BUILT-IN EXCEPTIONS

Built-in exceptions are the **exceptions which are available in Java libraries.** These exceptions are suitable to explain certain error situations. Below is the list of important built-in exceptions in Java

Exceptions	Description
Arithmetic Exception	It is thrown when an exceptional condition has occurred in an arithmetic operation.
Array Index Out Of Bound Exception	It is thrown to indicate that an array has been accessed with an illegal index. The index is either negative or greater than or equal to the size of the array.
ClassNotFoundException	This Exception is raised when we try to access a class whose definition is not found.
FileNotFoundException	This Exception is raised when a file is not accessible or does not open.
IOException	It is thrown when an input-output operation failed or interrupted.
InterruptedException	It is thrown when a thread is waiting, sleeping, or doing some processing, and it is interrupted.
NoSuchFieldException	It is thrown when a class does not contain the field (or variable) specified.
NoSuchMethodException	It is thrown when accessing a method which is not found.
NullPointerException	This exception is raised when referring to the members of a null object. Null represents nothing.
NumberFormatException	This exception is raised when a method could not convert a string into a numeric format.
RuntimeException	This represents any exception which occurs during runtime.
StringIndexOutOfBoundsException	It is thrown by String class methods to indicate that an index is either negative than the size of the string

The following Java program explains NumberFormatException

```
class  NumberFormat_Example
{
   public static void main(String args[])
   {
      try {
         int num = Integer.parseInt (“hello”) ;
          System.out.println(num);
      }
      catch(NumberFormatException e) {
         System.out.println(“Number format exception”);
      }
```

```
    }
}
```

The following Java program explains StackOverflowError exception.

```
class Example {
public static void main(String[] args)
    {
            fun1();
    }
public static void fun1()
    {
            fun2();
    }
public static void fun2()
    {
            fun1();
    }
}
```

Output:

```
Exception in thread "main" java.lang.StackOverflowError at
Example.fun2(File.java:14)
at Example.fun1(File.java:10)
```

CHAINED EXCEPTIONS

Chained Exceptions allows **to relate one exception with another exception**, i.e one exception describes cause of another exception. For example, consider a situation in which a method throws an ArithmeticException because of an attempt to divide by zero but the actual cause of exception was an I/O error which caused the divisor to be zero. The method will throw only ArithmeticException to the caller. So the caller would not come to know about the actual cause of exception. Chained Exception is used in such type of situations.

throwable constructors that supports chained exceptions are:

1. Throwable(Throwable cause) :- Where cause is the exception that causes the current exception.
2. Throwable(String msg, Throwable cause) :- Where msg is the exception message and cause is the exception that causes the current exception.

throwable methods that supports chained exceptions are:

1. getCause() method :- This method returns actual cause of an exception.
2. initCause(Throwable cause) method :- This method sets the cause for the calling exception.

Example:

```
import java.io.IOException;
public class ChainedException
 {
  public static void divide(int a, int b)
  {
   if(b==0)
   {
    ArithmeticException ae = new ArithmeticException(“top layer”);
    ae.initCause( new IOException(“cause”) );
    throw ae;
   }
   else
   {
    System.out.println(a/b);
   }
  }
 public static void main(String[] args)
 {
  try {
   divide(5, 0);
  }
```

```
    catch(ArithmeticException ae) { System.out.println(
     "caught : " +ae); System.out.println("actual cause:
     "+ae.getCause());
    }
   }
  }
```

Sample Output:

```
caught : java.lang.ArithmeticException: top layer
actual cause: java.io.IOException: cause
```

In this example, the top-level exception is ArithmeticException. To it is added a cause exception, IOException. When the exception is thrown out of divide( ), it is caught by main( ). There, the top-level exception is displayed, followed by the underlying exception, which is obtained by calling getCause( ).

Exceptions

An exception **is an unexpected event**, which may occur during the execution of a program (at run time), to disrupt the normal flow of the program's instructions. This leads to the abnormal termination of the program.

Therefore, these exceptions are needed to be handled. The exception handling in java is one of the powerful mechanisms to handle the runtime errors so that normal flow of the application can be maintained.

An exception may occur due to the following reasons. They are.

- Invalid data as input.
- Network connection may be disturbed in the middle of communications
- JVM may run out of memory.
- File cannot be found/opened.

These exceptions are caused by user error, programmer error, and physical resources. Based on these, the exceptions can be classified into three categories.

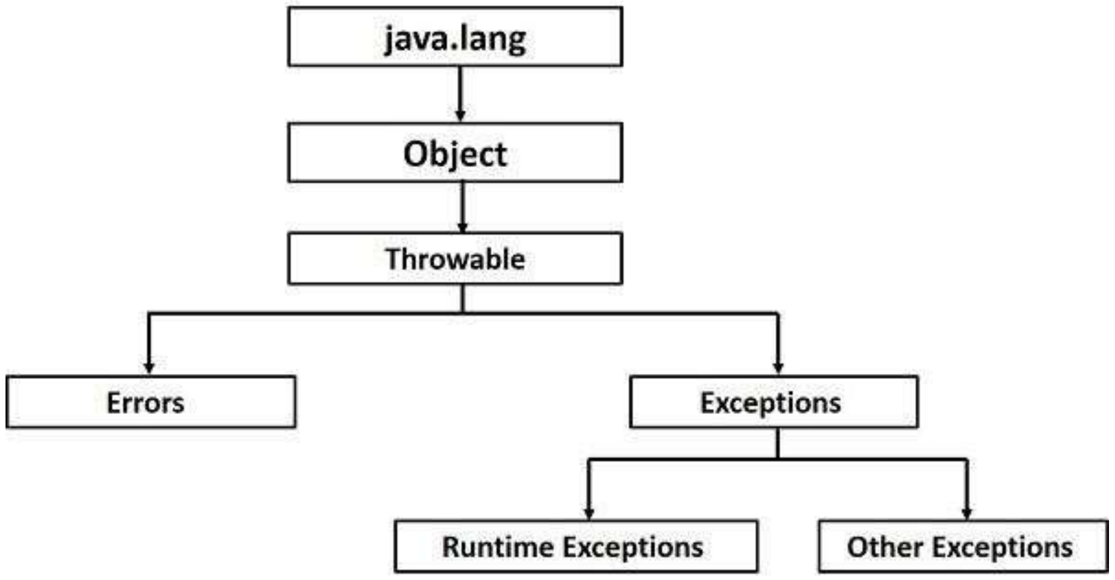
- ***Checked exceptions*** − A checked exception is an exception that occurs at the compile time, also called as compile time exceptions. These exceptions cannot be ignored at the time of compilation. So, the programmer should handle these exceptions.
- ***Unchecked exceptions*** − An unchecked exception is an exception that occurs at run time, also called as **Runtime Exceptions**. These include programming bugs, such as logic errors or improper use of an API. Runtime exceptions are ignored at the time of compilation.
- ***Errors*** − Errors are not exceptions, but problems may 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.
- ***Error:*** An Error indicates serious problem that a reasonable application should not try to catch.
- ***Exception:*** Exception indicates conditions that a reasonable application might try to catch.

Exception Hierarchy

The java.lang.Exception class is the base class for all exception classes. All exception and errors types are sub classes of class Throwabl**e**, which is base class of hierarchy. One branch is headed by Exception. This class is used for exceptional conditions that user programs should catch. NullPointerException is an example of such an exception. Another branch, Er- ror are used by the Java run-time system(JVM) to indicate errors having to do with the run- time environment itself(JRE). StackOverflowError is an example of such an error.

Errors are abnormal conditions that happen in case of severe failures, these are not han- dled 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.



Exceptions Methods

Method	Description
public String getMessage()	Returns a detailed message about the exception that has occurred. This message is initialized in the Throwable constructor.
public Throwable getCause()	Returns the cause of the exception as represented by a Throwable object.
public String toString()	Returns the name of the class concatenated with the result of getMessage().
public void printStackTrace()	Prints the result of toString() along with the stack trace to System.err, the error output stream.
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.
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.

Exception handling in java uses the following Keywords

1. try
2. catch
3. finally
4. throw
5. throws

The try/catch block is used as follows:

```
try
 {
// block of code to monitor for errors
// the code you think can raise an exception
}
catch (ExceptionType1 exOb)
 {
// exception handler for ExceptionType1
}
catch (ExceptionType2 exOb)
{
// exception handler for ExceptionType
}
// optional
finally {
// block of code to be executed after try block ends
}
```

throwing and catching exceptions

Catching Exceptions

A method catches an exception using a combination of the **try** and **catch** keywords. The program code that may generate an exception should be placed inside the try/catch block. The syntax for try/catch is depicted as below−

Syntax

```
try {
// Protected code
} catch (ExceptionName e1) {
// Catch block
}
```

The code which is prone to exceptions is placed in the try block. When an exception occurs, that exception is handled by catch block associated with it. Every try block should be immediately followed either by a catch block or finally block.

A catch statement involves declaring the type of exception that might be tried to catch. If an exception occurs, then the catch block (or blocks) which follow the try block is checked. If the type of exception that occurred is listed in a catch block, the exception is passed to the catch block similar to an argument that is passed into a method parameter.

To illustrate the try-catch blocks the following program is developed.

```
class Exception_example {
public static void main(String args[])
{
 int a,b;
try { // monitor a block of code. a
 = 0;
 b = 10 / a; //raises the arithmetic exception
System.out.println(“Try block.”);
}
 catch (ArithmeticException e)
{ // catch divide-by-zero error
System.out.println(“Division by zero.”);
 }
 System.out.println(“After try/catch block.”);
 }
 }
```

Output:

```
Division by zero.
After try/catch block.
```

Multiple catch clauses

In some cases, more than one exception could be raised by a single piece of code. To handle this multiple exceptions, two or more catch clauses can be specified. Here, each catch block catches different type of exception. When an exception is thrown, each catch statement is inspected in order, and the first one whose type matches that of the exception is executed. After one catch statement executes, the others are bypassed, and execution continues after the try/catch block. The following example traps two different exception types:

```
class MultiCatch_Example {
 public static void main(String args[]) {
try {
int a,b;
a = args.length;
System.out.println(“a = “ + a);
b = 10 / a; //may cause division-by-zero error
int arr[] = { 10,20 };
 c[5] =100;
```

```
        }
        catch(ArithmeticException e)
        {
System.out.println("Divide by 0: " + e);
}
         catch(ArrayIndexOutOfBoundsException e)
        {
         System.out.println("Array index oob: " +e);
        }
         System.out.println("After try/catch blocks.");
         }
         }
```

Here is the output generated by the execution of the program in both ways:

```
        C:\>java MultiCatch_

        Example a = 0
        Divide by 0: java.lang.ArithmeticException: / by zero
         After try/catch blocks.
        C:\>java MultiCatch_Example arg1
         a = 1
         Array index oob: java.lang.ArrayIndexOutOfBoundsException:5
        After try/catch blocks.
```

While the multiple catch statements is used, it is important to remember that exception subclasses must come before their superclasses. A catch statement which uses a superclass will catch exceptions of that type plus any of its subclasses. Thus, a subclass would never be reached if it came after its superclass. And also, in Java, unreachable code is an error. For example, consider the following program:

```
        class MultiCatch_Example {
         public static void main(String args[]) {
        try {
        int a,b;
        a = args.length;
        System.out.println("a = " + a);
        b = 10 / a; //may cause division-by-zero error
        int arr[] = { 10,20 };
         c[5] =100;
        }
```

```
catch(Exception e) { System.out.println("Generic
Exception catch.");
}
catch(ArithmeticException e)
{
System.out.println("Divide by 0: " + e);
}
 catch(ArrayIndexOutOfBoundsException e)
{
 System.out.println("Array index oob: " +e);
}
 System.out.println("After try/catch blocks.");
 }
 }
```

The exceptions such as ArithmeticException, and ArrayIndexOutOfBoundsException are the subclasses of Exception class. The catch statement after the base class catch statement is raising the unreachable code exception.

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.

```
try
{
   statement 1;
   statement 2;
   try
   {
      statement 1;
      statement 2;
   }
   catch(Exception e)
   {
   }
}
catch(Exception e)
{
}
```

....

The following program is an example for Nested try statements.

```
class Nestedtry_Example{
 public static void main(String args[]){
  try{
    try{
     System.out.println("division");
     int a,b;
     a=0;
     b =10/a;
    }
    catch(ArithmeticException e)
   {
   System.out.println(e);
  }
  try
  {
   int a[]=new int[5];
   a[6]=3;
   }
   catch(ArrayIndexOutOfBoundsException e)
   {
     System.out.println(e);
   }
   System.out.println("other statement);
  }
  catch(Exception e)
{
 System.out.println("handeled");}
 System.out.println("normal flow..");
 }
}
```

throw keyword

The Java throw keyword is used to explicitly throw an exception. The general form of throw is shown below:

```
throw ThrowableInstance;
```

Here, ThrowableInstance must be an object of type Throwable or a subclass of Throwable. Primitive types, such as int or char, as well as non-Throwable classes, such as String and Object, cannot be used as exceptions.

There are two ways to obtain a Throwable object:

1. using a parameter in a catch clause
2. creating one with the new operator.

The following program explains the use of throw keyword.

```
public class TestThrow1{
static void validate(int age){
try{
    if(age<18)
     throw new ArithmeticException("not valid");
    else
     System.out.println("welcome to vote");
  }
   Catch(ArithmeticException e)
 {
   System.out.println("Caught inside ArithmeticExceptions.");
  throw e; // rethrow the exception
 }
 }
  public static void main(String args[]){
try{
validate(13);
}
Catch(ArithmeticException e)
 {
   System.out.println("ReCaught ArithmeticExceptions.");
 }
}
}
```

The flow of execution stops immediately after the throw statement and any subsequent statements that are not executed. The nearest enclosing try block is inspected to see if it has a catch statement that matches the type of exception. If it does find a match, control is transferred to that statement. If not, then the next enclosing try statement is inspected, and so on. If no matching catch is found, then the default exception handler halts the program and prints the stack trace.

the throws/throw Keywords

If a method does not handle a checked exception, the method must be declared using the throws keyword. The throws keyword appears at the end of a method's signature.

The difference between throws and throw keywords is that, *throws* is used to postpone the handling of a checked exception and *throw* is used to invoke an exception explicitly.

The following method declares that it throws a Remote Exception –

Example

```
import java.io.*;
public class throw_Example1 {
public void function(int a) throws RemoteException {
// 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 ArithmeticException –

```
import java.io.*;
public class throw_Example2 {
public void function(int a) throws RemoteException,ArithmeticException {
// Method implementation
  }
 // Remainder of class definition
}
```

the Finally Block

The finally block follows a try block or a catch block. A finally block of code always executes, irrespective of the occurrence of an Exception. A finally block appears at the end of the catch blocks that follows the below syntax.

Syntax

```
try {
  // Protected code
} catch (ExceptionType1 e1) {
  // Catch block
} catch (ExceptionType2 e2) {
  // Catch block
}
finally {
  // The finally block always executes.
  }
```

Example

```
    public class Finally_Example {
      public static void main(String args[]) {
          try {
                int a,b;
             a=0;
            b=10/a;
          } catch (ArithmeticException e) {
          System.out.println("Exception thrown :" + e);
         }finally {
          System.out.println("The finally block is executed");
          }
         }
         }
```

READING AND WRITING FILES

In Java, all files are byte-oriented, and **Java provides methods to read and write bytes from and to a file.**

Two of the most often-used stream classes are FileInputStream and FileOutputStream, which create byte streams linked to files.

File input stream

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.

The two constructors which can be used to create a FileInputStream object:

i) Following constructor takes a file name as a string to create an input stream object to read the file:

InputStream f = new FileInputStream("filename ");

ii) 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);

Methods to read to stream or to do other operations on the stream

Method	Description
public void close() throws IOException{}	• Closes the file output stream. • Releases any system resources associated with the file. • Throws an IOException.
protected void finalize()throws IOException {}	• Ceans up the connection to the file. • Ensures that the close method of this file output stream is called when there are no morereferences to this stream. • Throws an IOException.
public int read(int r)throws IOException{}	• 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 the end of the file.
public int read(byte[] r) throws IOException{}	• Reads r.length bytes from the input stream into an array. • Returns the total number of bytes read. If it is the end of the file, -1 will be returned.
public int available() throws IOException{}	• Gives the number of bytes that can be read from this file input stream. • Returns an int.

File output stream

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.

The two constructors which can be used to create a FileOutputStream object:

i) Following constructor takes a file name as a string to create an input stream object to write the file:

OutputStream f = new FileOutputStream("filename");

ii) 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);

Methods to write to stream or to do other operations on the stream

Method	Description
public void close() throws IO-Exception{}	• Closes the file output stream. • Releases any system resources associated with the file. • Throws an IOException.
protected void finalize()throws IOException {}	• 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.
public void write(int w)throws IOException{}	• Writes the specified byte to the output stream.
public void write(byte[] w)	• Writes w.length bytes from the mentioned byte array to the OutputStream.

Following code demonstrates the use of 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("test.txt");
        for(int x = 0; x < bWrite.length ; x++)
       {
           os.write( bWrite[x] ); // writes the bytes
         }
         os.close();
         InputStream is = new FileInputStream("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 creates a file named test.txt and writes given numbers in binary format. The same will be displayed as output on the stdout screen.

Reading characters

The **read() method is used with BufferedReader object to read characters**. As this function returns integer type value has we need to use typecasting to convert it into char type.

Syntax:

int read() throws IOException

Example:

Read character from keyboard

```
import java.io.*;
class Main
{
 public static void main( String args[]) throws IOException
 {
  BufferedReader br = new BufferedReader(new InputStreamReader(System.in));
  char c;
  System.out.println("Enter characters, @ to quit");
  do{
     c = (char)br.read();     //Reading character
      System.out.println(c);
  }while(c!='@');
 }
}
```

Sample Output:

```
Enter characters, @ to quit
abcd23@
a b
c d
2
  3
  @
```

Example:

Read string from keyboard

The readLine() function with BufferedReader class's object is used to read string from keyboard.

Syntax:

String readLine() throws IOException

Example :

```
import java.io.*;
public class Main{
public static void main(String args[])throws Exception{
   InputStreamReader r=new InputStreamReader(System.in);
   BufferedReader br=new BufferedReader(r);
   System.out.println("Enter your name");
   String name=br.readLine();
   System.out.println("Welcome "+name);
}
}
```

Sample Output :

```
Enter your name
Priya

Welcome Priya
```

WRITING CONSOLE OUTPUT

- Console output is most easily accomplished with print( ) and println( ). These methods are defined by the class PrintStream (which is the type of object referenced by System. out).
- Since PrintStream is an output stream derived from OutputStream, it also implements the low-level method write( ).
- So, write( ) can be used to write to the console.

Syntax:

void write(int byteval)

This method writes to the stream the byte specified by byteval.

The following java program uses write( ) to output the character "A" followed by a new-line to the screen:

```
// Demonstrate System.out.write().
class WriteDemo
 {
public static void main(String args[])
{
 int b;
b = 'A';
System.out.write(b);
System.out.write('\n');
```

}

}

THE PRINT WRITER CLASS

- Although using System.outto write to the console is acceptable, its use is recommended mostly for debugging purposes or for sample programs.
- For real-world programs, the recommended method of writing to the console when using Java is through a PrintWriter stream.
- PrintWriter is one of the character-based classes.
- Using a character-based class for console output makes it easier to internationalize our program.
- PrintWriter defines several constructors.

Syntax:

PrintWriter(OutputStream outputStream, boolean flushOnNewline) Here,

- output Stream is an object of type OutputStream
- flushOnNewline controls whether Java flushes the output stream every time a println( ) method is called.
- If flushOnNewline is true, flushing automatically takes place. If false, flushing isnot automatic.
- PrintWriter supports the print( ) and println( ) methods for all types including Object.
- Thus, we can use these methods in the same way as they have been used with System. out.
- If an argument is not a simple type, the PrintWriter methods call the object's toString( ) method and then print the result.
- To write to the console by using a PrintWriter, specify System.out for the output stream and flush the stream after each newline.

For example, the following code creates a PrintWriter that is connected to console output:

PrintWriter pw = new PrintWriter(System.out, true);

The following application illustrates using a PrintWriter to handle console output:

```
// Demonstrate PrintWriter import
java.io.*;
public class PrintWriterDemo
{
 public static void main(String args[])
{
PrintWriter pw = new PrintWriter(System.out, true);
pw.println("This is a string");
 int i = -7;
pw.println(i); double
d = 4.5e-7;
pw.println(d);
 }
 }
```

Sample Output:

```
This is a string
-7
 4.5E-7
```

STACK TRACE ELEMENT

The **StackTraceElement class element represents a single stack frame which is a stack trace when an exception occurs**. Extracting stack trace from an exception could provide useful information such as class name, method name, file name, and the source-code line number. The getStackTrace() method of the Throwable class returns an array of StackTraceEle- ments.

stack traceElement class constructor

StackTraceElement(String declaringClass, String methodName, String fileName, int lineNumber)

This creates a stack trace element representing the specified execution point.

Stack Trace Element class methods

Method	Description
boolean equals(Object obj)	Returns true if the invoking StackTraceElement is the same as the one passed in obj. Otherwise, it returns false.
String getClassName()	Returns the class name of the execution point
String getFileName( )	Returns the filename of the execution point
int getLineNumber( )	Returns the source-code line number of the execution point
String getMethodName( )	Returns the method name of the execution point
String toString( )	Returns the String equivalent of the invoking sequence

Example:

```
public class StackTraceEx{
    public static void main(String[] args) {
     try{
            throw new RuntimeException(“go”); //raising an runtime exception
     }
    catch(Exception e){
            System.out.println(“Printing stack trace:”);
//create array of stack trace elements
final StackTraceElement[] stackTrace = e.getStackTrace();
 for (StackTraceElement s : stackTrace) {
    System.out.println(“\tat “ + s.getClassName() + “.” + s.getMethodName()
            + “(“ + s.getFileName() + “:” + s.getLineNumber() + “)”);
            }
    }
    }
}
```

Sample Output:

```
Printing stack trace:at StackTraceEx.main(StackTraceEx.java:5)
```

USER DEFINED EXCEPTION IN JAVA

Java allows the user **to create their own exception class** which is derived from built-in class Exception. The Exception class inherits all the methods from the class Throwable. The Throwable class is the superclass of all errors and exceptions in the Java language. It contains a snapshot of the execution stack of its thread at the time it was created. It can also contain a message string that gives more information about the error.

- The Exception class is defined in **java.lang package.**
- User defined exception class must inherit Exception class.
- The user defined exception can be thrown using throw keyword.

Syntax:

class User_defined_name extends Exception{

……….

}

Some of the methods defined by Throwable are shown in below table.

Methods	**Description**
Throwable fillInStackTrace( )	Fills in the execution stack trace and returns a Throwable object.
String getLocalizedMessage()	Returns a localized description of the exception.
String getMessage()	Returns a description of the exception.
void printStackTrace( )	Displays the stack trace.
String toString( )	Returns a String object containing a description of the Exception.
StackTraceElement[ ]get StackTrace( )	Returns an array that contains the stack trace, one element at a time, as an array of StackTraceEle- ment.

two commonly used constructors of Exception class are:

- Exception() - Constructs a new exception with null as its detail message.
- Exception(String message) - Constructs a new exception with the specified detail message.

Example:

```
//creating a user-defined exception class derived from Exception class
public class MyException extends Exception
{
public String toString(){            // overriding toString() method
   return "User-Defined Exception";
}
public static void main(String args[]){
```

```
            MyException obj= new MyException();
            try
            {
                    throw new MyException();    // customized exception is raised
        }
            catch(MyException e)
            {
             System.out.println("Exception handled - "+ e);
            }
    }
    }
```

Sample Output:

```
Exception handled - User-Defined Exception
```

In the above example, a custom defined exception class MyException is created by inher- iting it from Exception class. The toString() method is overridden to display the customized method on catch. The MyException is raised using the throw keyword.

Example:

Program to create user defined exception that test for odd numbers.

```
import java.util.Scanner;
class OddNumberException extends Exception
{
     OddNumberException()      //default constructor
     {
        super("Odd number exception");
     }
     OddNumberException(String msg) //parameterized constructor
     {
        super(msg);
     }
}
public class UserdefinedExceptionDemo{
     public static void main(String[] args)
     {
        int num;
        Scanner Sc = new Scanner(System.in); // create Scanner object to read
        input System.out.println("Enter a number : ");
        num = Integer.parseInt(Sc.nextLine());
        try
        {
          if(num%2 != 0) // test for odd number
            throw(new OddNumberException()); // raise the exception if number is odd
          else
             System.out.println(num + " is an even number");
        }
        catch(OddNumberException Ex)
        {
          System.out.print("\n\tError : " + Ex.getMessage());
        }
     }
     }
```

Sample Output1:

```
Enter a number : 11
Error : Odd number exception
```

Sample Output2:

```
10 is an even number
```

Odd Number Exception class is derived from the Exception class. To implement user defined exception we need to throw an exception object explicitly. In the above example, If the value of num variable is odd, then the throw keyword will raise the user defined exception and the catch block will get execute.