MODULE II

JAVA PROGRAMMING

File Operations in Java

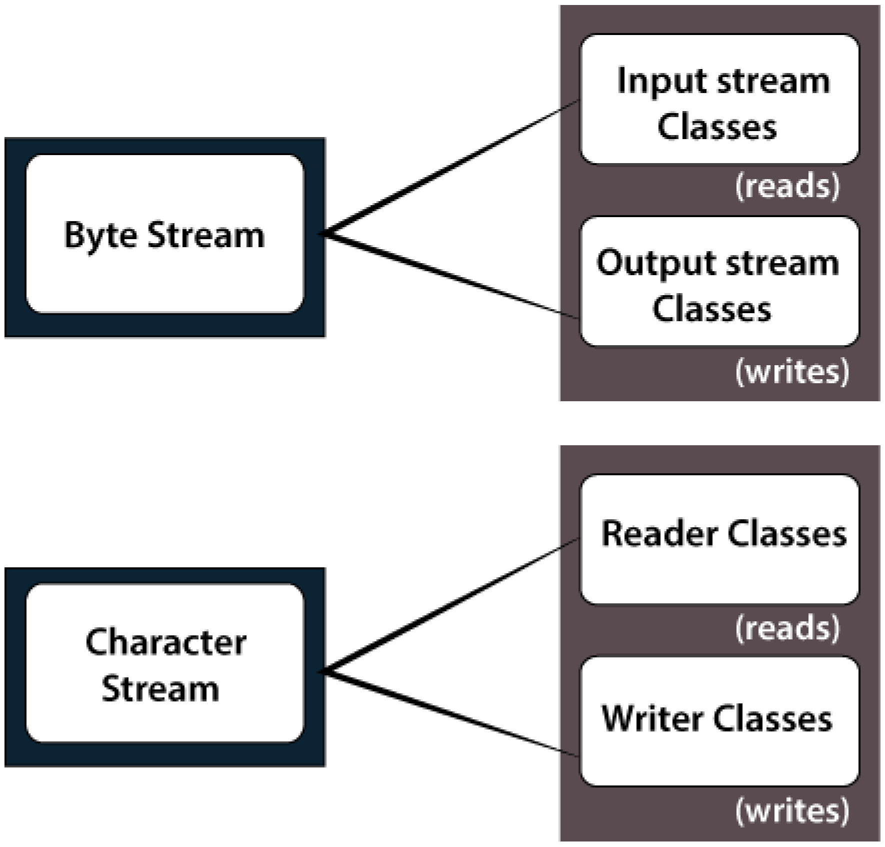
In Java, a **File** is an abstract data type. A named location used to store related information is known as a **File**. There are several **File Operations** like **creating a new File, getting information about File, writing into a File, reading from a File** and **deleting a File**.

Before understanding the File operations, it is required that we should have knowledge of **Stream** and **File methods**. If you have knowledge about both of them, you can skip it.

Stream

A series of data is referred to as **a stream**. In Java

, **Stream** is classified into two types, i.e., **Byte Stream** and **Character Stream**.



Brief classification of I/O streams

Character Stream

Character Stream is mainly involved with character data. A file handling process with a character stream is a process in which an input is provided and executed with the character data.

To get more knowledge about the stream, click here

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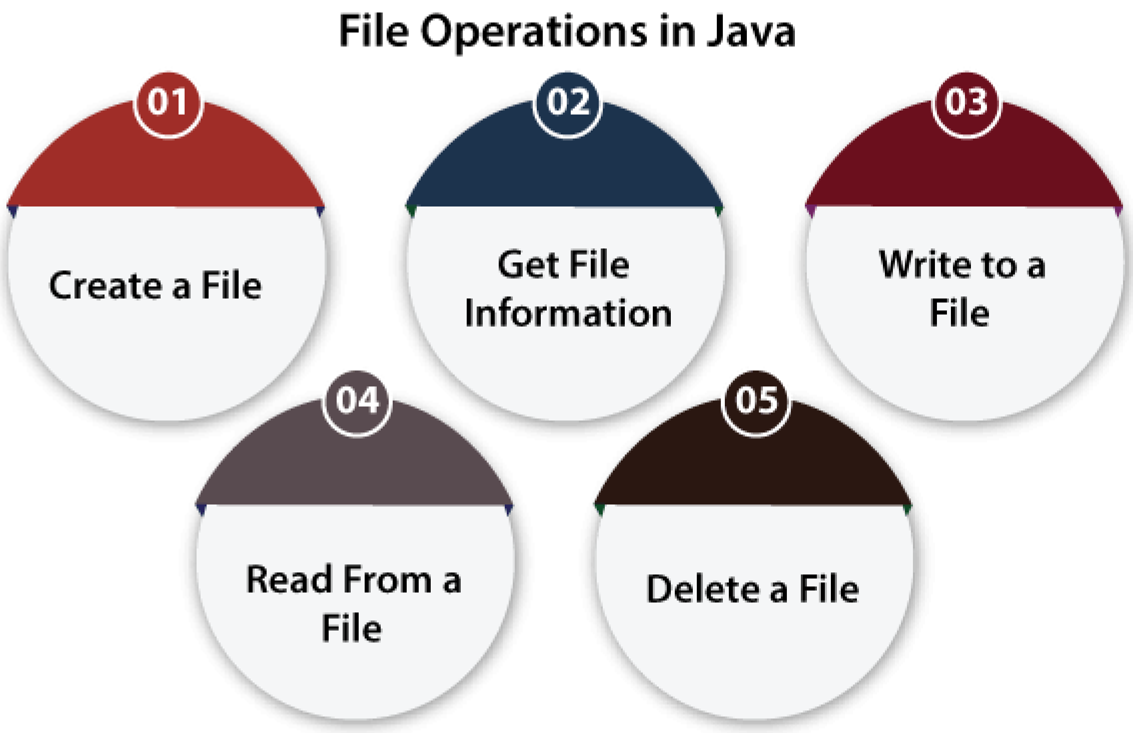
Java File Class Methods

S.No.	Method	Return Type	Description
1.	canRead()	Boolean	The **canRead()** method is used to check whether we can read the data of the file or not.
2.	createNewFile()	Boolean	The **createNewFile()** method is used to create a new empty file.
3.	canWrite()	Boolean	The **canWrite()** method is used to check whether we can write the data into the file or not.
4.	exists()	Boolean	The **exists()** method is used to check whether the specified file is present or not.
5.	delete()	Boolean	The **delete()** method is used to delete a file.
6.	getName()	String	The **getName()** method is used to find the file name.
7.	getAbsolutePath()	String	The **getAbsolutePath()** method is used to get the absolute pathname of the file.
8.	length()	Long	The **length()** method is used to get the size of the file in bytes.

File Operations

We can perform the following operation on a file:

- Create a File
- Get File Information
- Write to a File
- Read from a File
- Delete a File



Create a File

Create a File operation is performed to create a new file. We use the **createNewFile()** method of file. The **createNewFile()** method returns true when it successfully creates a new file and returns false when the file already exists.

Get File Information

The operation is performed to get the file information. We use several methods to get the information about the file like name, absolute path, is readable, is writable and length.

```
// Import the File class
import java.io.File;   class FileInfo {
  public static void main(String[] args) {
     // Creating file object
    File f0 = new File("D:FileOperationExample.txt");
    if (f0.exists()) {
        // Getting file name
        System.out.println("The name of the file is: " + f0.getName());


        // Getting path of the file
```

```
                System.out.println("The absolute path of the file is: " + f0.getAbsolutePath());

                // Checking whether the file is writable or not
                System.out.println("Is file writeable?: " + f0.canWrite());

                // Checking whether the file is readable or not
                System.out.println("Is file readable " + f0.canRead());

               // Getting the length of the file in bytes
        System.out.println("The size of the file in bytes is: " + f0.length());
         } else {
               System.out.println("The file does not exist.");
            }
          }
        }
```

Write to a File

The next operation which we can perform on a file is **"writing into a file"**. In order to write data into a file, we will use the **FileWriter** class and its **write()** method together. We need to close the stream using the **close()** method to retrieve the allocated resources.

Read from a File

The next operation which we can perform on a file is **"read from a file"**. In order to write data into a file, we will use the **Scanner** class. Here, we need to close the stream using the **close()** method. We will create an instance of the Scanner class

and use the **hasNextLine()** method

Delete a File

The next operation which we can perform on a file is **"deleting a file"**. In order to delete a file, we will use the **delete()** method of the file. We don't need to close the stream using the **close()** method because for deleting a file, we neither use the FileWriter class nor the Scanner class.

Java I/O (Input and Output) is used *to process the input* and *produce the output*.

Stream

A stream is a sequence of data. In Java, a stream is composed of bytes. It's called a stream because it is like a stream of water that continues to flow.

In Java, 3 streams are created for us automatically. All these streams are attached with the console.

1) System.out: standard output stream

2) System.in: standard input stream

3) System.err: standard error stream

Let's see the code to print **output and an error** message to the console.

1. System.out.println("simple message");
2. System.err.println("error message");

Let's see the code to get **input** from console.

1. **int** i=System.in.read();//returns ASCII code of 1st character
2. System.out.println((**char**)i);//will print the character

OutputStream vs InputStream

The explanation of OutputStream and InputStream classes are given below:

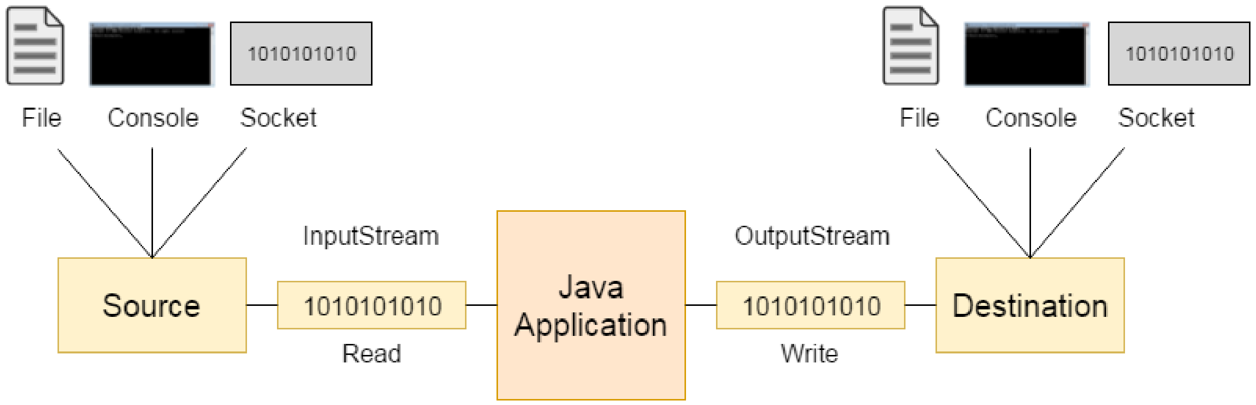
OutputStream

Java application uses an output stream to write data to a destination; it may be a file, an array, peripheral device or socket.

InputStream

Java application uses an input stream to read data from a source; it may be a file, an array, peripheral device or socket.

Let's understand the working of Java OutputStream and InputStream by the figure given below.

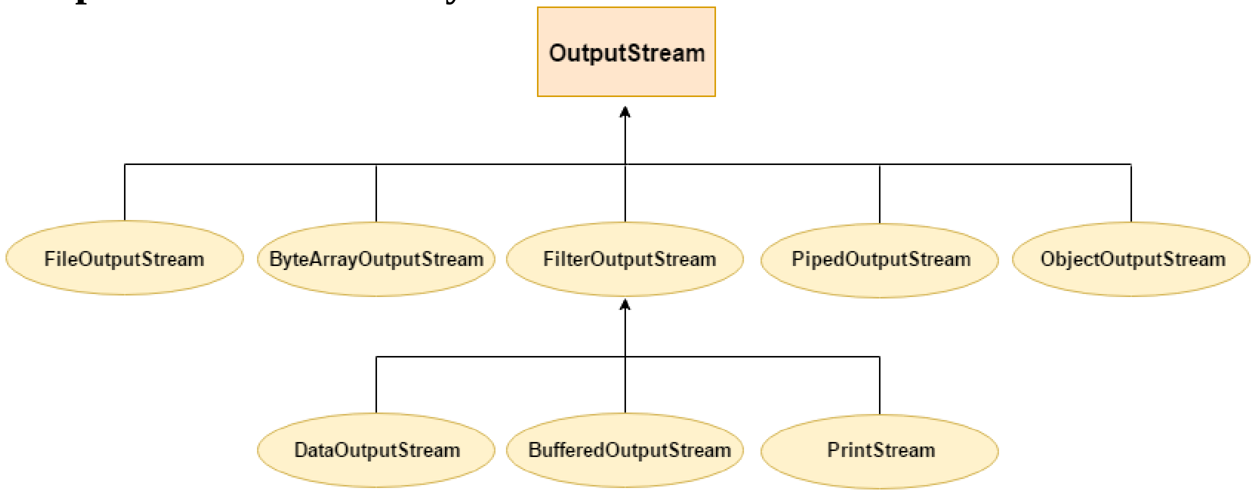


OutputStream class

OutputStream class is an abstract class. It is the superclass of all classes representing an output stream of bytes. An output stream accepts output bytes and sends them to some sink.

Method	Description
1) public void write(int)throws IOException	is used to write a byte to the current output stream.
2) public void write(byte[])throws IOException	is used to write an array of byte to the current output stream.
3) public void flush()throws IOException	flushes the current output stream.
4) public void close()throws IOException	is used to close the current output stream.

OutputStream Hierarchy

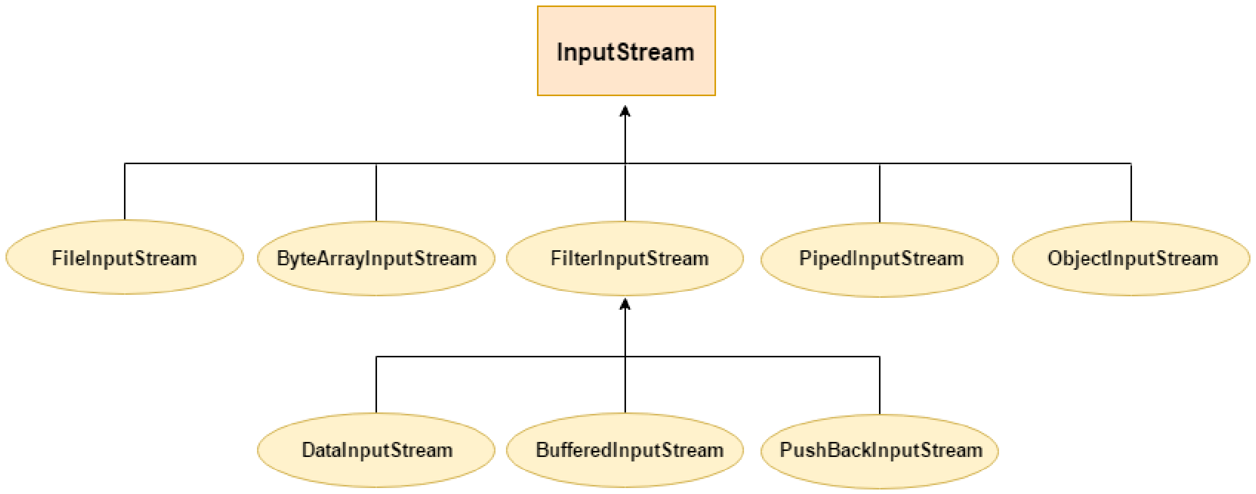


InputStream class

InputStream class is an abstract class. It is the superclass of all classes representing an input stream of bytes.

Useful methods of InputStream

Method	Description
1) public abstract int read()throws IOException	reads the next byte of data from the input stream. It returns -1 at the end of the file.
2) public int available()throws IOException	returns an estimate of the number of bytes that can be read from the current input stream.
3) public void close()throws IOException	is used to close the current input stream.



Java FileOutputStream Class

Java FileOutputStream is an output stream used for writing data to a file.

If you have to write primitive values into a file, use FileOutputStream class. You can write byte-oriented as well as character-oriented data through FileOutputStream class. But, for character-oriented data, it is preferred to use FileWriter than FileOutputStream.

FileOutputStream class declaration

Let's see the declaration for Java.io.FileOutputStream class:

```
public class FileOutputStream extends OutputStream
import java.io.FileOutputStream;
public class FileOutputStreamExample {
  public static void main(String args[]){
       try{
         FileOutputStream fout=new FileOutputStream("D:\\testout.txt");
        fout.write(65);
        fout.close();
        System.out.println("success...");
       }catch(Exception e){System.out.println(e);}
   }
}
```

Java FileInputStream Class

Java FileInputStream class obtains input bytes from a file. It is used for reading byte-oriented data (streams of raw bytes) such as image data, audio, video etc. You can also read character-stream data. But, for reading streams of characters, it is recommended to use FileReader class.

Java FileInputStream class declaration

Let's see the declaration for java.io.FileInputStream class:

```
public class FileInputStream extends InputStream
import java.io.FileInputStream;
public class DataStreamExample {
    public static void main(String args[]){
        try{
FileInputStream fin=new FileInputStream("D:\\testout.txt");
          int i=fin.read();
           System.out.print((char)i);

           fin.close();
        }catch(Exception e){System.out.println(e);}
     }
      }
```

Java BufferedOutputStream Class

Java BufferedOutputStream class is used for buffering an output stream. It internally uses buffer to store data. It adds more efficiency than to write data directly into a stream. So, it makes the performance fast.

For adding the buffer in an OutputStream, use the BufferedOutputStream class. Let's see the syntax for adding the buffer in an OutputStream:

```
1. OutputStream os= new BufferedOutputStream(new FileOutputStream("D:\\IO Package\\testout.txt"));
```

Java BufferedOutputStream class declaration

Let's see the declaration for Java.io.BufferedOutputStream class:

1. **public class** BufferedOutputStream **extends** FilterOutputStream

Java BufferedInputStream Class

Java BufferedInputStream class is used to read information from stream. It internally uses buffer mechanism to make the performance fast.

The important points about BufferedInputStream are:

- When the bytes from the stream are skipped or read, the internal buffer automatically refilled from the contained input stream, many bytes at a time.
- When a BufferedInputStream is created, an internal buffer array is created.

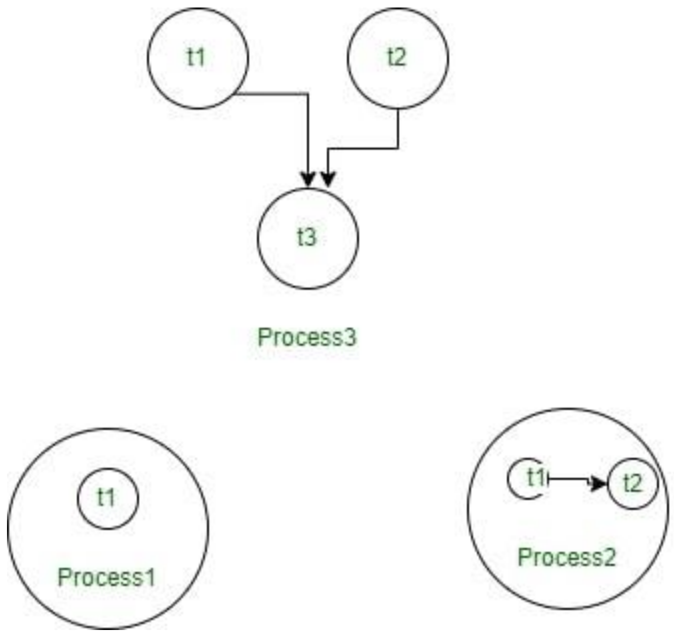
Java BufferedInputStream class declaration

Let's see the declaration for Java.io.BufferedInputStream class:

```
public class BufferedInputStream extends FilterInputStream
```

Java Threads

Typically, we can define threads as a subprocess with lightweight with the smallest unit of processes and also has separate paths of execution. These threads use shared memory but they act independently hence if there is an exception in threads that do not affect the working of other threads despite them sharing the same memory.



As we can observe in, the above diagram a thread runs inside the process and there will be context-based switching between threads there can be multiple processes running in OS, and each process again can have multiple threads running simultaneously. The Multithreading concept is popularly applied in games, animation…etc.

The Concept Of Multitasking

To help users Operating System accommodates users the privilege of multitasking, where users can perform multiple actions simultaneously on the machine. This Multitasking can be enabled in two ways:

1. **Process-Based Multitasking**
2. **Thread-Based Multitasking**

1. Process-Based Multitasking (Multiprocessing)

In this type of Multitasking, processes are heavyweight and each process was allocated by a separate memory area. And as the process is heavyweight the cost of communication between processes is high and it takes a long time for switching between processes as it involves actions such as loading, saving in registers, updating maps, lists, etc.

2. Thread-Based Multitasking

As we discussed above Threads are provided with lightweight nature and share the same address space, and the cost of communication between threads is also low.

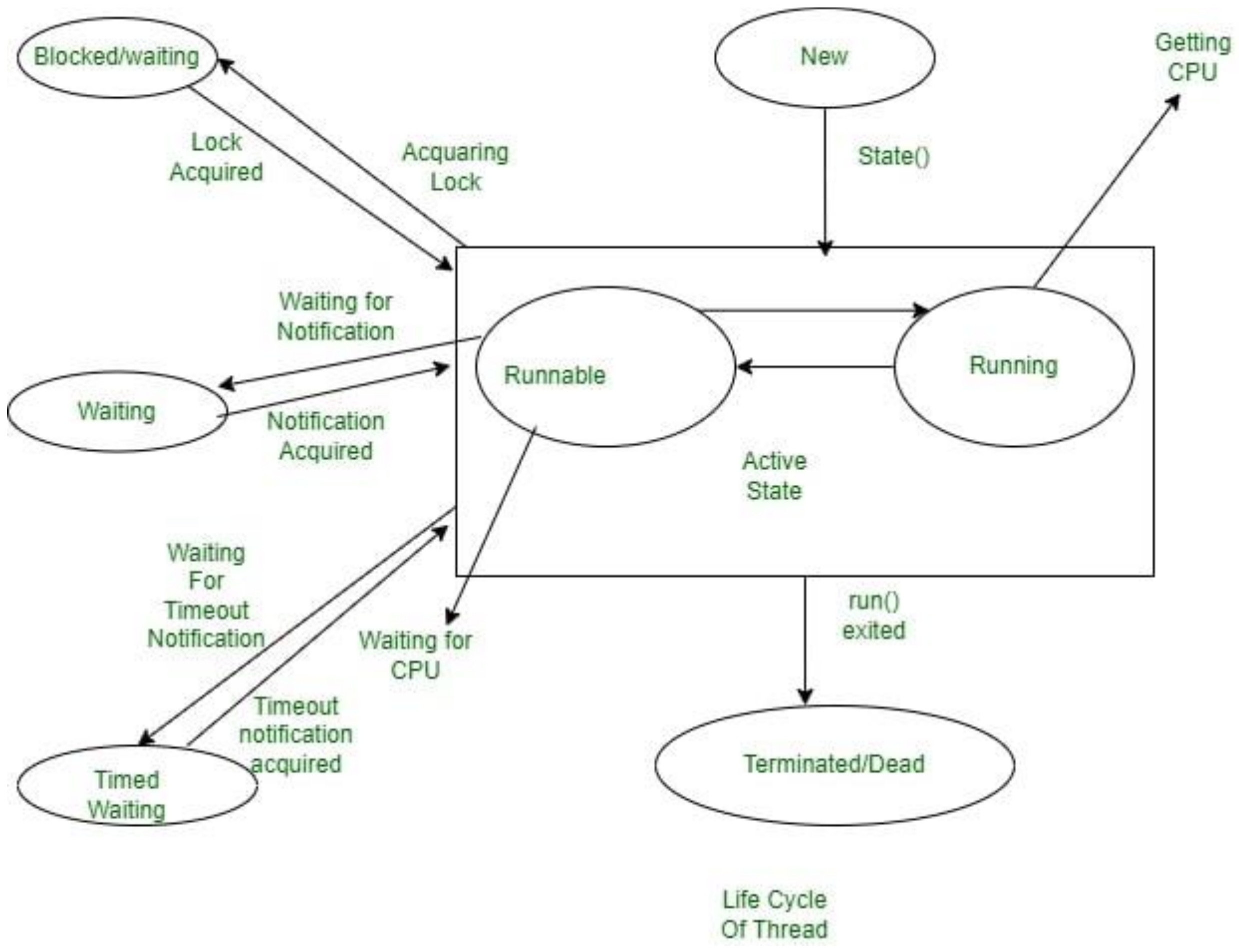
Why Threads are used?

Now, we can understand why threads are being used as they had the advantage of being lightweight and can provide communication between multiple threads at a Low Cost contributing to effective multi-tasking within a shared memory environment.

Life Cycle Of Thread

There are different states Thread transfers into during its lifetime, let us know about those states in the following lines: in its lifetime, a thread undergoes the following states, namely:

1. New State
2. Active State
3. Waiting/Blocked State
4. Timed Waiting State
5. Terminated State



We can see the working of different states in a Thread in the above Diagram, let us know in detail each and every state:

1. New State
By default, a Thread will be in a new state, in this state, code has not yet been run and the execution process is not yet initiated.

2. Active State
A Thread that is a new state by default gets transferred to Active state when it invokes the start() method, his Active state contains two sub-states namely:

- **Runnable State:** In This State, The Thread is ready to run at any given time and it’s the job of the Thread Scheduler to provide the thread time for the runnable state preserved threads. A program that has obtained Multithreading shares slices of time intervals which are shared between threads hence, these threads run for some short span of time and wait in the runnable state to get their schedules slice of a time interval.

- **Running State:** When The Thread Receives CPU allocated by Thread Scheduler, it transfers from the “Runnable” state to the “Running” state. and after the expiry of its given time slice session, it again moves back to the “Runnable” state and waits for its next time slice.

3. Waiting/Blocked State

If a Thread is inactive but on a temporary time, then either it is at waiting or blocked state, for example, if there are two threads, T1 and T2 where T1 need to communicate to the camera and other thread T2 already using a camera to scan then T1 waits until T2 Thread completes its work, at this state T1 is parked in waiting for the state, and in another scenario, the user called two Threads T2 and T3 with the same functionality and both had same time slice given by Thread Scheduler then both Threads T1, T2 is in a blocked state. When there are multiple threads parked in Blocked/Waiting state Thread Scheduler clears Queue by rejecting unwanted Threads and allocating CPU on a priority basis.

4. Timed Waiting State

Sometimes the longer duration of waiting for threads causes starvation, if we take an example like there are two threads T1, T2 waiting for CPU and T1 is undergoing Critical Coding operation and if it does not exit CPU until its operation gets executed then T2 will be exposed to longer waiting with undetermined certainty, In order to avoid this starvation situation, we had Timed Waiting for the state to avoid that kind of scenario as in Timed Waiting, each thread has a time period for which sleep() method is invoked and after the time expires the Threads starts executing its task.

5. Terminated State

A thread will be in Terminated State, due to the below reasons:

- Termination is achieved by a Thread when it finishes its task Normally.
- Sometimes Threads may be terminated due to unusual events like segmentation faults, exceptions…etc. and such kind of Termination can be called Abnormal Termination.
- A terminated Thread means it is dead and no longer available.

What is Main Thread?

As we are familiar that, we create Main Method in each and every Java Program, which acts as an entry point for the code to get executed by JVM, Similarly in this Multithreading Concept, Each Program has one Main Thread which was provided by default by JVM, hence whenever a program is being created in java, JVM provides the Main Thread for its Execution.

How to Create Threads using Java Programming Language?

We can create Threads in java using two ways, namely :

1. By extending Thread Class
2. By Implementing a Runnable interface

1. By Extending Thread Class

We can run Threads in Java by using Thread Class, which provides constructors and methods for creating and performing operations on a Thread, which extends a Thread class that can implement Runnable Interface. We use the following constructors for creating the Thread:

- Thread
- Thread(Runnable r)

- Thread(String name)
- Thread(String name, Runnable r)

Sample code to create Threads by Extending Thread Class:

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

public class GFG extends Thread {
    // initiated run method for Thread
   public void run()
   {
      System.out.println("Thread Started Running...");
   }
   public static void main(String[] args)
   {
      GFG g1 = new GFG();
        // invoking Thread
      g1.run();
   }
}
```

Output
Thread Started Running...

What is synchronization and how it is implemented in java?

It is a Java feature that restricts multiple threads from trying to access the commonly shared resources at the same time. Here shared resources refer to external file contents, class variables or database records. The main purpose of synchronization is to avoid thread interference. At times when more than one thread try to access a shared resource, we need to ensure that resource will be used by only one thread at a time. The process by which this is achieved is called synchronization.

The “Synchronized” keyword in java creates a block of code referred to as critical section.Synchronization is widely used in multithreaded programming. We can synchronize our code in either of two ways. Both involve the use of the synchronized keyword.

• Using Synchronized Statement Or Block

• Using Synchronized Methods Using Synchronized Statement Or Block Synchronized blocks in Java are marked with the synchronized keyword. A synchronized block in Java is synchronized on some object. All synchronized blocks synchronized on the same object can only have one thread executing inside them at a time. All other threads attempting to enter the synchronized block are blocked until the thread inside the synchronized block exits the block.

General Syntax: synchronized

(objRef) { //statement to be synchronized }

Here, objRef is a reference to the object being synchronized. A synchronized block ensures that a call to a synchronized method that is a member of objRef’s class occurs only after the current thread has successfully entered objRef’s monitor. This synchronization is implemented in Java with a concept called monitors. Only one thread can own a monitor at a given time. When a thread acquires a lock, it is said to have entered the monitor. All other threads attempting to enter the locked monitor will be suspended until the first thread exits the monitor. Using Synchronized Methods To make a method synchronized, simply add the synchronized keyword to its declaration: If you declare any method as synchronized, it is known as synchronized method.Synchronized method is used to lock an object for any shared resource. When a thread invokes a synchronized method, it automatically acquires the lock for that object and releases it when the thread completes its task.

```
public class SynchronizedCounter

 {

private int c = 0;

public synchronized void increment()

{
```

```
c++;

} public synchronized void decrement()

{

 c--;

}

 public synchronized int value()

 {

return c;

}}
```

it is not possible for two invocations of synchronized methods on the same object to interleave. When one thread is executing a synchronized method for an object, all other threads that invoke synchronized methods for the same object block (suspend execution) until the first thread is done with the object.

Exception Handling in Java

The **Exception Handling in Java** is one of the powerful *mechanism to handle the runtime errors* so that the normal flow of the application can be maintained.

In this tutorial, we will learn about Java exceptions, it's types, and the difference between checked and unchecked exceptions.

What is Exception in Java?

Dictionary Meaning: Exception is an abnormal condition.

In Java, an exception is an event that disrupts the normal flow of the program. It is an object which is thrown at runtime.

What is Exception Handling?

Exception Handling is a mechanism to handle runtime errors such as ClassNotFoundException, IOException, SQLException, RemoteException, etc.

Advantage of Exception Handling

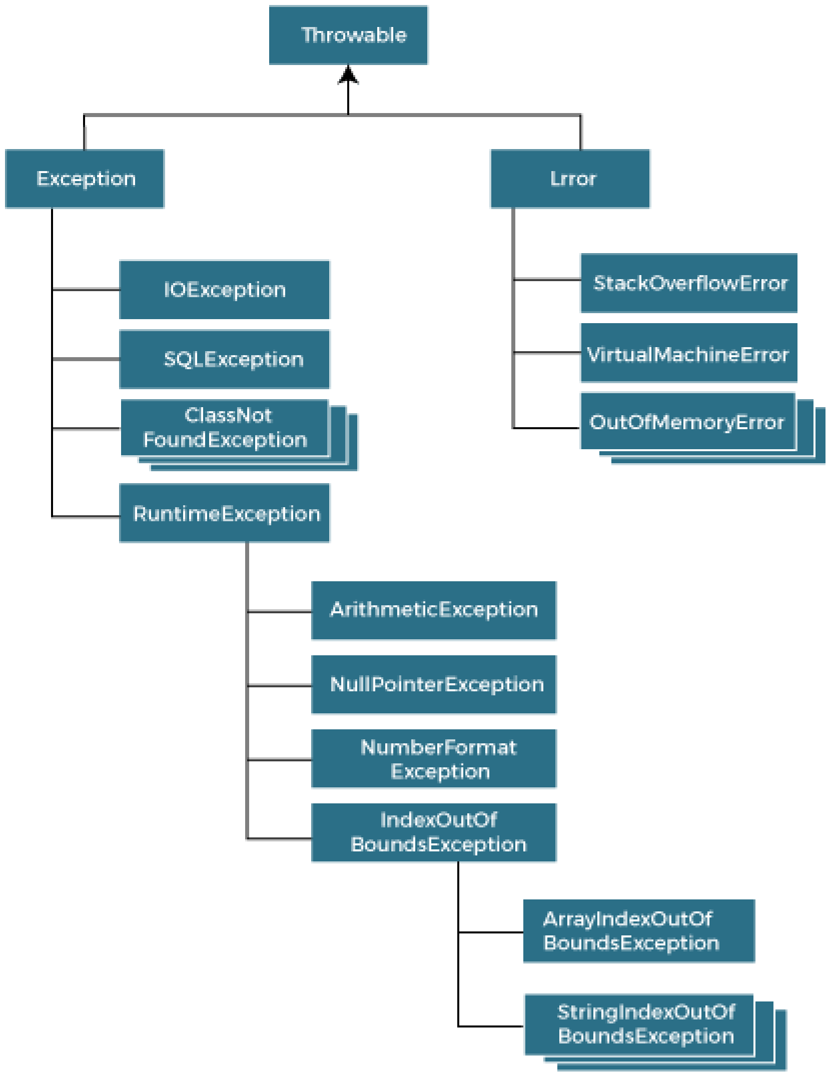
The core advantage of exception handling is **to maintain the normal flow of the application**. An exception normally disrupts the normal flow of the application; that is why we need to handle exceptions. Let's consider a scenario:

```
    statement 1;
    statement 2;
    statement 3;
    statement 4;
    statement 5;//exception occurs
    statement 6;
  statement 7;
    statement 8;
    statement 9;
    statement 10;
```

Suppose there are 10 statements in a Java program and an exception occurs at statement 5; the rest of the code will not be executed, i.e., statements 6 to 10 will not be executed. However, when we perform exception handling, the rest of the statements will be executed. That is why we use exception handling in Java.

Hierarchy of Java Exception classes

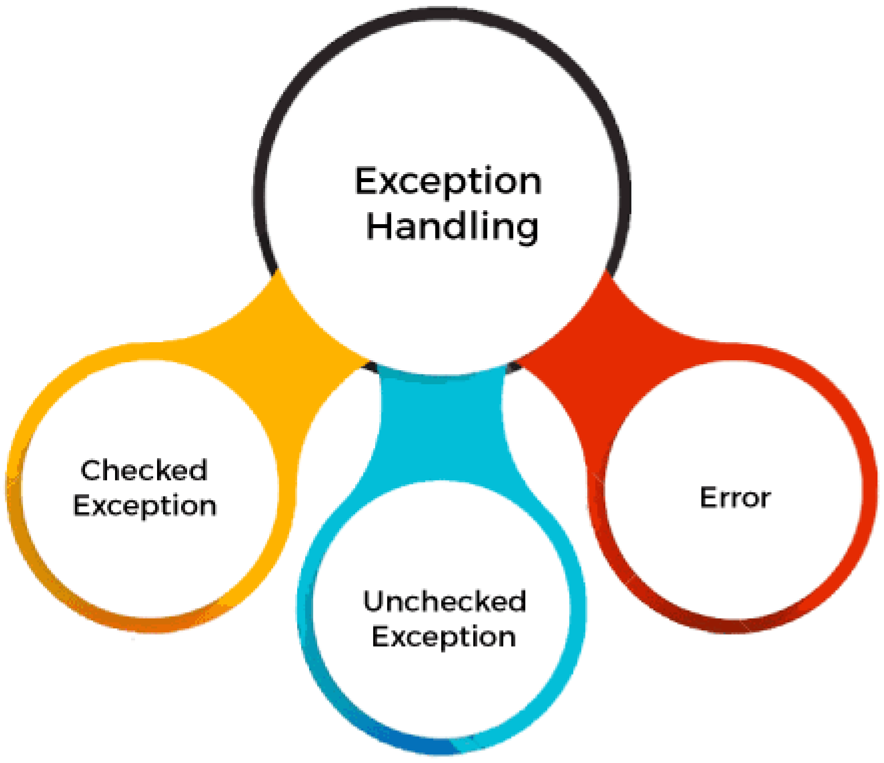
The java.lang.Throwable class is the root class of Java Exception hierarchy inherited by two subclasses: Exception and Error. The hierarchy of Java Exception classes is given below:



Types of Java Exceptions

There are mainly two types of exceptions: checked and unchecked. An error is considered as the unchecked exception. However, according to Oracle, there are three types of exceptions namely:

1. Checked Exception
2. Unchecked Exception
3. Error



Difference between Checked and Unchecked Exceptions

1) Checked Exception

The classes that directly inherit the Throwable class except RuntimeException and Error are known as checked exceptions. For example, IOException, SQLException, etc. Checked exceptions are checked at compile-time.

2) Unchecked Exception

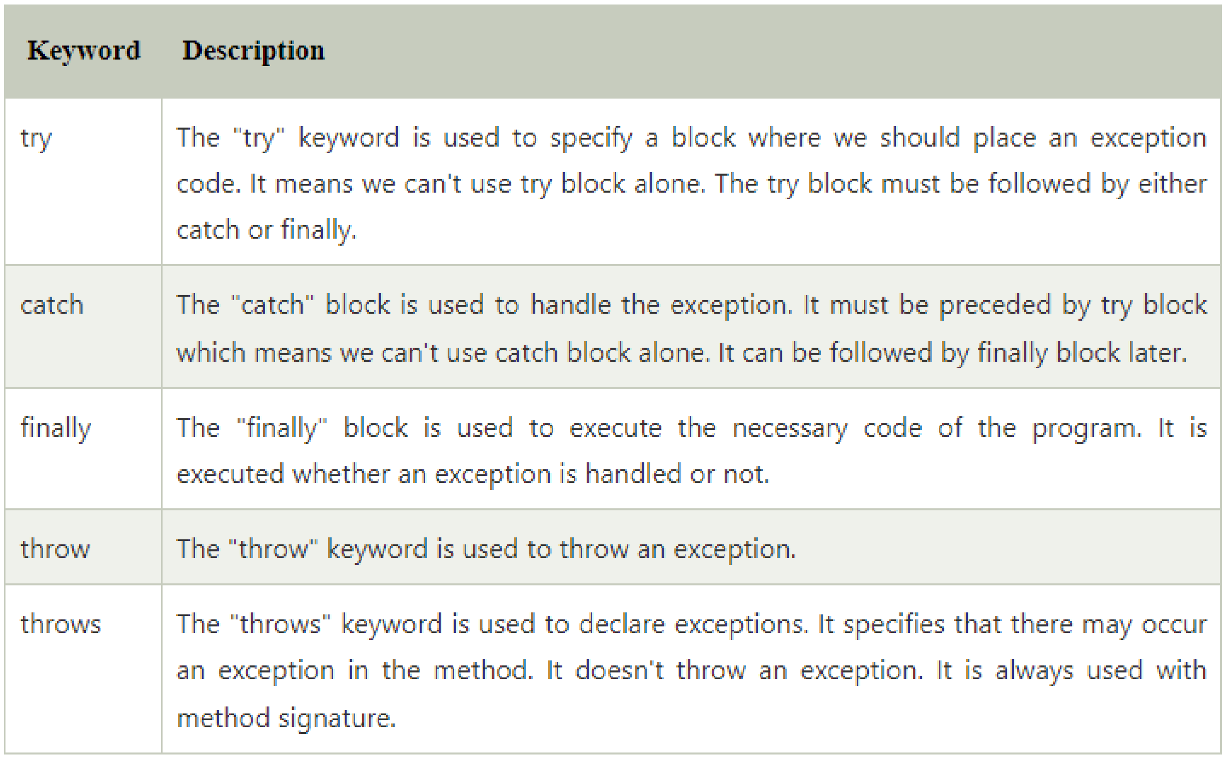
The classes that inherit the RuntimeException are known as unchecked exceptions. For example, ArithmeticException, NullPointerException, ArrayIndexOutOfBoundsException, etc. Unchecked exceptions are not checked at compile-time, but they are checked at runtime.

3) Error

Error is irrecoverable. Some example of errors are OutOfMemoryError, VirtualMachineError, AssertionError etc.

Java Exception Keywords

Java provides five keywords that are used to handle the exception. The following table describes each.



Keyword	Description
try	The "try" keyword is used to specify a block where we should place an exception code. It means we can't use try block alone. The try block must be followed by either catch or finally.
catch	The "catch" block is used to handle the exception. It must be preceded by try block which means we can't use catch block alone. It can be followed by finally block later.
finally	The "finally" block is used to execute the necessary code of the program. It is executed whether an exception is handled or not.
throw	The "throw" keyword is used to throw an exception.
throws	The "throws" keyword is used to declare exceptions. It specifies that there may occur an exception in the method. It doesn't throw an exception. It is always used with method signature.

Java Exception Handling Example

Let's see an example of Java Exception Handling in which we are using a try-catch statement to handle the exception.

JavaExceptionExample.java

```
public class JavaExceptionExample{
  public static void main(String args[]){
   try{
      //code that may raise exception
      int data=100/0;
   }catch(ArithmeticException e){System.out.println(e);}
   //rest code of the program
   System.out.println("rest of the code...");
  }
}
```

Output:

```
Exception in thread main java.lang.ArithmeticException:/ by zero
rest of the code...
```

Common Scenarios of Java Exceptions

There are given some scenarios where unchecked exceptions may occur. They are as follows:

1) A scenario where ArithmeticException occurs

If we divide any number by zero, there occurs an ArithmeticException.

```
1. int a=50/0;//ArithmeticException
```

2) A scenario where NullPointerException occurs

If we have a null value in any variable, performing any operation on the variable throws a NullPointerException.

```
1. String s=null;
2. System.out.println(s.length());//NullPointerException
```

3) A scenario where NumberFormatException occurs

If the formatting of any variable or number is mismatched, it may result into NumberFormatException. Suppose we have a string variable that has characters; converting this variable into digit will cause NumberFormatException.

```
1. String s="abc";
2. int i=Integer.parseInt(s);//NumberFormatException
```

4) A scenario where ArrayIndexOutOfBoundsException occurs

When an array exceeds to it's size, the ArrayIndexOutOfBoundsException occurs. there may be other reasons to occur ArrayIndexOutOfBoundsException. Consider the following statements.

```
1. int a[]=new int[5];
2. a[10]=50; //ArrayIndexOutOfBoundsException
```

Java try-catch block

Java try block

Java **try** block is used to enclose the code that might throw an exception. It must be used within the method.

If an exception occurs at the particular statement in the try block, the rest of the block code will not execute. So, it is recommended not to keep the code in try block that will not throw an exception.

Java try block must be followed by either catch or finally block.

Syntax of Java try-catch

1. **try**{
2. //code that may throw an exception
3. }**catch**(Exception_class_Name ref){}

Syntax of try-finally block

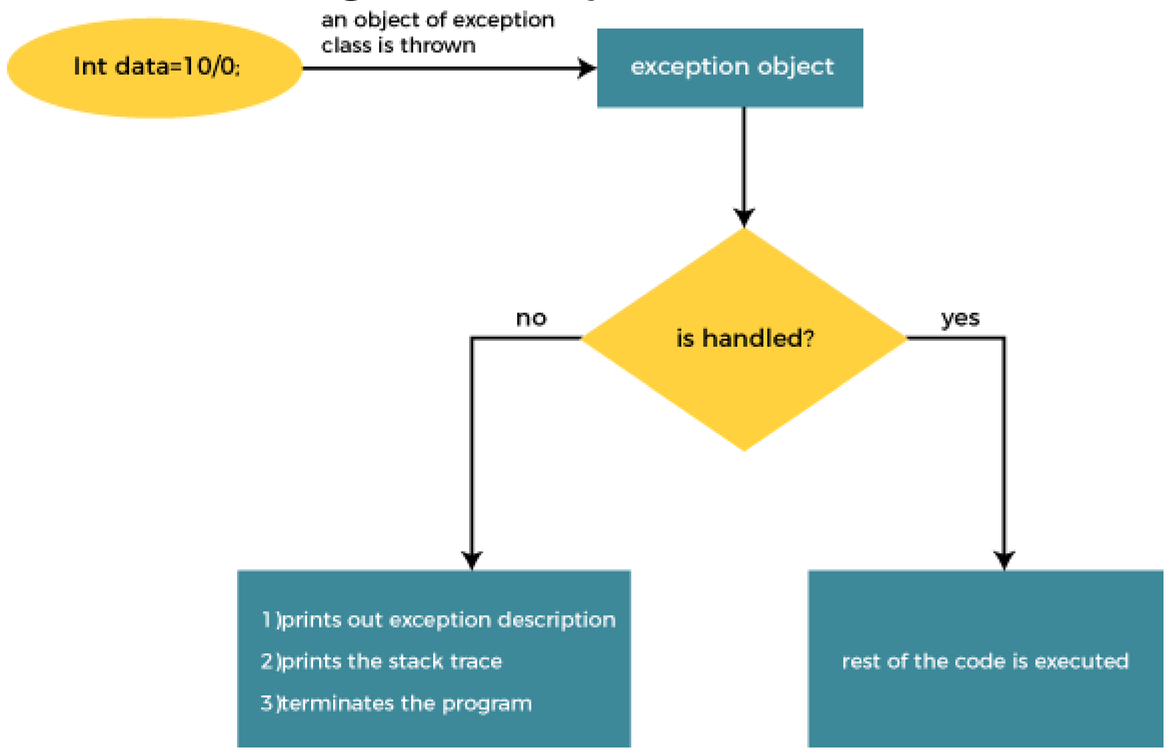
1. **try**{
2. //code that may throw an exception
3. }**finally**{}

Java catch block

Java catch block is used to handle the Exception by declaring the type of exception within the parameter. The declared exception must be the parent class exception (i.e., Exception) or the generated exception type. However, the good approach is to declare the generated type of exception.

The catch block must be used after the try block only. You can use multiple catch block with a single try block.

Internal Working of Java try-catch block


Int data=10/0;
an object of exception class is thrown
exception object
is handled?
no
yes
1)prints out exception description
2)prints the stack trace
3)terminates the program
rest of the code is executed

The JVM firstly checks whether the exception is handled or not. If exception is not handled, JVM provides a default exception handler that performs the following tasks:

- Prints out exception description.
- Prints the stack trace (Hierarchy of methods where the exception occurred).
- Causes the program to terminate.

But if the application programmer handles the exception, the normal flow of the application is maintained, i.e., rest of the code is executed.

Problem without exception handling

Let's try to understand the problem if we don't use a try-catch block.

Example 1

TryCatchExample1.java

```
public class TryCatchExample1 {
        public static void main(String[] args) {

            int data=50/0; //may throw exception

            System.out.println("rest of the code");

        }

    }
```

Output:

```
Exception in thread "main" java.lang.ArithmeticException: / by zero
```

et's see an example to print a custom message on exception.

TryCatchExample5.java

```
public class TryCatchExample5 {

        public static void main(String[] args) {
            try
       {
            int data=50/0; //may throw exception
             }
          // handling the exception
            catch(Exception e)
    {
                    // displaying the custom message
             System.out.println("Can't divided by zero");
             }



}
```

Output:

```
Can't divided by zero
```