animal is the superclass of Reptile class.
- Mammal and Reptile are subclasses of Animal class.
- Dog is the subclass of both Mammal and Animal classes.

Now, if we consider the IS-A relationship, we can say:

- Mammal IS-A Animal
- Reptile IS-A Animal

- Dog IS-A Mammal
- Hence : Dog IS-A Animal as well

With use of the extends keyword the subclasses will be able to inherit all the properties of the superclass except for the private properties of the superclass.

We can assure that Mammal is actually an Animal with the use of the instance operator.

Example:

```
public class Dog extends Mammal{

public static void main(String args[]){

Animal a = newAnimal();
Mammal m = newMammal();
Dog d = new Dog();

System.out.println(m instanceof Animal);
System.out.println(d instanceof Mammal);
System.out.println(d instanceof Animal);
}
}
```

This would produce the following result:

```
true
true
true
```

Since we have a good understanding of the **extends** keyword, let us look into how the **implements**keyword is used to get the IS-A relationship.

The **implements** keyword is used by classes by inherit from interfaces. Interfaces can never be extended by the classes.

Example:

```
publicinterfaceAnimal{}

public class Mammal implements Animal{
}

public class Dog extends Mammal{
}
```

The instanceof Keyword:

Let us use the **instanceof** operator to check determine whether Mammal is actually an Animal, and dog is actually an Animal

```
interface Animal{}

class Mammal implements Animal{}

public class Dog extends Mammal{
public static void main(String args[]){
```

```
Mammal m =new Mammal();
Dog d =new Dog();

System.out.println(m instanceof Animal);
System.out.println(d instanceof Mammal);
System.out.println(d instanceof Animal);
}
}
```

This would produce the following result:

```
true
true
true
```

HAS-A relationship:

These relationships are mainly based on the usage. This determines whether a certain class **HAS-A**certain thing. This relationship helps to reduce duplication of code as well as bugs.

Lets us look into an example:

```
public class Vehicle{}
public class Speed{}
public class VanextendsVehicle{
   privateSpeed sp;
}
```

This shows that class Van HAS-A Speed. By having a separate class for Speed, we do not have to put the entire code that belongs to speed inside the Van class which makes it possible to reuse the Speed class in multiple applications.

In Object-Oriented feature, the users do not need to bother about which object is doing the real work. To achieve this, the Van class hides the implementation details from the users of the Van class. So basically what happens is the users would ask the Van class to do a certain action and the Van class will either do the work by itself or ask another class to perform the action.

A very important fact to remember is that Java only supports only single inheritance. This means that a class cannot extend more than one class. Therefore following is illegal:

```
public class extends Animal,Mammal{}
```

However, a class can implement one or more interfaces. This has made Java get rid of the impossibility of multiple inheritance.

CHAPTER

21

Java Overriding

In the previous chapter, we talked about superclasses and subclasses. If a class inherits a method from its superclass, then there is a chance to override the method provided that it is not marked final.

The benefit of overriding is: ability to define a behavior that's specific to the subclass type which means a subclass can implement a parent class method based on its requirement.

In object-oriented terms, overriding means to override the functionality of an existing method.

Example:

Let us look at an example.

```
class Animal{

public void move(){
  System.out.println("Animals can move");
}
}

class Dog extends Animal{

public void move(){
  System.out.println("Dogs can walk and run");
}
}

public class TestDog{

public static void main(String args[]){
    Animal a = new Animal();// Animal reference and object
    Animal b = new Dog();// Animal reference but Dog object

    a.move();// runs the method in Animal class

    b.move();//Runs the method in Dog class
}
}
```

This would produce the following result:

```
Animals can move
Dogs can walk and run
```

In the above example, you can see that the even though **b** is a type of Animal it runs the move method in the Dog class. The reason for this is: In compile time, the check is made on the reference type. However, in the runtime, JVM figures out the object type and would run the method that belongs to that particular object.

Therefore, in the above example, the program will compile properly since Animal class has the method move. Then, at the runtime, it runs the method specific for that object.

Consider the following example:

```
class Animal{

public void move(){
  System.out.println("Animals can move");
}
}

class Dog extends Animal{

public void move(){
  System.out.println("Dogs can walk and run");
}
public void bark(){
  System.out.println("Dogs can bark");
}
}

public class TestDog{

public static void main(String args[]){
   Animal a = new Animal();// Animal reference and object
   Animal b = new Dog();// Animal reference but Dog object

   a.move();// runs the method in Animal class
   b.move();//Runs the method in Dog class
   b.bark();
}
}
```

This would produce the following result:

```
TestDog.java:30: cannot find symbol
symbol  : method bark()
location:classAnimal
                b.bark();
^
```

This program will throw a compile time error since b's reference type Animal doesn't have a method by the name of bark.

Rules for method overriding:

- The argument list should be exactly the same as that of the overridden method.
- The return type should be the same or a subtype of the return type declared in the original overridden method in the superclass.

- The access level cannot be more restrictive than the overridden method's access level. For example, if the superclass method is declared public, then the overriding method in the subclass cannot be either private or protected.
- Instance methods can be overridden only if they are inherited by the subclass.
- A method declared final cannot be overridden.
- A method declared static cannot be overridden but can be re-declared.
- If a method cannot be inherited, then it cannot be overridden.
- A subclass within the same package as the instance's superclass can override any superclass method that is not declared private or final.
- A subclass in a different package can only override the non-final methods declared public or protected.
- An overriding method can throw any uncheck exceptions, regardless of whether the overridden method throws exceptions or not. However the overriding method should not throw checked exceptions that are new or broader than the ones declared by the overridden method. The overriding method can throw narrower or fewer exceptions than the overridden method.
- Constructors cannot be overridden.

Using the super keyword:

When invoking a superclass version of an overridden method the **super** keyword is used.

```
class Animal{

public void move(){
   System.out.println("Animals can move");
}
}

class Dog extends Animal{

public void move(){
   super.move();// invokes the super class method
   System.out.println("Dogs can walk and run");
}
}

public class TestDog{

public static void main(String args[]){

   Animal b = new Dog();// Animal reference but Dog object
   b.move();//Runs the method in Dog class
}
}
```

This would produce the following result:

```
Animals can move
Dogs can walk and run
```

CHAPTER

22

Java Polymorphism

Polymorphism is the ability of an object to take on many forms. The most common use of polymorphism in OOP, occurs when a parent class reference is used to refer to a child class object.

Any Java object that can pass more than one IS-A test is considered to be polymorphic. In Java, all Java objects are polymorphic since any object will pass the IS-A test for their own type and for the class Object.

It is important to know that the only possible way to access an object is through a reference variable. A reference variable can be of only one type. Once declared, the type of a reference variable cannot be changed.

The reference variable can be reassigned to other objects provided that it is not declared final. The type of the reference variable would determine the methods that it can invoke on the object.

A reference variable can refer to any object of its declared type or any subtype of its declared type. A reference variable can be declared as a class or interface type.

Example:

Let us look at an example.

```
public interface Vegetarian{}
public class Animal{}
public class Deer extends Animal implements Vegetarian{}
```

Now, the Deer class is considered to be polymorphic since this has multiple inheritance. Following are true for the above example:

- A Deer IS-A Animal
- A Deer IS-A Vegetarian
- A Deer IS-A Deer
- A Deer IS-A Object

When we apply the reference variable facts to a Deer object reference, the following declarations are legal:

```
Deer d = new Deer();
Animal a = d;
Vegetarian v = d;
```

```
Object o = d;
```

All the reference variables d,a,v,o refer to the same Deer object in the heap.

Virtual Methods:

In this section, I will show you how the behavior of overridden methods in Java allows you to take advantage of polymorphism when designing your classes.

We already have discussed method overriding, where a child class can override a method in its parent. An overridden method is essentially hidden in the parent class, and is not invoked unless the child class uses the super keyword within the overriding method.

```
/* File name : Employee.java */
public class Employee
{
private String name;
private String address;
private int number;
public Employee(String name,String address,int number)
{
   System.out.println("Constructing an Employee");
   this.name = name;
   this.address = address;
   this.number = number;
}
public void mailCheck()
{
   System.out.println("Mailing a check to "+this.name
   +" "+this.address);
}
public String toString()
{
   return name +" "+ address +" "+ number;
}
public String getName()
{
   return name;
}
public String getAddress()
{
   return address;
}
public void setAddress(String newAddress)
{
   address = newAddress;
}
public int getNumber()
{
   return number;
}
}
```

Now suppose we extend Employee class as follows:

```
/* File name : Salary.java */
public class Salary extends Employee
{
private double salary;//Annual salary
public Salary(String name,String address,int number,double
```

```
      salary)
{
super(name, address, number);
   setSalary(salary);
}
public void mailCheck()
{
   System.out.println("Within mailCheck of Salary class ");
   System.out.println("Mailing check to "+ getName()
   +" with salary "+ salary);
}
public double getSalary()
{
   return salary;
}
public void setSalary(double newSalary)
{
if(newSalary >=0.0)
{
   salary = newSalary;
}
}
public double computePay()
{
   System.out.println("Computing salary pay for "+ getName());
   return salary/52;
}
}
```

Now, you study the following program carefully and try to determine its output:

```
/* File name : VirtualDemo.java */
public class VirtualDemo
{
public static void main(String[] args)
{
   Salary s = new Salary("Mohd Mohtashim","Ambehta,  UP",
   3,3600.00);
   Employee e = new Salary("John Adams","Boston, MA",
   2,2400.00);
   System.out.println("Call mailCheck using Salary reference --");
   s.mailCheck();
   System.out.println("\n Call mailCheck using Employee reference--");
   e.mailCheck();
}
}
```

This would produce the following result:

```
Constructing an Employee
Constructing an Employee
Call mailCheck using Salary reference --
Within mailCheck of Salary class
Mailing check to MohdMohtashim with salary 3600.0

Call mailCheck using Employee reference--
Within mailCheck of Salary class
Mailing check to JohnAdams with salary 2400.0
```

Here, we instantiate two Salary objects, one using a Salary reference s, and the other using an Employee reference e.

While invoking *s.mailCheck()* the compiler sees mailCheck() in the Salary class at compile time, and the JVM invokes mailCheck() in the Salary class at run time.
Invoking mailCheck() on e is quite different because e is an Employee reference. When the compiler sees*e.mailCheck()*, the compiler sees the mailCheck() method in the Employee class.

Here, at compile time, the compiler used mailCheck() in Employee to validate this statement. At run time, however, the JVM invokes mailCheck() in the Salary class.

This behavior is referred to as virtual method invocation, and the methods are referred to as virtual methods. All methods in Java behave in this manner, whereby an overridden method is invoked at run time, no matter what data type the reference is that was used in the source code at compile time.

CHAPTER

23

Java Abstraction

Abstraction refers to the ability to make a class abstract in OOP. An abstract class is one that cannot be instantiated. All other functionality of the class still exists, and its fields, methods, and constructors are all accessed in the same manner. You just cannot create an instance of the abstract class.

If a class is abstract and cannot be instantiated, the class does not have much use unless it is subclass. This is typically how abstract classes come about during the design phase. A parent class contains the common functionality of a collection of child classes, but the parent class itself is too abstract to be used on its own.

Abstract Class:

Use the **abstract** keyword to declare a class abstract. The keyword appears in the class declaration somewhere before the class keyword.

```
/* File name : Employee.java */
public abstract class Employee
{
private String name;
private String address;
private int number;
public Employee(String name,String address,int number)
{
  System.out.println("Constructing an Employee");
  this.name = name;
  this.address = address;
  this.number = number;
}
public double computePay()
{
  System.out.println("Inside Employee computePay");
  return0.0;
}
public void mailCheck()
{
  System.out.println("Mailing a check to "+this.name
  +" "+this.address);
}
public String toString()
{
  return name +" "+ address +" "+ number;
}
```

```
public String getName()
{
  return name;
}
public String getAddress()
{
  return address;
}
public void setAddress(String newAddress)
{
  address = newAddress;
}
public int getNumber()
{
  return number;
}
}
```

Notice that nothing is different in this Employee class. The class is now abstract, but it still has three fields, seven methods, and one constructor.

Now if you would try as follows:

```
/* File name : AbstractDemo.java */
public class AbstractDemo
{
public static void main(String[] args)
{
  /* Following is not allowed and would raise error */
  Employee e = new Employee("George W.","Houston, TX",43);

  System.out.println("\n Call mailCheck using Employee reference--");
  e.mailCheck();
}
}
```

When you would compile above class, then you would get the following error:

```
Employee.java:46:Employee is abstract; cannot be instantiated
Employee e = new Employee("George W.","Houston, TX",43);
^
1 error
```

Extending Abstract Class:

We can extend Employee class in normal way as follows:

```
/* File name : Salary.java */
public class Salary extends Employee
{
private double salary;//Annual salary
public Salary(String name,String address, int number, double salary)
{
  super(name, address, number);
  setSalary(salary);
}
public void mailCheck()
{
  System.out.println("Within mailCheck of Salary class ");
  System.out.println("Mailing check to "+ getName()
```

```
  +" with salary "+ salary);
}
public double getSalary()
{
  return salary;
}
public void setSalary(double newSalary)
{
if(newSalary >=0.0)
{
  salary = newSalary;
}
}
public double computePay()
{
  System.out.println("Computing salary pay for "+ getName());
  return salary/52;
}
}
```

Here, we cannot instantiate a new Employee, but if we instantiate a new Salary object, the Salary object will inherit the three fields and seven methods from Employee.

```
/* File name : AbstractDemo.java */
public class AbstractDemo
{
public static void main(String[] args)
{
  Salary s = new Salary("Mohd Mohtashim","Ambehta,  UP",
  3,3600.00);
  Employee e = new Salary("John Adams","Boston, MA",
  2,2400.00);

  System.out.println("Call mailCheck using Salary reference --");
  s.mailCheck();
  System.out.println("\n Call mailCheck using Employee reference--");
  e.mailCheck();
}
}
```

This would produce the following result:

```
Constructing an Employee
Constructing an Employee
Call mailCheck using Salary reference --
Within mailCheck of Salary class
Mailing check to MohdMohtashim with salary 3600.0

Call mailCheck using Employee reference--
Within mailCheck of Salary class
Mailing check to JohnAdams with salary 2400.
```

Abstract Methods:

If you want a class to contain a particular method but you want the actual implementation of that method to be determined by child classes, you can declare the method in the parent class as abstract.

The abstract keyword is also used to declare a method as abstract. An abstract method consists of a method signature, but no method body.

Abstract method would have no definition, and its signature is followed by a semicolon, not curly braces as follows:

```
publicabstractclassEmployee
{
private String name;
private String address;
private int number;

public abstract double computePay();

//Remainder of class definition
}
```

Declaring a method as abstract has two results:

- The class must also be declared abstract. If a class contains an abstract method, the class must be abstract as well.
- Any child class must either override the abstract method or declare itself abstract.

A child class that inherits an abstract method must override it. If they do not, they must be abstractand any of their children must override it.

Eventually, a descendant class has to implement the abstract method; otherwise, you would have a hierarchy of abstract classes that cannot be instantiated.

If Salary is extending Employee class, then it is required to implement computePay() method as follows:

```
/* File name : Salary.java */
public class SalaryextendsEmployee
{
private double salary;// Annual salary

public double computePay()
{
System.out.println("Computing salary pay for "+ getName());
return salary/52;
}

//Remainder of class definition
}
```

CHAPTER

24

Java Encapsulation

Encapsulation is one of the four fundamental OOP concepts. The other three are inheritance, polymorphism, and abstraction.

Encapsulation is the technique of making the fields in a class private and providing access to the fields via public methods. If a field is declared private, it cannot be accessed by anyone outside the class, thereby hiding the fields within the class. For this reason, encapsulation is also referred to as data hiding.

Encapsulation can be described as a protective barrier that prevents the code and data being randomly accessed by other code defined outside the class. Access to the data and code is tightly controlled by an interface.

The main benefit of encapsulation is the ability to modify our implemented code without breaking the code of others who use our code. With this feature Encapsulation gives maintainability, flexibility and extensibility to our code.

Example:

Let us look at an example that depicts encapsulation:

```
/* File name : EncapTest.java */
public class EncapTest{

private String name;
private String idNum;
private int age;

public int getAge(){
   return age;
}

public String getName(){
   return name;
}

public String getIdNum(){
   return idNum;
}

public void setAge(int newAge){
   age = newAge;
}

public void setName(String newName){
```

```
   name = newName;
}

public void setIdNum(String newId){
   idNum = newId;
}
}
```

The public methods are the access points to this class' fields from the outside java world. Normally, these methods are referred as getters and setters. Therefore any class that wants to access the variables should access them through these getters and setters.

The variables of the EncapTest class can be access as below:

```
/* File name : RunEncap.java */
public class RunEncap{

public static void main(String args[]){
   EncapTest encap =newEncapTest();
   encap.setName("James");
   encap.setAge(20);
   encap.setIdNum("12343ms");

   System.out.print("Name : "+ encap.getName()+" Age : "+ encap.getAge());
}
}
```

This would produce the following result:

```
Name:JamesAge:20
```

Benefits of Encapsulation:

The fields of a class can be made read-only or write-only.

A class can have total control over what is stored in its fields.

The users of a class do not know how the class stores its data. A class can change the data type of a field and users of the class do not need to change any of their code.

CHAPTER

25

Java Interfaces

An interface is a collection of abstract methods. A class implements an interface, thereby inheriting the abstract methods of the interface.

An interface is not a class. Writing an interface is similar to writing a class, but they are two different concepts. A class describes the attributes and behaviors of an object. An interface contains behaviors that a class implements.

Unless the class that implements the interface is abstract, all the methods of the interface need to be defined in the class.

An interface is similar to a class in the following ways:

- An interface can contain any number of methods.
- An interface is written in a file with a **.java** extension, with the name of the interface matching the name of the file.
- The bytecode of an interface appears in a **.class** file.
- Interfaces appear in packages, and their corresponding bytecode file must be in a directory structure that matches the package name.

However, an interface is different from a class in several ways, including:

- You cannot instantiate an interface.
- An interface does not contain any constructors.
- All of the methods in an interface are abstract.
- An interface cannot contain instance fields. The only fields that can appear in an interface must be declared both static and final.
- An interface is not extended by a class; it is implemented by a class.
- An interface can extend multiple interfaces.

Declaring Interfaces:

The **interface** keyword is used to declare an interface. Here is a simple example to declare an interface:

Example:

Let us look at an example that depicts encapsulation:

```
/* File name : NameOfInterface.java */
import java.lang.*;
//Any number of import statements

public interface NameOfInterface
{
  //Any number of final, static fields
  //Any number of abstract method declarations\
}
```

Interfaces have the following properties:

- An interface is implicitly abstract. You do not need to use the **abstract** keyword when declaring an interface.
- Each method in an interface is also implicitly abstract, so the abstract keyword is not needed.
- Methods in an interface are implicitly public.

Example:

```
/* File name : Animal.java */
interface Animal{

  public void eat();
  public void travel();
}
```

Implementing Interfaces:

When a class implements an interface, you can think of the class as signing a contract, agreeing to perform the specific behaviors of the interface. If a class does not perform all the behaviors of the interface, the class must declare itself as abstract.

Aclass uses the **implements** keyword to implement an interface. The implements keyword appears in the class declaration following the extends portion of the declaration.

```
/* File name : MammalInt.java */
public class MammalInt implements Animal{

public void eat(){
  System.out.println("Mammal eats");
}

public void travel(){
  System.out.println("Mammal travels");
}

public int noOfLegs(){
  return 0;
}
```

```
public static void main(String args[]){
  MammalInt m = new MammalInt();
  m.eat();
  m.travel();
}
}
```

This would produce the following result:

```
Mammal eats
Mammal travels
```

When overriding methods defined in interfaces there are several rules to be followed:

- Checked exceptions should not be declared on implementation methods other than the ones declared by the interface method or subclasses of those declared by the interface method.
- The signature of the interface method and the same return type or subtype should be maintained when overriding the methods.
- An implementation class itself can be abstract and if so interface methods need not be implemented.

When implementation interfaces there are several rules:

- A class can implement more than one interface at a time.
- A class can extend only one class, but implement many interfaces.
- An interface can extend another interface, similarly to the way that a class can extend another class.

Extending Interfaces:

An interface can extend another interface, similarly to the way that a class can extend another class. The **extends** keyword is used to extend an interface, and the child interface inherits the methods of the parent interface.

The following Sports interface is extended by Hockey and Football interfaces.

```
//Filename: Sports.java
public interface Sports
{
public void setHomeTeam(String name);
public void setVisitingTeam(String name);
}

//Filename: Football.java
public interfaceFootballextendsSports
{
public void homeTeamScored(int points);
public void visitingTeamScored(int points);
public void endOfQuarter(int quarter);
}

//Filename: Hockey.java
public interface Hockey extends Sports
{
public void homeGoalScored();
public void visitingGoalScored();
```

```
public void endOfPeriod(int period);
public void overtimePeriod(int ot);
}
```

The Hockey interface has four methods, but it inherits two from Sports; thus, a class that implements Hockey needs to implement all six methods. Similarly, a class that implements Football needs to define the three methods from Football and the two methods from Sports.

Extending Multiple Interfaces:

A Java class can only extend one parent class. Multiple inheritance is not allowed. Interfaces are not classes, however, and an interface can extend more than one parent interface.

The extends keyword is used once, and the parent interfaces are declared in a comma-separated list.

For example, if the Hockey interface extended both Sports and Event, it would be declared as:

```
public interface Hockey extends Sports,Event
```

Tagging Interfaces:

The most common use of extending interfaces occurs when the parent interface does not contain any methods. For example, the MouseListener interface in the java.awt.event package extended java.util.EventListener, which is defined as:

```
package java.util;
public interface EventListener
{}
```

An interface with no methods in it is referred to as a **tagging** interface. There are two basic design purposes of tagging interfaces:

Creates a common parent: As with the EventListener interface, which is extended by dozens of other interfaces in the Java API, you can use a tagging interface to create a common parent among a group of interfaces. For example, when an interface extends EventListener, the JVM knows that this particular interface is going to be used in an event delegation scenario.

Adds a data type to a class: This situation is where the term tagging comes from. A class that implements a tagging interface does not need to define any methods (since the interface does not have any), but the class becomes an interface type through polymorphism.

CHAPTER

26

Java Packages

Packages are used in Java inorder to prevent naming conflicts, to control access, to make searching/locating and usage of classes, interfaces, enumerationsss and annotations easier, etc.

A Package can be defined as a grouping of related types(classes, interfaces, enumerations and annotations) providing access protection and name space management.

Some of the existing packages in Java are:

- **java.lang** - bundles the fundamental classes
- **java.io** - classes for input , output functions are bundled in this package

Programmers can define their own packages to bundle group of classes/interfaces, etc. It is a good practice to group related classes implemented by you so that a programmer can easily determine that the classes, interfaces, enumerations, annotations are related.

Since the package creates a new namespace there won't be any name conflicts with names in other packages. Using packages, it is easier to provide access control and it is also easier to locate the related classed.

Creating a package:

When creating a package, you should choose a name for the package and put a **package** statement with that name at the top of every source file that contains the classes, interfaces, enumerations, and annotation types that you want to include in the package.
The **package** statement should be the first line in the source file. There can be only one package statement in each source file, and it applies to all types in the file.

If a package statement is not used then the class, interfaces, enumerations, and annotation types will be put into an unnamed package.

Example:

Let us look at an example that creates a package called **animals**. It is common practice to use lowercased names of packages to avoid any conflicts with the names of classes, interfaces.

Put an interface in the package *animals*:

```
/* File name : Animal.java */
package animals;

interface Animal{
public void eat();
public void travel();
```

```
}
```

Now, put an implementation in the same package *animals*:

```
package animals;

/* File name : MammalInt.java */
public class MammalInt implements Animal{

public void eat(){
  System.out.println("Mammal eats");
}

public void travel(){
  System.out.println("Mammal travels");
}

public int noOfLegs(){
  return0;
}

public static void main(String args[]){
  MammalInt m = new MammalInt();
  m.eat();
  m.travel();
}
}
```

Now, you compile these two files and put them in a sub-directory called **animals** and try to run as follows:

```
$ mkdir animals
$ cp Animal.class MammalInt.class animals
$ java animals/MammalInt
Mammal eats
Mammal travels
```

The import Keyword:

If a class wants to use another class in the same package, the package name does not need to be used. Classes in the same package find each other without any special syntax.

Example:

Here, a class named Boss is added to the payroll package that already contains Employee. The Boss can then refer to the Employee class without using the payroll prefix, as demonstrated by the following Boss class.

```
package payroll;

public class Boss
{
  public void payEmployee(Employee e)
  {
    e.mailCheck();
  }
}
```

What happens if Boss is not in the payroll package? The Boss class must then use one of the following techniques for referring to a class in a different package.

- The fully qualified name of the class can be used. For example:

```
payroll.Employee
```

- The package can be imported using the import keyword and the wild card (*). For example:

```
import payroll.*;
```

- The class itself can be imported using the import keyword. For example:

```
import payroll.Employee;
```

Note: A class file can contain any number of import statements. The import statements must appear after the package statement and before the class declaration.

The Directory Structure of Packages:

Two major results occur when a class is placed in a package:

- The name of the package becomes a part of the name of the class, as we just discussed in the previous section.

- The name of the package must match the directory structure where the corresponding bytecode resides.

Here is simple way of managing your files in Java:

Put the source code for a class, interface, enumeration, or annotation type in a text file whose name is the simple name of the type and whose extension is **.java**. For example:

```
// File Name :  Car.java

package vehicle;

public class Car{
  // Class implementation.
}
```

Now, put the source file in a directory whose name reflects the name of the package to which the class belongs:

```
....\vehicle\Car.java
```

Now, the qualified class name and pathname would be as below:

- Class name -> vehicle.Car

- Path name -> vehicle\Car.java (in windows)

In general, a company uses its reversed Internet domain name for its package names. Example: A company's Internet domain name is apple.com, then all its package names would start with com.apple. Each component of the package name corresponds to a subdirectory.

Example: The company had a com.apple.computers package that contained a Dell.java source file, it would be contained in a series of subdirectories like this:

```
....\com\apple\computers\Dell.java
```

At the time of compilation, the compiler creates a different output file for each class, interface and enumeration defined in it. The base name of the output file is the name of the type, and its extension is**.class**

For example:

```
// File Name: Dell.java

package com.apple.computers;
public class Dell{

}
class Ups{

}
```

Now, compile this file as follows using -d option:

```
$javac -d .Dell.java
```

This would put compiled files as follows:

```
.\com\apple\computers\Dell.class
.\com\apple\computers\Ups.class
```

You can import all the classes or interfaces defined in *\com\apple\computers* as follows:

```
import com.apple.computers.*;
```

Like the .java source files, the compiled .class files should be in a series of directories that reflect the package name. However, the path to the .class files does not have to be the same as the path to the .java source files. You can arrange your source and class directories separately, as:

```
<path-one>\sources\com\apple\computers\Dell.java

<path-two>\classes\com\apple\computers\Dell.class
```

By doing this, it is possible to give the classes directory to other programmers without revealing your sources. You also need to manage source and class files in this manner so that the compiler and the Java Virtual Machine (JVM) can find all the types your program uses.

The full path to the classes directory, <path-two>\classes, is called the class path, and is set with the CLASSPATH system variable. Both the compiler and the JVM construct the path to your .class files by adding the package name to the class path.

Say <path-two>\classes is the class path, and the package name is com.apple.computers, then the compiler and JVM will look for .class files in <path-two>\classes\com\apple\compters.

A class path may include several paths. Multiple paths should be separated by a semicolon (Windows) or colon (UNIX). By default, the compiler and the JVM search the current directory and the JAR file containing the Java platform classes so that these directories are automatically in the class path.

Set CLASSPATH System Variable:

To display the current CLASSPATH variable, use the following commands in Windows and UNIX (Bourne shell):

- In Windows -> C:\> set CLASSPATH
- In UNIX -> % echo $CLASSPATH

To delete the current contents of the CLASSPATH variable, use:

- In Windows -> C:\> set CLASSPATH=
- In UNIX -> % unset CLASSPATH; export CLASSPATH

To set the CLASSPATH variable:

- In Windows -> set CLASSPATH=C:\users\jack\java\classes
- In UNIX -> % CLASSPATH=/home/jack/java/classes; export CLASSPATH

CHAPTER

27

Java Data Structures

The data structures provided by the Java utility package are very powerful and perform a wide range of functions. These data structures consist of the following interface and classes:

- Enumeration
- BitSet
- Vector
- Stack
- Dictionary
- Hashtable
- Properties

All these classes are now legacy and Java-2 has introduced a new framework called Collections Framework, which is discussed in next tutorial:

The Enumeration:

The Enumeration interface isn't itself a data structure, but it is very important within the context of other data structures. The Enumeration interface defines a means to retrieve successive elements from a data structure.

For example, Enumeration defines a method called nextElement that is used to get the next element in a data structure that contains multiple elements.

The Enumeration interface defines the methods by which you can enumerate (obtain one at a time) the elements in a collection of objects.

This legacy interface has been superceded by Iterator. Although not deprecated, Enumeration is considered obsolete for new code. However, it is used by several methods defined by the legacy classes such as Vector and Properties, is used by several other API classes, and is currently in widespread use in application code.

The methods declared by Enumeration are summarized in the following table:

SN	Methods with Description
1	**boolean hasMoreElements( )** When implemented, it must return true while there are still more elements to extract, and false when all the elements have been enumerated.
2	**Object nextElement( )** This returns the next object in the enumeration as a generic Object reference.

Example:

Following is the example showing usage of Enumeration.

```
import java.util.Vector;
import java.util.Enumeration;

public class EnumerationTester{

public static void main(String args[]){
  Enumeration days;
  Vector dayNames = new Vector();
  dayNames.add("Sunday");
  dayNames.add("Monday");
  dayNames.add("Tuesday");
  dayNames.add("Wednesday");
  dayNames.add("Thursday");
  dayNames.add("Friday");
  dayNames.add("Saturday");
  days = dayNames.elements();
  while(days.hasMoreElements()){
    System.out.println(days.nextElement());
  }
}
}
```

This would produce the following result:

```
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
```

The BitSet

The BitSet class implements a group of bits or flags that can be set and cleared individually.

This class is very useful in cases, where you need to keep up with a set of Boolean values; you just assign a bit to each value and set or clear it as appropriate.

A BitSet class creates a special type of array that holds bit values. The BitSet array can increase in size as needed. This makes it similar to a vector of bits.

This is a legacy class but it has been completely re-engineered in Java 2, version 1.4.

The BitSet defines two constructors. The first version creates a default object:

```
BitSet()
```

The second version allows you to specify its initial size, i.e., the number of bits that it can hold. All bits are initialized to zero.

```
BitSet(int size)
```

BitSet implements the Cloneable interface and defines the methods listed in table below:

SN	Methods with Description
1	**void and(BitSet bitSet)** ANDs the contents of the invoking BitSet object with those specified by bitSet. The result is placed into the invoking object.
2	**void andNot(BitSet bitSet)** For each 1 bit in bitSet, the corresponding bit in the invoking BitSet is cleared.
3	**int cardinality( )** Returns the number of set bits in the invoking object.
4	**void clear( )** Zeros all bits.
5	**void clear(int index)** Zeros the bit specified by index.
6	**void clear(int startIndex, int endIndex)** Zeros the bits from startIndex to endIndex.1.
7	**Object clone( )** Duplicates the invoking BitSet object.
8	**boolean equals(Object bitSet)** Returns true if the invoking bit set is equivalent to the one passed in bitSet. Otherwise, the method returns false.
9	**void flip(int index)** Reverses the bit specified by index. (
10	**void flip(int startIndex, int endIndex)** Reverses the bits from startIndex to endIndex.1.
11	**boolean get(int index)** Returns the current state of the bit at the specified index.
12	**BitSet get(int startIndex, int endIndex)** Returns a BitSet that consists of the bits from startIndex to endIndex.1. The invoking object is not changed.
13	**int hashCode( )** Returns the hash code for the invoking object.
14	**boolean intersects(BitSet bitSet)** Returns true if at least one pair of corresponding bits within the invoking object and bitSet are 1.
15	**boolean isEmpty( )** Returns true if all bits in the invoking object are zero.
16	**int length( )** Returns the number of bits required to hold the contents of the invoking BitSet. This value is determined by the location of the last 1 bit.

17	**int nextClearBit(int startIndex)** Returns the index of the next cleared bit, (that is, the next zero bit), starting from the index specified by startIndex
18	**int nextSetBit(int startIndex)** Returns the index of the next set bit (that is, the next 1 bit), starting from the index specified by startIndex. If no bit is set, .1 is returned.
19	**void or(BitSet bitSet)** ORs the contents of the invoking BitSet object with that specified by bitSet. The result is placed into the invoking object.
20	**void set(int index)** Sets the bit specified by index.
21	**void set(int index, boolean v)** Sets the bit specified by index to the value passed in v. true sets the bit, false clears the bit.
22	**void set(int startIndex, int endIndex)** Sets the bits from startIndex to endIndex.1.
23	**void set(int startIndex, int endIndex, boolean v)** Sets the bits from startIndex to endIndex.1, to the value passed in v. true sets the bits, false clears the bits.
24	**int size( )** Returns the number of bits in the invoking BitSet object.
25	**String toString( )** Returns the string equivalent of the invoking BitSet object.
26	**void xor(BitSet bitSet)** XORs the contents of the invoking BitSet object with that specified by bitSet. The result is placed into the invoking object

Example:

The following program illustrates several of the methods supported by this data structure:

```
import java.util.BitSet;

public class BitSetDemo{

public static void main(String args[]){
BitSet bits1 = new BitSet(16);
BitSet bits2 = new BitSet(16);

// set some bits
for(int i=0; i<16; i++){
  if((i%2)==0) bits1.set(i);
  if((i%5)!=0) bits2.set(i);
}
System.out.println("Initial pattern in bits1: ");
System.out.println(bits1);
System.out.println("\nInitial pattern in bits2: ");
System.out.println(bits2);

// AND bits
bits2.and(bits1);
System.out.println("\nbits2 AND bits1: ");
System.out.println(bits2);
```

```
// OR bits
bits2.or(bits1);
System.out.println("\nbits2 OR bits1: ");
System.out.println(bits2);

// XOR bits
bits2.xor(bits1);
System.out.println("\nbits2 XOR bits1: ");
System.out.println(bits2);
}
}
```

This would produce the following result:

```
Initial pattern in bits1:
{0,2,4,6,8,10,12,14}

Initial pattern in bits2:
{1,2,3,4,6,7,8,9,11,12,13,14}

bits2 AND bits1:
{2,4,6,8,12,14}

bits2 OR bits1:
{0,2,4,6,8,10,12,14}

bits2 XOR bits1:
{}
```

The Vector

The Vector class is similar to a traditional Java array, except that it can grow as necessary to accommodate new elements.

Like an array, elements of a Vector object can be accessed via an index into the vector.

The nice thing about using the Vector class is that you don't have to worry about setting it to a specific size upon creation; it shrinks and grows automatically when necessary.

Vector implements a dynamic array. It is similar to ArrayList, but with two differences:

- Vector is synchronized.
- Vector contains many legacy methods that are not part of the collections framework.

Vector proves to be very useful if you don't know the size of the array in advance or you just need one that can change sizes over the lifetime of a program.

The Vector class supports four constructors. The first form creates a default vector, which has an initial size of 10:

```
Vector()
```

The second form creates a vector whose initial capacity is specified by size:

```
Vector(int size)
```

The third form creates a vector whose initial capacity is specified by size and whose increment is specified by incr. The increment specifies the number of elements to allocate each time that a vector is resized upward:

```
Vector(int size,int incr)
```

The fourth form creates a vector that contains the elements of collection c:

```
Vector(Collection c)
```

Apart from the methods inherited from its parent classes, Vector defines the following methods:

SN	Methods with Description
1	**void add(int index, Object element)** Inserts the specified element at the specified position in this Vector.
2	**boolean add(Object o)** Appends the specified element to the end of this Vector.
3	**boolean addAll(Collection c)** Appends all of the elements in the specified Collection to the end of this Vector, in the order that they are returned by the specified Collection's Iterator.
4	**boolean addAll(int index, Collection c)** Inserts all of the elements in in the specified Collection into this Vector at the specified position.
5	**void addElement(Object obj)** Adds the specified component to the end of this vector, increasing its size by one.
6	**int capacity()** Returns the current capacity of this vector.
7	**void clear()** Removes all of the elements from this Vector.
8	**Object clone()** Returns a clone of this vector.
9	**boolean contains(Object elem)** Tests if the specified object is a component in this vector.
10	**boolean containsAll(Collection c)** Returns true if this Vector contains all of the elements in the specified Collection.
11	**void copyInto(Object[] anArray)** Copies the components of this vector into the specified array.
12	**Object elementAt(int index)** Returns the component at the specified index.
13	**Enumeration elements()** Returns an enumeration of the components of this vector.
14	**void ensureCapacity(int minCapacity)** Increases the capacity of this vector, if necessary, to ensure that it can hold at least the number of components specified by the minimum capacity argument.
15	**boolean equals(Object o)** Compares the specified Object with this Vector for equality.
16	**Object firstElement()** Returns the first component (the item at index 0) of this vector.
17	**Object get(int index)** Returns the element at the specified position in this Vector.

18	**int hashCode()** Returns the hash code value for this Vector.
19	**int indexOf(Object elem)** Searches for the first occurence of the given argument, testing for equality using the equals method.
20	**int indexOf(Object elem, int index)** Searches for the first occurence of the given argument, beginning the search at index, and testing for equality using the equals method.
21	**void insertElementAt(Object obj, int index)** Inserts the specified object as a component in this vector at the specified index.
22	**boolean isEmpty()** Tests if this vector has no components.
23	**Object lastElement()** Returns the last component of the vector.
24	**int lastIndexOf(Object elem)** Returns the index of the last occurrence of the specified object in this vector.
25	**int lastIndexOf(Object elem, int index)** Searches backwards for the specified object, starting from the specified index, and returns an index to it.
26	**Object remove(int index)** Removes the element at the specified position in this Vector.
27	**boolean remove(Object o)** Removes the first occurrence of the specified element in this Vector If the Vector does not contain the element, it is unchanged.
28	**boolean removeAll(Collection c)** Removes from this Vector all of its elements that are contained in the specified Collection.
29	**void removeAllElements()** Removes all components from this vector and sets its size to zero.
30	**boolean removeElement(Object obj)** Removes the first (lowest-indexed) occurrence of the argument from this vector.
31	**void removeElementAt(int index)** removeElementAt(int index)
32	**protected void removeRange(int fromIndex, int toIndex)** Removes from this List all of the elements whose index is between fromIndex, inclusive and toIndex, exclusive.
33	**boolean retainAll(Collection c)** Retains only the elements in this Vector that are contained in the specified Collection.
34	**Object set(int index, Object element)** Replaces the element at the specified position in this Vector with the specified element.
35	**void setElementAt(Object obj, int index)** Sets the component at the specified index of this vector to be the specified object.
36	**void setSize(int newSize)** Sets the size of this vector.
37	**int size()**

	Returns the number of components in this vector.
38	**List subList(int fromIndex, int toIndex)** Returns a view of the portion of this List between fromIndex, inclusive, and toIndex, exclusive.
39	**Object[] toArray()** Returns an array containing all of the elements in this Vector in the correct order.
40	**Object[] toArray(Object[] a)** Returns an array containing all of the elements in this Vector in the correct order; the runtime type of the returned array is that of the specified array.
41	**String toString()** Returns a string representation of this Vector, containing the String representation of each element.
42	**void trimToSize()** Trims the capacity of this vector to be the vector's current size.

Example:

The following program illustrates several of the methods supported by this collection:

```
import java.util.*;

public class VectorDemo{

public static void main(String args[]){
  // initial size is 3, increment is 2
  Vector v = new Vector(3,2);
  System.out.println("Initial size: "+ v.size());
  System.out.println("Initial capacity: "+v.capacity());
  v.addElement(new Integer(1));
  v.addElement(new Integer(2));
  v.addElement(new Integer(3));
  v.addElement(new Integer(4));
  System.out.println("Capacity after four additions: "+v.capacity());

  v.addElement(new Double(5.45));
  System.out.println("Current capacity: "+v.capacity());
  v.addElement(new Double(6.08));
  v.addElement(new Integer(7));
  System.out.println("Current capacity: "+v.capacity());
  v.addElement(new Float(9.4));
  v.addElement(new Integer(10));
  System.out.println("Current capacity: "+v.capacity());
  v.addElement(new Integer(11));
  v.addElement(new Integer(12));
  System.out.println("First element: "+(Integer)v.firstElement());
  System.out.println("Last element: "+(Integer)v.lastElement());
  if(v.contains(new Integer(3)))
  System.out.println("Vector contains 3.");
  // enumerate the elements in the vector.
  Enumeration vEnum = v.elements();
  System.out.println("\nElements in vector:");
  while(vEnum.hasMoreElements())
   System.out.print(vEnum.nextElement()+" ");
   System.out.println();
  }
}
```

This would produce the following result:

```
Initial size:0
Initial capacity:3
Capacity after four additions:5
Current capacity:5
Current capacity:7
Current capacity:9
First element:1
Last element:12
Vector contains 3.

Elements in vector:
12345.456.0879.4101112
```

The Stack

The Stack class implements a last-in-first-out (LIFO) stack of elements.

You can think of a stack literally as a vertical stack of objects; when you add a new element, it gets stacked on top of the others.

When you pull an element off the stack, it comes off the top. In other words, the last element you added to the stack is the first one to come back off.

Stack is a subclass of Vector that implements a standard last-in, first-out stack.

Stack only defines the default constructor, which creates an empty stack. Stack includes all the methods defined by Vector and adds several of its own.

```
Stack()
```

Apart from the methods inherited from its parent class Vector, Stack defines the following methods:

SN	Methods with Description
1	**boolean empty()** Tests if this stack is empty. Returns true if the stack is empty, and returns false if the stack contains elements.
2	**Object peek( )** Returns the element on the top of the stack, but does not remove it.
3	**Object pop( )** Returns the element on the top of the stack, removing it in the process.
4	**Object push(Object element)** Pushes element onto the stack. element is also returned.
5	**int search(Object element)** Searches for element in the stack. If found, its offset from the top of the stack is returned. Otherwise, .1 is returned.

Example:

The following program illustrates several of the methods supported by this collection:

```
import java.util.*;

public class StackDemo{
```

```
static void showpush(Stack st,int a){
  st.push(new Integer(a));
  System.out.println("push("+ a +")");
  System.out.println("stack: "+ st);
}

static void showpop(Stack st){
  System.out.print("pop -> ");
  Integer a =(Integer) st.pop();
  System.out.println(a);
  System.out.println("stack: "+ st);
}

public static void main(String args[]){
  Stack st = new Stack();
  System.out.println("stack: "+ st);
  showpush(st,42);
  showpush(st,66);
  showpush(st,99);
  showpop(st);
  showpop(st);
  showpop(st);
try{
  showpop(st);
}catch(EmptyStackException e){
  System.out.println("empty stack");
 }
}
}
```

This would produce the following result:

```
stack:[]
push(42)
stack:[42]
push(66)
stack:[42,66]
push(99)
stack:[42,66,99]
pop ->99
stack:[42,66]
pop ->66
stack:[42]
pop ->42
stack:[]
pop -> empty stack
```

The Dictionary

The Dictionary class is an abstract class that defines a data structure for mapping keys to values.

This is useful in cases where you want to be able to access data via a particular key rather than an integer index.

Since the Dictionary class is abstract, it provides only the framework for a key-mapped data structure rather than a specific implementation.

Dictionary is an abstract class that represents a key/value storage repository and operates much like Map.

Given a key and value, you can store the value in a Dictionary object. Once the value is stored, you can retrieve it by using its key. Thus, like a map, a dictionary can be thought of as a list of key/value pairs.

The abstract methods defined by Dictionary are listed below:

SN	Methods with Description
1	**Enumeration elements( )** Returns an enumeration of the values contained in the dictionary.
2	**Object get(Object key)** Returns the object that contains the value associated with key. If key is not in the dictionary, a null object is returned.
3	**boolean isEmpty( )** Returns true if the dictionary is empty, and returns false if it contains at least one key.
4	**Enumeration keys( )** Returns an enumeration of the keys contained in the dictionary.
5	**Object put(Object key, Object value)** Inserts a key and its value into the dictionary. Returns null if key is not already in the dictionary; returns the previous value associated with key if key is already in the dictionary.
6	**Object remove(Object key)** Removes key and its value. Returns the value associated with key. If key is not in the dictionary, a null is returned.
7	**int size( )** Returns the number of entries in the dictionary.

The Dictionary class is obsolete. You should implement the **Map interface** to obtain key/value storage functionality.

Map Interface

The Map interface maps unique keys to values. A key is an object that you use to retrieve a value at a later date.

- Given a key and a value, you can store the value in a Map object. After the value is stored, you can retrieve it by using its key.
- Several methods throw a NoSuchElementException when no items exist in the invoking map.
- A ClassCastException is thrown when an object is incompatible with the elements in a map.
- A ClassCastException is thrown when an object is incompatible with the elements in a map.
- A NullPointerException is thrown if an attempt is made to use a null object and null is not allowed in the map.
- An UnsupportedOperationException is thrown when an attempt is made to change an unmodifiable map.

SN	Methods with Description
1	**void clear( )** Removes all key/value pairs from the invoking map.
2	**boolean containsKey(Object k)** Returns true if the invoking map contains k as a key. Otherwise, returns false.
3	**boolean containsValue(Object v)**

	Returns true if the map contains v as a value. Otherwise, returns false.
4	**Set entrySet( )** Returns a Set that contains the entries in the map. The set contains objects of type Map.Entry. This method provides a set-view of the invoking map.
5	**boolean equals(Object obj)** Returns true if obj is a Map and contains the same entries. Otherwise, returns false.
6	**Object get(Object k)** Returns the value associated with the key k.
7	**int hashCode( )** Returns the hash code for the invoking map.
8	**boolean isEmpty( )** Returns true if the invoking map is empty. Otherwise, returns false.
9	**Set keySet( )** Returns a Set that contains the keys in the invoking map. This method provides a set-view of the keys in the invoking map.
10	**Object put(Object k, Object v)** Puts an entry in the invoking map, overwriting any previous value associated with the key. The key and value are k and v, respectively. Returns null if the key did not already exist. Otherwise, the previous value linked to the key is returned.
11	**void putAll(Map m)** Puts all the entries from m into this map.
12	**Object remove(Object k)** Removes the entry whose key equals k.
13	**int size( )** Returns the number of key/value pairs in the map.
14	**Collection values( )** Returns a collection containing the values in the map. This method provides a collection-view of the values in the map.

Example:

Map has its implementation in various classes like HashMap, Following is the example to explain map functionality:

```
import java.util.*;

public class CollectionsDemo {

public static void main(String[] args) {
  Map m1 = new HashMap();
  m1.put("Zara","8");
  m1.put("Mahnaz","31");
  m1.put("Ayan","12");
  m1.put("Daisy","14");
  System.out.println();
  System.out.println(" Map Elements");
  System.out.print("\t"+ m1);
}
}
```

This would produce the following result:

```
MapElements
{Mahnaz=31,Ayan=12,Daisy=14,Zara=8}
```

The Hashtable

The Hashtable class provides a means of organizing data based on some user-defined key structure.

For example, in an address list hash table you could store and sort data based on a key such as ZIP code rather than on a person's name.

The specific meaning of keys in regard to hashtables is totally dependent on the usage of the hashtable and the data it contains.

Hashtable was part of the original java.util and is a concrete implementation of a Dictionary.

However, Java 2 reengineered Hashtable so that it also implements the Map interface. Thus, Hashtable is now integrated into the collections framework. It is similar to HashMap, but is synchronized.

Like HashMap, Hashtable stores key/value pairs in a hashtable. When using a Hashtable, you specify an object that is used as a key, and the value that you want linked to that key. The key is then hashed, and the resulting hash code is used as the index at which the value is stored within the table.

The Hashtable defines four constructors. The first version is the default constructor:

```
Hashtable()
```

The second version creates a hashtable that has an initial size specified by size:

```
Hashtable(int size)
```

The third version creates a hashtable that has an initial size specified by size and a fill ratio specified by fillRatio.

This ratio must be between 0.0 and 1.0, and it determines how full the hashtable can be before it is resized upward.

```
Hashtable(int size,float fillRatio)
```

The fourth version creates a hashtable that is initialized with the elements in m.

The capacity of the hashtable is set to twice the number of elements in m. The default load factor of 0.75 is used.

```
Hashtable(Map m)
```

Apart from the methods defined by Map interface, Hashtable defines the following methods:

SN	Methods with Description
1	**void clear( )** Resets and empties the hash table.
2	**Object clone( )** Returns a duplicate of the invoking object.
3	**boolean contains(Object value)** Returns true if some value equal to value exists within the hash table. Returns false if the value isn't found.
4	**boolean containsKey(Object key)** Returns true if some key equal to key exists within the hash table. Returns false if the key isn't

	found.
5	**boolean containsValue(Object value)** Returns true if some value equal to value exists within the hash table. Returns false if the value isn't found.
6	**Enumeration elements( )** Returns an enumeration of the values contained in the hash table.
7	**Object get(Object key)** Returns the object that contains the value associated with key. If key is not in the hash table, a null object is returned.
8	**boolean isEmpty( )** Returns true if the hash table is empty; returns false if it contains at least one key.
9	**Enumeration keys( )** Returns an enumeration of the keys contained in the hash table.
10	**Object put(Object key, Object value)** Inserts a key and a value into the hash table. Returns null if key isn't already in the hash table; returns the previous value associated with key if key is already in the hash table.
11	**void rehash( )** Increases the size of the hash table and rehashes all of its keys.
12	**Object remove(Object key)** Removes key and its value. Returns the value associated with key. If key is not in the hash table, a null object is returned.
13	**int size( )** Returns the number of entries in the hash table.
14	**String toString( )** Returns the string equivalent of a hash table.

Example:

The following program illustrates several of the methods supported by this data structure:

```
import java.util.*;

public class HashTableDemo{

public static void main(String args[]){
  // Create a hash map
  Hashtable balance = new Hashtable();
  Enumeration names;
  String str;
  double bal;

  balance.put("Zara",new Double(3434.34));
  balance.put("Mahnaz",new Double(123.22));
  balance.put("Ayan",new Double(1378.00));
  balance.put("Daisy",new Double(99.22));
  balance.put("Qadir",new Double(-19.08));

  // Show all balances in hash table.
  names = balance.keys();
  while(names.hasMoreElements()){
    str =(String) names.nextElement();
    System.out.println(str +": "+balance.get(str));
```

```
  }
 System.out.println();
 // Deposit 1,000 into Zara's account
 bal =((Double)balance.get("Zara")).doubleValue();
 balance.put("Zara",newDouble(bal+1000));
 System.out.println("Zara's new balance: "+balance.get("Zara"));
}
}
```

This would produce the following result:

```
Qadir:-19.08
Zara:3434.34
Mahnaz:123.22
Daisy:99.22
Ayan:1378.0

Zara's new balance: 4434.34
```

The Properties

Properties is a subclass of Hashtable. It is used to maintain lists of values in which the key is a String and the value is also a String.

The Properties class is used by many other Java classes. For example, it is the type of object returned by System.getProperties( ) when obtaining environmental values.

Properties is a subclass of Hashtable. It is used to maintain lists of values in which the key is a String and the value is also a String.

The Properties class is used by many other Java classes. For example, it is the type of object returned by System.getProperties( ) when obtaining environmental values.

Properties define the following instance variable. This variable holds a default property list associated with a Properties object.

```
Properties defaults;
```

The Properties define two constructors. The first version creates a Properties object that has no default values:

```
Properties()
```

The second creates an object that uses propDefault for its default values. In both cases, the property list is empty:

```
Properties(Properties propDefault)
```

Apart from the methods defined by Hashtable, Properties define the following methods:

SN	Methods with Description
1	**String getProperty(String key)** Returns the value associated with key. A null object is returned if key is neither in the list nor in the default property list.
2	**String getProperty(String key, String defaultProperty)** Returns the value associated with key. defaultProperty is returned if key is neither in the list nor in the default property list.

3	**void list(PrintStream streamOut)** Sends the property list to the output stream linked to streamOut.
4	**void list(PrintWriter streamOut)** Sends the property list to the output stream linked to streamOut.
5	**void load(InputStream streamIn) throws IOException** Inputs a property list from the input stream linked to streamIn.
6	**Enumeration propertyNames( )** Returns an enumeration of the keys. This includes those keys found in the default property list, too.
7	**Object setProperty(String key, String value)** Associates value with key. Returns the previous value associated with key, or returns null if no such association exists.
8	**void store(OutputStream streamOut, String description)** After writing the string specified by description, the property list is written to the output stream linked to streamOut.

Example:

The following program illustrates several of the methods supported by this data structure:

```
import java.util.*;

public class PropDemo{

public static void main(String args[]){
  Properties capitals = new Properties();
  Set states;
  String str;

  capitals.put("Illinois","Springfield");
  capitals.put("Missouri","Jefferson City");
  capitals.put("Washington","Olympia");
  capitals.put("California","Sacramento");
  capitals.put("Indiana","Indianapolis");

  // Show all states and capitals in hashtable.
  states = capitals.keySet();// get set-view of keys
  Iterator itr = states.iterator();
  while(itr.hasNext()){
    str =(String) itr.next();
    System.out.println("The capital of "+str +" is "+capitals.getProperty(str)+".");
  }
  System.out.println();

  // look for state not in list -- specify default
  str = capitals.getProperty("Florida","Not Found");
  System.out.println("The capital of Florida is "+ str +".");
 }
}
```

This would produce the following result:

```
The capital of Missouri is JeffersonCity.
The capital of Illinois is Springfield.
The capital of Indiana is Indianapolis.
The capital of California is Sacramento.
```

```
The capital of WashingtonisOlympia.

The capital of FloridaisNotFound.
```

CHAPTER

28

Java Collections

Priorto Java 2, Java provided ad hoc classes such as **Dictionary, Vector, Stack**, and **Properties** to store and manipulate groups of objects. Although these classes were quite useful, they lacked a central, unifying theme. Thus, the way that you used Vector was different from the way that you used Properties.

The collections framework was designed to meet several goals.

- The framework had to be high-performance. The implementations for the fundamental collections (dynamic arrays, linked lists, trees, and hashtables) are highly efficient.
- The framework had to allow different types of collections to work in a similar manner and with a high degree of interoperability.
- Extending and/or adapting a collection had to be easy.

Towards this end, the entire collections framework is designed around a set of standard interfaces. Several standard implementations such as **LinkedList, HashSet,** and **TreeSet**, of these interfaces are provided that you may use as-is and you may also implement your own collection, if you choose.

A collections framework is a unified architecture for representing and manipulating collections. All collections frameworks contain the following:

- **Interfaces:** These are abstract data types that represent collections. Interfaces allow collections to be manipulated independently of the details of their representation. In object-oriented languages, interfaces generally form a hierarchy.
- **Implementations, i.e., Classes:** These are the concrete implementations of the collection interfaces. In essence, they are reusable data structures.
- **Algorithms:** These are the methods that perform useful computations, such as searching and sorting, on objects that implement collection interfaces. The algorithms are said to be polymorphic: that is, the same method can be used on many different implementations of the appropriate collection interface.

In addition to collections, the framework defines several map interfaces and classes. Maps store key/value pairs. Although maps are not *collections* in the proper use of the term, but they are fully integrated with collections.

The Collection Interfaces:

The collections framework defines several interfaces. This section provides an overview of each interface:

SN	Interfaces with Description
1	The Collection Interface

	This enables you to work with groups of objects; it is at the top of the collections hierarchy.
2	The List Interface This extends **Collection** and an instance of List stores an ordered collection of elements.
3	The Set This extends Collection to handle sets, which must contain unique elements
4	The SortedSet This extends Set to handle sorted sets
5	The Map This maps unique keys to values.
6	The Map.Entry This describes an element (a key/value pair) in a map. This is an inner class of Map.
7	The SortedMap This extends Map so that the keys are maintained in ascending order.
8	The Enumeration This is legacy interface and defines the methods by which you can enumerate (obtain one at a time) the elements in a collection of objects. This legacy interface has been superceded by Iterator.

The Collection Classes:

Java provides a set of standard collection classes that implement Collection interfaces. Some of the classes provide full implementations that can be used as-is and others are abstract class, providing skeletal implementations that are used as starting points for creating concrete collections.

The standard collection classes are summarized in the following table:

SN	Classes with Description
1	**AbstractCollection** Implements most of the Collection interface.
2	**AbstractList** Extends AbstractCollection and implements most of the List interface.
3	**AbstractSequentialList** Extends AbstractList for use by a collection that uses sequential rather than random access of its elements.
4	LinkedList Implements a linked list by extending AbstractSequentialList.
5	ArrayList Implements a dynamic array by extending AbstractList.
6	**AbstractSet** Extends AbstractCollection and implements most of the Set interface.
7	HashSet Extends AbstractSet for use with a hash table.
8	LinkedHashSet Extends HashSet to allow insertion-order iterations.
9	TreeSet Implements a set stored in a tree. Extends AbstractSet.

10	**AbstractMap** Implements most of the Map interface.
11	HashMap Extends AbstractMap to use a hash table.
12	TreeMap Extends AbstractMap to use a tree.
13	WeakHashMap Extends AbstractMap to use a hash table with weak keys.
14	LinkedHashMap Extends HashMap to allow insertion-order iterations.
15	IdentityHashMap Extends AbstractMap and uses reference equality when comparing documents.

The *AbstractCollection, AbstractSet, AbstractList, AbstractSequentialList* and *AbstractMap* classes provide skeletal implementations of the core collection interfaces, to minimize the effort required to implement them.

The following legacy classes defined by java.util have been discussed in previous tutorial:

SN	Classes with Description
1	Vector This implements a dynamic array. It is similar to ArrayList, but with some differences.
2	Stack Stack is a subclass of Vector that implements a standard last-in, first-out stack.
3	Dictionary Dictionary is an abstract class that represents a key/value storage repository and operates much like Map.
4	Hashtable Hashtable was part of the original java.util and is a concrete implementation of a Dictionary.
5	Properties Properties is a subclass of Hashtable. It is used to maintain lists of values in which the key is a String and the value is also a String.
6	BitSet A BitSet class creates a special type of array that holds bit values. This array can increase in size as needed.

The Collection Algorithms:

The collections framework defines several algorithms that can be applied to collections and maps. These algorithms are defined as static methods within the Collections class.

Several of the methods can throw a **ClassCastException**, which occurs when an attempt is made to compare incompatible types, or an **UnsupportedOperationException**, which occurs when an attempt is made to modify an unmodifiable collection.

Collections define three static variables: EMPTY_SET, EMPTY_LIST, and EMPTY_MAP. All are immutable.

SN	Algorithms with Description
1	The Collection Algorithms Here is a list of all the algorithm implementation.

How to use an Iterator?

Often, you will want to cycle through the elements in a collection. For example, you might want to display each element.

The easiest way to do this is to employ an iterator, which is an object that implements either the Iterator or the ListIterator interface.

Iterator enables you to cycle through a collection, obtaining or removing elements. ListIterator extends Iterator to allow bidirectional traversal of a list and the modification of elements.

SN	Iterator Methods with Description
1	Using Java Iterator Here is a list of all the methods with examples provided by Iterator and ListIterator interfaces.

How to use a Comparator?

Both TreeSet and TreeMap store elements in sorted order. However, it is the comparator that defines precisely what *sorted order* means.

This interface lets us sort a given collection any number of different ways. Also, this interface can be used to sort any instances of any class(even classes we cannot modify).

SN	Iterator Methods with Description
1	Using Java Comparator Here is a list of all the methods with examples provided by Comparator Interface.

Summary:

The Java collections framework gives the programmer access to prepackaged data structures as well as to algorithms for manipulating them.

A collection is an object that can hold references to other objects. The collection interfaces declare the operations that can be performed on each type of collection.

The classes and interfaces of the collections framework are in package java.util.

CHAPTER

29

Java Generics

It wouldbe nice if we could write a single sort method that could sort the elements in an Integer array, a String array or an array of any type that supports ordering.

Java **Generic** methods and generic classes enable programmers to specify, with a single method declaration, a set of related methods or, with a single class declaration, a set of related types, respectively.

Generics also provide compile-time type safety that allows programmers to catch invalid types at compile time.

Using Java Generic concept, we might write a generic method for sorting an array of objects, then invoke the generic method with Integer arrays, Double arrays, String arrays and so on, to sort the array elements.

Generic Methods:

You can write a single generic method declaration that can be called with arguments of different types. Based on the types of the arguments passed to the generic method, the compiler handles each method call appropriately. Following are the rules to define Generic Methods:

- All generic method declarations have a type parameter section delimited by angle brackets (< and >) that precedes the method's return type (< E > in the next example).
- Each type parameter section contains one or more type parameters separated by commas. A type parameter, also known as a type variable, is an identifier that specifies a generic type name.
- The type parameters can be used to declare the return type and act as placeholders for the types of the arguments passed to the generic method, which are known as actual type arguments.
- A generic method's body is declared like that of any other method. Note that type parameters can represent only reference types, not primitive types (like int, double and char).

Example:

Following example illustrates how we can print array of different type using a single Generic method:

```
public class GenericMethodTest
{
  // generic method printArray
  public static< E >void printArray( E[] inputArray )
 {
```

```
// Display array elements
for( E element : inputArray ){
  System.out.printf("%s ", element );
}
System.out.println();
}

public static void main(String args[])
{
  // Create arrays of Integer, Double and Character
  Integer[] intArray ={1,2,3,4,5};
  Double[] doubleArray ={1.1,2.2,3.3,4.4};
  Character[] charArray ={'H','E','L','L','O'};

  System.out.println("Array integerArray contains:");
  printArray( intArray  );// pass an Integer array

  System.out.println("\nArray doubleArray contains:");
  printArray( doubleArray );// pass a Double array

  System.out.println("\nArray characterArray contains:");
  printArray( charArray );// pass a Character array
}
}
```

This would produce the following result:

```
Array integerArray contains:
123456

Array doubleArray contains:
1.12.23.34.4

Array characterArray contains:
H E L L O
```

Bounded Type Parameters:

There may be times when you'll want to restrict the kinds of types that are allowed to be passed to a type parameter. For example, a method that operates on numbers might only want to accept instances of Number or its subclasses. This is what bounded type parameters are for.

To declare a bounded type parameter, list the type parameter's name, followed by the extends keyword, followed by its upper bound.

Example:

Following example illustrates how extends is used in a general sense to mean either "extends" (as in classes) or "implements" (as in interfaces). This example is Generic method to return the largest of three Comparable objects:

```
public class MaximumTest
{
  // determines the largest of three Comparable objects
  public static<T extends Comparable<T>> T maximum(T x, T y, T z)
  {
    T max = x;// assume x is initially the largest
    if( y.compareTo( max )>0){
      max = y;// y is the largest so far
   }
```

```
if( z.compareTo( max )>0){
    max = z;// z is the largest now
}
return max;// returns the largest object
}
public static void main(String args[])
{
  System.out.printf("Max of %d, %d and %d is %d\n\n",3,4,5, maximum(3,4,5));

  System.out.printf("Maxm of %.1f,%.1f and %.1f is %.1f\n\n",6.6,8.8,7.7,
  maximum(6.6,8.8,7.7));

  System.out.printf("Max of %s, %s and %s is %s\n","pear",
  "apple","orange", maximum("pear","apple","orange"));
}
}
```

This would produce the following result:

```
Maximum of 3,4 and 5 is 5

Maximum of 6.6,8.8 and 7.7 is 8.8

Maximum of pear, apple and orange is pear
```

Generic Classes:

A generic class declaration looks like a non-generic class declaration, except that the class name is followed by a type parameter section.

As with generic methods, the type parameter section of a generic class can have one or more type parameters separated by commas. These classes are known as parameterized classes or parameterized types because they accept one or more parameters.

Example:

Following example illustrates how we can define a generic class:

```
public class Box<T>{

private T t;

public void add(T t){
  this.t = t;
}

public T get(){
  return t;
}

public static void main(String[] args){
  Box<Integer> integerBox = new Box<Integer>();
  Box<String> stringBox = new Box<String>();

  integerBox.add(new Integer(10));
  stringBox.add(new String("Hello World"));

  System.out.printf("Integer Value :%d\n\n", integerBox.get());
  System.out.printf("String Value :%s\n", stringBox.get());
```

```
}
}
```

This would produce the following result:

```
IntegerValue:10

StringValue:HelloWorld
```

CHAPTER

30

Java Serialization

Java provides a mechanism, called object serialization where an object can be represented as a sequence of bytes that includes the object's data as well as information about the object's type and the types of data stored in the object.

After a serialized object has been written into a file, it can be read from the file and deserialized that is, the type information and bytes that represent the object and its data can be used to recreate the object in memory.

Most impressive is that the entire process is JVM independent, meaning an object can be serialized on one platform and deserialized on an entirely different platform.

Classes **ObjectInputStream** and **ObjectOutputStream** are high-level streams that contain the methods for serializing and deserializing an object.

The ObjectOutputStream class contains many write methods for writing various data types, but one method in particular stands out:

```
public final void writeObject(Object x) throws IOException
```

The above method serializes an Object and sends it to the output stream. Similarly, the ObjectInputStream class contains the following method for deserializing an object:

```
public final Object readObject()throws IOException,
ClassNotFoundException
```

This method retrieves the next Object out of the stream and deserializes it. The return value is Object, so you will need to cast it to its appropriate data type.

To demonstrate how serialization works in Java, I am going to use the Employee class that we discussed early on in the book. Suppose that we have the following Employee class, which implements the Serializable interface:

```
public class Employee implements java.io.Serializable
{
public String name;
public String address;
public transient int SSN;
public int number;
public void mailCheck()
{
  System.out.println("Mailing a check to "+ name +" "+ address);
}
}
```

Notice that for a class to be serialized successfully, two conditions must be met:

- The class must implement the java.io.Serializable interface.
- All of the fields in the class must be serializable. If a field is not serializable, it must be marked transient.

If you are curious to know if a Java Standard Class is serializable or not, check the documentation for the class. The test is simple: If the class implements java.io.Serializable, then it is serializable; otherwise, it's not.

Serializing an Object:

The ObjectOutputStream class is used to serialize an Object. The following SerializeDemo program instantiates an Employee object and serializes it to a file.

When the program is done executing, a file named employee.ser is created. The program does not generate any output, but study the code and try to determine what the program is doing.

Note: When serializing an object to a file, the standard convention in Java is to give the file a **.ser**extension.

```
import java.io.*;

public class SerializeDemo
{
public static void main(String[] args)
{
  Employee e = new Employee();
  e.name ="Reyan Ali";
  e.address ="Phokka Kuan, Ambehta Peer";
  e.SSN =11122333;
  e.number =101;
try
{
  FileOutputStream fileOut = new FileOutputStream("employee.ser");
  ObjectOutputStream out= new ObjectOutputStream(fileOut);
  out.writeObject(e);
  out.close();
  fileOut.close();
}catch(IOException i)
{
  i.printStackTrace();
}
}
}
```

Deserializing an Object:

The following DeserializeDemo program deserializes the Employee object created in the SerializeDemo program. Study the program and try to determine its output:

```
import java.io.*;
public class DeserializeDemo
{
public static void main(String[] args)
{
  Employee e = null;
try
{
FileInputStream fileIn = new FileInputStream("employee.ser");
```

```
ObjectInputStream in = new ObjectInputStream(fileIn);
e =(Employee)in.readObject();
in.close();
fileIn.close();
}catch(IOException i)
{
  i.printStackTrace();
  return;
}catch(ClassNotFoundException c)
{
  System.out.println("Employee class not found");
  c.printStackTrace();
  return;
}
  System.out.println("Deserialized Employee...");
  System.out.println("Name: "+ e.name);
  System.out.println("Address: "+ e.address);
  System.out.println("SSN: "+ e.SSN);
  System.out.println("Number: "+ e.number);
}
}
```

This would produce the following result:

```
Deserialized Employee...
Name:Reyan Ali
Address:Phokka Kuan,Ambehta Peer
SSN:0
Number:101
```

Here are following important points to be noted:

- The try/catch block tries to catch a ClassNotFoundException, which is declared by the readObject() method. For a JVM to be able to deserialize an object, it must be able to find the bytecode for the class. If the JVM can't find a class during the deserialization of an object, it throws a ClassNotFoundException.

- Notice that the return value of readObject() is cast to an Employee reference.

- The value of the SSN field was 11122333 when the object was serialized, but because the field is transient, this value was not sent to the output stream. The SSN field of the deserialized Employee object is 0.

CHAPTER

31

Java Networking

The term *network programming* refers to writing programs that execute across multiple devices (computers), in which the devices are all connected to each other using a network.

The java.net package of the J2SE APIs contains a collection of classes and interfaces that provide the low-level communication details, allowing you to write programs that focus on solving the problem at hand.

The java.net package provides support for the two common network protocols:

- **TCP:** TCP stands for Transmission Control Protocol, which allows for reliable communication between two applications. TCP is typically used over the Internet Protocol, which is referred to as TCP/IP.
- **UDP:** UDP stands for User Datagram Protocol, a connection-less protocol that allows for packets of data to be transmitted between applications.

This tutorial gives good understanding on the following two subjects:

- **Socket Programming**: This is most widely used concept in Networking and it has been explained in very detail.
- **URL Processing**: This would be covered separately. Click here to learn about URL Processing in Java language.

Url Processing

URL stands for Uniform Resource Locator and represents a resource on the World Wide Web, such as a Web page or FTP directory.

This section shows you how to write Java programs that communicate with a URL. A URL can be broken down into parts, as follows:

```
protocol://host:port/path?query#ref
```

Examples of protocols include HTTP, HTTPS, FTP, and File. The path is also referred to as the filename, and the host is also called the authority.

The following is a URL to a Web page whose protocol is HTTP:

```
http://www.amrood.com/index.htm?language=en#j2se
```

Notice that this URL does not specify a port, in which case the default port for the protocol is used. With HTTP, the default port is 80.

URL Class Methods:

The **java.net.URL** class represents a URL and has complete set of methods to manipulate URL in Java.

The URL class has several constructors for creating URLs, including the following:

SN	Methods with Description
1	**public URL(String protocol, String host, int port, String file) throws MalformedURLException.** Creates a URL by putting together the given parts.
2	**public URL(String protocol, String host, String file) throws MalformedURLException** Identical to the previous constructor, except that the default port for the given protocol is used.
3	**public URL(String url) throws MalformedURLException** Creates a URL from the given String
4	**public URL(URL context, String url) throws MalformedURLException** Creates a URL by parsing the together the URL and String arguments

The URL class contains many methods for accessing the various parts of the URL being represented.

Some of the methods in the URL class include the following:

SN	Methods with Description
1	**public String getPath()** Returns the path of the URL.
2	**public String getQuery()** Returns the query part of the URL.
3	**public String getAuthority()** Returns the authority of the URL.
4	**public int getPort()** Returns the port of the URL.
5	**public int getDefaultPort()** Returns the default port for the protocol of the URL.
6	**public String getProtocol()** Returns the protocol of the URL.
7	**public String getHost()** Returns the host of the URL.
8	**public String getHost()** Returns the host of the URL.
9	**public String getFile()** Returns the filename of the URL.
10	**public String getRef()** Returns the reference part of the URL.
11	**public URLConnection openConnection() throws IOException** Opens a connection to the URL, allowing a client to communicate with the resource.

Example:

The following URLDemo program demonstrates the various parts of a URL. A URL is entered on the command line, and the URLDemo program outputs each part of the given URL.

```
// File Name : URLDemo.java

import java.net.*;
import java.io.*;

public class URLDemo
{
public static void main(String[] args)
{
try
{
  URL url =new URL(args[0]);
  System.out.println("URL is "+ url.toString());
  System.out.println("protocol is "+ url.getProtocol());
  System.out.println("authority is "+ url.getAuthority());
  System.out.println("file name is "+ url.getFile());
  System.out.println("host is "+ url.getHost());
  System.out.println("path is "+ url.getPath());
  System.out.println("port is "+ url.getPort());
  System.out.println("default port is "+ url.getDefaultPort());
  System.out.println("query is "+ url.getQuery());
  System.out.println("ref is "+ url.getRef());
}catch(IOException e)
{
   e.printStackTrace();
}
}
}
```

A sample run of the thid program would produce the following result:

```
$ java URLDemo http://www.amrood.com/index.htm?language=en#j2se
URL is http://www.amrood.com/index.htm?language=en#j2se
protocol is http
authority is www.amrood.com
file name is/index.htm?language=en
host is www.amrood.com
path is/index.htm
port is-1
default port is80
query is language=en
refis j2se
```

URLConnections Class Methods:

The openConnection() method returns a **java.net.URLConnection**, an abstract class whose subclasses represent the various types of URL connections.

For example:

- If you connect to a URL whose protocol is HTTP, the openConnection() method returns an HttpURLConnection object.
- If you connect to a URL that represents a JAR file, the openConnection() method returns a JarURLConnection object.
- etc...

The URLConnection class has many methods for setting or determining information about the connection, including the following:

SN	Methods with Description
1	**Object getContent()** Retrieves the contents of this URL connection.
2	**Object getContent(Class[] classes)** Retrieves the contents of this URL connection.
3	**String getContentEncoding()** Returns the value of the content-encoding header field.
4	**int getContentLength()** Returns the value of the content-length header field.
5	**String getContentType()** Returns the value of the content-type header field.
6	**int getLastModified()** Returns the value of the last-modified header field.
7	**long getExpiration()** Returns the value of the expires header field.
8	**long getIfModifiedSince()** Returns the value of this object's ifModifiedSince field.
9	**public void setDoInput(boolean input)** Passes in true to denote that the connection will be used for input. The default value is true because clients typically read from a URLConnection.
10	**public void setDoOutput(boolean output)** Passes in true to denote that the connection will be used for output. The default value is false because many types of URLs do not support being written to.
11	**public InputStream getInputStream() throws IOException** Returns the input stream of the URL connection for reading from the resource.
12	**public OutputStream getOutputStream() throws IOException** Returns the output stream of the URL connection for writing to the resource
13	**public URL getURL()** Returns the URL that this URLConnection object is connected to

Example:

The following URLConnectionDemo program connects to a URL entered from the command line.

If the URL represents an HTTP resource, the connection is cast to HttpURLConnection, and the data in the resource is read one line at a time.

```
// File Name : URLConnDemo.java

import java.net.*;
import java.io.*;
public class URLConnDemo
{
public static void main(String[] args)
{
try
{
   URL url = new URL(args[0]);
URLConnection urlConnection = url.openConnection();
```

```
HttpURLConnection connection = null;
if(urlConnection instanceof HttpURLConnection)
{
   connection =(HttpURLConnection) urlConnection;
}
else
{
   System.out.println("Please enter an HTTP URL.");
   return;
}
BufferedReader in=new BufferedReader(
new InputStreamReader(connection.getInputStream()));
String urlString ="";
String current;
while((current = in.readLine())!=null)
{
   urlString += current;
}
System.out.println(urlString);
}catch(IOException e)
{
   e.printStackTrace();
}
}
}
```

A sample run of the thid program would produce the following result:

```
$ java URLConnDemo http://www.amrood.com

.....a complete HTML content of home page of amrood.com.....
```

Socket Programming:

Sockets provide the communication mechanism between two computers using TCP. A client program creates a socket on its end of the communication and attempts to connect that socket to a server.

When the connection is made, the server creates a socket object on its end of the communication. The client and server can now communicate by writing to and reading from the socket.

The java.net.Socket class represents a socket, and the java.net.ServerSocket class provides a mechanism for the server program to listen for clients and establish connections with them.

The following steps occur when establishing a TCP connection between two computers using sockets:

- The server instantiates a ServerSocket object, denoting which port number communication is to occur on.
- The server invokes the accept() method of the ServerSocket class. This method waits until a client connects to the server on the given port.
- After the server is waiting, a client instantiates a Socket object, specifying the server name and port number to connect to.
- The constructor of the Socket class attempts to connect the client to the specified server and port number. If communication is established, the client now has a Socket object capable of communicating with the server.

- On the server side, the accept() method returns a reference to a new socket on the server that is connected to the client's socket.

After the connections are established, communication can occur using I/O streams. Each socket has both an OutputStream and an InputStream. The client's OutputStream is connected to the server's InputStream, and the client's InputStream is connected to the server's OutputStream.

TCP is a twoway communication protocol, so data can be sent across both streams at the same time. There are following usefull classes providing complete set of methods to implement sockets.

ServerSocket Class Methods:

The **java.net.ServerSocket** class is used by server applications to obtain a port and listen for client requests

The ServerSocket class has four constructors:

SN	Methods with Description
1	**public ServerSocket(int port) throws IOException** Attempts to create a server socket bound to the specified port. An exception occurs if the port is already bound by another application.
2	**public ServerSocket(int port, int backlog) throws IOException** Similar to the previous constructor, the backlog parameter specifies how many incoming clients to store in a wait queue.
3	**public ServerSocket(int port, int backlog, InetAddress address) throws IOException** Similar to the previous constructor, the InetAddress parameter specifies the local IP address to bind to. The InetAddress is used for servers that may have multiple IP addresses, allowing the server to specify which of its IP addresses to accept client requests on
4	**public ServerSocket() throws IOException** Creates an unbound server socket. When using this constructor, use the bind() method when you are ready to bind the server socket

If the ServerSocket constructor does not throw an exception, it means that your application has successfully bound to the specified port and is ready for client requests.

Here are some of the common methods of the ServerSocket class:

SN	Methods with Description
1	**public int getLocalPort()** Returns the port that the server socket is listening on. This method is useful if you passed in 0 as the port number in a constructor and let the server find a port for you.
2	**public Socket accept() throws IOException** Waits for an incoming client. This method blocks until either a client connects to the server on the specified port or the socket times out, assuming that the time-out value has been set using the setSoTimeout() method. Otherwise, this method blocks indefinitely.
3	**public void setSoTimeout(int timeout)** Sets the time-out value for how long the server socket waits for a client during the accept().
4	**public void bind(SocketAddress host, int backlog)** Binds the socket to the specified server and port in the SocketAddress object. Use this method if you instantiated the ServerSocket using the no-argument constructor.

When the ServerSocket invokes accept(), the method does not return until a client connects. After a client does connect, the ServerSocket creates a new Socket on an unspecified port and returns a reference to this new Socket. A TCP connection now exists between the client and server, and communication can begin.

Socket Class Methods:

The **java.net.Socket** class represents the socket that both the client and server use to communicate with each other. The client obtains a Socket object by instantiating one, whereas the server obtains a Socket object from the return value of the accept() method.

The Socket class has five constructors that a client uses to connect to a server:

SN	Methods with Description
1	**public Socket(String host, int port) throws UnknownHostException, IOException.** This method attempts to connect to the specified server at the specified port. If this constructor does not throw an exception, the connection is successful and the client is connected to the server.
2	**public Socket(InetAddress host, int port) throws IOException** This method is identical to the previous constructor, except that the host is denoted by an InetAddress object.
3	**public Socket(String host, int port, InetAddress localAddress, int localPort) throws IOException.** Connects to the specified host and port, creating a socket on the local host at the specified address and port.
4	**public Socket(InetAddress host, int port, InetAddress localAddress, int localPort) throws IOException.** This method is identical to the previous constructor, except that the host is denoted by an InetAddress object instead of a String
5	**public Socket()** Creates an unconnected socket. Use the connect() method to connect this socket to a server.

When the Socket constructor returns, it does not simply instantiate a Socket object but it actually attempts to connect to the specified server and port.

Some methods of interest in the Socket class are listed here. Notice that both the client and server have a Socket object, so these methods can be invoked by both the client and server.

SN	Methods with Description
1	**public void connect(SocketAddress host, int timeout) throws IOException** This method connects the socket to the specified host. This method is needed only when you instantiated the Socket using the no-argument constructor.
2	**public InetAddress getInetAddress()** This method returns the address of the other computer that this socket is connected to.
3	**public int getPort()** Returns the port the socket is bound to on the remote machine.
4	**public int getLocalPort()** Returns the port the socket is bound to on the local machine.
5	**public SocketAddress getRemoteSocketAddress()** Returns the address of the remote socket.
6	**public InputStream getInputStream() throws IOException** Returns the input stream of the socket. The input stream is connected to the output stream of the remote socket.
7	**public OutputStream getOutputStream() throws IOException** Returns the output stream of the socket. The output stream is connected to the input stream of the

	remote socket
8	**public void close() throws IOException** Closes the socket, which makes this Socket object no longer capable of connecting again to any server

InetAddress Class Methods:

This class represents an Internet Protocol (IP) address. Here are following useful methods, which you would need while doing socket programming:

SN	Methods with Description
1	**static InetAddress getByAddress(byte[] addr)** Returns an InetAddress object given the raw IP address .
2	**static InetAddress getByAddress(String host, byte[] addr)** Create an InetAddress based on the provided host name and IP address.
3	**static InetAddress getByName(String host)** Determines the IP address of a host, given the host's name.
4	**String getHostAddress()** Returns the IP address string in textual presentation.
5	**String getHostName()** Gets the host name for this IP address.
6	**static InetAddress InetAddress getLocalHost()** Returns the local host.
7	**String toString()** Converts this IP address to a String.

Socket Client Example:

The following GreetingClient is a client program that connects to a server by using a socket and sends a greeting, and then waits for a response.

```
// File Name GreetingClient.java

import java.net.*;
import java.io.*;

public class GreetingClient
{
public static void main(String[] args)
{
String serverName = args[0];
int port =Integer.parseInt(args[1]);
try
{
  System.out.println("Connecting to "+ serverName+" on port "+ port);
  Socket client = new Socket(serverName, port);
  System.out.println("Just connected to "+ client.getRemoteSocketAddress());
  OutputStream outToServer = client.getOutputStream();
  DataOutputStream out = new DataOutputStream(outToServer);

  out.writeUTF("Hello from "+ client.getLocalSocketAddress());
  InputStream inFromServer = client.getInputStream();
```

```
  DataInputStream in = new DataInputStream(inFromServer);
  System.out.println("Server says "+in.readUTF());
  client.close();
}catch(IOException e)
{
  e.printStackTrace();
}
}
}
```

Socket Server Example:

The following GreetingServer program is an example of a server application that uses the Socket class to listen for clients on a port number specified by a command-line argument:

```
// File Name GreetingServer.java

import java.net.*;
import java.io.*;

public class GreetingServer extends Thread
{
privateServerSocket serverSocket;

public GreetingServer(int port) throws IOException
{
   serverSocket = new ServerSocket(port);
   serverSocket.setSoTimeout(10000);
}

public void run()
{
while(true)
{
try
{
  System.out.println("Waiting for client on port "+
  serverSocket.getLocalPort()+"...");
  Socket server = serverSocket.accept();
  System.out.println("Just connected to "
  + server.getRemoteSocketAddress());
  DataInputStream in = new DataInputStream(server.getInputStream());
  System.out.println(in.readUTF());
  DataOutputStream out = newDataOutputStream(server.getOutputStream());
  out.writeUTF("Thank you for connecting to "+
  server.getLocalSocketAddress()+"\nGoodbye!");
  server.close();
}catch(SocketTimeoutException s)
{
  System.out.println("Socket timed out!");
  break;
}catch(IOException e)
{
  e.printStackTrace();
  break;
}
}
}
public static void main(String[] args)
```

```
{
int port = Integer.parseInt(args[0]);
try
{
   Thread t =new GreetingServer(port);
   t.start();
}catch(IOException e)
{
   e.printStackTrace();
}
}
}
```

Compile client and server and then start server as follows:

```
$ java GreetingServer6066
Waiting for client on port 6066...
```

Check client program as follows:

```
$ java GreetingClient localhost 6066
Connecting to localhost on port 6066
Just connected to localhost/127.0.0.1:6066
Server says Thank you for connecting to /127.0.0.1:6066
Goodbye!
```

CHAPTER

32

Java Sending E-mail

To send an e-mail using your Java Application is simple enough but to start with you should have **JavaMail API** and **Java Activation Framework (JAF)** installed on your machine.

- You can download latest version of JavaMail (Version 1.2) from Java's standard website.
- You can download latest version of JAF (Version 1.1.1) from Java's standard website.

Download and unzip these files, in the newly created top level directories you will find a number of jar files for both the applications. You need to add **mail.jar** and **activation.jar** files in your CLASSPATH.

Send a Simple E-mail:

Here is an example to send a simple e-mail from your machine. Here it is assumed that your **localhost** is connected to the internet and capable enough to send an e-mail.

```
// File Name SendEmail.java

import java.util.*;
import javax.mail.*;
import javax.mail.internet.*;
import javax.activation.*;

public class SendEmail
{
public static void main(String[] args)
{
  // Recipient's email ID needs to be mentioned.
  String to ="abcd@gmail.com";

  // Sender's email ID needs to be mentioned
  String from ="web@gmail.com";

  // Assuming you are sending email from localhost
  String host ="localhost";

  // Get system properties
  Properties properties =System.getProperties();

  // Setup mail server
  properties.setProperty("mail.smtp.host", host);

  // Get the default Session object.
```

```
  Session session =Session.getDefaultInstance(properties);

  try{
  // Create a default MimeMessage object.
  MimeMessage message = new MimeMessage(session);

  // Set From: header field of the header.
  message.setFrom(new InternetAddress(from));

  // Set To: header field of the header.
  message.addRecipient(Message.RecipientType.TO,new InternetAddress(to));

  // Set Subject: header field
  message.setSubject("This is the Subject Line!");

  // Now set the actual message
  message.setText("This is actual message");

  // Send message
  Transport.send(message);
  System.out.println("Sent message successfully....");
}catch(MessagingException mex){
  mex.printStackTrace();
}
}
}
```

Compile and run this program to send a simple e-mail:

```
$ java SendEmail
Sent message successfully....
```

If you want to send an e-mail to multiple recipients, then following methods would be used to specify multiple e-mail IDs:

```
void addRecipients(Message.RecipientType type,
Address[] addresses)
throws MessagingException
```

Here is the description of the parameters:

- **type:** This would be set to TO, CC or BCC. Here CC represents Carbon Copy and BCC represents Black Carbon Copy. Example *Message.RecipientType.TO*
- **addresses:** This is the array of e-mail ID. You would need to use InternetAddress() method while specifying e-mail IDs

Send an HTML E-mail:

Here is an example to send an HTML e-mail from your machine. Here, it is assumed that your **localhost**is connected to the internet and capable enough to send an e-mail.

This example is very similar to previous one, except here we are using setContent() method to set content, whose second argument is "text/html" to specify that the HTML content is included in the message.

Using this example, you can send as big as HTML content you like.

```
// File Name SendHTMLEmail.java

import java.util.*;
import javax.mail.*;
```

```
import javax.mail.internet.*;
import javax.activation.*;

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

// Recipient's email ID needs to be mentioned.
String to ="abcd@gmail.com";

// Sender's email ID needs to be mentioned
String from="web@gmail.com";

// Assuming you are sending email from localhost
String host ="localhost";

// Get system properties
Properties properties =System.getProperties();

// Setup mail server
properties.setProperty("mail.smtp.host", host);

// Get the default Session object.
Session session = Session.getDefaultInstance(properties);

try{
// Create a default MimeMessage object.
MimeMessage message = new MimeMessage(session);

// Set From: header field of the header.
message.setFrom(new InternetAddress(from));

// Set To: header field of the header.
message.addRecipient(Message.RecipientType.TO,
new InternetAddress(to));

// Set Subject: header field
message.setSubject("This is the Subject Line!");

// Send the actual HTML message, as big as you like
message.setContent("<h1>This is actual message</h1>",
"text/html");

// Send message
Transport.send(message);
System.out.println("Sent message successfully....");
}catch(MessagingException mex){
    mex.printStackTrace();
}
}
}
```

Compile and run this program to send an HTML e-mail:

```
$ java SendHTMLEmail
Sent message successfully....
```

Send Attachment in E-mail:

Here is an example to send an e-mail with attachment from your machine. Here, it is assumed that your**localhost** is connected to the internet and capable enough to send an e-mail.

```
// File Name SendFileEmail.java

import java.util.*;
import javax.mail.*;
import javax.mail.internet.*;
import javax.activation.*;

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

// Recipient's email ID needs to be mentioned.
String to ="abcd@gmail.com";

// Sender's email ID needs to be mentioned
String from="web@gmail.com";

// Assuming you are sending email from localhost
String host ="localhost";

// Get system properties
Properties properties = System.getProperties();

// Setup mail server
 properties.setProperty("mail.smtp.host", host);

// Get the default Session object.
Session session =Session.getDefaultInstance(properties);

try{
// Create a default MimeMessage object.
MimeMessage message =new MimeMessage(session);

// Set From: header field of the header.
message.setFrom(new InternetAddress(from));

// Set To: header field of the header.
message.addRecipient(Message.RecipientType.TO,
new InternetAddress(to));

// Set Subject: header field
message.setSubject("This is the Subject Line!");

// Create the message part
BodyPart messageBodyPart = new MimeBodyPart();

// Fill the message
messageBodyPart.setText("This is message body");

// Create a multipar message
Multipart multipart = new MimeMultipart();

// Set text message part
multipart.addBodyPart(messageBodyPart);
```

```
// Part two is attachment
messageBodyPart =new MimeBodyPart();
String filename ="file.txt";
DataSource source =new FileDataSource(filename);
messageBodyPart.setDataHandler(new DataHandler(source));
messageBodyPart.setFileName(filename);
multipart.addBodyPart(messageBodyPart);

// Send the complete message parts
message.setContent(multipart );

// Send message
Transport.send(message);
System.out.println("Sent message successfully....");
}catch(MessagingException mex){
   mex.printStackTrace();
}
}
}
```

Compile and run this program to send an HTML e-mail:

```
$ java SendFileEmail
Sent message successfully....
```

User Authentication Part:

If it is required to provide user ID and Password to the e-mail server for authentication purpose, then you can set these properties as follows:

```
 props.setProperty("mail.user","myuser");
 props.setProperty("mail.password","mypwd");
```

Rest of the e-mail sending mechanism would remain as explained above.

CHAPTER

33

Java Multithreading

Java provides built-in support for *multithreaded programming*. A multithreaded program contains two or more parts that can run concurrently. Each part of such a program is called a thread, and each thread defines a separate path of execution.

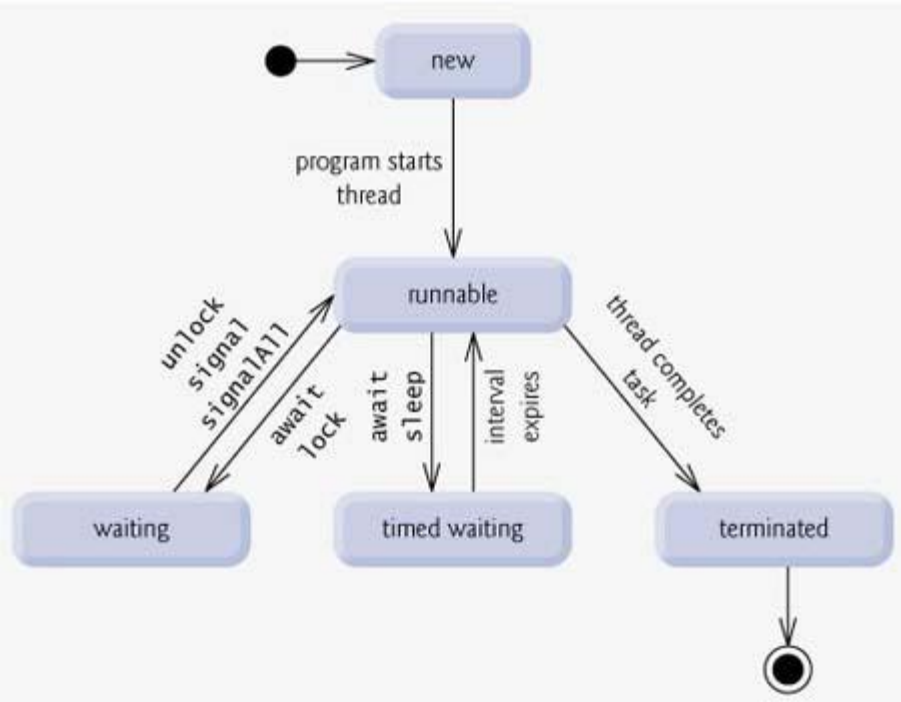
A multithreading is a specialized form of multitasking. Multithreading requires less overhead than multitasking processing.

I need to define another term related to threads: **process:** A process consists of the memory space allocated by the operating system that can contain one or more threads. A thread cannot exist on its own; it must be a part of a process. A process remains running until all of the non-daemon threads are done executing.

Multithreading enables you to write very efficient programs that make maximum use of the CPU, because idle time can be kept to a minimum.

Life Cycle of a Thread:

A thread goes through various stages in its life cycle. For example, a thread is born, started, runs, and then dies. Following diagram shows complete life cycle of a thread.



Above-mentioned stages are explained here:

- **New:** A new thread begins its life cycle in the new state. It remains in this state until the program starts the thread. It is also referred to as a born thread.
- **Runnable:** After a newly born thread is started, the thread becomes runnable. A thread in this state is considered to be executing its task.
- **Waiting:** Sometimes, a thread transitions to the waiting state while the thread waits for another thread to perform a task.A thread transitions back to the runnable state only when another thread signals the waiting thread to continue executing.
- **Timed waiting:** A runnable thread can enter the timed waiting state for a specified interval of time. A thread in this state transitions back to the runnable state when that time interval expires or when the event it is waiting for occurs.
- **Terminated:** A runnable thread enters the terminated state when it completes its task or otherwise terminates.

Thread Priorities:

Every Java thread has a priority that helps the operating system determine the order in which threads are scheduled.

Java priorities are in the range between MIN_PRIORITY (a constant of 1) and MAX_PRIORITY (a constant of 10). By default, every thread is given priority NORM_PRIORITY (a constant of 5).

Threads with higher priority are more important to a program and should be allocated processor time before lower-priority threads. However, thread priorities cannot guarantee the order in which threads execute and very much platform dependent.

Creating a Thread:

Java defines two ways in which this can be accomplished:

- You can implement the Runnable interface.

- You can extend the Thread class itself.

Create Thread by Implementing Runnable:

The easiest way to create a thread is to create a class that implements the **Runnable** interface.

To implement Runnable, a class needs to only implement a single method called **run( )**, which is declared like this:

```
publicvoid run()
```

You will define the code that constitutes the new thread inside run() method. It is important to understand that run() can call other methods, use other classes, and declare variables, just like the main thread can.

After you create a class that implements Runnable, you will instantiate an object of type Thread from within that class. Thread defines several constructors. The one that we will use is shown here:

```
Thread(Runnable threadOb,String threadName);
```

Here, *threadOb* is an instance of a class that implements the Runnable interface and the name of the new thread is specified by *threadName*.

After the new thread is created, it will not start running until you call its **start( )** method, which is declared within Thread. The start( ) method is shown here:

```
void start();
```

Example:

Here is an example that creates a new thread and starts it running:

```
// Create a new thread.
class NewThread implements Runnable{
Thread t;
NewThread(){
  // Create a new, second thread
  t = new Thread(this,"Demo Thread");
  System.out.println("Child thread: "+ t);
  t.start();// Start the thread
}

// This is the entry point for the second thread.
public void run(){
try{
  for(int i =5; i >0; i--){
    System.out.println("Child Thread: "+ i);
    // Let the thread sleep for a while.
    Thread.sleep(500);
}
}catch(InterruptedException e){
  System.out.println("Child interrupted.");
}
System.out.println("Exiting child thread.");
}
}

public class ThreadDemo{
public static void main(String args[]){
  new NewThread();// create a new thread
  try{
    for(int i =5; i >0; i--){
    System.out.println("Main Thread: "+ i);
```

```
   Thread.sleep(1000);
  }
 }catch(InterruptedException e){
  System.out.println("Main thread interrupted.");
 }
 System.out.println("Main thread exiting.");
}
}
```

This would produce the following result:

```
Child thread:Thread[Demo Thread,5,main]
Main Thread:5
Child Thread:5
Child Thread:4
Main Thread:4
Child Thread:3
Child Thread:2
Main Thread:3
Child Thread:1
Exiting child thread.
Main Thread:2
Main Thread:1
Main thread exiting.
```

Create Thread by Extending Thread:

The second way to create a thread is to create a new class that extends **Thread**, and then to create an instance of that class.

The extending class must override the **run( )** method, which is the entry point for the new thread. It must also call **start( )** to begin execution of the new thread.

Example:

Here is the preceding program rewritten to extend Thread:

```
// Create a second thread by extending Thread
class NewThread extends Thread{
NewThread(){
  // Create a new, second thread
  super("Demo Thread");
  System.out.println("Child thread: "+this);
  start();// Start the thread
}

// This is the entry point for the second thread.
public void run(){
try{
  for(int i =5; i >0; i--){
    System.out.println("Child Thread: "+ i);
    // Let the thread sleep for a while.
    Thread.sleep(500);
  }
}catch(InterruptedException e){
System.out.println("Child interrupted.");
}
System.out.println("Exiting child thread.");
}
}
```

```
public class ExtendThread{
public static void main(String args[]){
  new NewThread();// create a new thread
  try{
   for(int i =5; i >0; i--){
     System.out.println("Main Thread: "+ i);
     Thread.sleep(1000);
    }
  }catch(InterruptedException e){
     System.out.println("Main thread interrupted.");
  }
 System.out.println("Main thread exiting.");
}
}
```

This would produce the following result:

```
Child thread:Thread[Demo Thread,5,main]
Main Thread:5
Child Thread:5
Child Thread:4
Main Thread:4
Child Thread:3
Child Thread:2
Main Thread:3
Child Thread:1
Exiting child thread.
Main Thread:2
Main Thread:1
Main thread exiting.
```

Thread Methods:

Following is the list of important methods available in the Thread class.

SN	Methods with Description
1	**public void start()** Starts the thread in a separate path of execution, then invokes the run() method on this Thread object.
2	**public void run()** If this Thread object was instantiated using a separate Runnable target, the run() method is invoked on that Runnable object.
3	**public final void setName(String name)** Changes the name of the Thread object. There is also a getName() method for retrieving the name.
4	**public final void setPriority(int priority)** Sets the priority of this Thread object. The possible values are between 1 and 10.
5	**public final void setDaemon(boolean on)** A parameter of true denotes this Thread as a daemon thread.
6	**public final void join(long millisec)** The current thread invokes this method on a second thread, causing the current thread to block until the second thread terminates or the specified number of milliseconds passes.
7	**public void interrupt()**

	Interrupts this thread, causing it to continue execution if it was blocked for any reason.
8	**public final boolean isAlive()** Returns true if the thread is alive, which is any time after the thread has been started but before it runs to completion.

The previous methods are invoked on a particular Thread object. The following methods in the Thread class are static. Invoking one of the static methods performs the operation on the currently running thread.

SN	Methods with Description
1	**public static void yield()** Causes the currently running thread to yield to any other threads of the same priority that are waiting to be scheduled.
2	**public static void sleep(long millisec)** Causes the currently running thread to block for at least the specified number of milliseconds.
3	**public static boolean holdsLock(Object x)** Returns true if the current thread holds the lock on the given Object.
4	**public static Thread currentThread()** Returns a reference to the currently running thread, which is the thread that invokes this method.
5	**public static void dumpStack()** Prints the stack trace for the currently running thread, which is useful when debugging a multithreaded application.

Example:

The following ThreadClassDemo program demonstrates some of these methods of the Thread class:

```
// File Name : DisplayMessage.java
// Create a thread to implement Runnable
public class DisplayMessage implements Runnable
{
private String message;
public DisplayMessage(String message)
{
  this.message = message;
}
publicvoid run()
{
  while(true)
  {
    System.out.println(message);
  }
}
}

// File Name : GuessANumber.java
// Create a thread to extentd Thread
public class GuessANumber extends Thread
{
private int number;
public GuessANumber(int number)
{
  this.number = number;
}
public void run()
{
```

```
int counter =0;
int guess =0;
do
{
   guess =(int)(Math.random()*100+1);
   System.out.println(this.getName()+" guesses "+ guess);
   counter++;
}while(guess != number);
   System.out.println("** Correct! "+this.getName()+" in "+ counter +" guesses.**");
}
}

// File Name : ThreadClassDemo.java
public class ThreadClassDemo
{
public static void main(String[] args)
{
  Runnable hello =new DisplayMessage("Hello");
  Thread thread1 =new Thread(hello);
  thread1.setDaemon(true);
  thread1.setName("hello");
  System.out.println("Starting hello thread...");
  thread1.start();

  Runnable bye =new DisplayMessage("Goodbye");
  Thread thread2 =new Thread(hello);
  thread2.setPriority(Thread.MIN_PRIORITY);
  thread2.setDaemon(true);
  System.out.println("Starting goodbye thread...");
  thread2.start();

  System.out.println("Starting thread3...");
  Thread thread3 =new GuessANumber(27);
  thread3.start();
  try
  {
    thread3.join();
  }catch(InterruptedException e)
  {
    System.out.println("Thread interrupted.");
  }
  System.out.println("Starting thread4...");
  Thread thread4 =new GuessANumber(75);

  thread4.start();
  System.out.println("main() is ending...");
}
}
```

This would produce the following result. You can try this example again and again and you would get different result every time.

```
Starting hello thread...
Starting goodbye thread...
Hello
Hello
Hello
Hello
Hello
Hello
Hello
```

```
Hello
Hello
Thread-2 guesses 27
Hello
**Correct!Thread-2 in 102 guesses.**
Hello
Starting thread4...
Hello
Hello
..........remaining result produced.
```

Major Thread Concepts:

While doing Multithreading programming, you would need to have the following concepts very handy:

Thread Synchronization

When two or more threads need access to a shared resource, they need some way to ensure that the resource will be used by only one thread at a time.

The process by which this synchronization is achieved is called *thread synchronization*.

The synchronized keyword in Java creates a block of code referred to as a critical section. Every Java object with a critical section of code gets a lock associated with the object. To enter a critical section, a thread needs to obtain the corresponding object's lock.

This is the general form of the synchronized statement:

```
synchronized(object){
// statements to be synchronized
}
```

Here, object is a reference to the object being synchronized. A synchronized block ensures that a call to a method that is a member of object occurs only after the current thread has successfully entered object's monitor.

Here is an example, using a synchronized block within the run( ) method:

```
// File Name : Callme.java
// This program uses a synchronized block.
class Callme{
  void call(String msg){
  System.out.print("["+ msg);
  try{
   Thread.sleep(1000);
  }catch(InterruptedException e){
   System.out.println("Interrupted");
  }
  System.out.println("]");
 }
}

// File Name : Caller.java
class Caller implements Runnable{
String msg;
Callme target;
Thread t;
public Caller(Callme targ,String s){
   target = targ;
   msg = s;
   t =new Thread(this);
   t.start();
```

```
}

// synchronize calls to call()
public void run(){
synchronized(target){// synchronized block
  target.call(msg);
}
}
}
// File Name : Synch.java
public class Synch{
  public static void main(String args[]){
  Callme target =new Callme();
  Caller ob1 =new Caller(target,"Hello");
  Caller ob2 =new Caller(target,"Synchronized");
  Caller ob3 =new Caller(target,"World");

  // wait for threads to end
  try{
     ob1.t.join();
     ob2.t.join();
     ob3.t.join();
  }catch(InterruptedException e){
     System.out.println("Interrupted");
 }
}
}
```

This would produce the following result:

```
[Hello]
[World]
[Synchronized]
```

Interthread Communication

Consider the classic queuing problem, where one thread is producing some data and another is consuming it. To make the problem more interesting, suppose that the producer has to wait until the consumer is finished before it generates more data.

In a polling system, the consumer would waste many CPU cycles while it waited for the producer to produce. Once the producer was finished, it would start polling, wasting more CPU cycles waiting for the consumer to finish, and so on. Clearly, this situation is undesirable.

To avoid polling, Java includes an elegant interprocess communication mechanism via the following methods:

- **wait( ):** This method tells the calling thread to give up the monitor and go to sleep until some other thread enters the same monitor and calls notify( ).
- **notify( ):** This method wakes up the first thread that called wait( ) on the same object.
- **notifyAll( ):** This method wakes up all the threads that called wait( ) on the same object. The highest priority thread will run first.

These methods are implemented as **final** methods in Object, so all classes have them. All three methods can be called only from within a **synchronized** context.

These methods are declared within Object. Various forms of wait( ) exist that allow you to specify a period of time to wait.

Example:

The following sample program consists of four classes: Q, the queue that you're trying to synchronize; Producer, the threaded object that is producing queue entries; Consumer, the threaded object that is consuming queue entries; and PC, the tiny class that creates the single Q, Producer, and Consumer.

The proper way to write this program in Java is to use wait( ) and notify( ) to signal in both directions, as shown here:

```
class Q {
  int n;
  boolean valueSet = false;
  synchronized int get(){
    if(!valueSet)
    try{
       wait();
    }catch(InterruptedException e){
       System.out.println("InterruptedException caught");
    }
    System.out.println("Got: "+ n);
    valueSet =false;
    notify();
    return n;
  }

  synchronized void put(int n){
    if(valueSet)
    try{
       wait();
    }catch(InterruptedException e){
       System.out.println("InterruptedException caught");
    }
    this.n = n;
    valueSet =true;
    System.out.println("Put: "+ n);
    notify();
  }
}

class Producer implements Runnable{
   Q q;
   Producer(Q q){
     this.q = q;
     new Thread(this,"Producer").start();
   }

   public void run(){
     int i =0;
     while(true){
       q.put(i++);
     }
   }
}

class Consumer implements Runnable{
   Q q;
   Consumer(Q q){
   this.q = q;
  new Thread(this,"Consumer").start();
}
public void run(){
```

```
while(true){
  q.get();
}
}
}
public class PCFixed{

public static void main(String args[]){
  Q q =new Q();
  new Producer(q);
  new Consumer(q);
  System.out.println("Press Control-C to stop.");
}
}
```

Inside get( ), wait( ) is called. This causes its execution to suspend until the Producer notifies you that some data is ready.

When this happens, execution inside get( ) resumes. After the data has been obtained, get( ) calls notify( ). This tells Producer that it is okay to put more data in the queue.

Inside put( ), wait( ) suspends execution until the Consumer has removed the item from the queue. When execution resumes, the next item of data is put in the queue, and notify( ) is called. This tells the Consumer that it should now remove it.

Here is some output from this program, which shows the clean synchronous behavior:

```
Put:1
Got:1
Put:2
Got:2
Put:3
Got:3
Put:4
Got:4
Put:5
Got:5
```

Thread Deadlock

A special type of error that you need to avoid that relates specifically to multitasking is deadlock, which occurs when two threads have a circular dependency on a pair of synchronized objects.

For example, suppose one thread enters the monitor on object X and another thread enters the monitor on object Y. If the thread in X tries to call any synchronized method on Y, it will block as expected. However, if the thread in Y, in turn, tries to call any synchronized method on X, the thread waits forever, because to access X, it would have to release its own lock on Y so that the first thread could complete.

Example:

To understand deadlock fully, it is useful to see it in action. The next example creates two classes, A and B, with methods foo( ) and bar( ), respectively, which pause briefly before trying to call a method in the other class.

The main class, named Deadlock, creates an A and a B instance, and then starts a second thread to set up the deadlock condition. The foo( ) and bar( ) methods use sleep( ) as a way to force the deadlock condition to occur.

```
class A {
synchronized void foo(B b){
String name =Thread.currentThread().getName();
System.out.println(name +" entered A.foo");
```

```
try{
  Thread.sleep(1000);
}catch(Exception e){
  System.out.println("A Interrupted");
}
System.out.println(name +" trying to call B.last()");
b.last();
}
synchronized void last(){
  System.out.println("Inside A.last");
}
}
class B {
  synchronized void bar(A a){
  String name =Thread.currentThread().getName();
  System.out.println(name +" entered B.bar");
  try{
    Thread.sleep(1000);
  }catch(Exception e){
  System.out.println("B Interrupted");
}
System.out.println(name +" trying to call A.last()");
a.last();
}
synchronized void last(){
  System.out.println("Inside A.last");
}
}
public class Deadlock implements Runnable{
   A a =new A();
   B b =new B();
  Deadlock(){
  Thread.currentThread().setName("MainThread");
  Thread t =new Thread(this,"RacingThread");
  t.start();
  a.foo(b);// get lock on a in this thread.
  System.out.println("Back in main thread");
}
public void run(){
  b.bar(a);// get lock on b in other thread.
  System.out.println("Back in other thread");
}
public static void main(String args[]){
  new Deadlock();
}
}
```

Here is some output from this program:

```
MainThread entered A.foo
RacingThread entered B.bar
MainThread trying to call B.last()
RacingThread trying to call A.last()
```

Because the program has deadlocked, you need to press CTRL-C to end the program. You can see a full thread and monitor cache dump by pressing CTRL-BREAK on a PC .

You will see that RacingThread owns the monitor on **b**, while it is waiting for the monitor on **a**. At the same time, MainThread owns **a** and is waiting to get **b**. This program will never complete.

As this example illustrates, if your multithreaded program locks up occasionally, deadlock is one of the first conditions that you should check for.

Ordering Locks:

Acommon threading trick to avoid the deadlock is to order the locks. By ordering the locks, it gives threads a specific order to obtain multiple locks.

Deadlock Example:

Following is the depiction of a deadlock:

```
// File Name ThreadSafeBankAccount.java
public class ThreadSafeBankAccount
{
private double balance;
private int number;
public ThreadSafeBankAccount(int num,double initialBalance)
{
      balance = initialBalance;
      number = num;
}
public int getNumber()
{
return number;
}
public double getBalance()
{
return balance;
}
public void deposit(double amount)
{
synchronized(this)
{
double prevBalance = balance;
try
{
Thread.sleep(4000);
}catch(InterruptedException e)
{}
   balance = prevBalance + amount;
}
}
public void withdraw(double amount)
{
synchronized(this)
{
   double prevBalance = balance;
try
{
Thread.sleep(4000);
}catch(InterruptedException e)
{}
   balance = prevBalance - amount;
}
}
}

// File Name LazyTeller.java
public class LazyTellerextendsThread
{
```

```
private ThreadSafeBankAccount source, dest;
public LazyTeller(ThreadSafeBankAccount a,ThreadSafeBankAccount b)
{
   source = a;
   dest = b;
}
public void run()
{
   transfer(250.00);
}
public void transfer(double amount)
{
  System.out.println("Transferring from "+ source.getNumber()+" to "+
  dest.getNumber());
  synchronized(source)
  {
    Thread.yield();
    synchronized(dest)
    {
      System.out.println("Withdrawing from "+ source.getNumber());
      source.withdraw(amount);
      System.out.println("Depositing into "+ dest.getNumber());
      dest.deposit(amount);
    }
  }
 }
}
public class DeadlockDemo
{
public static void main(String[] args)
{
  System.out.println("Creating two bank accounts...");
  ThreadSafeBankAccount checking = new ThreadSafeBankAccount(101,1000.00);
  ThreadSafeBankAccount savings = new ThreadSafeBankAccount(102,5000.00);

  System.out.println("Creating two teller threads...");
  Thread teller1 = new LazyTeller(checking, savings);
  Thread teller2 = new LazyTeller(savings, checking);
  System.out.println("Starting both threads...");
  teller1.start();
  teller2.start();
}
}
```

This would produce the following result:

```
Creating two bank accounts...
Creating two teller threads...
Starting both threads...
Transferring from 101 to 102
Transferring from 102 to 101
```

The problem with the LazyTeller class is that it does not consider the possibility of a race condition, a common occurrence in multithreaded programming.

After the two threads are started, teller1 grabs the checking lock and teller2 grabs the savings lock. When teller1 tries to obtain the savings lock, it is not available. Therefore, teller1 blocks until the savings lock becomes available. When the teller1 thread blocks, teller1 still has the checking lock and does not let it go.

Similarly, teller2 is waiting for the checking lock, so teller2 blocks but does not let go of the savings lock. This leads to one result: deadlock!

Deadlock Solution Example:

Here, transfer() method, in a class named OrderedTeller, in stead of arbitrarily synchronizing on locks, this transfer() method obtains locks in a specified order based on the number of the bank account.

```
// File Name ThreadSafeBankAccount.java
public class ThreadSafeBankAccount
{
private double balance;
private int number;
public ThreadSafeBankAccount(int num,double initialBalance)
{
   balance = initialBalance;
   number = num;
}
public int getNumber()
{
return number;
}
public double getBalance()
{
return balance;
}
public void deposit(double amount)
{
synchronized(this)
{
double prevBalance = balance;
try
{
Thread.sleep(4000);
}catch(InterruptedException e)
{}
    balance = prevBalance + amount;
}
}
public void withdraw(double amount)
{
synchronized(this)
{
    double prevBalance = balance;
try
{
Thread.sleep(4000);
}catch(InterruptedException e)
{}
    balance = prevBalance - amount;
}
}
}
// File Name OrderedTeller.java
public class OrderedTeller extends Thread
{
private ThreadSafeBankAccount source, dest;
public OrderedTeller(ThreadSafeBankAccount a,
ThreadSafeBankAccount b)
{
      source = a;
```

```
      dest = b;
}
public void run()
{
   transfer(250.00);
}
public void transfer(double amount)
{
System.out.println("Transferring from "+ source.getNumber()
+" to "+ dest.getNumber());
ThreadSafeBankAccount first, second;
if(source.getNumber()< dest.getNumber())
{
   first = source;
   second = dest;
}
else
{
   first = dest;
   second = source;
}
synchronized(first)
{
Thread.yield();
synchronized(second)
{
  System.out.println("Withdrawing from "+ source.getNumber());
  source.withdraw(amount);
  System.out.println("Depositing into "+ dest.getNumber());
  dest.deposit(amount);
}
}
}
}

// File Name DeadlockDemo.java
public class DeadlockDemo
{
public static void main(String[] args)
{
  System.out.println("Creating two bank accounts...");
  ThreadSafeBankAccount checking = new ThreadSafeBankAccount(101,1000.00);
  ThreadSafeBankAccount savings = new ThreadSafeBankAccount(102,5000.00);

  System.out.println("Creating two teller threads...");
  Thread teller1 =new OrderedTeller(checking, savings);
  Thread teller2 =new OrderedTeller(savings, checking);
  System.out.println("Starting both threads...");
  teller1.start();
  Teller2.start();
}
}
```

This would remove deadlock problem and would produce the following result:

```
Creating two bank accounts...
Creating two teller threads...
Starting both threads...
Transferringfrom101 to 102
Transferringfrom102 to 101
Withdrawingfrom101
```

```
Depositinginto102
Withdrawingfrom102
Depositinginto101
```

Thread Control: Suspend, Stop and Resume

While the suspend( ), resume( ), and stop( ) methods defined by **Thread** class seem to be a perfectly reasonable and convenient approach to managing the execution of threads, they must not be used for new Java programs and obsolete in newer versions of Java.

The following example illustrates how the wait( ) and notify( ) methods that are inherited from Object can be used to control the execution of a thread.

This example is similar to the program in the previous section. However, the deprecated method calls have been removed. Let us consider the operation of this program.

The NewThread class contains a boolean instance variable named suspendFlag, which is used to control the execution of the thread. It is initialized to false by the constructor.

The run( ) method contains a synchronized statement block that checks suspendFlag. If that variable is true, the wait( ) method is invoked to suspend the execution of the thread. The mysuspend( ) method sets suspendFlag to true. The myresume( ) method sets suspendFlag to false and invokes notify( ) to wake up the thread. Finally, the main( ) method has been modified to invoke the mysuspend( ) and myresume( ) methods.

Example:

```
// Suspending and resuming a thread for Java 2
class NewThread implements Runnable{
String name;// name of thread
Thread t;
boolean suspendFlag;
NewThread(String threadname){
      name = threadname;
      t = new Thread(this, name);
System.out.println("New thread: "+ t);
      suspendFlag = false;
      t.start();// Start the thread
}
// This is the entry point for thread.
public void run(){
try{
for(int i =15; i >0; i--){
System.out.println(name +": "+ i);
Thread.sleep(200);
synchronized(this){
while(suspendFlag){
  wait();
}
}
}
}catch(InterruptedException e){
System.out.println(name +" interrupted.");
}
System.out.println(name +" exiting.");
}
void mysuspend(){
  suspendFlag =true;
}
synchronizedvoid myresume(){
```

```
  suspendFlag =false;
  notify();
}
}

public class SuspendResume{
public static void main(String args[]){
NewThread ob1 =new NewThread("One");
NewThread ob2 =new NewThread("Two");
try{
  Thread.sleep(1000);
  ob1.mysuspend();
  System.out.println("Suspending thread One");
  Thread.sleep(1000);
  ob1.myresume();
  System.out.println("Resuming thread One");
  ob2.mysuspend();
  System.out.println("Suspending thread Two");
  Thread.sleep(1000);
  ob2.myresume();
  System.out.println("Resuming thread Two");
}catch(InterruptedException e){
  System.out.println("Main thread Interrupted");
}
// wait for threads to finish
try{
  System.out.println("Waiting for threads to finish.");
  ob1.t.join();
  ob2.t.join();
}catch(InterruptedException e){
  System.out.println("Main thread Interrupted");
}
System.out.println("Main thread exiting.");
}
}
```

Here is the output produced by the above program:

```
New thread:Thread[One,5,main]
One:15
New thread:Thread[Two,5,main]
Two:15
One:14
Two:14
One:13
Two:13
One:12
Two:12
One:11
Two:11
Suspending thread One
Two:10
Two:9
Two:8
Two:7
Two:6
Resuming thread One
Suspending thread Two
One:10
One:9
One:8
One:7
One:6
Resuming thread Two
```

```
Waitingfor threads to finish.
Two:5
One:5
Two:4
One:4
Two:3
One:3
Two:2
One:2
Two:1
One:1
Two exiting.
One exiting.
Main thread exiting.
```

Using Multithreading:

The key to utilizing multithreading support effectively is to think concurrently rather than serially. For example, when you have two subsystems within a program that can execute concurrently, make them individual threads.

With the careful use of multithreading, you can create very efficient programs. A word of caution is in order, however: If you create too many threads, you can actually degrade the performance of your program rather than enhance it.

Remember, some overhead is associated with context switching. If you create too many threads, more CPU time will be spent changing contexts than executing your program!

CHAPTER

34

Java Applet Basics

An applet is a Java program that runs in a Web browser. An applet can be a fully functional Java application because it has the entire Java API at its disposal.

There are some important differences between an applet and a standalone Java application, including the following:

- An applet is a Java class that extends the java.applet.Applet class.
- A main() method is not invoked on an applet, and an applet class will not define main().
- Applets are designed to be embedded within an HTML page.
- When a user views an HTML page that contains an applet, the code for the applet is downloaded to the user's machine.
- A JVM is required to view an applet. The JVM can be either a plug-in of the Web browser or a separate runtime environment.
- The JVM on the user's machine creates an instance of the applet class and invokes various methods during the applet's lifetime.
- Applets have strict security rules that are enforced by the Web browser. The security of an applet is often referred to as sandbox security, comparing the applet to a child playing in a sandbox with various rules that must be followed.
- Other classes that the applet needs can be downloaded in a single Java Archive (JAR) file.

Life Cycle of an Applet:

Four methods in the Applet class give you the framework on which you build any serious applet:

- **init:** This method is intended for whatever initialization is needed for your applet. It is called after the param tags inside the applet tag have been processed.
- **start:** This method is automatically called after the browser calls the init method. It is also called whenever the user returns to the page containing the applet after having gone off to other pages.
- **stop:** This method is automatically called when the user moves off the page on which the applet sits. It can, therefore, be called repeatedly in the same applet.

- **destroy:** This method is only called when the browser shuts down normally. Because applets are meant to live on an HTML page, you should not normally leave resources behind after a user leaves the page that contains the applet.
- **paint:** Invoked immediately after the start() method, and also any time the applet needs to repaint itself in the browser. The paint() method is actually inherited from the java.awt.

A "Hello, World" Applet:

The following is a simple applet named HelloWorldApplet.java:

```
import java.applet.*;
import java.awt.*;

public class HelloWorldApplet extends Applet
{
public void paint (Graphics g)
{
   g.drawString ("Hello World",25,50);
}
}
```

These import statements bring the classes into the scope of our applet class:

- java.applet.Applet.
- java.awt.Graphics.

Without those import statements, the Java compiler would not recognize the classes Applet and Graphics, which the applet class refers to.

The Applet CLASS:

Every applet is an extension of the *java.applet.Applet class*. The base Applet class provides methods that a derived Applet class may call to obtain information and services from the browser context.

These include methods that do the following:

- Get applet parameters
- Get the network location of the HTML file that contains the applet
- Get the network location of the applet class directory
- Print a status message in the browser
- Fetch an image
- Fetch an audio clip
- Play an audio clip
- Resize the applet

Additionally, the Applet class provides an interface by which the viewer or browser obtains information about the applet and controls the applet's execution. The viewer may:

- request information about the author, version and copyright of the applet

- request a description of the parameters the applet recognizes
- initialize the applet
- destroy the applet
- start the applet's execution
- stop the applet's execution

The Applet class provides default implementations of each of these methods. Those implementations may be overridden as necessary.

The "Hello, World" applet is complete as it stands. The only method overridden is the paint method.

Invoking an Applet:

An applet may be invoked by embedding directives in an HTML file and viewing the file through an applet viewer or Java-enabled browser.

The <applet> tag is the basis for embedding an applet in an HTML file. Below is an example that invokes the "Hello, World" applet:

```
<html>
<title>The Hello, World Applet</title>
<hr>
<applet code="HelloWorldApplet.class" width="320" height="120">
If your browser was Java-enabled, a "Hello, World"
message would appear here.
</applet>
<hr>
</html>
```

Based on the above examples, here is the live applet example: Applet Example.

Note: You can refer to HTML Applet Tag to understand more about calling applet from HTML.

The code attribute of the <applet> tag is required. It specifies the Applet class to run. Width and height are also required to specify the initial size of the panel in which an applet runs. The applet directive must be closed with a </applet> tag.

If an applet takes parameters, values may be passed for the parameters by adding <param> tags between <applet> and </applet>. The browser ignores text and other tags between the applet tags.

Non-Java-enabled browsers do not process <applet> and </applet>. Therefore, anything that appears between the tags, not related to the applet, is visible in non-Java-enabled browsers.

The viewer or browser looks for the compiled Java code at the location of the document. To specify otherwise, use the codebase attribute of the <applet> tag as shown:

```
<applet codebase="http://amrood.com/applets"
code="HelloWorldApplet.class"width="320"height="120">
```

If an applet resides in a package other than the default, the holding package must be specified in the code attribute using the period character (.) to separate package/class components. For example:

```
<applet code="mypackage.subpackage.TestApplet.class"
```

```
width="320"height="120">
```

Getting Applet Parameters:

The following example demonstrates how to make an applet respond to setup parameters specified in the document. This applet displays a checkerboard pattern of black and a second color.

The second color and the size of each square may be specified as parameters to the applet within the document.

CheckerApplet gets its parameters in the init() method. It may also get its parameters in the paint() method. However, getting the values and saving the settings once at the start of the applet, instead of at every refresh, is convenient and efficient.

The applet viewer or browser calls the init() method of each applet it runs. The viewer calls init() once, immediately after loading the applet. (Applet.init() is implemented to do nothing.) Override the default implementation to insert custom initialization code.

The Applet.getParameter() method fetches a parameter given the parameter's name (the value of a parameter is always a string). If the value is numeric or other non-character data, the string must be parsed.

The following is a skeleton of CheckerApplet.java:

```
import java.applet.*;
import java.awt.*;
public class CheckerApplet extends Applet
{
int squareSize =50;// initialized to default size
public void init (){}
private void parseSquareSize (String param){}
private Color parseColor (String param){}
public void paint (Graphics g){}
}
```

Here are CheckerApplet's init() and private parseSquareSize() methods:

```
publicvoid init ()
{
  String squareSizeParam = getParameter ("squareSize");
  parseSquareSize (squareSizeParam);
  String colorParam = getParameter ("color");
  Color fg = parseColor (colorParam);
  setBackground (Color.black);
  setForeground (fg);
}
private void parseSquareSize (String param)
{
if(param ==null)return;
try{
  squareSize =Integer.parseInt (param);
}
catch(Exception e){
  // Let default value remain
}
}
```

The applet calls parseSquareSize() to parse the squareSize parameter. parseSquareSize() calls the library method Integer.parseInt(), which parses a string and returns an integer. Integer.parseInt() throws an exception whenever its argument is invalid.

Therefore, parseSquareSize() catches exceptions, rather than allowing the applet to fail on bad input.

The applet calls parseColor() to parse the color parameter into a Color value. parseColor() does a series of string comparisons to match the parameter value to the name of a predefined color. You need to implement these methods to make this applet works.

Specifying Applet Parameters:

The following is an example of an HTML file with a CheckerApplet embedded in it. The HTML file specifies both parameters to the applet by means of the <param> tag.

```
<html>
<title>Checkerboard Applet</title>
<hr>
<applet code="CheckerApplet.class" width="480" height="320">
<param name="color" value="blue">
<param name="squaresize" value="30">
</applet>
<hr>
</html>
```

Note: Parameter names are not case sensitive.

Application Conversion to Applets:

It is easy to convert a graphical Java application (that is, an application that uses the AWT and that you can start with the java program launcher) into an applet that you can embed in a web page.

Here are the specific steps for converting an application to an applet.

- Make an HTML page with the appropriate tag to load the applet code.
- Supply a subclass of the JApplet class. Make this class public. Otherwise, the applet cannot be loaded.
- Eliminate the main method in the application. Do not construct a frame window for the application. Your application will be displayed inside the browser.
- Move any initialization code from the frame window constructor to the init method of the applet. You don't need to explicitly construct the applet object.the browser instantiates it for you and calls the init method.
- Remove the call to setSize; for applets, sizing is done with the width and height parameters in the HTML file.
- Remove the call to setDefaultCloseOperation. An applet cannot be closed; it terminates when the browser exits.
- If the application calls setTitle, eliminate the call to the method. Applets cannot have title bars. (You can, of course, title the web page itself, using the HTML title tag.)
- Don't call setVisible(true). The applet is displayed automatically.

Event Handling:

Applets inherit a group of event-handling methods from the Container class. The Container class defines several methods, such as processKeyEvent and processMouseEvent, for handling particular types of events, and then one catch-all method called processEvent.

Inorder to react an event, an applet must override the appropriate event-specific method.

```
import java.awt.event.MouseListener;
import java.awt.event.MouseEvent;
import java.applet.Applet;
import java.awt.Graphics;

public class ExampleEventHandling extends Applet implements MouseListener{

  StringBuffer strBuffer;

  public void init(){
   addMouseListener(this);
   strBuffer = new StringBuffer();
   addItem("initializing the apple ");
}

public void start(){
   addItem("starting the applet ");
}

public void stop(){
   addItem("stopping the applet ");
}

public void destroy(){
   addItem("unloading the applet");
}

void addItem(String word){
  System.out.println(word);
  strBuffer.append(word);
  repaint();
}

public void paint(Graphics g){
  //Draw a Rectangle around the applet's display area.
  g.drawRect(0,0,
  getWidth()-1,
  getHeight()-1);
  //display the string inside the rectangle.
  g.drawString(strBuffer.toString(),10,20);
}


public void mouseEntered(MouseEvent event){
}
public void mouseExited(MouseEvent event){
}
public void mousePressed(MouseEvent event){
}
public void mouseReleased(MouseEvent event){
}
```

```
public void mouseClicked(MouseEvent event){
        addItem("mouse clicked! ");
}
}
```

Now, let us call this applet as follows:

```
<html>
<title>Event Handling</title>
<hr>
<applet code="ExampleEventHandling.class" width="300" height="300">
</applet>
<hr>
</html>
```

Initially, the applet will display "initializing the applet. Starting the applet." Then once you click inside the rectangle "mouse clicked" will be displayed as well.

Based on the above examples, here is the live applet example: Applet Example.

Displaying Images:

An applet can display images of the format GIF, JPEG, BMP, and others. To display an image within the applet, you use the drawImage() method found in the java.awt.Graphics class.

Following is the example showing all the steps to show images:

```
import java.applet.*;
import java.awt.*;
import java.net.*;
public class ImageDemo extends Applet
{
private Image image;
private AppletContext context;
publicvoid init()
{
context =this.getAppletContext();
String imageURL =this.getParameter("image");
if(imageURL == null)
{
    imageURL ="java.jpg";
}
try
{
    URL url =new URL(this.getDocumentBase(), imageURL);
    image = context.getImage(url);
}catch(MalformedURLException e)
{
    e.printStackTrace();
    // Display in browser status bar
    context.showStatus("Could not load image!");
}
}
public void paint(Graphics g)
{
    context.showStatus("Displaying image");
    g.drawImage(image,0,0,200,84,null);
    g.drawString("www.javalicense.com",35,100);
}
```

```
}
```

Now, let us call this applet as follows:

```
<html>
<title>The ImageDemo applet</title>
<hr>
<applet code="ImageDemo.class" width="300" height="200">
<param name="image" value="java.jpg">
</applet>
<hr>
</html>
```

Based on the above examples, here is the live applet example: Applet Example.

Playing Audio:

An applet can play an audio file represented by the AudioClip interface in the java.applet package. The AudioClip interface has three methods, including:

- **public void play():** Plays the audio clip one time, from the beginning.
- **public void loop():** Causes the audio clip to replay continually.
- **public void stop():** Stops playing the audio clip.

To obtain an AudioClip object, you must invoke the getAudioClip() method of the Applet class. The getAudioClip() method returns immediately, whether or not the URL resolves to an actual audio file. The audio file is not downloaded until an attempt is made to play the audio clip.

Following is the example showing all the steps to play an audio:

```
import java.applet.*;
import java.awt.*;
import java.net.*;
public class AudioDemoextendsApplet
{
private AudioClip clip;
private AppletContext context;
public void init()
{
   context =this.getAppletContext();
   String audioURL =this.getParameter("audio");
   if(audioURL ==null)
   {
      audioURL ="default.au";
   }
   try
   {
       URL url =new URL(this.getDocumentBase(), audioURL);
       clip = context.getAudioClip(url);
   }catch(MalformedURLException e)
   {
       e.printStackTrace();
       context.showStatus("Could not load audio file!");
    }
 }
public void start()
{
if(clip !=null)
{
   clip.loop();
```

```
}
}
public void stop()
{
if(clip !=null)
{
   clip.stop();
}
}
}
```

Now, let us call this applet as follows:

```
<html>
<title>The ImageDemo applet</title>
<hr>
<applet code="ImageDemo.class" width="0" height="0">
<param name="audio" value="test.wav">
</applet>
<hr>
</html>
```

You can use your test.wav at your PC to test the above example.

CHAPTER

35

Java Documentation

Java supports three types of comments. The first two are the // and the /* */. The third type is called a documentation comment. It begins with the character sequence /** and it ends with */.

Documentation comments allow you to embed information about your program into the program itself. You can then use the javadoc utility program to extract the information and put it into an HTML file.

Documentation comments make it convenient to document your programs.

The javadoc Tags:

The javadoc utility recognizes the following tags:

Tag	Description	Example
@author	Identifies the author of a class.	@author description
@deprecated	Specifies that a class or member is deprecated.	@deprecated description
{@docRoot}	Specifies the path to the root directory of the current documentation	Directory Path
@exception	Identifies an exception thrown by a method.	@exception exception-name explanation
{@inheritDoc}	Inherits a comment from the immediate superclass.	Inherits a comment from the immediate surperclass.
{@link}	Inserts an in-line link to another topic.	{@link name text}
{@linkplain}	Inserts an in-line link to another topic, but the link is displayed in a plain-text font.	Inserts an in-line link to another topic.
@param	Documents a method's parameter.	@param parameter-name explanation
@return	Documents a method's return value.	@return explanation
@see	Specifies a link to another topic.	@see anchor
@serial	Documents a default serializable field.	@serial description
@serialData	Documents the data written by the writeObject(	@serialData description

	) or writeExternal( ) methods	
@serialField	Documents an ObjectStreamField component.	@serialField name type description
@since	States the release when a specific change was introduced.	@since release
@throws	Same as @exception.	The @throws tag has the same meaning as the @exception tag.
{@value}	Displays the value of a constant, which must be a static field.	Displays the value of a constant, which must be a static field.
@version	Specifies the version of a class.	@version info

Documentation Comment:

After the beginning /**, the first line or lines become the main description of your class, variable, or method.

After that, you can include one or more of the various @ tags. Each @ tag must start at the beginning of a new line or follow an asterisk (*) that is at the start of a line.

Multiple tags of the same type should be grouped together. For example, if you have three @see tags, put them one after the other.

Here is an example of a documentation comment for a class:

```
/**
* This class draws a bar chart.
* @author Zara Ali
* @version 1.2
*/
```

What javadoc Outputs?

The javadoc program takes as input your Java program's source file and outputs several HTML files that contain the program's documentation.

Information about each class will be in its own HTML file. Java utility **javadoc** will also output an index and a hierarchy tree. Other HTML files can be generated.

Since different implementations of javadoc may work differently, you will need to check the instructions that accompany your Java development system for details specific to your version.

Example:

Following is a sample program that uses documentation comments. Notice the way each comment immediately precedes the item that it describes.

After being processed by javadoc, the documentation about the SquareNum class will be found in SquareNum.html.

```
import java.io.*;

/**
* This class demonstrates documentation comments.
* @author Ayan Amhed
* @version 1.2
*/
public class SquareNum{
/**
```

```
   * This method returns the square of num.
   * This is a multiline description. You can use
   * as many lines as you like.
   * @param num The value to be squared.
   * @return num squared.
   */
public double square(double num){
  return num * num;
}
/**
   * This method inputs a number from the user.
   * @return The value input as a double.
   * @exception IOException On input error.
   * @see IOException
   */
public double getNumber()throws IOException{
  InputStreamReader isr = new InputStreamReader(System.in);
  BufferedReader inData = new BufferedReader(isr);
  String str;
  str = inData.readLine();
  return(new Double(str)).doubleValue();
}
/**
   * This method demonstrates square().
   * @param args Unused.
   * @return Nothing.
   * @exception IOException On input error.
   * @see IOException
   */
public static void main(String args[])throws IOException
{
  SquareNum ob =new SquareNum();
  double val;
  System.out.println("Enter value to be squared: ");
  val = ob.getNumber();
  val = ob.square(val);
  System.out.println("Squared value is "+ val);
}
}
```

Now, process above SquareNum.java file using javadoc utility as follows:

```
$ javadoc SquareNum.java
Loading source file SquareNum.java...
ConstructingJavadoc information...
StandardDoclet version 1.5.0_13
Building tree for all the packages and classes...
GeneratingSquareNum.html...
SquareNum.java:39: warning -@return tag cannot be used\
in method withvoidreturn type.
Generating package-frame.html...
Generating package-summary.html...
Generating package-tree.html...
Generating constant-values.html...
Building index for all the packages and classes...
Generating overview-tree.html...
Generating index-all.html...
Generating deprecated-list.html...
Building index for all classes...
Generating allclasses-frame.html...
Generating allclasses-noframe.html...
```

```
Generating index.html...
Generating help-doc.html...
Generating stylesheet.css...
1 warning
$
```

You can check all the generated documentation here: SquareNum.

CHAPTER

36

Java Library Classes

This tutorial would cover package **java.lang,** which provides classes that are fundamental to the design of the Java programming language. The most important classes are Object, which is the root of the class hierarchy, and Class, instances of which represent classes at run time.
Here is the list of classes of ackage **java.lang**. These classes are very important to know for a Java programmer. Click a class link to know more detail about that class. For a further drill, you can refer standard Java documentation.

SN	Methods with Description
1	Boolean Boolean
2	Byte The Byte class wraps a value of primitive type byte in an object.
3	Character The Character class wraps a value of the primitive type char in an object.
4	Class Instances of the class Class represent classes and interfaces in a running Java application.
5	ClassLoader A class loader is an object that is responsible for loading classes.
6	Compiler The Compiler class is provided to support Java-to-native-code compilers and related services.
7	Double The Double class wraps a value of the primitive type double in an object.
8	Float The Float class wraps a value of primitive type float in an object.
9	Integer The Integer class wraps a value of the primitive type int in an object.
10	Long The Long class wraps a value of the primitive type long in an object.
11	Math The class Math contains methods for performing basic numeric operations such as the elementary exponential, logarithm, square root, and trigonometric functions.

12	Number The abstract class Number is the superclass of classes BigDecimal, BigInteger, Byte, Double, Float, Integer, Long, and Short.
13	Object Class Object is the root of the class hierarchy.
14	Package Package objects contain version information about the implementation and specification of a Java package.
15	Process The Runtime.exec methods create a native process and return an instance of a subclass of Process that can be used to control the process and obtain information about it.
16	Runtime Every Java application has a single instance of class Runtime that allows the application to interface with the environment in which the application is running.
17	RuntimePermission This class is for runtime permissions.
18	SecurityManager The security manager is a class that allows applications to implement a security policy.
19	Short The Short class wraps a value of primitive type short in an object.
20	StackTraceElement An element in a stack trace, as returned by Throwable.getStackTrace().
21	StrictMath The class StrictMath contains methods for performing basic numeric operations such as the elementary exponential, logarithm, square root, and trigonometric functions.
22	String The String class represents character strings.
23	StringBuffer A string buffer implements a mutable sequence of characters.
24	System The System class contains several useful class fields and methods.
25	Thread A thread is a thread of execution in a program.
26	ThreadGroup A thread group represents a set of threads.
27	ThreadLocal This class provides thread-local variables.
28	Throwable The Throwable class is the superclass of all errors and exceptions in the Java language.
29	Void The Void class is an uninstantiable placeholder class to hold a reference to the Class object representing the Java keyword void.