Exception Handling in Java

The **exception handling in java** is one of the powerful *mechanism to handle the runtime errors* so that normal flow of the application can be maintained.

In this page, we will learn about java exception, its type and the difference between checked and unchecked exceptions.

What is exception

Dictionary Meaning: Exception is an abnormal condition.

In java, 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 ClassNotFound, IO, SQL, Remote etc.

Advantage of Exception Handling

The core advantage of exception handling is **to maintain the normal flow of the application**. Exception normally disrupts the normal flow of the application that is why we use exception handling. Let's take a scenario:

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

statement 9;

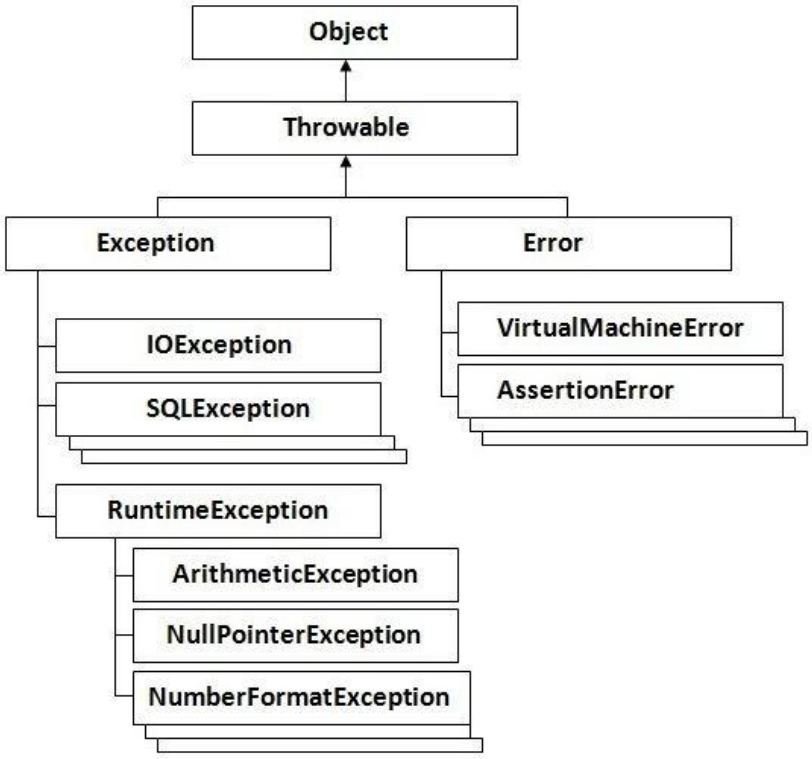
statement 10;

Suppose there is 10 statements in your program and there occurs an exception at statement 5, rest of the code will not be executed i.e. statement 6 to 10 will not run. If we perform exception handling, rest of the statement will be executed. That is why we use exception handling in java.

Assignment Questions:

- What is the difference between checked and unchecked exceptions ?
- What happens behind the code int data=50/0; ?
- Why use multiple catch block ?
- Is there any possibility when finally block is not executed ?
- What is exception propagation ?
- What is the difference between throw and throws keyword ?
- What are the 4 rules for using exception handling with method overriding ?

Hierarchy of Java Exception classes



Types of Exception

There are mainly two types of exceptions: checked and unchecked where error is considered as unchecked exception. The sun micro-system says there are three types of exceptions:

1. Checked Exception
2. Unchecked Exception
3. Error

Difference between checked and unchecked exceptions

1) Checked Exception

The classes that extend Throwable class except RuntimeException and Error are known as checked exceptions e.g.IOException, SQLException etc. Checked exceptions are checked at compile-time.

2) Unchecked Exception

The classes that extend RuntimeException are known as unchecked exceptions e.g. ArithmeticException, NullPointerException, ArrayIndexOutOfBoundsException etc. Unchecked exceptions are not checked at compile-time rather they are checked at runtime.

3) Error

Error is irrecoverable e.g. OutOfMemoryError, VirtualMachineError, AssertionError etc.

Common scenarios where exceptions may occur

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

1) Scenario where ArithmeticException occurs

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

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

2) Scenario where NullPointerException occurs

If we have null value in any variable, performing any operation by the variable occurs an NullPointerException.

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

3) Scenario where NumberFormatException occurs

The wrong formatting of any value, may occur NumberFormatException. Suppose I have a string variable that have characters, converting this variable into digit will occur NumberFormatException.

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

4) Scenario where ArrayIndexOutOfBoundsException occurs

If you are inserting any value in the wrong index, it would result ArrayIndexOutOfBoundsException as shown below:

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

Java Exception Handling Keywords

There are 5 keywords used in java exception handling.

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

Java try-catch

Java try block:

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

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

Syntax of java try-catch

```
try{
//code that may throw exception
}catch(Exception_class_Name ref){}
```

Syntax of try-finally block

```
try{
//code that may throw exception
}finally{}
```

Java catch block:

Java catch block is used to handle the Exception. It must be used after the try block only.

You can use multiple catch block with a single try.

Problem without exception handling

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

```
public class Testtrycatch1{
 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

As displayed in the above example, rest of the code is not executed (in such case, rest of the code... statement is not printed).

There can be 100 lines of code after exception. So all the code after exception will not be executed.

Solution by exception handling

Let's see the solution of above problem by java try-catch block.

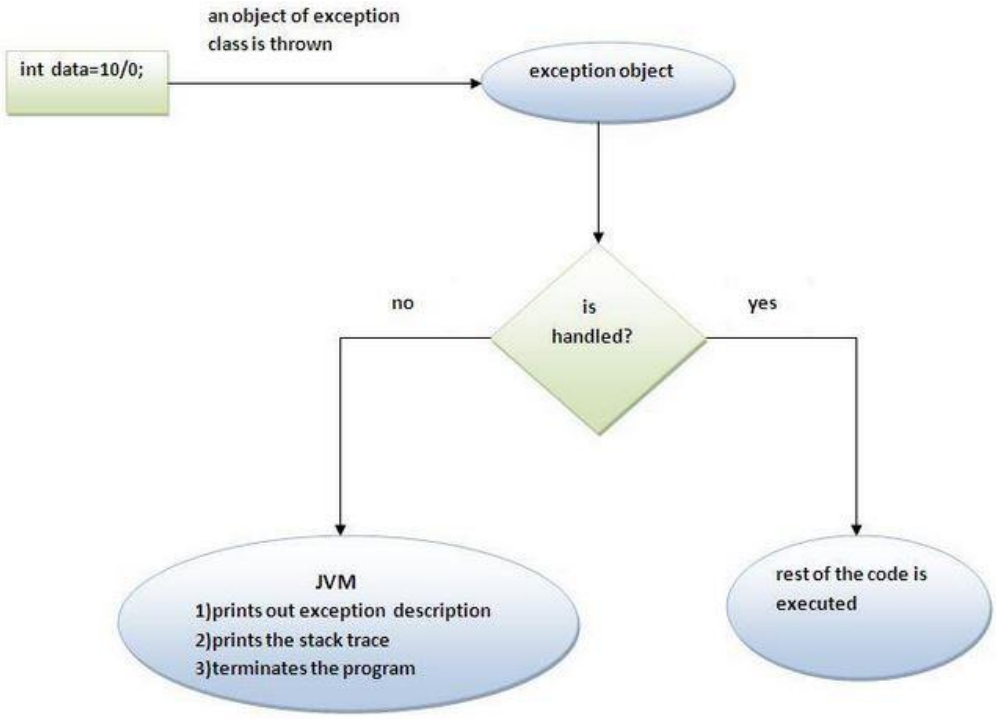
```
public class Testtrycatch2{
 public static void main(String args[]){
  try{
    int data=50/0;
  }catch(ArithmeticException e){System.out.println(e);}
  System.out.println("rest of the code...");
}
}
```

Output:

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

Now, as displayed in the above example, rest of the code is executed i.e. rest of the code... statement is printed.

Internal working of java try-catch block



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.

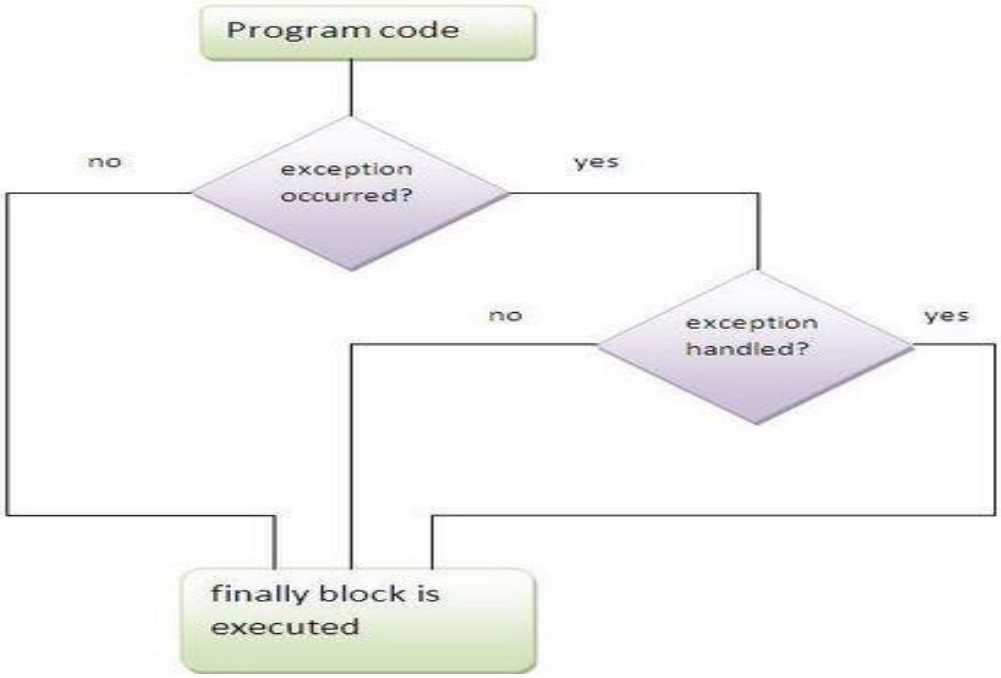
But if exception is handled by the application programmer, normal flow of the application is maintained i.e. rest of the code is executed.

Java finally block

Java finally block is a block that is used *to execute important code* such as closing connection, stream etc.

Java finally block is always executed whether exception is handled or not.

Java finally block follows try or catch block.



Why use java finally

- Finally block in java can be used to put "cleanup" code such as closing a file, closing connection etc.

Usage of Java finally

Let's see the different cases where java finally block can be used.

Case 1

Let's see the java finally example where exception doesn't occur.

```
class TestFinallyBlock{
 public static void main(String args[]){
 try{
  int data=25/5;
  System.out.println(data);
 }
 catch(NullPointerException e){System.out.println(e);}
 finally{System.out.println("finally block is always executed");}
 System.out.println("rest of the code...");
 }
}
```

Output:5

```
finally block is always executed
rest of the code...
```

Case 2

Let's see the java finally example where **exception occurs and not handled**.

```
class TestFinallyBlock1{
 public static void main(String args[]){
 try{
  int data=25/0;
  System.out.println(data);
 }
 catch(NullPointerException e){System.out.println(e);}
 finally{System.out.println("finally block is always executed");}
```

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

Output: finally block is always executed

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

Case 3

Let's see the java finally example where **exception occurs and handled**.

```
 public class TestFinallyBlock2{
  public static void main(String args[]){
  try{
   int data=25/0;
   System.out.println(data);
  }
  catch(ArithmeticException e){System.out.println(e);}
  finally{System.out.println("finally block is always executed");}
  System.out.println("rest of the code...");
  }
 }
```

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

finally block is always executed

rest of the code...

Difference between final, finally and finalize

Sl. No	final	finally	finalize
1	Final is used to apply restrictions on class, method and variable. Final class can't be inherited, final method can't be overridden and final variable value can't be changed.	Finally is used to place important code, it will be executed whether exception is handled or not.	Finalize is used to perform clean up processing just before object is garbage collected.
2	Final is a keyword.	Finally is a block.	Finalize is a method.

Java final example

```
class FinalExample{
public static void main(String[] args){
final int x=100;
x=200;//Compile Time Error
}}
```

Java finally example

```
class FinallyExample{
public static void main(String[] args){
try{
int x=300;
```

```
}catch(Exception e){System.out.println(e);}
finally{System.out.println("finally block is executed");}
}}
```

Java finalize example

```
class FinalizeExample{
public void finalize(){System.out.println("finalize called");}
public static void main(String[] args){
FinalizeExample f1=new FinalizeExample();
FinalizeExample f2=new FinalizeExample();
f1=null;
f2=null;
System.gc();
}}
```

Java throw exception

Java throw keyword

The Java throw keyword is used to explicitly throw an exception.

We can throw either checked or uncheked exception in java by throw keyword. The throw keyword is mainly used to throw custom exception. We will see custom exceptions later.

The syntax of java throw keyword is given below.

```
throw exception;
```

java throw keyword example

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.

```
public class TestThrow1{
  static void validate(int age){
    if(age<18)
     throw new ArithmeticException("not valid");
    else
     System.out.println("welcome to vote");
  }
  public static void main(String args[]){
    validate(13);
    System.out.println("rest of the code...");
 }
}
```

Output: Exception in thread main java.lang.ArithmeticException:not valid

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 normal flow 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 performing check up before the code 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 your control so correct your code.
- **error:** beyond your control e.g. you 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

Let's see the example of java throws clause which describes that checked exceptions can be propagated by throws keyword.

```
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...");
 }
}
```

Output: exception handled normal flow..

Rule: If we are calling a method that declares an exception, we must either caught or declare the exception.

There are two cases:

1. **Case1:**You caught the exception i.e. handle the exception using try/catch.
2. **Case2:**You declare the exception i.e. specifying throws with the method.

Case1: You handle the exception

- In case you handle the exception, the code will be executed fine whether exception occurs during the program or not.

```
import java.io.*;
class M{
 void method()throws IOException{
  throw new IOException("device error");
 }
}
public class Testthrows2{
   public static void main(String args[]){
    try{
     M m=new M();
     m.method();
    }catch(Exception e){System.out.println("exception handled");}

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

Output: exception handled normal flow...

Case2: You declare the exception

- In case you declare the exception, if exception does not occur, the code will be executed fine.
- In case you declare the exception if exception occures, an exception will be thrown at runtime because throws does not handle the exception.

A) Program if exception does not occur

```
import java.io.*;
class M{
 void method()throws IOException{
  System.out.println("device operation performed");
 }
}
class Testthrows3{
  public static void main(String args[])throws IOException{//declare exception
    M m=new M();
    m.method();

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

Output: device operation performed normal flow...

B) Program if exception occurs

```
import java.io.*;
class M{
 void method()throws IOException
{
   throw new IOException("device error");
```

```
 }
}
class Testthrows4{
  public static void main(String args[])throws IOException{//declare exception
    M m=new M();
    m.method();

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

Output: Runtime Exception

Difference between throw and throws in Java

There are many differences between throw and throws keywords. A list of differences between throw and throws are given below:

SI. No	Throw	Throws
1	Java throw keyword is used to explicitly throw an exception.	Java throws keyword is used to declare an exception.
2	Checked exception cannot be propagated using throw only.	Checked exception can be propagated with throws.
3	Throw is followed by an instance.	Throws is followed by class.
4	Throw is used within the method.	Throws is used with the method signature.
5	You cannot throw multiple exceptions.	You can declare multiple exceptions e.g. public void method()throws IOException,SQLException

Custom Exception

If you are creating your own Exception that is known as custom exception or user-defined exception. Java custom exceptions are used to customize the exception according to user need.

By the help of custom exception, you can have your own exception and message.

Let's see a simple example of java custom exception.

```
  class InvalidAgeException extends Exception{
   InvalidAgeException(String s){
    super(s);
   }
  }

class TestCustomException1{
   static void validate(int age)throws InvalidAgeException{
   if(age<18)
    throw new InvalidAgeException("not valid");
   else
    System.out.println("welcome to vote");
 }
    public static void main(String args[]){
    try{
    validate(13);
    }catch(Exception m){System.out.println("Exception occured: "+m);}

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

```
}
```

Output: Exception occured: InvalidAgeException:not valid rest of the code...

Exception Handling with Method Overriding in Java

There are many rules if we talk about methodoverriding with exception handling. The Rules are as follows:

- **If the superclass method does not declare an exception**
  - If the superclass method does not declare an exception, subclass overridden method cannot declare the checked exception but it can declare unchecked exception.
- **If the superclass method declares an exception**
  - If the superclass method declares an exception, subclass overridden method can declare same, subclass exception or no exception but cannot declare parent exception.

1) Rule: If the superclass method does not declare an exception, subclass overridden method cannot declare the checked exception.

If the superclass method does not declare an exception

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

class TestExceptionChild extends Parent{
 void msg()throws IOException{
  System.out.println("TestExceptionChild");
 }
 public static void main(String args[]){
```

```
    Parent p=new TestExceptionChild();
    p.msg();
   }
  }
```

Output: Compile Time Error

2) Rule: If the superclass method does not declare an exception, subclass overridden method cannot declare the checked exception but can declare unchecked exception.

```
  import java.io.*;
  class Parent{
   void msg(){System.out.println("parent");}
  }
   class TestExceptionChild1 extends Parent{
    void msg()throws ArithmeticException{
     System.out.println("child");
    }
    public static void main(String args[]){
     Parent p=new TestExceptionChild1();
     p.msg();
    }
  }
```

Output: child

If the superclass method declares an exception

1) Rule: If the superclass method declares an exception, subclass overridden method can declare same, subclass exception or no exception but cannot declare parent exception.

Example in case subclass overridden method declares parent exception

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

class TestExceptionChild2 extends Parent{
 void msg()throws Exception{System.out.println("child");}

 public static void main(String args[]){
  Parent p=new TestExceptionChild2();
  try{
  p.msg();
  }catch(Exception e){}
 }
}
```

Output: Compile Time Error

Example in case subclass overridden method declares same exception

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

class TestExceptionChild3 extends Parent{
 void msg()throws Exception{System.out.println("child");}

 public static void main(String args[]){
  Parent p=new TestExceptionChild3();
  try{
  p.msg();
  }catch(Exception e){}
 }
}
```

Output: child

Example in case subclass overridden method declares subclass exception

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

class TestExceptionChild4 extends Parent{
 void msg()throws ArithmeticException{System.out.println("child");
}
```

```
    public static void main(String args[])
    {
              Parent p=new TestExceptionChild4();
             try{
             p.msg();
            }
            catch(Exception e){
            }
 }
}                                        Output: child
```

Example in case subclass overridden method declares no exception

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

class TestExceptionChild5 extends Parent
    {
        void msg()
        {
        System.out.println("child");
    }

 public static void main(String args[])
    {
        Parent p=new TestExceptionChild5();
```

```
            try{
             p.msg();
            }
        catch(Exception e){
        }
  }
}
```

Output: child