EXCEPTION HANDLING

Agenda

1. Introduction to Exception Handling.
2. Runtime stack mechanism
3. Default exception handling in java

Introduction

Exception: An unwanted unexpected event that disturbs normal flow of the program is called exception.

Example:
SleepingException
TyrePunchuredException
FileNotFoundException ...etc

- It is highly recommended to handle exceptions. The main objective of exception handling is graceful (normal) termination of the program.

What is the meaning of exception handling?

Exception handling doesn't mean repairing an exception. We have to define alternative way to continue rest of the program normally this way of "defining alternative is nothing but exception handling".

Example: Suppose our programming requirement is to read data from remote file locating at London at runtime if London file is not available our program should not be terminated abnormally.

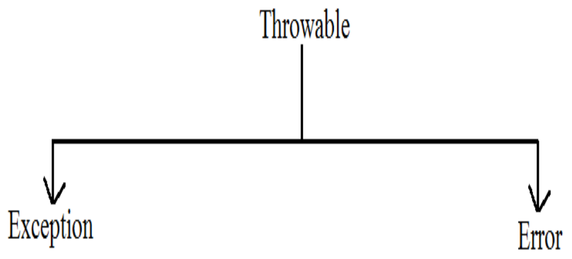
We have to provide a local file to continue rest of the program normally. This way of defining alternative is nothing but exception handling.

```
Example:

try
{
       read data from london file
}
catch(FileNotFoundException e)
{
       use local file and continue rest of the program normally
}
...
```

Exception hierarchy:

- Throwable acts as a root for exception hierarchy.
- Throwable class contains the following two child classes.



1) Exception: Most of the cases, exceptions are caused by our program and these are recoverable.
Ex :
If FileNotFoundException occurs, we can use local file and we can continue rest of the program execution normally.

2) Error: Most of the cases, errors are not caused by our program.
These are due to lack of system resources and these are non recoverable.
Ex :
If OutOfMemoryError occurs being a programmer, we can't do anything the program will be terminated abnormally.

System Admin or Server Admin is responsible to raise/increase heap memory.

Checked Vs Unchecked Exceptions:

➔The exceptions which are checked by the compiler for smooth execution of the program at runtime are called checked exceptions.

1. HallTicketMissingException
2. PenNotWorkingException
3. FileNotFoundException

➔The exceptions which are not checked by the compiler are called unchecked exceptions.

1. BombBlaustException
2. ArithmeticException
3. NullPointerException

Note: RuntimeException and its child classes, Error and its child classes are unchecked and all the remaining are considered as checked exceptions.

Note: Whether exception is checked or unchecked compulsory it should occur at runtime only there is no chance of occurring any exception at compile time.

Partially checked vs fully checked :

➔A checked exception is said to be fully checked, if and only if all its child classes are also checked.
Example:
1) IOException
2) InterruptedException

➔A checked exception is said to be partially checked, if and only if some of its child classes are unchecked.

Example:
Exception

Note: The only partially checked exceptions available in java are:

1. Throwable.
2. Exception.

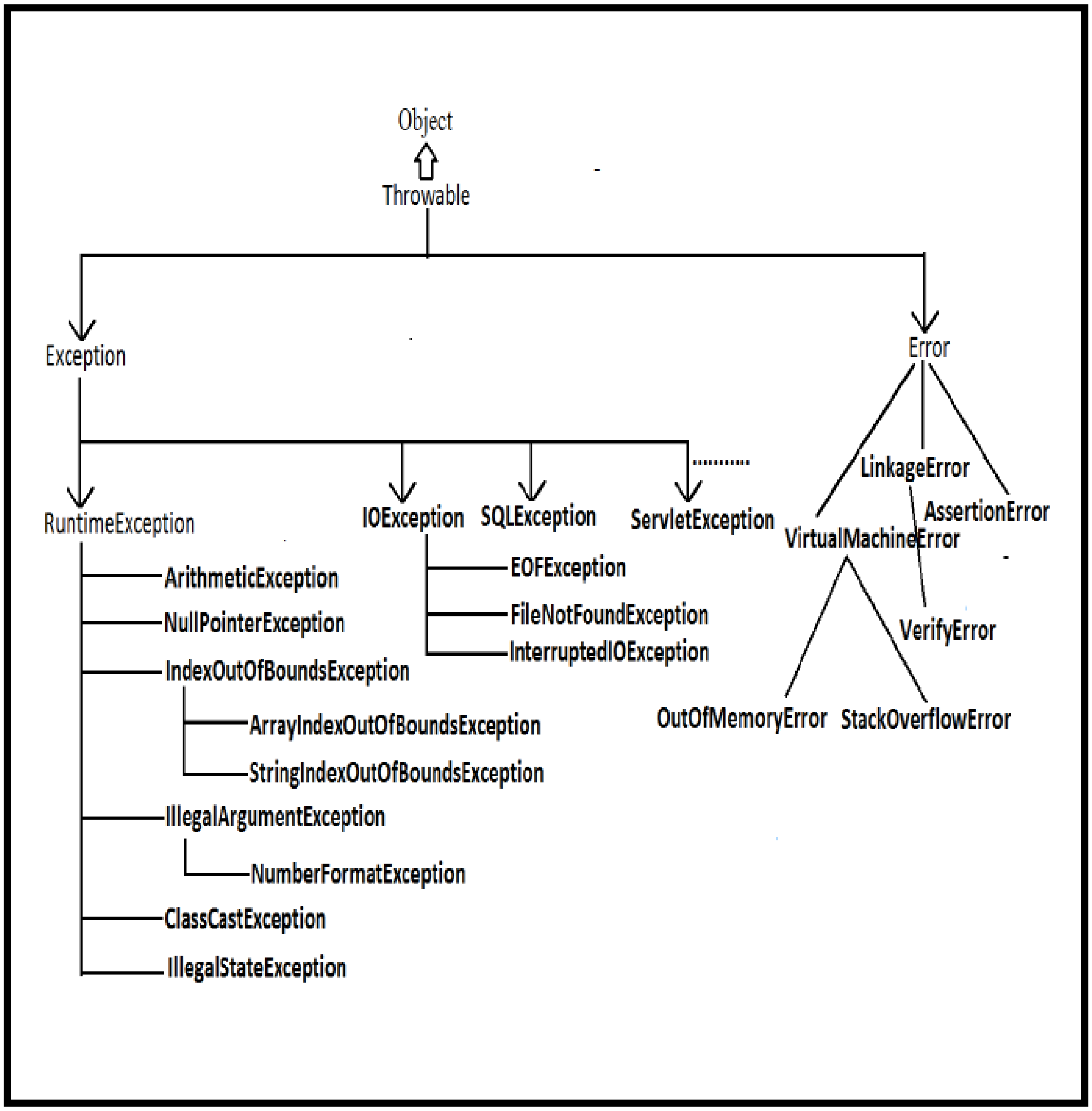


Figure: Exception Hierarchy

Q: Describe behavior of following exceptions ?

1. RuntimeException-----------unchecked
2. Error---------------------------unchecked
3. IOException------------------fully checked
4. Exception---------------------partially checked
5. InterruptedException--------fully checked
6. Throwable--------------------partially checked
7. ArithmeticException -------unchecked
8. NullPointerException ------ unchecked
9. FileNotFoundException ----fully checked

Exception Handling

Agenda

1. **Customized exception handling by try catch**
2. **Control flow in try catch**
3. **Try with multiple catch blocks**
4. **Finally**
5. **Difference between final, finally, finalize**
6. **Control flow in try catch finally**
7. **Control flow in nested try catch finally**
8. **Various possible combinations of try catch finally**

1.Customized exception handling by try catch:

- It is highly recommended to handle exceptions.
- In our program the code which may cause an exception is called risky code, we have to place risky code inside try block and the corresponding handling code inside catch block.

```
Example:

try
{
        risky code
}
catch(Exception e)
{
        handling code
}
```

Without try catch	With try catch

```
class Test
{
    psvm(String[] args)
   {
       S.o.p("statement1");
       S.o.p(10/0);
       S.o.p("statement3");
    }
}
output:
statement1
RE:AE:/by zero
at Test.main()
```
	```
	class Test
	{
	psvm(String[] args)
	{
	    S.o.p("statement1");
	    try
	    {
	        S.o.p(10/0);
	    }
	    catch(ArithmeticException e)
	    {
	        S.o.p(10/2);
	    }
	```

Abnormal termination.	`S.o.p("statement3");`
	`}`
	`}`
	`Output:`
	`statement1`
	`5`
	`statement3`
	
	`Normal termination.`

2.Control flow in try catch:

```
try
{
        statement1;
        statement2;
        statement3;
}
catch(X e)
{
        statement4;
}
statement5;
```

- **Case 1:** There is no exception.
  1, 2, 3, 5 normal termination.
- **Case 2:** if an exception raised at statement 2 and corresponding catch block matched 1, 4, 5 normal termination.
- **Case 3**: if an exception raised at statement 2 but the corresponding catch block not matched , 1 followed by abnormal termination.
- **Case 4:** if an exception raised at statement 4 or statement 5 then it's always abnormal termination of the program.

Note:

1. Within the try block if anywhere an exception raised then rest of the try block won't be executed even though we handled that exception. Hence we have to place/take only risk code inside try and length of the try block should be as less as possible.
2. If any statement which raises an exception and it is not part of any try block then it is always abnormal termination of the program.
3. There may be a chance of raising an exception inside catch and finally blocks also in addition to try block.

3.Try with multiple catch blocks:

The way of handling an exception is varied from exception to exception. Hence for every exception type it is recommended to take a separate catch block. That is try with multiple catch blocks is possible and recommended to use.

Example:

`try`
`{`
`.`
`.`
`}`
`catch(Exception e)`
`{`
`    default handler`
`}`
	`try`
	`{`
	`.`
	`.`
	`}`
	`catch(FileNotFoundException e)`
	`{`
	`  use local file`
	`}`
	`catch(ArithmeticException e)`
	`{`
	`  perform these Arithmetic operations`
	`}`
	`catch(SQLException e)`
	`{`
	`  don't use oracle db, use mysqldb`
	`}`
	
	`catch(Exception e)`
	`{`
	`  default handler`
	`}`

This approach is not recommended because for any type of Exception we are using the same catch block.	This approach is highly recommended because for any exception raise we are defining a separate catch block.

If try with multiple catch blocks present then order of catch blocks is very important. It should be from child to parent by mistake if we are taking from parent to child then we will get Compile time error saying, "exception xxx has already been caught".

Example:

```
class Test
{
      psvm(String[] args)
      {
            try
            {
            System.out.println(10/0);
            }
            catch(Exception e)
            {
            e.printStackTrace();
            }
            catch(ArithmeticException e)
            {
            e.printStackTrace();
            }
      }
}
 CE:exception
java.lang.ArithmeticException  has
already been caught
```

```
class Test
{
psvm(String[] args)
{
try
{
      System.out.println(10/0);
}
catch(ArithmeticException e)
{
      e.printStackTrace();
}
catch(Exception e)
{
      e.printStackTrace();
}}}
Output:
Compile successfully.
```

4.Finally block:

- It is never recommended to take clean up code inside try block because there is no guarantee for the execution of every statement inside a try.
- It is never recommended to place clean up code inside catch block because if there is no exception then catch block won't be executed.
- We require some place to maintain clean up code which should be executed always irrespective of whether exception raised or not raised and whether handled or not handled such type of place is nothing but finally block.
- Hence the main objective of finally block is to maintain cleanup code.

```
Example:

try
{
        risky code
}
catch(x e)
{
        handling code
}
finally
{
        cleanup code
}
```

The speciality of finally block is it will be executed always irrespective of whether the exception raised or not raised and whether handled or not handled.

```
Example 1:
class Test
{
        public static void main(String[] args)
        {
                try
                {
                        System.out.println("try block executed");
                }
                catch(ArithmeticException e)
                {
                        System.out.println("catch block executed");
                }
                finally
                {
                        System.out.println("finally block executed");
                }
        }
}
Output:
Try block executed
Finally block executed

Example 2:
class Test
{
        public static void main(String[] args)
        {
                try
                {
                        System.out.println("try block executed");
                        System.out.println(10/0);
                }
                catch(ArithmeticException e)
                {
                        System.out.println("catch block executed");
                }
                finally
                {
                        System.out.println("finally block executed");
                }
        }
}
Output:
Try block executed
Catch block executed
Finally block executed
Example 3:
class Test
{
        public static void main(String[] args)
        {
                try
                {
                        System.out.println("try block executed");
                        System.out.println(10/0);
                }
                catch(NullPointerException e)
                {
                        System.out.println("catch block executed");
                }
                finally
                {
                        System.out.println("finally block executed");
                }
        }
}
Output:
Try block executed
Finally block executed
Exception in thread "main" java.lang.ArithmeticException: / by zero
         at Test.main(Test.java:8)
```

5. Difference between final, finally, and finalize:

Final:

- Final is the modifier applicable for class, methods and variables.
- If a class declared as the final then child class creation is not possible.
- If a method declared as the final then overriding of that method is not possible.

- If a variable declared as the final then reassignment is not possible.

Finally:

- It is the block always associated with try catch to maintain clean up code which should be executed always irrespective of whether exception raised or not raised and whether handled or not handled.
- There is only one situation where the finally block won't be executed is whenever we are using **System.exit(0)**method.

Finalize:

It is a method which should be called by garbage collector always just before destroying an object to perform cleanup activities.

Note: To maintain clean up code faunally block is recommended over finalize() method because we can't expect exact behavior of GC.

6.Control flow in try catch finally:

Example:

```
class Test
{
		public static void main(String[] args)
		{
				Try
				{
						System.out.println("statement1");
						System.out.println("statement2");
						System.out.println("statement3");
				}
				catch(Exception e)
				{
						System.out.println("statement4");
				}
				finally
				{
						System.out.println("statement5");
				}
				System.out.println("statement6");
		}
}
```

- **Case 1:** If there is no exception. 1, 2, 3, 5, 6 normal termination.
- **Case 2:** if an exception raised at statement 2 and corresponding catch block matched. 1,4,5,6 normal terminations.
- **Case 3:** if an exception raised at statement 2 and corresponding catch block is not matched. 1,5 abnormal termination.
- **Case 4:** if an exception raised at statement 4 then it's always abnormal termination but before the finally block will be executed.

- **Case 5:** if an exception raised at statement 5 or statement 6 its always abnormal termination.

7.Control flow in nested try catch finally:

```
Example:
class Test
{
	public static void main(String[] args)
	{
	try
	{
		System.out.println("statement1");
		System.out.println("statement2");
		System.out.println("statement3");
		try
		{
			System.out.println("statement4");
			System.out.println("statement5");
			System.out.println("statement6");
		}
		catch(ArithmeticException  e)
		{
			System.out.println("statement7");
		}
		finally
		{
			System.out.println("statement8");
		}
		System.out.println("statement9");
	}
	catch(Exception e)
	{
		System.out.println("statement10");
	}
	finally
	{
		System.out.println("statement11");
	}
	System.out.println("statement12");
	}
}
```

- **Case 1:** if there is no exception. 1, 2, 3, 4, 5, 6, 8, 9, 11, 12 normal termination.
- **Case 2:** if an exception raised at statement 2 and corresponding catch block matched 1,10,11,12 normal terminations.
- **Case 3**: if an exception raised at statement 2 and corresponding catch block is not matched 1, 11 abnormal termination.
- **Case 4:** if an exception raised at statement 5 and corresponding inner catch has matched 1, 2, 3, 4, 7, 8, 9, 11, 12 normal termination.

- **Case 5:** if an exception raised at statement 5 and inner catch has not matched but outer catch block has matched. 1, 2, 3, 4, 8, 10, 11, 12 normal termination.
- **Case 6:** if an exception raised at statement 5 and both inner and outer catch blocks are not matched. 1, 2, 3, 4, 8, 11 abnormal termination.
- **Case 7:** if an exception raised at statement 7 and the corresponding catch block matched 1, 2, 3, 4, 5, 6, 8, 10, 11, 12 normal termination.
- **Case 8:** if an exception raised at statement 7 and the corresponding catch block not matched 1, 2, 3, 4, 5, 6, 8, 11 abnormal terminations.
- **Case 9:** if an exception raised at statement 8 and the corresponding catch block has matched 1, 2, 3, 4, 5, 6, 7, 10, 11,12 normal termination.
- **Case 10:** if an exception raised at statement 8 and the corresponding catch block not matched 1, 2, 3, 4, 5, 6, 7, 11 abnormal terminations.
- **Case 11:** if an exception raised at statement 9 and corresponding catch block matched 1, 2, 3, 4, 5, 6, 7, 8,10,11,12 normal termination.
- **Case 12:** if an exception raised at statement 9 and corresponding catch block not matched 1, 2, 3, 4, 5, 6, 7, 8, 11 abnormal termination.
- **Case 13:** if an exception raised at statement 10 is always abnormal termination but before that finally block 11 will be executed.
- **Case 14:** if an exception raised at statement 11 or 12 is always abnormal termination.

Note: if we are not entering into the try block then the finally block won't be executed. Once we entered into the try block without executing finally block we can't come out.

We can take try-catch inside try i.e., nested try-catch is possible
The most specific exceptions can be handled by using inner try-catch and generalized exceptions can be handle by using outer try-catch.

```
Example:
class Test
{
        public static void main(String[] args)
        {
                try
                {
                        System.out.println(10/0);
                }
                catch(ArithmeticException e)
                {
                        System.out.println(10/0);
                }
                finally{
                String s=null;
                System.out.println(s.length());
                }
        }
}
output :
RE:NullPointerException
```

Note: Default exception handler can handle only one exception at a time and that is the most recently raised exception.

8.Various possible combinations of try catch finally:

1. Whenever we are writing try block compulsory we should write either catch or finally. i.e., try without catch or finally is invalid.
2. Whenever we are writing catch block compulsory we should write try. i.e., catch without try is invalid.
3. Whenever we are writing finally block compulsory we should write try. i.e., finally without try is invalid.
4. In try-catch-finally order is important.
5. With in the try-catch -finally blocks we can take try-catch-finally. i.e., nesting of try-catch-finally is possible.
6. For try-catch-finally blocks curly braces are mandatory.

```
try {}
catch (X e) {}
```
✓

```
try {}
catch (X e) {}
catch (Y e) {}
```
✓

```
try {}
catch (X e) {}
catch (X e) {} //CE:exception ArithmeticException has already been caught
```
✗

```
try {}
catch (X e) {}
finally {}
```
✓

```
try {}
finally {}
```
✓

```
try {} //CE: 'try' without 'catch', 'finally' or resource declarations
```
✗

```
catch (X e) {} //CE: 'catch' without 'try'
```
✗

```
finally {} //CE: 'finally' without 'try'
```
✗

```
try {} //CE: 'try' without 'catch', 'finally' or resource declarations
System.out.println("Hello");
catch {} //CE: 'catch' without 'try'
```

✗

```
try {}
catch (X e) {}
System.out.println("Hello");
catch (Y e) {} //CE: 'catch' without 'try'
```

✗

```
try {}
catch (X e) {}
System.out.println("Hello");
finally {} //CE: 'finally' without 'try'
```

✗

```
try {}
finally {}
catch (X e) {} //CE: 'catch' without 'try'
```

✗

```
try {}
catch (X e) {}
try {}
finally {}
```

✓

```
try {}
catch (X e) {}
finally {}
finally {} //CE: 'finally' without 'try'
```

✗

```
try {}
catch (X e) {
try {}
catch (Y e1) {}
}
```

✓

```
try {
try {} //CE: 'try' without 'catch', 'finally' or resource declarations
}
catch (X e) {}
```

✗

```
try //CE: '{' expected
System.out.println("Hello");
catch (X e1) {} //CE: 'catch' without 'try'
```

✗

```
try {}
catch (X e) //CE:'{' expected
System.out.println("Hello");
```

✗

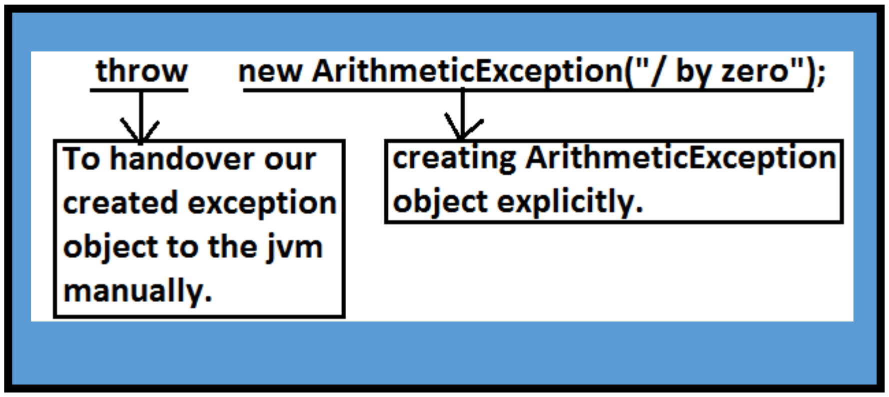
```
try {}
catch (NullPointerException e1) {}
finally //CE: '{' expected
System.out.println("Hello");
```

✗

Throw statement:

Sometimes we can create Exception object explicitly and we can hand over to the JVM manually by using throw keyword.

Example:


throw new ArithmeticException("/ by zero");
To handover our created exception object to the jvm manually.
creating ArithmeticException object explicitly.

The result of following 2 programs is exactly same.

`class Test`
`{`
`        p s v main(String[] args)`
`        {`
`              S.o.p(10/0);`
`        }`
`}`
In this case creation of arithmeticException object and handover to the jvm will be performed automatically by the main() method.
	`class Test`
	`{`
	`    public static void main(String[] args)`
	`    {`
	`          throw new ArithmeticException("/ by zero");`
	`    }`
	`}`
	In this case we are creating exception object explicitly and handover to the JVM manually.

Note: In general we can use throw keyword for customized exceptions but not for predefined exceptions.

Case 1:
throw e;

If e refers null then we will get NullPointerException.

Example:

```
class Test3
{
  static ArithmeticException e=new ArithmeticException( );
  public static void main(String[] args)
  {
      throw e;
   }
}
Output:
Runtime exception: Exception in thread "main"
            java.lang.ArithmeticException
```

```
class Test3
{
      static ArithmeticException e;
       p s v main(String[] args)
      {
            throw e;
       }
}

Output:
Exception in thread "main"
   java.lang.NullPointerException
        at Test3.main(Test3.java:5)
```

Case 2:
After throw statement we can't take any statement directly otherwise we will get compile time error saying unreachable statement.
Example:

```
class Test3
{
public static void main(String[] args){
System.out.println(10/0);
System.out.println("hello");
}
}
Output:
Runtime error: Exception in thread "main"
  java.lang.ArithmeticException: / by zero
        at Test3.main(Test3.java:4)
```

```
class Test3
{
public static void main(String[] args){
throw new ArithmeticException("/ by zero");
System.out.println("hello");
}
}
Output:
Compile time error.
Test3.java:5: unreachable statement
System.out.println("hello");
```

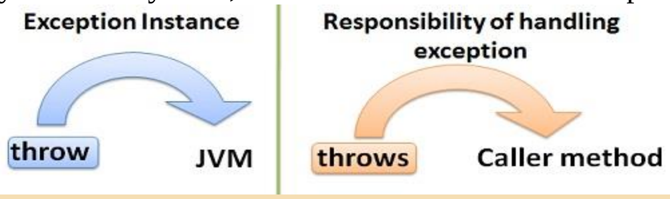
Case 3:
We can use throw keyword only for Throwable types otherwise we will get compile time error saying incomputable types.
Example:

```
class Test3
{
   public static void main(String[] args)
  {
      throw new Test3();
   }
}
Output:
Compile time error.
Test3.java:4: incompatible types
found   : Test3
required: java.lang.Throwable
throw new Test3();
```

```
class Test3 extends RuntimeException
{
      public static void main(String[] args)
     {
          throw new Test3();
      }
}
Output:
Runtime error: Exception in thread "main"
Test3
        at Test3.main(Test3.java:4)
```

Throws statement:

In our program if there is any chance of raising checked exception, compulsory we should handle either by try catch or by throws keyword, otherwise the code won't compile.



Example:

```
import java.io.*;
class Test3
{
        public static void main(String[] args)
        {
                PrinterWriter out=new PrintWriter("abc.txt");
                out.println("hello");
        }
}
```

CE :
Unreported exception java.io.FileNotFoundException;
must be caught or declared to be thrown.

Example:

```
class Test3
{
        public static void main(String[] args)
        {
                Thread.sleep(5000);
        }
}
```

Unreported exception java.lang.InterruptedException;
must be caught or declared to be thrown.

We can handle this compile time error by using the following 2 ways.

Example:

By using try catch	By using throws keyword

```
class Test3
{
    psvm(String[] args)
   {
      try
      {
        Thread.sleep(5000);
      }
      catch(InterruptedException e){}
   }
}
```
Output:
Compile and running successfully
	We can use throws keyword to delicate the responsibility of exception handling to the caller method. Then caller method is responsible to handle that exception.
	```
	class Test3
	{
	   psvm(String[] args) throws InterruptedException
	   {
	      Thread.sleep(5000);
	   }
	}
	```
	Output:
	Compile and running successfully

Note :

- Hence the main objective of "throws" keyword is to delicate the responsibility of exception handling to the caller method.
- "throws" keyword required only checked exceptions. Usage of throws for unchecked exception there is no use.
- "throws" keyword required only to convenes complier. Usage of throws keyword doesn't prevent abnormal termination of the program.
  Hence recommended to use try-catch over throws keyword.

```
Example:
class Test
{
        public static void main(String[] args)throws InterruptedException
        {
                doStuff();
        }
        public static void doStuff()throws InterruptedException
        {
                doMoreStuff();
        }
        public static void doMoreStuff()throws InterruptedException
        {
                Thread.sleep(5000);
        }
}
Output:
Compile and running successfully.
```

In the above program, if we are removing at least one throws keyword, then the program won't compile.

Case 1:
we can use throws keyword only for Throwable types otherwise we will get compile time error saying “incompatible types”.

Example:

class Test3
{
    psvm(String[] args) throws Test3
    {
    }
}
Output:
Compile time error
Test3.java:2: incompatible types
found   : Test3
	class Test3 extends RuntimeException
	{
	    psvm(String[] args) throws Test3
	    {
	    }
	}
	Output:
	Compile and running successfully.

```
required: java.lang.Throwable
public static void main(String[] args)
                throws Test3
```

Case 2: Example:

```
class Test3
{
   public static void main(String[] args)
   {
     throw new Exception();
   }
}
Output:
Compile time error.
Test3.java:3: unreported exception
     java.lang.Exception;
must be caught or declared to be thrown
```

```
class Test3
{
      public static void main(String[] args)
      {
            throw new Error();
      }
}
Output:
Runtime error
Exception in thread "main" java.lang.Error
        at Test3.main(Test3.java:3)
```

Case 3:
In our program with in the try block, if there is no chance of rising an exception then we can't write catch block for that exception. otherwise we will get compile time error saying **"exception XXX is never thrown in body of corresponding try statement".** But this rule is applicable only for fully checked exception.
Example:

```
class Test
{
public static void main(String[] args){
try{
System.out.println("hello");
}
catch(Exception e)
{}   output:
}    hello
}    partial checked
```

```
class Test
{
public static void main(String[] args){
try{
System.out.println("hello");
}
catch(ArithmeticException e)
{}   output:
}    hello
}    unchecked
```

```
class Test
{
public static void main(String[] args){
try{
System.out.println("hello");
}
catch(java.io.IOException e)
{} output:
}  compile time error
}  fully checked
```

```
class Test
{
public static void main(String[] args){
try{
System.out.println("hello");
}
catch(InterruptedException e)
{} output:
}  compile time error
}  Fully checked
```

```
class Test
{
public static void main(String[] args){
try{
System.out.println("hello");
}
catch(Error e)
{} output:
}  compile successfully
}  unchecked
```

Case 4:
We can use throws keyword only for constructors and methods but not for classes.

Example:

```
class Test  throws Exception      //invalid
{
  Test() throws Exception                 //valid
   { }
   methodOne() throws Exception      //valid
    { }
}
```

Exception handling keywords summary:

1. **try:** To maintain risky code.
2. **catch:** To maintain handling code.
3. **finally:** To maintain cleanup code.
4. **throw:** To handover our created exception object to the JVM manually.
5. **throws:** To delegate responsibility of exception handling to the caller method.

Various possible compile time errors in exception handling:

1. Exception XXX has already been caught.
2. Unreported exception XXX must be caught or declared to be thrown.
3. Exception XXX is never thrown in body of corresponding try statement.
4. Try without catch or finally.
5. Catch without try.
6. Finally without try.
7. Incompatible types.
   Found:test
   Requried:java.lang.Throwable;

8. Unreachable statement.

DIFFERENCES BETWEEN THROW AND THROWS:

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

Customized Exceptions (User defined Exceptions):

Sometimes we can create our own exception to meet our programming requirements. Such type of exceptions are called customized exceptions (user defined exceptions).

Example:

1. InSufficientFundsException
2. TooYoungException
3. TooOldException

```
Program:
class TooYoungException extends RuntimeException
{
		TooYoungException(String s)
		{
				super(s);
		}
}
class TooOldException extends RuntimeException
{
		TooOldException(String s)
		{
				super(s);
		}
}
class CustomizedExceptionDemo
{
public static void main(String[ ] args)
{
   int age=Integer.parseInt(args[0]);
  if(age>60)
  {
       throw new TooYoungException("please wait some more time.... u will get best match");
  }
  else if(age<18)
  {
       throw new TooOldException("u r age already crossed....no chance of getting married");
  }
  else
 {
       System.out.println("you will get match details soon by e-mail");
  }
}
}
```

```
Output:

1)E:\Sai>java CustomizedExceptionDemo 61
Exception in thread "main" TooYoungException:
please wait some more time.... u will get best match
at CustomizedExceptionDemo.main(CustomizedExceptionDemo.java:21)



2)E:\Sai>java CustomizedExceptionDemo 27
You will get match details soon by e-mail

3)E:\Sai>java CustomizedExceptionDemo 9
Exception in thread "main" TooOldException:
u r age already crossed....no chance of getting married
at CustomizedExceptionDemo.main(CustomizedExceptionDemo.java:25)
```

<u>Note:</u> It is highly recommended to maintain our customized exceptions as unchecked by extending RuntimeException.
We can catch any Throwable type including Errors also.

Example:

```
try
{}
catch(Error e)
{}
```
valid