What is Exception in Java? 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.

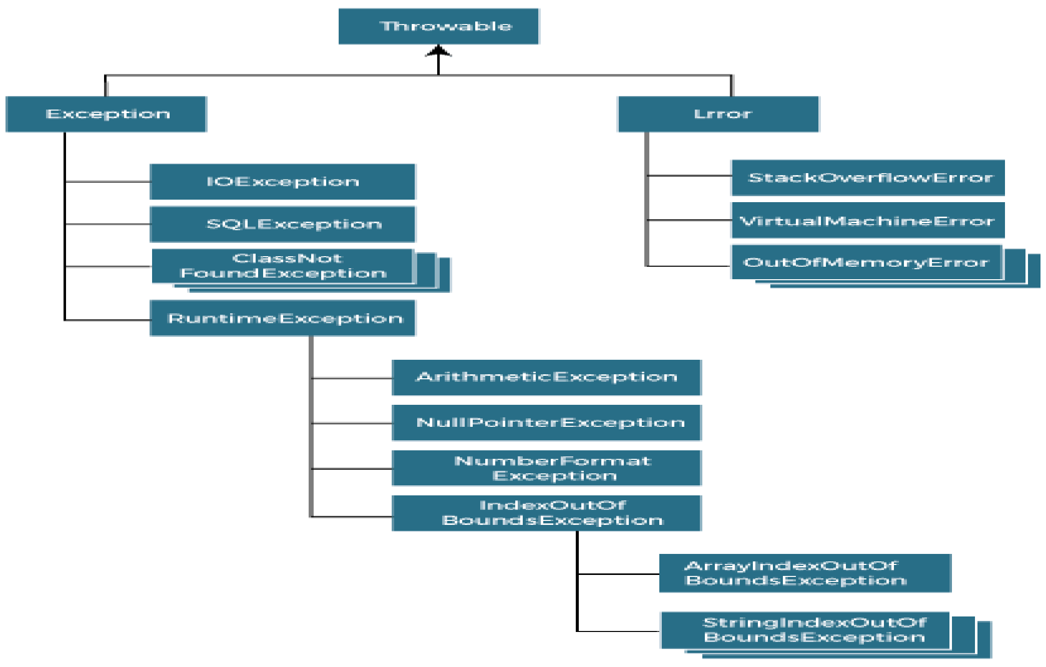
What is Exception Handling?

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

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

Hierarchy of Java Exception classes

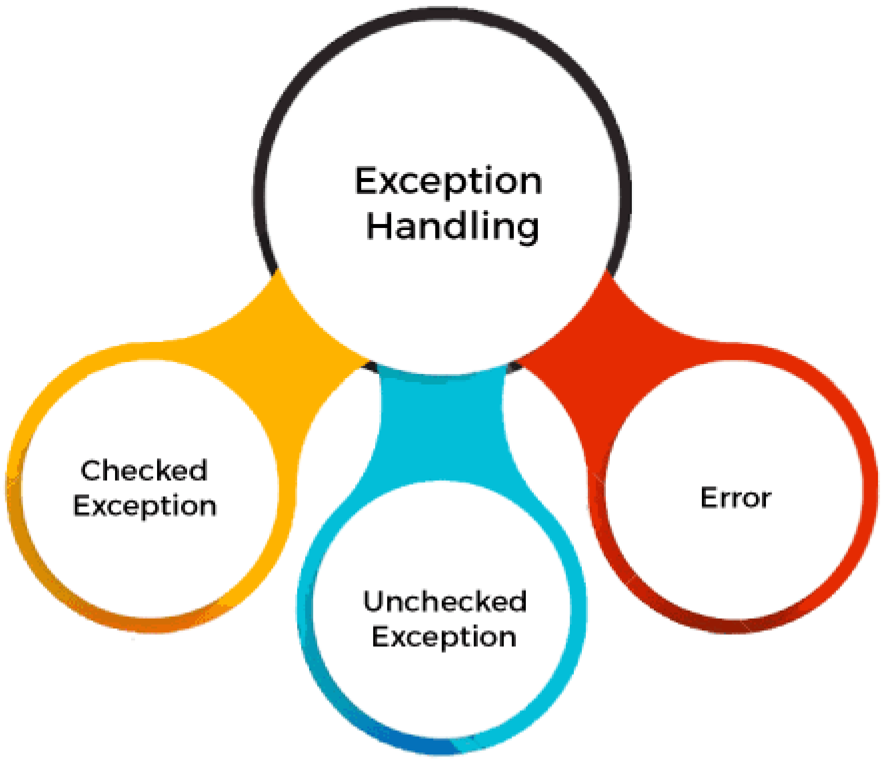
The java.lang.Throwable class is the root class of Java Exception hierarchy inherited by two subclasses: Exception and Error. The hierarchy of Java Exception classes is given below:



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 Exceptions

- Checked by the compiler.
- Must be handled using try-catch or declared with throws.
- Examples: IOException, SQLException, ClassNotFoundException.

2. Unchecked Exceptions (Runtime Exceptions)

- Not checked at compile time.
- Usually programming mistakes (logic errors).
- Examples: NullPointerException, ArrayIndexOutOfBoundsException, ArithmeticException.

3. Errors

- Serious issues outside the control of the programmer.
- Example: OutOfMemoryError, StackOverflowError.

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.

Difference Between Exception and Error

In Java, Error, and Exception both are subclasses of the Java Throwable class that belongs to java.lang package.

Basis of Compariso n	**Exception**	**Error**
Recoverable/ Irrecoverable	Exception can be recovered by using the try-catch block.	An error cannot be recovered.
Type	It can be classified into two categories i.e. checked and unchecked.	All errors in Java are unchecked.
Occurrence	It occurs at compile time or run time.	It occurs at run time.
Package	It belongs to java.lang.Exception package.	It belongs to java.lang.Error package.

Known or unknown	Only checked exceptions are known to the compiler.	Errors will not be known to the compiler.
Causes	It is mainly caused by the application itself.	It is mostly caused by the environment in which the application is running.
Example	**CheckedExceptions:** SQLException, IOException **Unchecked Exceptions:** ArrayIndexOutOfBoundException, NullPointerException, ArithmaticException	Java.lang.StackOverFlow, java.lang.OutOfMemory

java Exception Handling Example

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...");
 }
}
```

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.

```
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.

```
String s=null;
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.

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

Other common cases that cause NumberFormatException:

1. **Empty string** → `Integer.parseInt("")`
2. **String with spaces** → `Integer.parseInt(" 123 ")`
3. **Alphanumeric string** → `Integer.parseInt("123abc")`
4. **Number too large** → `Integer.parseInt("9999999999999")`

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.

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

MultipleCatchBlock1.java

```
public class MultipleCatchBlock1 {

     public static void main(String[] args)
{

          try{
               int a[]=new int[5];
               a[5]=30/0;
String s=null;
System.out.println(s.length());//NullPointerException
```

10. String s1="abc";

```
int i=Integer.parseInt(s1);//NumberFormatException


           }
           catch(ArithmeticException e)
             {
              System.out.println("Arithmetic Exception occurs");
             }
           catch(ArrayIndexOutOfBoundsException e)
             {
              System.out.println("ArrayIndexOutOfBounds Exception occurs");
             }
catch(NullPointerException e)
             {
              System.out.println("NullPointerException raise");
             }
catch (NumberFormatException e)
             {
              System.out.println("NumberFormatException raise");
             }



           catch(Exception e)
             {
              System.out.println("Parent Exception occurs");
             }
           System.out.println("rest of the code");
     }
}
```

TestThrow1.java

In this example, we have created the validate method that takes integer value as a parameter. If the age is less than 18, we are throwing the ArithmeticException otherwise print a message welcome to vote.

```java
public class TestThrow1 {
    //function to check if person is eligible to vote or not
    public static void validate(int age) {
        if(age<18) {
            //throw Arithmetic exception if not eligible to vote
            throw new ArithmeticException("Person is not eligible to vote");
        }
        else {
            System.out.println("Person is eligible to vote!!");
        }
    }
    //main method
    public static void main(String args[]){
        //calling the function
        validate(13);
        System.out.println("rest of the code..
 }
}
```

java Catch Multiple Exceptions

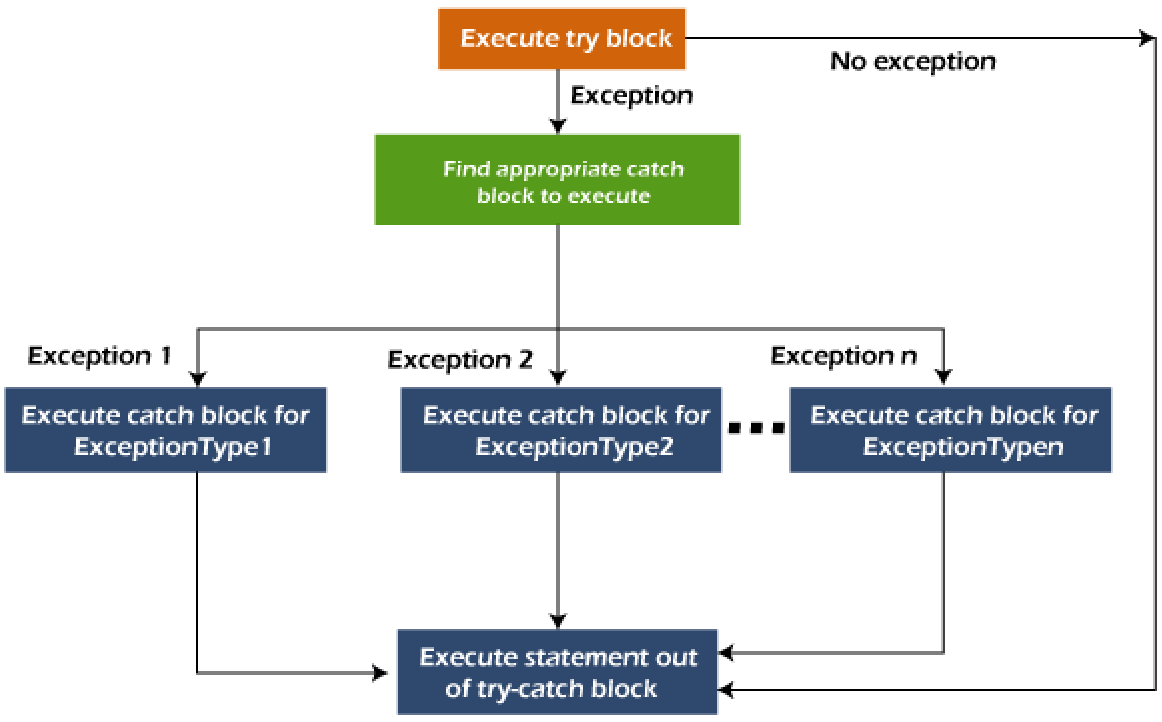
Java Multi-catch block

A try block can be followed by one or more catch blocks. Each catch block must contain a different exception handler. So, if you have to perform different tasks at the occurrence of different exceptions, use java multi-catch block.

Points to remember

- At a time only one exception occurs and at a time only one catch block is executed.
- All catch blocks must be ordered from most specific to most general, i.e. catch for ArithmeticException must come before catch for Exception.

Flowchart of Multi-catch Block


Execute try block
No exception
Exception
Find appropriate catch block to execute
Exception 1
Exception 2
Exception n
Execute catch block for ExceptionType1
Execute catch block for ExceptionType2
Execute catch block for ExceptionTypen
Execute statement out of try-catch block

Example 1

a simple example of java multi-catch block.

MultipleCatchBlock1.java

```
public class MultipleCatchBlock1 {

    public static void main(String[] args) {

        try{
            int a[]=new int[5];
            a[5]=30/0;
           }
           catch(ArithmeticException e)
             {
              System.out.println("Arithmetic Exception occurs");
             }
           catch(ArrayIndexOutOfBoundsException e)
             {
              System.out.println("ArrayIndexOutOfBounds Exception occurs");
             }
           catch(Exception e)
             {
              System.out.println("Parent Exception occurs");
             }
           System.out.println("rest of the code");
    }
}
```

Java throws keyword

The **Java throws keyword** is used to declare an exception. It gives an information to the programmer that there may occur an exception. So, it is better for the programmer to provide the exception handling code so that the normal flow of the program can be maintained.

Exception Handling is mainly used to handle the checked exceptions. If there occurs any unchecked exception such as NullPointerException, it is programmers' fault that he is not checking the code before it being used.

Syntax of Java throws

```
return_type method_name() throws exception_class_name{
//method code
}
```

Which exception should be declared?

Ans: Checked exception only, because:

- **unchecked exception:** under our control so we can correct our code.
- **error:** beyond our control. For example, we are unable to do anything if there occurs VirtualMachineError or StackOverflowError.

Advantage of Java throws keyword

Now Checked Exception can be propagated (forwarded in call stack).

It provides information to the caller of the method about the

exception.

Java throws Example

the example of Java throws clause which describes that checked exceptions can be propagated by throws keyword.

Testthrows1.java

```
import java.io.IOException;
class Testthrows1{
 void m()throws IOException{
  throw new IOException("device error");//checked exception
 }
 void n()throws IOException{
  m();
 }
 void p(){
  try{
   n();
  }catch(Exception e){System.out.println("exception handled");}
 }
 public static void main(String args[]){
  Testthrows1 obj=new Testthrows1();
  obj.p();
  System.out.println("normal flow...");
 }
}
```

Java Nested try block

In Java, using a try block inside another try block is permitted. It is called as nested try block. Every statement that we enter a statement in try block, context of that exception is pushed onto the stack.

For example, the **inner try block** can be used to handle **ArrayIndexOutOfBoundsException** while the **outer try block** can handle the **ArithemeticException** (division by zero).

Why use nested try block

Sometimes a situation may arise where a part of a block may cause one error and the entire block itself may cause another error. In such cases, exception handlers have to be nested.

Syntax:

```
....
//main try block
try
```

```
{
    statement 1;
    statement 2;
//try catch block within another try block
    try
    {
        statement 3;
        statement 4;
//try catch block within nested try block
        try
        {
            statement 5;
            statement 6;
     }
        catch(Exception e2)
        {
//exception message
        }

    }
    catch(Exception e1)
    {
//exception message
    }
}
//catch block of parent (outer) try block
catch(Exception e3)
{
//exception message
}
....
```

Java Nested try Example

Example 1

an example where we place a try block within another try block for two different exceptions.

NestedTryBlock.java

```java
public class NestedTryBlock{
 public static void main(String args[]){
 //outer try block
  try{
  //inner try block 1
    try{
     System.out.println("going to divide by 0");
     int b =39/0;
    }
    //catch block of inner try block 1
    catch(ArithmeticException e)
    {
      System.out.println(e);
    }


    //inner try block 2
    try{
      int a[]=new int[5];
    //assigning the value out of array bounds
     a[5]=4;
     }

    //catch block of inner try block 2
    catch(ArrayIndexOutOfBoundsException e)
    {
       System.out.println(e);
    }


    System.out.println("other statement");
 }
  //catch block of outer try block
  catch(Exception e)
  {
    System.out.println("handled the exception (outer catch)");
 }

  System.out.println("normal flow..");
 }
}
```

Multithreading in Java

1. Multithreading
2. Multitasking
3. Process-based multitasking
4. Thread-based multitasking
5. What is Thread

Multithreading in Java is a process of executing multiple threads simultaneously.

A thread is a lightweight sub-process, the smallest unit of processing. Multiprocessing and multithreading, both are used to achieve multitasking.

However, we use multithreading than multiprocessing because threads use a shared memory area. They don't allocate separate memory area so saves memory, and context-switching between the threads takes less time than process.

Java Multithreading is mostly used in games, animation, etc.

Multitasking

Multitasking is a process of executing multiple tasks simultaneously. We use multitasking to utilize the CPU. Multitasking can be achieved in two ways:

- Process-based Multitasking (Multiprocessing)
- Thread-based Multitasking (Multithreading)

1) Process-based Multitasking (Multiprocessing)

- Each process has an address in memory. In other words, each process allocates a separate memory area.

- A process is heavyweight.
- Cost of communication between the process is high.
- Switching from one process to another requires some time for saving and loading registers, memory maps, updating lists, etc.

2) Thread-based Multitasking (Multithreading)

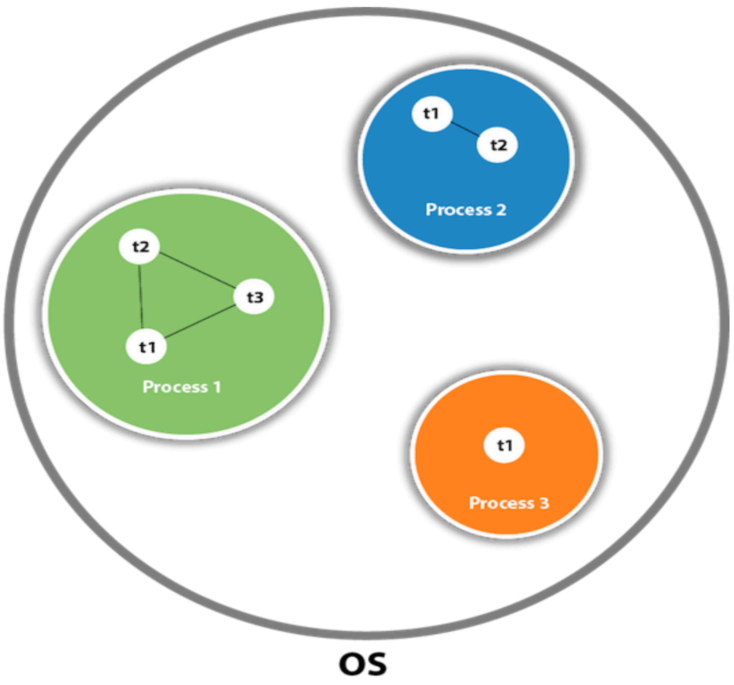
- Threads share the same address space.
- A thread is lightweight.
- Cost of communication between the thread is low.

Note: At least one process is required for each thread.

What is Thread in java

A thread is a lightweight subprocess, the smallest unit of processing. It is a separate path of execution.

Threads are independent. If there occurs exception in one thread, it doesn't affect other threads. It uses a shared memory area.



As shown in the above figure, a thread is executed inside the process. There is context-switching between the threads. There can be multiple processes inside the OS, and one process can have multiple threads.

Note: At a time one thread is executed only.

Java Thread class

Java provides **Thread class** to achieve thread programming. Thread class provides constructors and methods to create and perform operations on a thread. Thread class extends Object class and implements Runnable interface.

Java Thread Methods

S.N.	**Modifier and Type**	**Method**	**Description**
1)	Void	start()	It is used to start the execution of the thread.
2)	Void	run()	It is used to do an action for a thread.
3)	static void	sleep()	It sleeps a thread for the specified amount of time.
4)	static Thread	currentThread()	It returns a reference to the currently executing thread object.
5)	Void	join()	It waits for a thread to die.
6)	Int	getPriority()	It returns the priority of the thread.
7)	Void	setPriority()	It changes the priority of the thread.
8)	String	getName()	It returns the name of the thread.

9)	Void	setName()	It changes the name of the thread.
10)	Long	getId()	It returns the id of the thread.
11)	Boolean	isAlive()	It tests if the thread is alive.
12)	static void	yield()	It causes the currently executing thread object to pause and allow other threads to execute temporarily.
13)	Void	suspend()	It is used to suspend the thread.
14)	Void	resume()	It is used to resume the suspended thread.
15)	Void	stop()	It is used to stop the thread.
16)	Void	destroy()	It is used to destroy the thread group and all of its subgroups.
17)	Boolean	isDaemon()	It tests if the thread is a daemon thread.
18)	Void	setDaemon()	It marks the thread as daemon or user thread.
19)	Void	interrupt()	It interrupts the thread.
20)	Boolean	isinterrupted()	It tests whether the thread has been interrupted.

21)	static boolean	interrupted()	It tests whether the current thread has been interrupted.
22)	static int	activeCount()	It returns the number of active threads in the current thread's group.
23)	Void	checkAccess()	It determines if the currently running thread has permission to modify the thread.
24)	ThreadGroup	getThreadGroup()	It is used to return the thread group to which this thread belongs
25)	String	toString()	It is used to return a string representation of this thread, including the thread's name, priority, and thread group.
26)	Void	notify()	It is used to give the notification for only one thread which is waiting for a particular object.
27)	Void	notifyAll()	It is used to give the notification to all waiting threads of a particular object.

Life cycle of a Thread (Thread States)

In Java, a thread always exists in any one of the following states. These states are:

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

Explanation of Different Thread States

New: Whenever a new thread is created, it is always in the new state. For a thread in the new state, the code has not been run yet and thus has not begun its execution.

Active: When a thread invokes the start () method, it moves from the new state to the active state. The active state contains two states within it: one is **runnable**, and the other is **running**.

- **Runnable:** A thread, that is ready to run is then moved to the runnable state. In the runnable state, the thread may be running or may be ready to run at any given instant of time. It is the duty of the thread scheduler to provide the thread time to run, i.e., moving the thread the running state.
  A program implementing multithreading acquires a fixed slice of time to each individual thread. Each and every thread runs for a short span of time and when that allocated time slice is over, the thread voluntarily gives up the CPU to the other thread, so that the other threads can also run for their slice of time. Whenever such a scenario occurs, all those threads that are willing to run, waiting for their turn to run, lie in the runnable state. In the runnable state, there is a queue where the threads lie.
- **Running:** When the thread gets the CPU, it moves from the runnable to the running state. Generally, the most common change in the state of a thread is from runnable to running and again back to runnable.

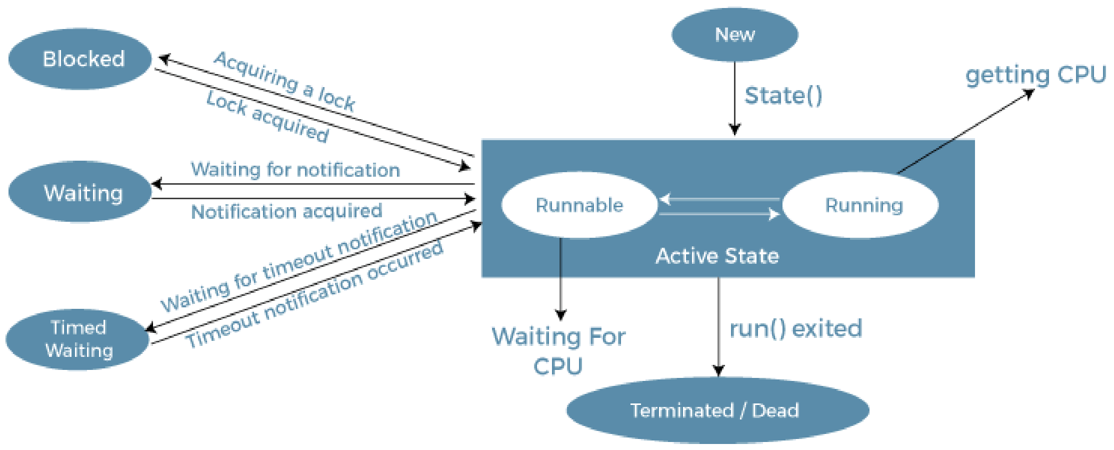
Blocked or Waiting: Whenever a thread is inactive for a span of time (not permanently) then, either the thread is in the blocked state or is in the waiting state.

For example, a thread (let's say its name is A) may want to print some data from the printer. However, at the same time, the other thread (let's say its name is B) is using the printer to print some data. Therefore, thread A has to wait for thread B to use the printer. Thus, thread A is in the blocked state. A thread in the blocked state is unable to perform any execution and thus never consume any cycle of the Central Processing Unit (CPU). Hence, we can say that thread A remains idle until the thread scheduler reactivates thread A, which is in the waiting or blocked state.

Timed Waiting: Sometimes, waiting for leads to starvation. For example, a thread (its name is A) has entered the critical section of a code and is not willing to leave that critical section. In such a scenario, another thread (its name is B) has to wait forever, which leads to starvation. To avoid such scenario, a timed waiting state is given to thread B. Thus, thread lies in the waiting state for a specific span of time, and not forever. A real example of timed waiting is when we invoke the sleep() method on a specific thread. The sleep() method puts the thread in the timed wait state. After the time runs out, the thread wakes up and start its execution from when it has left earlier.

Terminated: A thread reaches the termination state because of the following reasons:

- When a thread has finished its job, then it exists or terminates normally.
- **Abnormal termination:** It occurs when some unusual events such as an unhandled exception or segmentation fault.
- The following diagram shows the different states involved in the life cycle of a thread.



Life Cycle of a Thread

Java Threads | How to create a thread in Java

There are two ways to create a thread:

1. By extending Thread class
2. By implementing Runnable interface.

Thread class:

Thread class provide constructors and methods to create and perform operations on a thread.Thread class extends Object class and implements Runnable interface.

Commonly used Constructors of Thread class:

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

Commonly used methods of Thread class:

1. **public void run():** is used to perform action for a thread.
2. **public void start():** starts the execution of the thread.JVM calls the run() method on the thread.

3. **public void sleep(long miliseconds):** Causes the currently executing thread to sleep (temporarily cease execution) for the specified number of milliseconds.
4. **public void join():** waits for a thread to die.
5. **public void join(long miliseconds):** waits for a thread to die for the specified miliseconds.
6. **public int getPriority():** returns the priority of the thread.
7. **public int setPriority(int priority):** changes the priority of the thread.
8. **public String getName():** returns the name of the thread.
9. **public void setName(String name):** changes the name of the thread.
10. **public Thread currentThread():** returns the reference of currently executing thread.
11. **public int getId():** returns the id of the thread.
12. **public Thread.State getState():** returns the state of the thread.
13. **public boolean isAlive():** tests if the thread is alive.
14. **public void yield():** causes the currently executing thread object to temporarily pause and allow other threads to execute.
15. **public void suspend():** is used to suspend the thread(depricated).
16. **public void resume():** is used to resume the suspended thread(depricated).
17. **public void stop():** is used to stop the thread(depricated).
18. **public boolean isDaemon():** tests if the thread is a daemon thread.
19. **public void setDaemon(boolean b):** marks the thread as daemon or user thread.
20. **public void interrupt():** interrupts the thread.
21. **public boolean isInterrupted():** tests if the thread has been interrupted.
22. **public static boolean interrupted():** tests if the current thread has been interrupted.

Runnable interface:

The Runnable interface should be implemented by any class whose instances are intended to be executed by a thread. Runnable interface have only one method named run().

1. **public void run():** is used to perform action for a thread.

Java Thread Example by extending Thread class

FileName: Multi.java

```java
class Multi extends Thread
{
public void run(){
System.out.println("thread is running...");
}
public static void main(String args[]){
Multi t1=new Multi();
t1.start();
 }
}
```

Java Thread Example by implementing Runnable interface

FileName: Multi3.java

```java
class Multi3 implements Runnable{
public void run(){
System.out.println("thread is running...");
}

public static void main(String args[]){
Multi3 m1=new Multi3();
Thread t1 =new Thread(m1);  // Using the constructor Thread(Runnable r)
t1.start();
 }
}
```

Using the Thread Class: Thread(String Name)

We can directly use the Thread class to spawn new threads using the constructors defined above.

FileName: MyThread1.java

```java
public class MyThread1
{

public static void main(String argvs[])
{
// creating an object of the Thread class using the constructor Thread(String name)
```

```
      Thread t= new Thread("My first
thread");
// the start() method moves the thread to the active state
t.start();
// getting the thread name by invoking the getName() method
String str = t.getName();
System.out.println(str);
}
}
```

Thread.sleep() in Java with Examples

The Java Thread class provides the two variant of the sleep() method. First one accepts only an arguments, whereas the other variant accepts two arguments. The method sleep() is being used to halt the working of a thread for a given amount of time. The time up to which the thread remains in the sleeping state is known as the sleeping time of the thread. After the sleeping time is over, the thread starts its execution from where it has left.

The sleep() Method Syntax:

Following are the syntax of the sleep() method.

```
public static void sleep(long mls) throws InterruptedException
public static void sleep(long mls, int n) throws InterruptedException
```

The method sleep() with the one parameter is the native method, and the implementation of the native method is accomplished in another programming language. The other methods having the two parameters are not the native method. That is, its implementation is accomplished in Java. We can access the sleep() methods with the help of the Thread class, as the signature of the sleep() methods contain the static keyword. The native, as well as the non-native method, throw a checked Exception. Therefore, either try-catch block or the throws keyword can work here.

```
class TestSleepMethod1 extends Thread{
 public void run(){
  for(int i=1;i<5;i++)
  {
  // the thread will sleep for the 500 milli seconds
    Try
{
Thread.sleep(500);
}
catch(InterruptedException e)
{
System.out.println(e);
}
   System.out.println(i);
 }
}
 public static void main(String args[]){
 TestSleepMethod1 t1=new TestSleepMethod1();
    TestSleepMethod1 t2=new
TestSleepMethod1();

 t1.start();
 t2.start();
 }
}
```

Priority of a Thread (Thread Priority)

Each thread has a priority. Priorities are represented by a number between 1 and 10. In most cases, the thread scheduler schedules the threads according to their priority (known as preemptive scheduling). But it is not guaranteed because it depends on JVM specification that which scheduling it chooses. Note that not only JVM a Java programmer can also assign the priorities of a thread explicitly in a Java program.

public final int getPriority(): The java.lang.Thread.getPriority() method returns the priority of the given thread.

public final void setPriority(int newPriority): The java.lang.Thread.setPriority() method updates or assign the priority of the thread to newPriority. The method throws IllegalArgumentException if the value newPriority goes out of the range, which is 1 (minimum) to 10 (maximum).

3 constants defined in Thread class:

1. public static int MIN_PRIORITY
2. public static int NORM_PRIORITY
3. public static int MAX_PRIORITY

Default priority of a thread is 5 (NORM_PRIORITY). The value of MIN_PRIORITY is 1 and the value of MAX_PRIORITY is 10.

Example of priority of a Thread:

FileName: ThreadPriorityExample.java

```java
// Importing the required classes
//import java.lang.*;

public class ThreadPriorityExample extends Thread
{
  public void run()
 {

System.out.println("Inside the run() method");
}
public static void main(String argvs[])
{
// Creating threads with the help of ThreadPriorityExample class
ThreadPriorityExample th1 = new ThreadPriorityExample();
ThreadPriorityExample th2 = new ThreadPriorityExample();
ThreadPriorityExample th3 = new ThreadPriorityExample();
System.out.println("Priority of the thread th1 is : " + th1.getPriority());
System.out.println("Priority of the thread th2 is : " + th2.getPriority());
System.out.println("Priority of the thread th3 is : " + th3.getPriority());
th1.setPriority(6);
th2.setPriority(3);
th3.setPriority(9);
System.out.println("Priority of the thread th1 is : " + th1.getPriority());
System.out.println("Priority of the thread th2 is : " + th2.getPriority());
System.out.println("Priority of the thread th3 is : " + th3.getPriority());
System.out.println("Currently Executing The Thread : " + Thread.currentThread().getName());
System.out.println("Priority of the main thread is : " + Thread.currentThread().getPriority());
Thread.currentThread().setPriority(10);
System.out.println("Priority of the main thread is : " + Thread.currentThread().getPriority());
}
}
```

Daemon Thread in Java

Daemon thread in Java is a service provider thread that provides services to the user thread. Its life depend on the mercy of user threads i.e. when all the user threads dies, JVM terminates this thread automatically.

There are many java daemon threads running automatically e.g. gc, finalizer etc.

You can see all the detail by typing the jconsole in the command prompt. The jconsole tool provides information about the loaded classes, memory usage, running threads etc.

Points to remember for Daemon Thread in Java

- It provides services to user threads for background supporting tasks. It has no role in life than to serve user threads.
- Its life depends on user threads.
- It is a low priority thread.

Why JVM terminates the daemon thread if there is no user thread?

The sole purpose of the daemon thread is that it provides services to user thread for background supporting task. If there is no user thread, why should JVM keep running this thread. That is why JVM terminates the daemon thread if there is no user thread.

Methods for Java Daemon thread by Thread class

The java.lang.Thread class provides two methods for java daemon thread.

No.	Method	Description
1)	public void setDaemon(boolean status)	is used to mark the current thread as daemon thread or user thread.
2)	public boolean isDaemon()	is used to check that current is daemon.

Simple example of Daemon thread in java

```
public class TestDaemonThread1 extends Thread{
 public void run(){
  if(Thread.currentThread().isDaemon()){//checking for daemon thread
   System.out.println("daemon thread work");
  }
  else{
  System.out.println("user thread work");
 }
 }
 public static void main(String[] args){
  TestDaemonThread1 t1=new TestDaemonThread1();//creating thread
  TestDaemonThread1 t2=new TestDaemonThread1();
      TestDaemonThread1 t3=new
TestDaemonThread1();
t1.setDaemon(true);//now t1 is daemon thread

  t1.start();//starting threads
  t2.start();
  t3.start();
 }
}
```

ThreadGroup in Java

Java provides a convenient way to group multiple threads in a single object. In such a way, we can suspend, resume or interrupt a group of threads by a single method call.

Note: Now suspend(), resume() and stop() methods are deprecated.

Java thread group is implemented by *java.lang.ThreadGroup* class.

A ThreadGroup represents a set of threads. A thread group can also include the other thread group. The thread group creates a tree in which every thread group except the initial thread group has a parent.

A thread is allowed to access information about its own thread group, but it cannot access the information about its thread group's parent thread group or any other thread groups.

Constructors of ThreadGroup class

There are only two constructors of ThreadGroup class.

No.	Constructor	Description
1)	ThreadGroup(String name)	creates a thread group with given name.
2)	ThreadGroup(ThreadGroup parent, String name)	creates a thread group with a given parent grou name.

Methods of ThreadGroup class

There are many methods in ThreadGroup class. A list of ThreadGroup methods is given below.

S.N.	Modifier and Type	Method	Description
1)	Void	checkAccess()	This method determines if the currently running thread has permission to modify the thread group.
2)	Int	activeCount()	This method returns an estimate of the number of active threads in the thread group and its subgroups.
3)	Int	activeGroupCount()	This method returns an estimate of the number of active groups in the thread group and its subgroups.
4)	Void	destroy()	This method destroys the thread group and all of its subgroups.
5)	Int	enumerate(Thread[] list)	This method copies into the specified array every active thread in the thread group and its subgroups.

6)	Int	getMaxPriority()	This method returns the maximum priority of the thread group.
7)	String	getName()	This method returns the name of the thread group.
8)	ThreadGroup	getParent()	This method returns the parent of the thread group.
9)	Void	interrupt()	This method interrupts all threads in the thread group.
10)	Boolean	isDaemon()	This method tests if the thread group is a daemon thread group.
11)	Void	setDaemon(boolean daemon)	This method changes the daemon status of the thread group.
12)	Boolean	isDestroyed()	This method tests if this thread group has been destroyed.
13)	Void	list()	This method prints information about the thread group to the standard output.
14)	Boolean	parentOf(ThreadGroup g	This method tests if the thread group is either the thread group argument or one of its ancestor thread groups.
15)	Void	suspend()	This method is used to suspend all threads in the thread group.
16)	Void	resume()	This method is used to resume all threads in the thread group which was suspended using suspend() method.
17)	Void	setMaxPriority(int pri)	This method sets the maximum priority of the group.
18)	Void	stop()	This method is used to stop all threads in the thread group.

19)	String	toString()	This method returns a string representation of the Thread group.

ThreadGroup Example

File: ThreadGroupDemo.java

```java
public class ThreadGroupDemo implements Runnable{
    public void run() {
          System.out.println(Thread.currentThread().getName());
    }
   public static void main(String[] args) {
      ThreadGroupDemo runnable = new ThreadGroupDemo();
      ThreadGroup tg1 = new ThreadGroup("Parent ThreadGroup");
          Thread t1 = new Thread(tg1, runnable,"one");
          t1.start();
          Thread t2 = new Thread(tg1, runnable,"two");
          t2.start();
          Thread t3 = new Thread(tg1, runnable,"three");
          t3.start();

          System.out.println("Thread Group Name: "+tg1.getName());
         tg1.list();

    }
   }
```

Synchronization in Java

Synchronization in Java is the capability to control the access of multiple threads to any shared resource.

Java Synchronization is better option where we want to allow only one thread to access the shared resource.

Why use Synchronization?

The synchronization is mainly used to

1. To prevent thread interference.
2. To prevent consistency problem.

Types of Synchronization

There are two types of synchronization

1. Process Synchronization
2. Thread Synchronization

Thread Synchronization

There are two types of thread synchronization mutual exclusive and inter-thread communication.

1. Mutual Exclusive
    1. Synchronized method.
    2. Synchronized block.
    3. Static synchronization.
2. Cooperation (Inter-thread communication in java)

Mutual Exclusive

In Java, mutual exclusion means making sure that only one thread can access a shared resource or critical section at a time — preventing data corruption and race conditions.

Mutual Exclusive helps keep threads from interfering with one another while sharing data. It can be achieved by using the following three ways:

1. By Using Synchronized Method
2. By Using Synchronized Block
3. By Using Static Synchronization

Understanding the problem without Synchronization

In this example, there is no synchronization, so output is inconsistent.

TestSynchronization1.java

```java
class Table{
void printTable(int n){//method not synchronized
   for(int i=1;i<=5;i++){
     System.out.println(n*i);
     try{
      Thread.sleep(400);
     }catch(Exception e){System.out.println(e);}
   }

}
}

class MyThread1 extends Thread{
Table t;
MyThread1(Table t){
this.t=t;
}
public void run(){
t.printTable(5);
}

}
class MyThread2 extends Thread{
Table t;
MyThread2(Table t){
this.t=t;
}
public void run(){
t.printTable(100);
}
}

class TestSynchronization1{
public static void main(String args[]){
Table obj = new Table();//only one object
MyThread1 t1=new MyThread1(obj);
MyThread2 t2=new MyThread2(obj);
t1.start();
t2.start();
}
}
```

Output:

```
5
100
10
200
15
300
20
400
25
500
```

Java Synchronized Method

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.

TestSynchronization2.java

```java
//example of java synchronized method
class Table{
 synchronized void printTable(int n){//synchronized method
   for(int i=1;i<=5;i++){
     System.out.println(n*i);
     try{
      Thread.sleep(400);
     }catch(Exception e){System.out.println(e);}
   }

}
}

class MyThread1 extends Thread{
```

```java
Table t;
MyThread1(Table t){
this.t=t;
}
public void run(){
t.printTable(5);
}

}
class MyThread2 extends Thread{
Table t;
MyThread2(Table t){
this.t=t;
}
public void run(){
t.printTable(100);
}
}

public class TestSynchronization2{
public static void main(String args[]){
Table obj = new Table();//only one object
MyThread1 t1=new MyThread1(obj);
MyThread2 t2=new MyThread2(obj);
t1.start();
t2.start();
}
}
```

Java Thread stop() method

The **stop()** method of thread class terminates the thread execution. Once a thread is stopped, it cannot be restarted by start() method.

Syntax

```java
public final void stop()
public final void stop(Throwable obj)
```

```java
public class JavaStopExp extends Thread
{
    public void run()
    {
        for(int i=1; i<5; i++)
        {
            try
            {
                // thread to sleep for 500 milliseconds
                sleep(500);
                System.out.println(Thread.currentThread().getName());
            }catch(InterruptedException e){System.out.println(e);}
            System.out.println(i);
        }
    }
    public static void main(String args[])
    {
        // creating three threads
        JavaStopExp t1=new JavaStopExp ();
        JavaStopExp t2=new JavaStopExp ();
        JavaStopExp t3=new JavaStopExp ();
        // call run() method
        t1.start();
        t2.start();
        // stop t3 thread
        t3.stop();
        System.out.println("Thread t3 is stopped");
    }
}
```