Exception Handling

Q1. What is an exception?

Exception is an event which occurs at program run time and which is responsible for disturbing the normal flow of application called as exception.

Q2. What is the benefit of exception handling?

1. Exception handling helps developers to detect the run time error.
2. Exception handling helps us to handle the run time error at program run time means skip the code in which an exception may occur and execute the remaining code in the safe zone.
3. Developers can generate exception warnings in code at program compile time using checked exceptions.
4. Developer can create own exception and handle it and reuse in project according to requirement of application

Types of Exception

1. **Checked Exception: t**hose exceptions occur at program compile time called checked exceptions.
   Checked exceptions, especially used for generating exception warnings may occur in future so better way you can handle that exception at program compile time.

2. Unchecked Exception: those exceptions occur at program run time called as unchecked exceptions.

3. Error : Error is part of exceptions but not handled by a programmer called as error.

Q. What is the difference between Error and Exceptions?

Exception may be compile time and run time as well as exception may be handle by developer at compile time or may be at run time but error cannot handle by developer and always occur at program run time and may be occur at program compile time when developer make mistake in syntax

If we want to work with exceptions in JAVA we have five major keywords.

1. **Try :** try is blocked in exception handling. We can use it to write code in which exceptions may occur.
   Suppose consider we have some logic if developer want logic may be generate exceptions program run time then need to write code in try block
   Example: Suppose consider we have program we want to input two values and calculate its division then we have logic c=a/b here if b value is zero then it is consider infinity and system cannot calculate infinity so here system may be generate run time error so we required to write this logic in try block.
   Note: When try block generates exception then JVM creates one exception class object in try block according to exception category and hand over to catch for further executions.

2. Catch: catch block always use with try block and catch block execute when try block generate exception if try block not generate exception then catch not executed

Means we can say catch block specially design for handle the exception and execute the logics after exceptions
Normally we can detect or handle the exception using a catch block.
Syntax:

```
try
{
  write here logic in which exception may be occur
}
catch(exceptiontype ref)
{
    write here logics want to execute after exception
}
```

Or
Single try can have more than one catch block.

```
try
{
  write here logics in which exception may be occur
}
catch(exceptiontype ref)
{
}
catch(exceptiontype ref)
{
}
...
...
catch(exceptiontype ref)
{
}
```

3. Finally: finally is a block in exception handling which always executes if exceptions are generated in code or not.

Note: sometimes we have some logic. We are required to execute any situation if an exception occurs in code or not then we can write that type of logic in the finally block.
Example: database connection close, file connection close etc

```
try
{
   write here logics in which exception may be occur
}
finally
{
    write logic which want to execute in any situation.
}
```

Note: we can use try catch and finally at the same time.

```
try
{
}
catch(exception ex)
{
}
finally
{
}
```

Q. Can we write try without catch?
Yes we can write try without catch using finally block.

Q. Can we use catch and finally at same time with try block?

Yes we can use catch and finally at same time with try block but precedence of catch must be before finally means we need to write catch block before finally and after try block shown in above screen shot

Q. What is the difference between finally , finalize and final?
Or
Q. What is the difference between final finally and finalize?

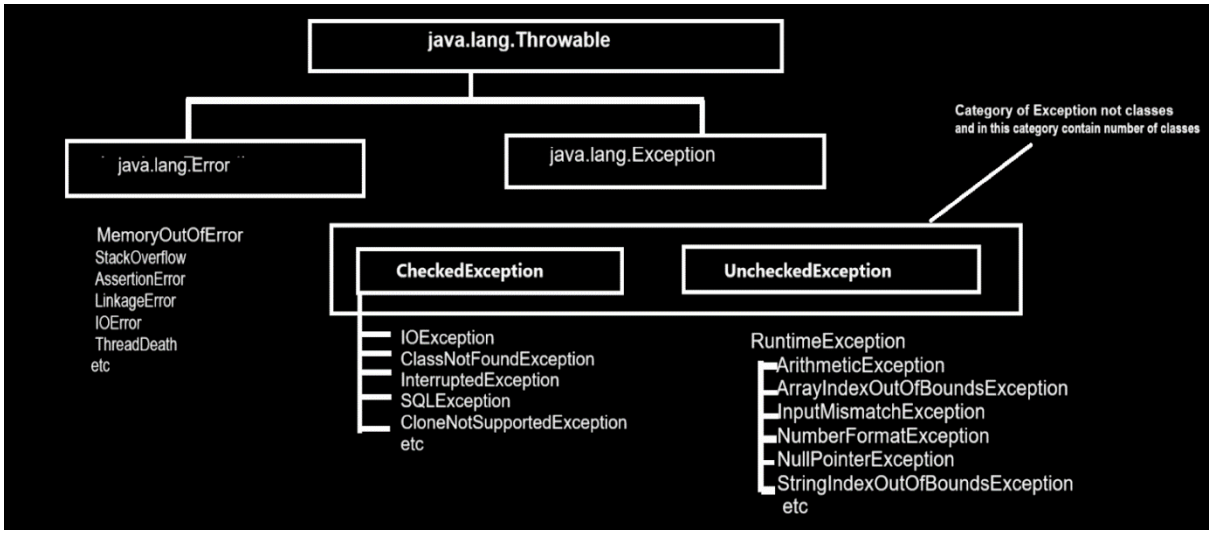
Final is non access specifier in java and we can use final keyword with variable , function and class
So when use final keyword with variable then variable mark as constant value means cannot modify later once we initialize it and when we use final keyword with method then method cannot override and when we use final keyword with class then class cannot be inherit in any another class
Finally : finally is block specially we use in exception handling and can use with try block or may be use with catch also and it is used for write logic if exception generate in code or not and when we not use catch with try and if program have exception then finally execute before by JVM
Finalize: finalize is a method from Object class and which is used for resource cleaning purpose means normally finalize method used in garbage collection process and this method executed automatically when developer call the System.gc() method in garbage collection process.

4. **Throw : t**hrow is clause in exception handling which is used with function means we can use throw keyword in function definition for throw exception object from function definition to function calling point and throw clause specially use by developer if developer wants to handle the user define exceptions.

5. **Throws**: throws clause we can use in function definition and it helps us to return exception objects implicitly from function definition to function calling and normally throws clause use by developer for handling checked exceptions.

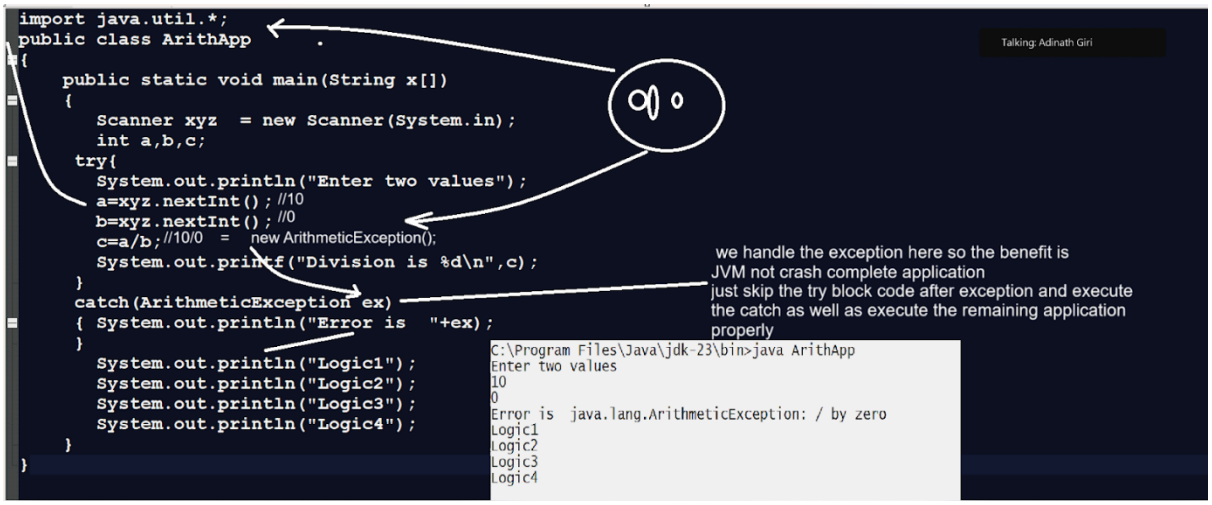
If we want to handle the exceptions in JAVA then java provides a number of classes to us for handle exceptions or work with exception

Class Hierarchy of Exception Handling



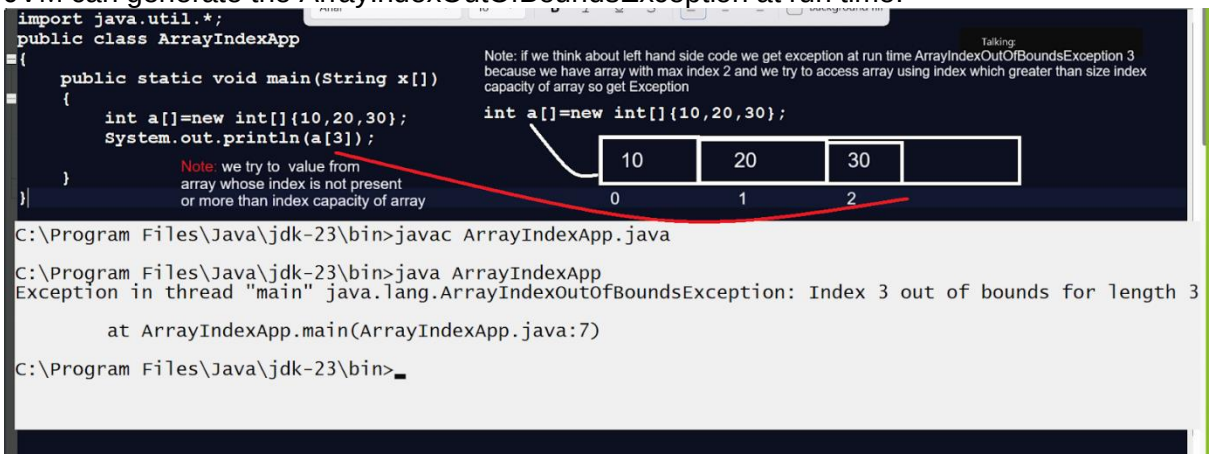
Examples of Exception Handling

ArithmeticException: This is inbuilt class from java.lang package and which is used for handle the division by zero error means when we divide any number by zero then there is infinity result and we cannot calculate infinity result as well as system cannot calculate infinity result so if we have this type of problem and if we want to handle it then JAVA provide ArithmeticException class to us.

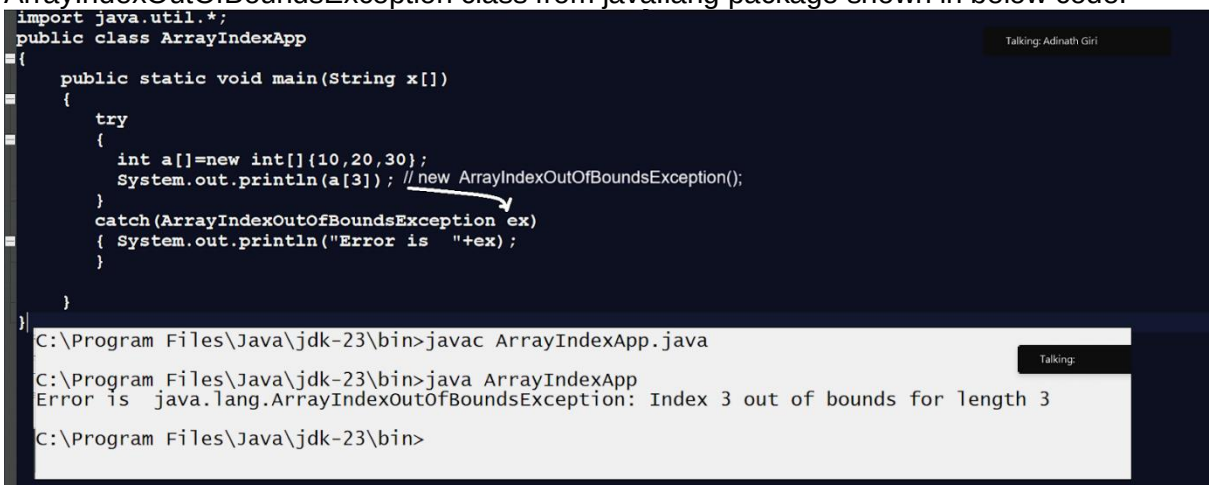


ArrayIndexOutOfBoundsException : this class is also a member of java.lang package and JVM generates its object as an exception object when developers try to access an array out of its size or range.

So Normally this exception occurs when we try to access at run time or write some logic on an array using its index then there is possible index size may exceed the size of array then JVM can generate the ArrayIndexOutOfBoundsException at run time.



Note: if we want to handle this exception we have to use the ArrayIndexOutOfBoundsException class from java.lang package shown in below code.



NullPointerException: NullPointerException occur when we use any reference without new keyword or without allocation of memory means if we array without new keyword or if we use any object without new keyword then JVM generate the NullPointerException at run time.

Note: if we want to handle the above exception we have the handle the NullPointerException at program run time using try and catch block.

```
import java.util.*;
public class NullPointerApp
{   static int a[];
    public static void main(String x[])
    {
    try{
       a[0]=100;
       System.out.println(a[0]);
    }
    catch(NullPointerException ex)
    { System.out.println("Error is  "+ex);
    }
    }
}
```

```
C:\Program Files\Java\jdk-23\bin>javac NullPointerApp.java

C:\Program Files\Java\jdk-23\bin>java NullPointerApp
Error is  java.lang.NullPointerException: Cannot store to int array because "NullPointerApp.a" is null

C:\Program Files\Java\jdk-23\bin>
```

```
import java.util.*;
class A
{
     void show(){
          System.out.println("I am show method");
     }
}
public class NullPointerApp
{    static A a1;
    public static void main(String x[])
    {   a1.show();
    }
}
```

Note: if we think about left hand side code we have statement static A a1; here we have a1 is reference variable and its default value is null means we not created object for a1 in our code and we try to access non static method show() of class A using reference means without using object so we get NullPointerException at run time.

```
C:\Program Files\Java\jdk-23\bin>javac NullPointerApp.java

C:\Program Files\Java\jdk-23\bin>java NullPointerApp
Exception in thread "main" java.lang.NullPointerException: Cannot invoke "A.show()" because "NullPointerApp.a1" is null
        at NullPointerApp.main(NullPointerApp.java:11)
```

So use NullPointerException to handle the above code exceptions.

```
import java.util.*;
class A
{
          void show(){
                    System.out.println("I am show method");
          }
}
public class NullPointerApp
{    static A a1;
    public static void main(String x[])
          {
            try{
          a1.show();
            }
            catch(NullPointerException ex)
            { System.out.println("Error is  "+ex);
            }
          }
}
```

NumberFormatException: NumberFormatExceptions normally occur when we try to convert string value to primitive type of value.

Sometimes we have numeric values but present in the form of String and we want to convert that value in associated numeric type but if string contains some non numeric values like

space or any other alphabet or special symbol then JVM generates the NumberFormatException to us.

```
import java.util.*;

public class NumFormatExeApp
{   public static void main(String x[])
    {
        String s="1234 "; //we have integer value but in the form of String.

        int a = Integer.parseInt(s);

        System.out.println("A is  "+a);

    }
}
```

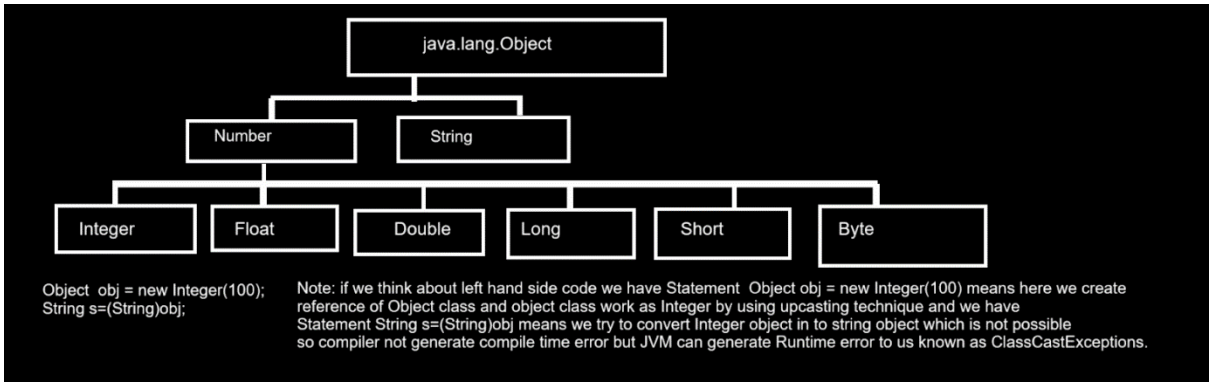
Note: if we think about left hand side we have String s="1234 " means it contain space and we try to convert this value in to integer so JVM can convert 1234 to integer from string but JVM cannot convert space to integer so it will raise runtime exception known as NumberFormatException you can handle this exception by using NumberFormatException class from java.lang package.

```
C:\Program Files\Java\jdk-23\bin>javac NumFormatExeApp.java

C:\Program Files\Java\jdk-23\bin>java NumFormatExeApp
Exception in thread "main" java.lang.NumberFormatException: For input string: "1234 "
        at java.base/java.lang.NumberFormatException.forInputString(NumberFormatException.java:67)
        at java.base/java.lang.Integer.parseInt(Integer.java:588)
        at java.base/java.lang.Integer.parseInt(Integer.java:685)
        at NumFormatExeApp.main(NumFormatExeApp.java:8)

C:\Program Files\Java\jdk-23\bin>
```

ClassCastException: Normally ClassCastException occur in Referencial conversion means we have two different types of classes and if we try to convert one class reference to another class reference then there is possible of ClassCastException in JAVA



FileNotFoundException: this exception occurs when a file is not found an I/O Operation.

```
import java.io.*;
public class ReadFileApp
{
   public static void main(String x[])
        {
         try{
            FileReader fr= new FileReader("D:\\july 2024\\myfilehandling\\buffaprp.txt");
                int data;
                while((data=fr.read())!=-1)
                {
                   char ch=(char)data;
                        System.out.print(ch);
                }
        }
```

```
            catch(FileNotFoundException ex)
            { System.out.println("Error is "+ex);
            }
            catch(IOException ex)
            {System.out.println("Error is  "+ex);
            }
          }
}
```

IllegalArgumentException: Normally this exception thrown by java developer or JAVA inbuilt API when we try to provide wrong argument to the function/array etc

Example: Suppose we are creating an array and array size should not be negative and if someone tries to set array size as negative we want to throw IllegalArgumentException at program run time.

```
import java.util.*;
public class TestArrApp
{
   public static void main(String x[])
          {
          try{
             Scanner xyz  = new Scanner(System.in);
             int size;
             System.out.println("Enter size of array");
             size=xyz.nextInt();
             if(size<0)
             {
throw new IllegalArgumentException("Invalid argument pass to array should not negative");
             }
             int a[]=new int[size];
             System.out.println("Length of array is "+a.length);
          }
          catch(IllegalArgumentException ex)
          { System.out.println("Error is  "+ex.getMessage());
          }
          }
}
```

IndexOutOfBoundsException: this exception occur access invalid index as list or array or string.

```
import java.util.*;
public class TestArrApp
{
   public static void main(String x[])
          {
          try{
            ArrayList al = new ArrayList();
                    al.add(10);
                    al.add(20);
            Object obj = al.get(2);
            System.out.println(obj);
          }
```

```
        catch(IndexOutOfBoundsException ex)
        { System.out.println("Error is  "+ex);
        }
        }
}
```

NoSuchElementException: this exception occur if we have no element present in collection and try to fetch it then we get NoSuchElementException found

```
import java.util.*;
public class TestArrApp
{
   public static void main(String x[])
        {
         try{
          List al = new ArrayList();
           Iterator i=al.iterator();
           System.out.println(i.next());
         }
         catch(NoSuchElementException ex)
         { System.out.println(ex);
         }

        }
}
```

SQLException: this exception normally handles the database connection related exceptions.

StackOverflow: this exception thrown by JVM when your stack memory exceeds.

```
import java.util.*;
public class TestArrApp
{
   public static void main(String x[])
        {
           show();

        }
        public static void show()
        {
                try{
                  show(); //recursion call
                }
                catch(StackOverflowError e)
                { System.out.println(e);
                }
        }
}
```

OutOfMemoryError: this exception occurs when JVM runs out of memory during runtime

```
import java.util.*;
public class TestArrApp
```

```
{
   public static void main(String x[])
        {
                try{
           int a[]=new int[Integer.MAX_VALUE];
                }
                catch(OutOfMemoryError ex)
                {
                        System.out.println(ex);
                }

        }

}
```

Output

```
C:\Program Files\Java\jdk-23\bin>javac TestArrApp.java

C:\Program Files\Java\jdk-23\bin>java TestArrApp
java.lang.OutOfMemoryError: Requested array size exceeds VM limit

C:\Program Files\Java\jdk-23\bin>
```

NoClassDefFoundError & ClassNotFoundException: this error occurs when we use the particular in code but class exists then we get this type of error.
Basically ClassNotFoundException occur at program compile time.
Example: Sometime we are creating object of class by using Class.forName() method if class not present then we get this type of exception

```
import java.util.*;
public class TestArrApp
{
   public static void main(String x[])
        {
                try{
                 Class.forName("asdfaf");
                }
                catch(ClassNotFoundException ex)
                { System.out.println("Error is "+ex);
                }
                catch(NoClassDefFoundError ex)
                { System.out.println("Error is  "+ex);
                }
        }

}
```

Finally block

Finally is block in exception handling which always execute if exception generate in program or not

```
import java.util.*;
public class DivApp
{
   public static void main(String x[])
```

```
	{
		Scanner xyz  = new Scanner(System.in);
		try{
			int a,b,c;
			System.out.println("Enter two values");
			a=xyz.nextInt();
			b=xyz.nextInt();
			c=a/b;
			System.out.printf("Division is %d\n",c);
		}
		finally
		{ System.out.println("Hey I can execute always");
		}
	}

}
```

```
C:\Program Files\Java\jdk-23\bin>javac DivApp.java

C:\Program Files\Java\jdk-23\bin>java DivApp
Enter two values
10
2
Division is 5
Hey I can execute always

C:\Program Files\Java\jdk-23\bin>java DivApp
Enter two values
6
0
Hey I can execute always
Exception in thread "main" java.lang.ArithmeticException: / by zero
        at DivApp.main(DivApp.java:12)

C:\Program Files\Java\jdk-23\bin>
```

Note: if we think about above screen shot we can check finally executed in both situation when our program executed properly means there is exception then finally get executed and if our code has exception then finally executed before exceptions
So we can say finally executed if an exception is generated in code or not.

Q. What is the difference between catch and finally?

---

1. Finally is not responsible for handle the exception just finally take care own logics means execute own logic if exception occur or not and catch is responsible for handle the exception
2. If use finally and if program contain exception then finally executed before exception and catch execute after exception if occur
3. When we use try ,catch and finally all at the same time then catch has higher execution priority than finally means if an exception is generated in code then catch executes before finally.

```java
import java.util.*;
public class DivApp
{
    public static void main(String x[])
    {
         Scanner xyz  = new Scanner(System.in);
         try{
             int a,b,c;
             System.out.println("Enter two values");
             a=xyz.nextInt();
             b=xyz.nextInt();
             c=a/b;
             System.out.printf("Division is %d\n",c);
         }
         catch(ArithmeticException ex)
         { System.out.println("Error is "+ex);
         }
         finally
         { System.out.println("Hey I can execute always");
         }
    }
}
```

```
Talking: Adinath Giri

C:\Program Files\Java\jdk-23\bin>javac DivApp.java

C:\Program Files\Java\jdk-23\bin>java DivApp
Enter two values
100
0
Error is java.lang.ArithmeticException: / by zero
Hey I can execute always

C:\Program Files\Java\jdk-23\bin>
```

Throw and throws

Throws : throws is a clause in exception handling which help us to handle the checked exceptions
Normally we use throws clause with function definition and when we use throws clause with function definition we need to write try and catch at function calling point.
Normally throws use when we want to handle the exception at function calling point in compilation phase

Syntax:

return type functionname(datatype variablename)throws exceptiontype
{
}

Note: if we think about throws clause we have some important points.

1. When we use throws clause we not need to write try and catch in function definition

2. When we use throws then we must have to use try and catch at function calling point or means we must have to handle exceptions at function calling point.

3. When we use throws with function and we do not use try and catch at function calling point then we get compile time error or compiler time exception error.

4. When using the throws then JVM creates an exception class object in function definition and throws it at the function calling point.
5.

Throw clause

Throw clause is used to handle the user defined exceptions.

Q. What are user defined exceptions?

Those exceptions defined by the user for its own use are called as user-defined exceptions.

Q. Why do users need to develop their own exceptions?

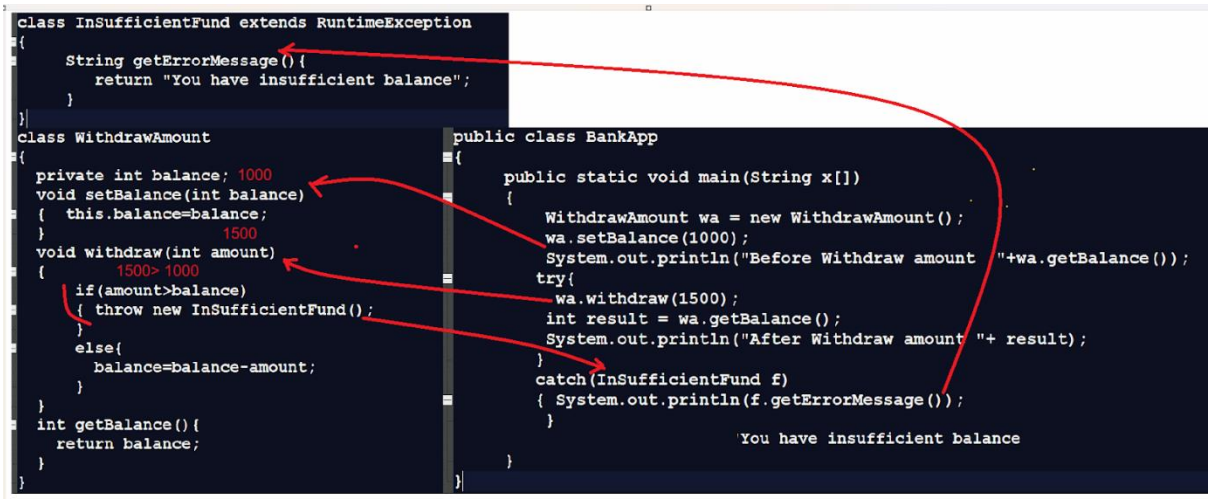
1. If a developer has some exception in an application but java does not provide an inbuilt exception class to handle that exception then the developer can create own exception class called as user defined exceptions.
2. If a developer wants to create exceptions or error messages according to project requirements then the developer can create own exception class called a user defined exceptions.

How to create user defined exceptions in JAVA?

If we want to create user define exception in java we have to create own class and inherit the inbuilt class properties in it
Means using inheritance we can access Exception handling properties define by JAVA as well as we are adding own properties in it according to our requirement

Syntax:
access specifier class class name extends exceptionclassname
{
}

Example: Suppose consider we are working on Banking Application and user try to withdraw amount more than balance of his account then system should generate the exception at run time insufficient fund then we can use the user define exceptions



Example: Suppose consider we are developing project for ManPower Hiring Agency Means Goal of our project maintain smooth recruitment process but the clause or rule is employee age should be greater than 15

```
class AgeVerificationExe extends RuntimeException
{  private String message;
   AgeVerificationExe(String message)
   {
      this.message=message;
   }
   public String getErrMessage(){
          return message;
   }
}
class Hiring
{
   void checkAge(int age)
   {
     if(age<=15)
          { throw new AgeVerificationExe("Your age is not suitable "+age);
          }
          else
          { System.out.println("On boarding process start");
          }
   }
}
public class ManPowerHiringApp
{
    public static void main(String x[])
          {
            try{
                  Hiring h  = new Hiring();
                   h.checkAge(10);
            }
            catch(AgeVerificationExe e)
            { System.out.println("Error is "+e.getErrMessage());
            }
          }
}
```

Important points related with throws clause

1. Throw keyword use to handle user defined exceptions
2. Throw keyword can work with single exception class at time
3. Need to create manual object exception class
4. No need to try and catch in function definition, need to write try and catch at function calling point.

Q. What is the difference between throw and throws?

Throw	**Throws**
Throw use to handle user define exception	Throws use to handle the checked exceptions
Throw can work with single exception object at time	Throws can work with more than one exception at time
Throw need to create manually exception object and throw it	Throws create implicitly exception object and throw it
No need to handle exception at compile time if use throw keyword	Need to handle exception at compile time if use throws keyword

Assignment

Interview Question

Q1. What is Exception and why use it?
Q2. Explain the type exception?
Q3. What is checked, unchecked and error exception?
Q4. Explain exception hierarchy?
Q5. what is used for try ,catch,finally,throws and throw?
Q6. explain any 8 exception class examples with description?
Q7. What is the difference between catch and finally?
Q8. What is the difference between final ,finally and finalize()?
Q9. What is throw and throws explained with an example?
Q10. What is the difference between throw and throws?

Programming Assignment on user defined exceptions?
Q1. Check InvalidEmailFormatException

Description: you have created an application for checking if an email entered by a user is proper or not means email must contain @ and . (dot operator) and after dot operator there must 2 or 3 characters and dot may be repeat and @ must be only once in email and if this criteria is not match then system should generate exception at run time InvalidEmailFormatException

Q2. ProductOufOfStockException
Description: Suppose consider we are working on InventoryControl Application and we have one module name as StockManagment and we want to store product count in stack if product is less than 0 then system should generate run time exception to us name as ProductOutOfStockException

Q3. InvalidPasswordException
Description: Suppose consider we are working on Login Application and we have one class name as PasswordChecker and this class check the password enter by user and password checking rules given below

a. Password length must be minimum 8 char
b. Password must be contain at least on capital letter
c. Password must be contain at least on digit
d. Password must be contained at one special symbol

Note: if any one of above criteria not match in user password then system should generate exception InvalidPasswordException