Exception Handling

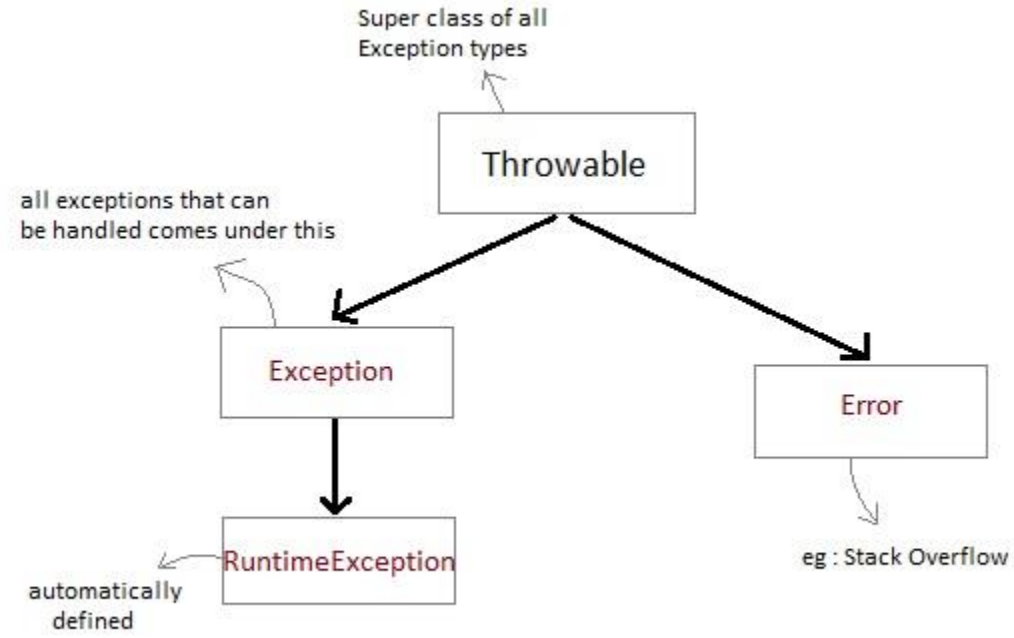
Exception Handling is the mechanism to handle runtime malfunctions. We need to handle such exceptions to prevent abrupt termination of program. The term exception means exceptional condition, it is a problem that may arise during the execution of program. A bunch of things can lead to exceptions, including programmer error, hardware failures, files that need to be opened cannot be found, resource exhaustion etc.

Exception

A Java Exception is an object that describes the exception that occurs in a program. When an exceptional events occurs in java, an exception is said to be thrown. The code that's responsible for doing something about the exception is called an **exception handler**.

Exception class Hierarchy

All exception types are subclasses of class **Throwable**, which is at the top of exception class hierarchy.



- **Exception** class is for exceptional conditions that program should catch. This class is extended to create user specific exception classes.
- **RuntimeException** is a subclass of Exception. Exceptions under this class are automatically defined for programs.

Exception are categorized into 3 category.

- **Checked Exception**

  The exception that can be predicted by the programmer.*Example :* File that need to be opened is not found. These type of exceptions must be checked at compile time.

- **Unchecked Exception**

  Unchecked exceptions are the class that extends RuntimeException. Unchecked exception are ignored at compile time. *Example :* ArithmeticException, NullPointerException, Array Index out of Bound exception. Unchecked exceptions are checked at runtime.

- **Error**

  Errors are typically ignored in code because you can rarely do anything about an error. *Example :* if stack overflow occurs, an error will arise. This type of error is not possible handle in code.

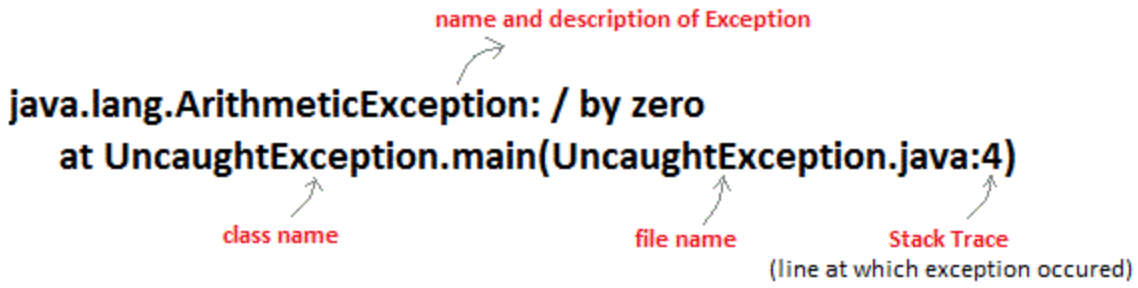
Uncaught Exceptions

When we don't handle the exceptions, they lead to unexpected program termination. Lets take an example for better understanding.

```
class UncaughtException

{

 public static void main(String args[])

 {

  int a = 0;
```

```
  int b = 7/a;     // Divide by zero, will lead to exception
 }
}
```

This will lead to an exception at runtime, hence the Java run-time system will construct an exception and then throw it. As we don't have any mechanism for handling exception in the above program, hence the default handler will handle the exception and will print the details of the exception on the terminal.



Exception Handling Mechanism

In java, exception handling is done using five keywords,

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

Exception handling is done by transferring the execution of a program to an appropriate exception handler when exception occurs.

Using try and catch

Try is used to guard a block of code in which exception may occur. This block of code is called guarded region. A catch statement involves declaring the type of exception you are trying to catch. If an exception occurs in guarded code, the catch block that follows the try is checked, if the type of

exception that occured is listed in the catch block then the exception is handed over to the catch block which then handles it.

Example using Try and catch

```
class Excp

{

 public static void main(String args[])

 {

  int a,b,c;

  try

  {

   a=0;

   b=10;

   c=b/a;

   System.out.println("This line will not be executed");

  }

  catch(ArithmeticException e)

  {

   System.out.println("Divided by zero");

  }

  System.out.println("After exception is handled");

 }

}
```

output:

```
Divided by zero

After exception is handled
```

An exception will thrown by this program as we are trying to divide a number by zero inside **try** block. The program control is transfered outside **try** block. Thus the line "*This line will not be executed*" is never parsed by the compiler. The exception thrown is handle in **catch** block. Once

the exception is handled the program controls continue with the next line in the program. Thus the line "*After exception is handled*" is printed.

Multiple catch blocks:

A try block can be followed by multiple catch blocks. You can have any number of catch blocks after a single try block.If an exception occurs in the guarded code the exception is passed to the first catch block in the list. If the exception type of exception, matches with the first catch block it gets caught, if not the exception is passed down to the next catch block. This continue until the exception is caught or falls through all catches.

Example for Multiple Catch blocks

```
class Excep
{
 public static void main(String[] args)
 {
  try
  {
   int arr[]={1,2};
   arr[2]=3/0;
  }
  catch(ArithmeticException ae)
  {
   System.out.println("divide by zero");
  }
  catch(ArrayIndexOutOfBoundsException e)
  {
   System.out.println("array index out of bound exception");
  }
 }
```

```
}
```

Output:

```
divide by zero
```

Example for Unreachable Catch block

While using multiple **catch** statements, it is important to remember that exception sub classes inside **catch**must come before any of their super classes otherwise it will lead to compile time error.

```
class Excep
{
 public static void main(String[] args)
 {
  try
  {
   int arr[]={1,2};
   arr[2]=3/0;
  }
  catch(Exception e)    //This block handles all Exception
  {
   System.out.println("Generic exception");
  }
  catch(ArrayIndexOutOfBoundsException e)    //This block is unreachable
  {
   System.out.println("array index out of bound exception");
  }
 }
}
```

Nested try statement

try statement can be **nested** inside another block of **try**. Nested try block is used when a part of a block may cause one error while entire block may cause another error. In case if inner **try** block does not have a **catch**handler for a particular exception then the outer **try** is checked for match.

```
class Excep
{
 public static void main(String[] args)
 {
  try
  {
   int arr[]={5,0,1,2};
   try
   {
    int x=arr[3]/arr[1];
   }
   catch(ArithmeticException ae)
   {
    System.out.println("divide by zero");
   }
   arr[4]=3;
  }
  catch(ArrayIndexOutOfBoundsException e)
  {
   System.out.println("array index out of bound exception");
  }
 }
}
```

Important points to Remember

1. If you do not explicitly use the try catch blocks in your program, java will provide a default exception handler, which will print the exception details on the terminal, whenever exception occurs.
2. Super class **Throwable** overrides **toString()** function, to display error message in form of string.
3. While using multiple catch block, always make sure that exception subclasses comes before any of their super classes. Else you will get compile time error.
4. In nested try catch, the inner try block, uses its own catch block as well as catch block of the outer try, if required.
5. Only the object of Throwable class or its subclasses can be thrown.

Try with Resource Statement

JDK 7 introduces a new version of try statement known as **try-with-resources statement**. This feature add another way to exception handling with resources management,it is also referred to as **automatic resource management**.

Syntax

```
try(resource-specification)
{
//use the resource
}catch()
{...}
```

This **try statement** contains a paranthesis in which one or more resources is declare. Any object that implements `java.lang.AutoCloseable` or `java.io.Closeable`, can be passed as a parameter to **try statement**. A resource is an object that is used in program and must be closed after the program is finished. The **try-with-resources statement** ensures that each resource is closed at the end of the statement, you do not have to explicitly close the resources.

Example without using *try* with Resource Statement

```
import java.io.*;
class Test
{
public static void main(String[] args)
{
try{
String str;
//opening file in read mode using BufferedReader stream
BufferedReader br=new BufferedReader(new FileReader("d:\\myfile.txt"));
while((str=br.readLine())!=null)
 {
System.out.println(str);
 }
br.close();     //closing BufferedReader stream
}catch(IOException ie)
{  System.out.println("exception");  }
 }
}
```

Example using *try* with Resource Statement

```
import java.io.*;
class Test
{
public static void main(String[] args)
{
try(BufferedReader br=new BufferedReader(new FileReader("d:\\myfile.txt")))
{
```

```
String str;
while((str=br.readLine())!=null)
{
System.out.println(str);
}
}catch(IOException ie)
{  System.out.println("exception");  }
}
}
```

NOTE: In the above example, we do not need to explicitly call `close()` method to close **BufferedReader stream.**

throw Keyword

throw keyword is used to throw an exception explicitly. Only object of Throwable class or its sub classes can be thrown. Program execution stops on encountering **throw** statement, and the closest catch statement is checked for matching type of exception.

Syntax :

```
throw ThrowableInstance
```

Creating Instance of Throwable class

There are two possible ways to get an instance of class Throwable,

1. Using a parameter in catch block.
2. Creating instance with **new** operator.

```
3. new NullPointerException("test");
```

   This constructs an instance of NullPointerException with name test.

Example demonstrating throw Keyword

```
class Test
{
 static void avg()
 {
  try
  {
   throw new ArithmeticException("demo");
  }
  catch(ArithmeticException e)
  {
   System.out.println("Exception caught");
  }
 }

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

In the above example the avg() method throw an instance of ArithmeticException, which is successfully handled using the catch statement.

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throws Keyword

Any method capable of causing exceptions must list all the exceptions possible during its execution, so that anyone calling that method gets a prior knowledge about which exceptions to handle. A method can do so by using the **throws** keyword.

Syntax :

```
type method_name(parameter_list) throws exception_list
{
 //definition of method
}
```

NOTE : It is necessary for all exceptions, except the exceptions of type **Error** and **RuntimeException**, or any of their subclass.

Example demonstrating throws Keyword

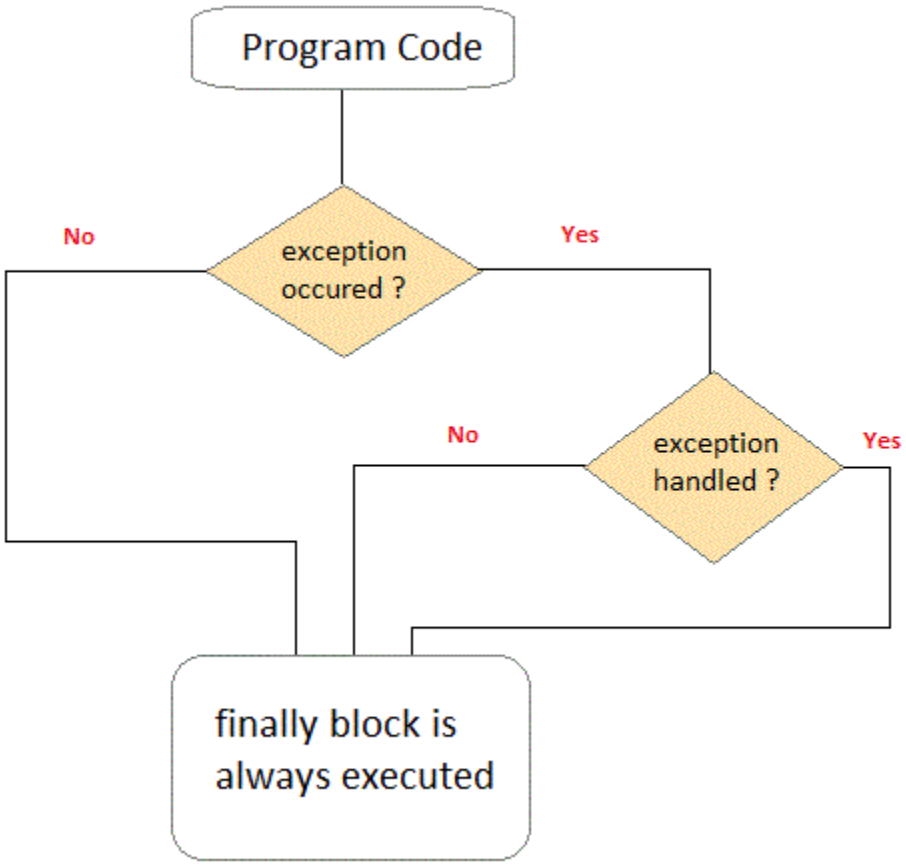
```
class Test
{
 static void check() throws ArithmeticException
 {
  System.out.println("Inside check function");
  throw new ArithmeticException("demo");
 }

 public static void main(String args[])
 {
  try
  {
   check();
  }
  catch(ArithmeticException e)
  {
   System.out.println("caught" + e);
  }
 }
```

```
}
```

---

finally clause

A finally keyword is used to create a block of code that follows a try block. A finally block of code always executes whether or not exception has occurred. Using a finally block, lets you run any cleanup type statements that you want to execute, no matter what happens in the protected code. A finally block appears at the end of catch block.



Example demonstrating finally Clause

```
Class ExceptionTest
{
 public static void main(String[] args)
 {
  int a[]= new int[2];
```

```
  System.out.println("out of try");
  try
  {
   System.out.println("Access invalid element"+ a[3]);
   /* the above statement will throw ArrayIndexOutOfBoundException */
  }
  finally
  {
   System.out.println("finally is always executed.");
  }
 }
}
```

Output:

```
Out of try
finally is always executed.
Exception in thread main java. Lang. exception array Index out of bound exception
.
```

You can see in above example even if exception is thrown by the program, which is not handled by catch block, still finally block will get executed.

User defined Exception subclass

You can also create your own exception sub class simply by extending java **Exception** class. You can define a constructor for your Exception sub class (not compulsory) and you can override the **toString()** function to display your customized message on catch.

```
class MyException extends Exception
{
 private int ex;
 MyException(int a)
 {
  ex=a;
```

```
 }
 public String toString()
 {
  return "MyException[" + ex +"] is less than zero";
 }
}

class Test
{
 static void sum(int a,int b) throws MyException
 {
  if(a<0)
  {
   throw new MyException(a);
  }
  else
  {
   System.out.println(a+b);
  }
 }

 public static void main(String[] args)
 {
  try
  {
   sum(-10, 10);
  }
  catch(MyException me)
  {
```

```
   System.out.println(me);
  }
 }
}
```

Points to Remember

1. Extend the Exception class to create your own ecxeption class.
2. You don't have to implement anything inside it, no methods are required.
3. You can have a Constructor if you want.
4. You can override the toString() function, to display customized message.

Method Overriding with Exception Handling

There are few things to remember when overriding a method with exception handling. If super class method does not declare any exception, then sub class overriden method cannot declare checked exception but it can declare unchecked exceptions.

Example of Subclass overriden Method declaring Checked Exception

```
import java.io.*;
class Super
{
 void show() { System.out.println("parent class"); }
}

public class Sub extends Super
{
 void show() throws IOException         //Compile time error
```

```
  { System.out.println("parent class"); }


 public static void main( String[] args )
 {
  Super s=new Sub();
  s.show();
 }
}
```

As the method **show()** doesn't throws any exception while in Super class, hence its overriden version can also not throw any checked exception.

Example of Subclass overriden Method declaring Unchecked Exception

```
import java.io.*;
class Super
{
 void show(){ System.out.println("parent class"); }
}


public class Sub extends Super
{
 void show() throws ArrayIndexOutOfBoundsException      //Correct
   { System.out.println("child class"); }


 public static void main(String[] args)
 {
  Super s=new Sub();
  s.show();
 }
```

```
}
```

```
Output : child class
```

Because *ArrayIndexOutOfBoundsException* is an unchecked exception hence, overrided **show()** method can throw it.

More about Overriden Methods and Exceptions

If Super class method throws an exception, then Subclass overriden method can throw the same exception or no exception, but must not throw parent exception of the exception thrown by Super class method.

It means, if Super class method throws object of **NullPointerException** class, then Subclass method can either throw same exception, or can throw no exception, but it can never throw object of **Exception** class (parent of NullPointerException class).

Example of Subclass overriden method with same Exception

```
import java.io.*;

class Super

{

 void show() throws Exception

  {  System.out.println("parent class");  }

}


public class Sub extends Super {

 void show() throws Exception           //Correct

   { System.out.println("child class"); }


 public static void main(String[] args)

 {

  try {
```

```
   Super s=new Sub();
   s.show();
   }
  catch(Exception e){}
 }
}
```

Output : child class

Example of Subclass overriden method with no Exception

```
import java.io.*;
class Super
{
 void show() throws Exception
  {  System.out.println("parent class");  }
}


public class Sub extends Super {
 void show()                              //Correct
   { System.out.println("child class"); }


 public static void main(String[] args)
 {
  try {
   Super s=new Sub();
   s.show();
   }
  catch(Exception e){}
 }
```

```
}
```

```
Output : child class
```

Example of Subclass overriden method with parent Exception

```
import java.io.*;
class Super
{
 void show() throws ArithmeticException
  {  System.out.println("parent class");  }
}

public class Sub extends Super {
 void show() throws Exception                    //Cmpile time Error
   { System.out.println("child class"); }

 public static void main(String[] args)
 {
  try {
   Super s=new Sub();
   s.show();
   }
  catch(Exception e){}
 }
}
```

Chained Exception

Chained Exception was added to Java in JDK 1.4. This feature allow you 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.

Two new constructors and two methods were added to **Throwable** class to support chained exception.

1. **Throwable**(*Throwable cause*)
2. **Throwable**(*String str*, *Throwable cause*)

In the first form, the paramter **cause** specifies the actual cause of exception. In the second form, it allows us to add an exception description in string form with the actual cause of exception.

getCause() and **initCause()** are the two methods added to **Throwable** class.

- **getCause()** method returns the actual cause associated with current exception.
- **initCause()** set an underlying cause(exception) with invoking 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());
  }
 }
}
```

output

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