Exception Handling in Java

Exception:

- Exception is an unwanted condition that occurs during the execution of the program and disrupts the normal flow of instructions.
- It represents an unexpected event that the program may encounter.
- When an exceptional situation arises, Java creates an object called Exception object representing the specific exception type and description of the exception. These exceptions can be caught and handled to prevent the program from terminating abruptly.

Exception Handling:

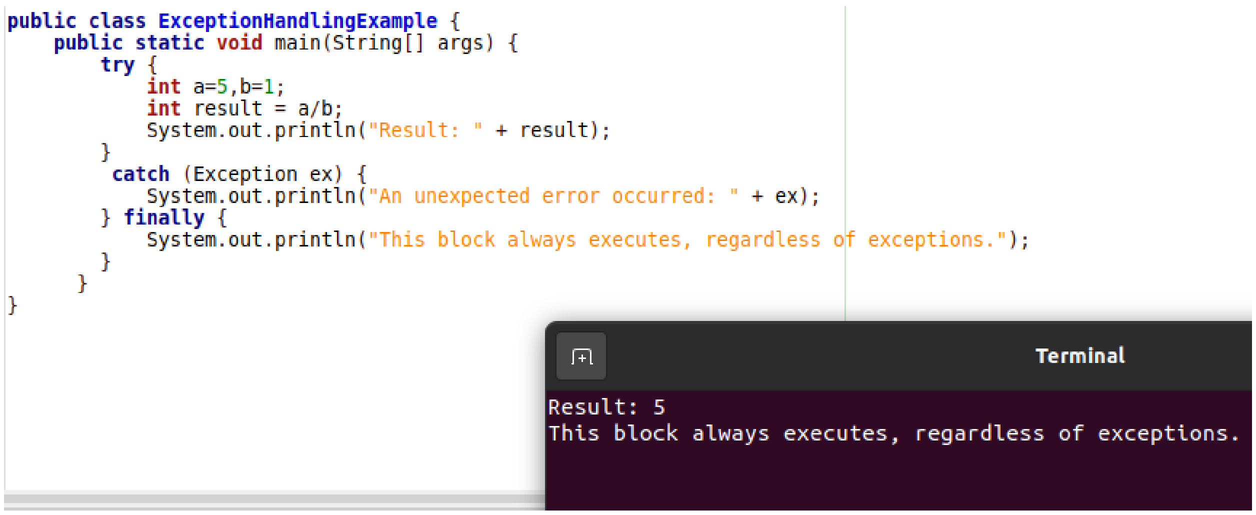
- Exception handling is the process of managing and responding to exceptions that occur while executing the program.
- It allows the program to handle errors, log meaningful error messages, and take appropriate actions to recover from exceptional situations.

- Exception handling is implemented using different ways.
- General Syntax of try-catch block:

```
try {
   // Code that may throw an exception
} catch (ExceptionType1 ex1) {
   // Code to handle ExceptionType1
} catch (ExceptionType2 ex2) {
   // Code to handle ExceptionType2
} finally {
   // Code that always executes (optional)
```

}

Example in Java: Let's consider a simple example where we try to divide two numbers and handle exceptions:



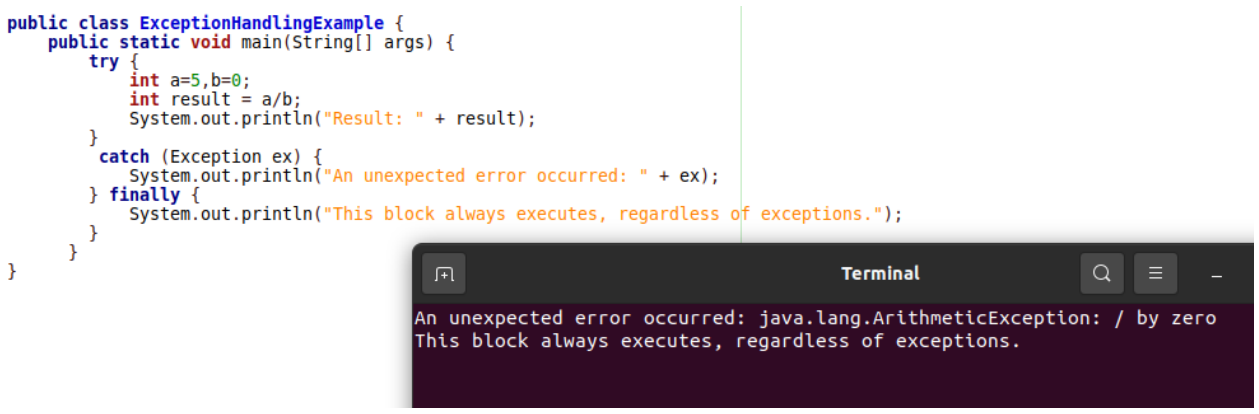
```java
public class ExceptionHandlingExample {
    public static void main(String[] args) {
        try {
            int a=5,b=1;
            int result = a/b;
            System.out.println("Result: " + result);
        }
         catch (Exception ex) {
            System.out.println("An unexpected error occurred: " + ex);
        } finally {
            System.out.println("This block always executes, regardless of exceptions.");
        }
      }
}
```

```
Result: 5
This block always executes, regardless of exceptions.
```

The try block: It contains the code that may throw an exception.

The catch block: If an exception occurs within the try block, Java looks for an appropriate catch block to handle that exception. In this example, If any unexpected exception occurs in the program, the catch block with the Exception parameter will catch it.

The finally block: This block is optional and is used to execute code that should be run whether an exception occurred or not. It is typically used to perform cleanup tasks or resource release operations. The finally block will execute no matter what.

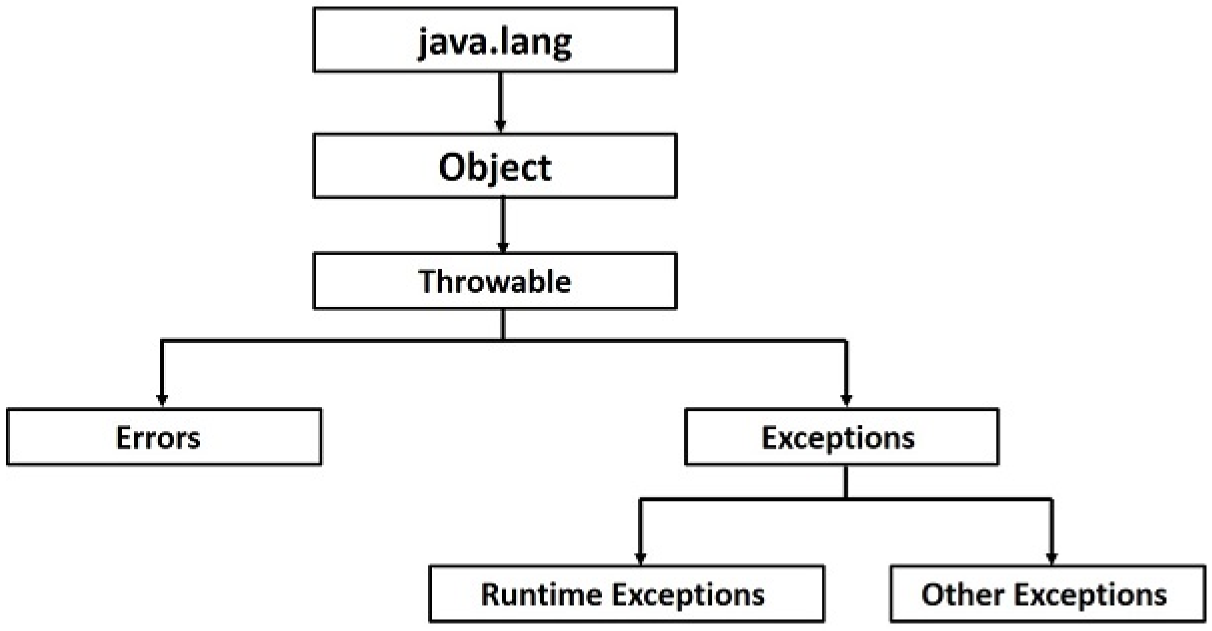


```
public class ExceptionHandlingExample {
    public static void main(String[] args) {
        try {
            int a=5,b=0;
            int result = a/b;
            System.out.println("Result: " + result);
        }
         catch (Exception ex) {
            System.out.println("An unexpected error occurred: " + ex);
        } finally {
            System.out.println("This block always executes, regardless of exceptions.");
        }
      }
}
```

```
An unexpected error occurred: java.lang.ArithmeticException: / by zero
This block always executes, regardless of exceptions.
```

In the first case, the division is performed successfully. In the second case, an ArithmeticException is thrown when dividing by zero. So, we can handle exceptions and keep your program running smoothly even when errors occur.

Exception Hierarchy:



java. lang.Throwable:

- All the exceptions are derived from the java.lang.Throwable class.
- Throwable is at the top of Exception hierarchy.
- The throwable class has two subclasses that partition exception into Exception and Errors.

Error:

- Error are the problems that are beyond the control of the application and are not caught or handled by regular application code. It typically lead to the termination of the application.
- It is impossible to recover. Errors are of unchecked type i.e. it happens at run-time.
- It usually indicates critical failures in the Java Virtual Machine (JVM) or the underlying hardware or environment.
    - Example: ‘OutOfMemoryError’, ‘NoClassDefFoundError’ etc.

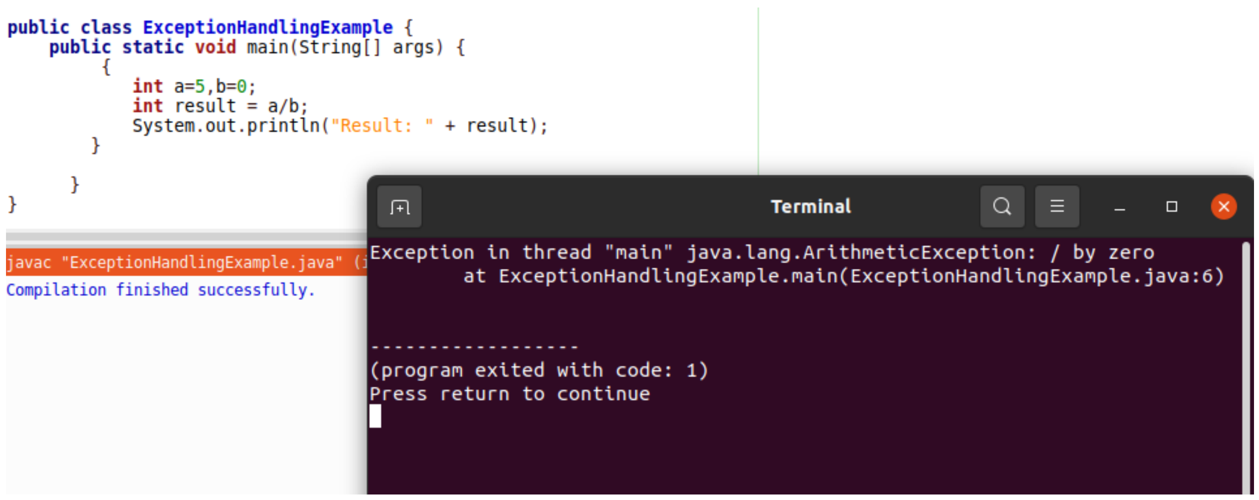
Exception:

- It indicates the exceptional conditions that can be caught and handled by the application.
- It can happen at compile time and run time.
- It can be recovered by handling them.
- It is of two types: Checked Exception, Unchecked Exception
    - Checked Exception:
      These are exceptions that must be either caught and handled during compile time.
      These are exceptions that need to be explicitly caught or declared in the method signature.
      If no exception handling code is provided, then compiler signals a compilation error.
      Examples: ‘IOException’, ‘SQLException’ etc.

- Unchecked Exception:
  These are exceptions that do not need to be explicitly caught or declared in the method signature.so it's up to the developer to handle them properly.
  These are the exceptions that are not checked at compile time.

  Examples:‘ArithmeticException’, ArrayIndexOutOfBoundsException’, etc.

Example 2:
Without exception handling at compile time(unchecked exception)

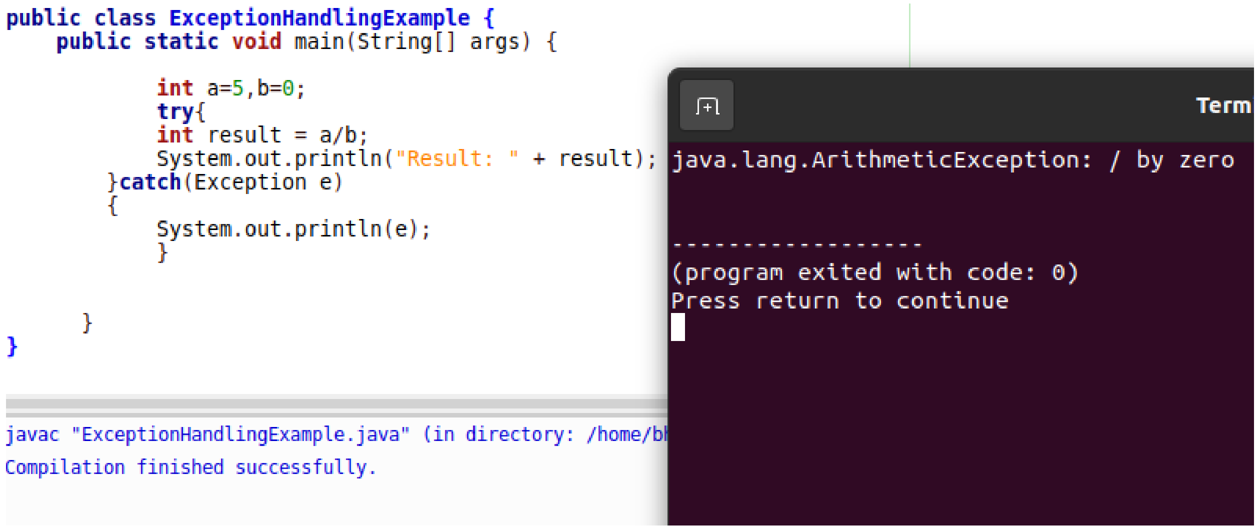


```
public class ExceptionHandlingExample {
    public static void main(String[] args) {
         {
            int a=5,b=0;
            int result = a/b;
            System.out.println("Result: " + result);
        }

      }
}
```

```
javac "ExceptionHandlingExample.java" (i
Compilation finished successfully.
```

```
Exception in thread "main" java.lang.ArithmeticException: / by zero
        at ExceptionHandlingExample.main(ExceptionHandlingExample.java:6)


------------------
(program exited with code: 1)
Press return to continue
```

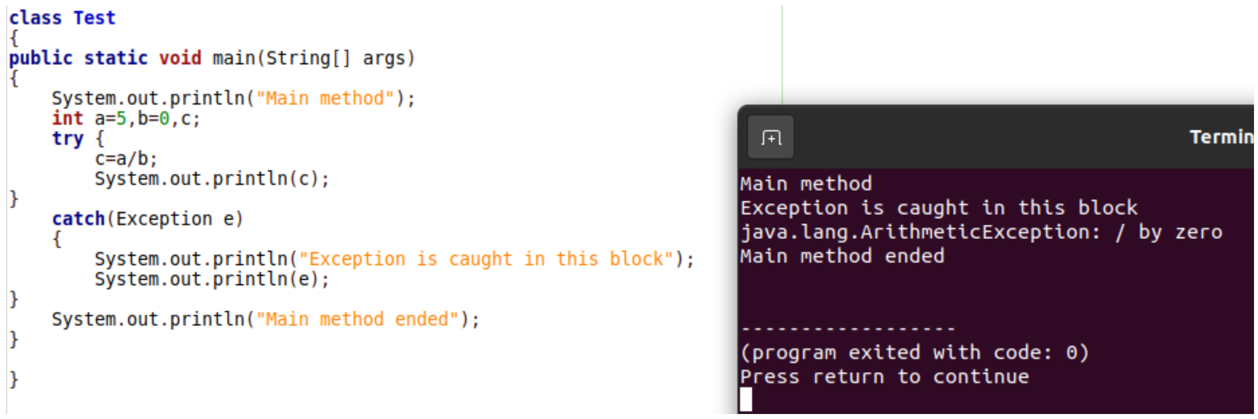
Here, there is no identification of exception during compile time and caught during compile time. The exception is identified only during run time. So, it is unchecked exception.


```
public class ExceptionHandlingExample {
    public static void main(String[] args) {

            int a=5,b=0;
            try{
            int result = a/b;
            System.out.println("Result: " + result);
        }catch(Exception e)
        {
            System.out.println(e);
            }


      }
}
```

```
javac "ExceptionHandlingExample.java" (in directory: /home/bh
Compilation finished successfully.
```

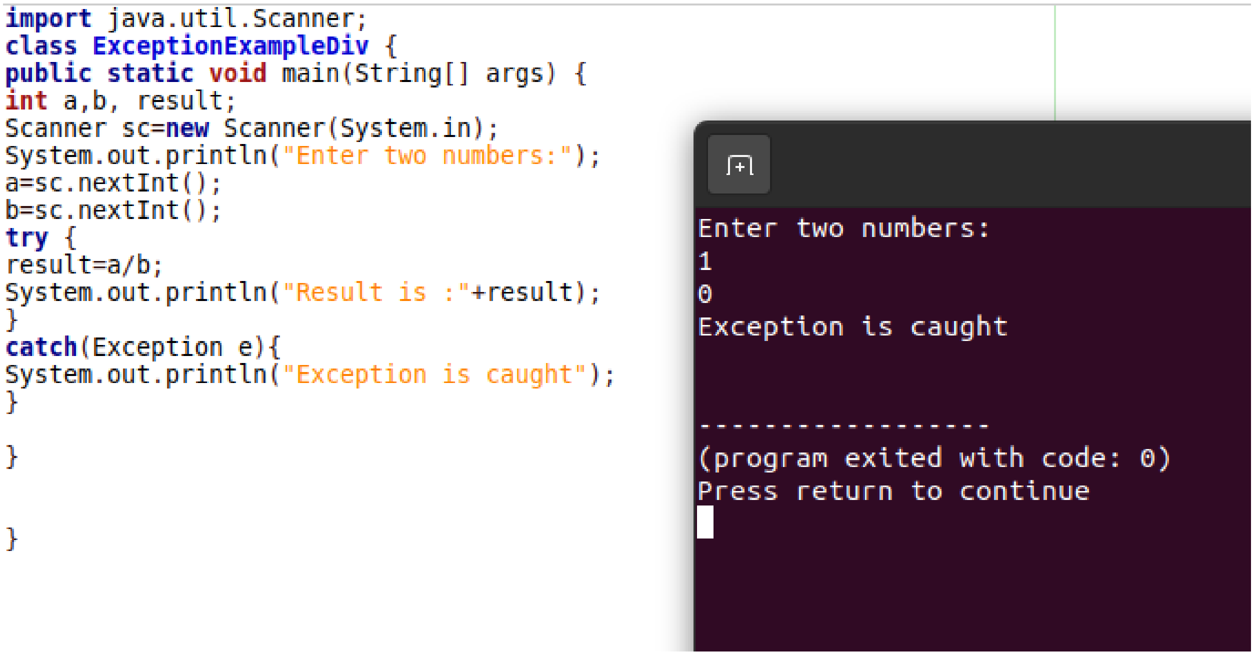
```
java.lang.ArithmeticException: / by zero


------------------
(program exited with code: 0)
Press return to continue
```

Example 3:


```
class Test
{
public static void main(String[] args)
{
    System.out.println("Main method");
    int a=5,b=0,c;
    try {
        c=a/b;
        System.out.println(c);
}
    catch(Exception e)
    {
        System.out.println("Exception is caught in this block");
        System.out.println(e);
}
    System.out.println("Main method ended");
}

}
```

```
Main method
Exception is caught in this block
java.lang.ArithmeticException: / by zero
Main method ended


------------------
(program exited with code: 0)
Press return to continue
```

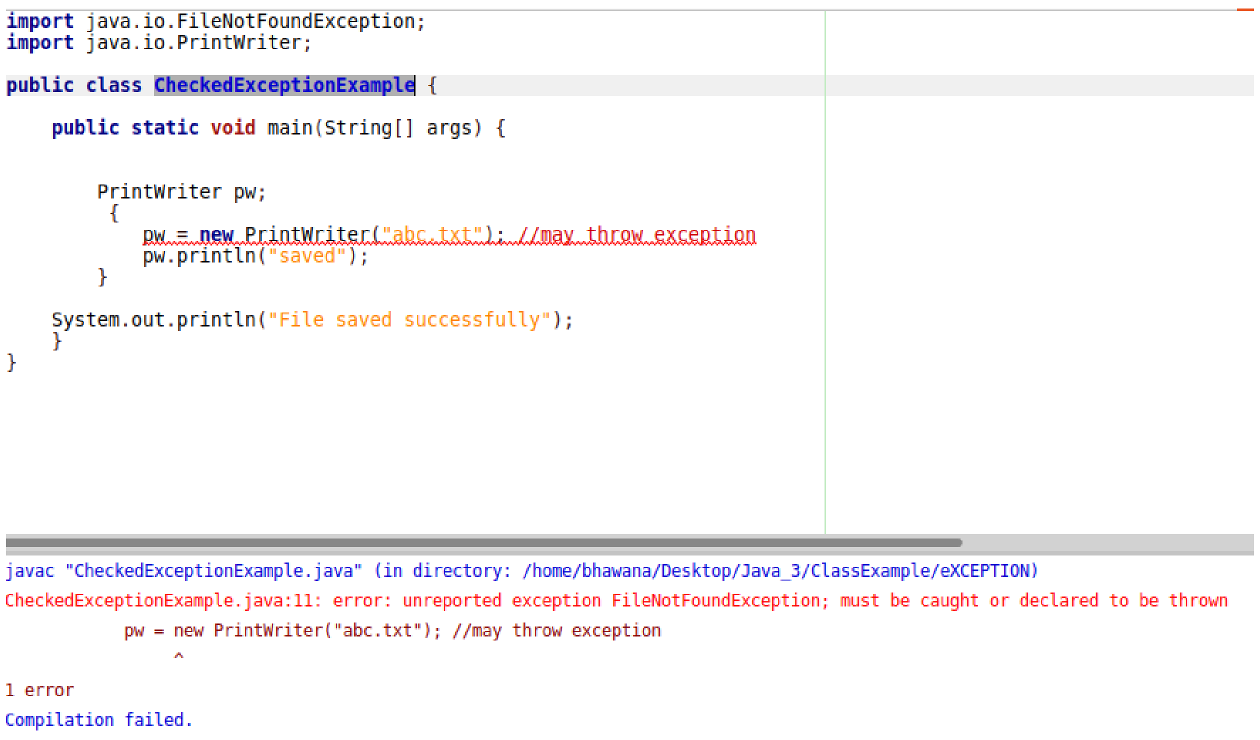
Example 4:



```
import java.util.Scanner;
class ExceptionExampleDiv {
public static void main(String[] args) {
int a,b, result;
Scanner sc=new Scanner(System.in);
System.out.println("Enter two numbers:");
a=sc.nextInt();
b=sc.nextInt();
try {
result=a/b;
System.out.println("Result is :"+result);
}
catch(Exception e){
System.out.println("Exception is caught");
}

}


}
```

```
Enter two numbers:
1
0
Exception is caught


------------------
(program exited with code: 0)
Press return to continue
```

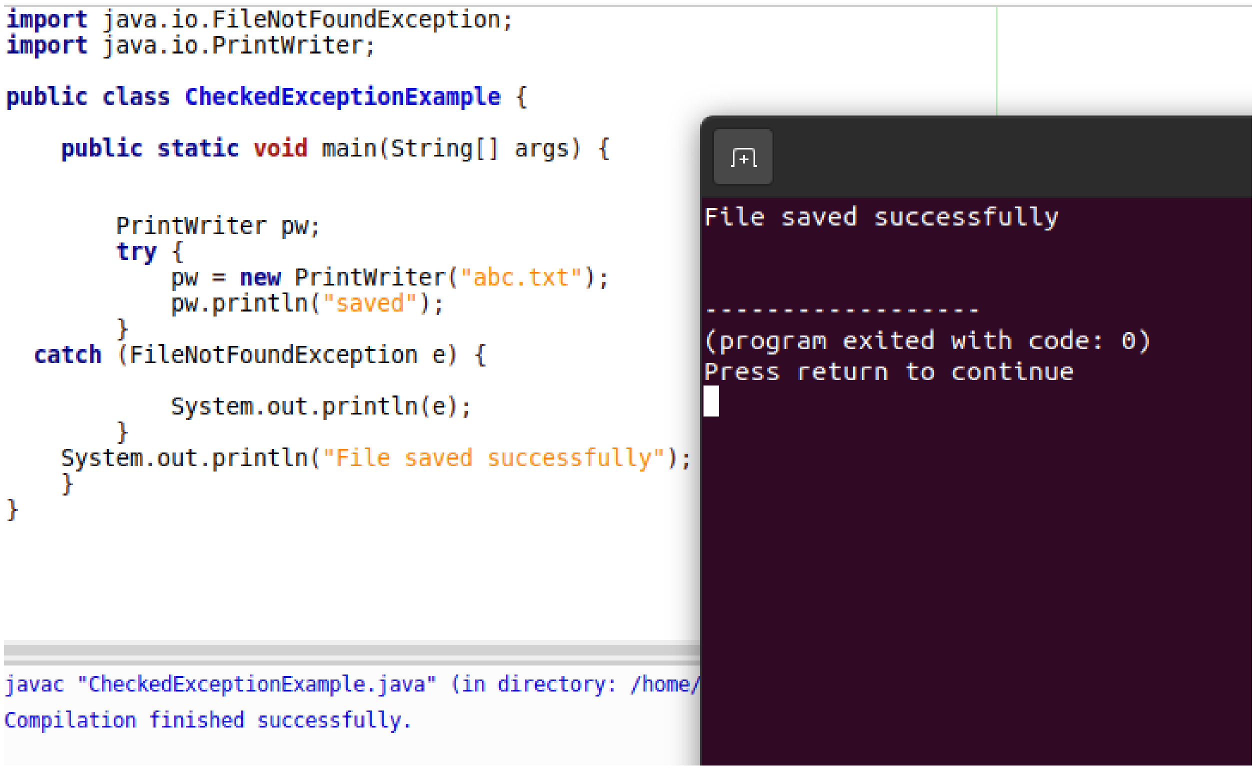
Example 5:(Checked exception)



```
import java.io.FileNotFoundException;
import java.io.PrintWriter;

public class CheckedExceptionExample {

    public static void main(String[] args) {


        PrintWriter pw;
         {
            pw = new PrintWriter("abc.txt"); //may throw exception
            pw.println("saved");
        }

    System.out.println("File saved successfully");
    }
}
```

```
javac "CheckedExceptionExample.java" (in directory: /home/bhawana/Desktop/Java_3/ClassExample/eXCEPTION)
CheckedExceptionExample.java:11: error: unreported exception FileNotFoundException; must be caught or declared to be thrown
            pw = new PrintWriter("abc.txt"); //may throw exception
                 ^
1 error
Compilation failed.
```

For solving:



```
import java.io.FileNotFoundException;
import java.io.PrintWriter;

public class CheckedExceptionExample {

    public static void main(String[] args) {


        PrintWriter pw;
        try {
            pw = new PrintWriter("abc.txt");
            pw.println("saved");
        }
  catch (FileNotFoundException e) {

            System.out.println(e);
        }
    System.out.println("File saved successfully");
    }
}
```

```
javac "CheckedExceptionExample.java" (in directory: /home/
Compilation finished successfully.
```

```
File saved successfully


------------------
(program exited with code: 0)
Press return to continue
```

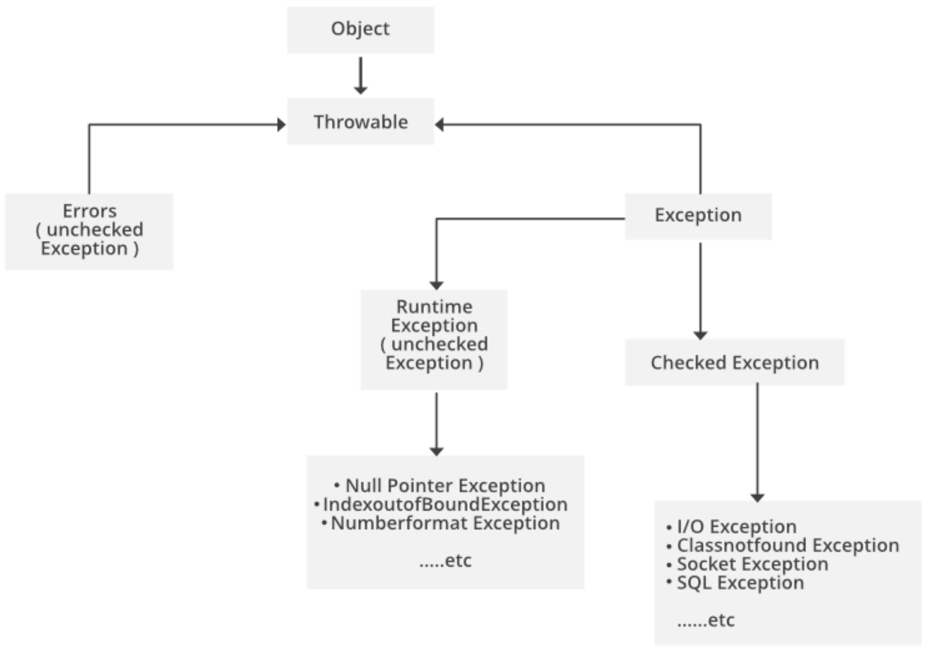
Saved location:

Java Exception Keywords:

Keyword	**Description**
try	This keyword is used to specify a block and this block must be followed by either catch or finally. That is, we can’t use try block alone.

catch	This keyword must be preceded by a try block to handle the exception and can be followed by a final block later.
finally	This keyword is used to execute the program, whether an exception is handled or not.
throw	This keyword is used to throw an exception.
throws	This keyword is used to declare exceptions.

Exception Classes:

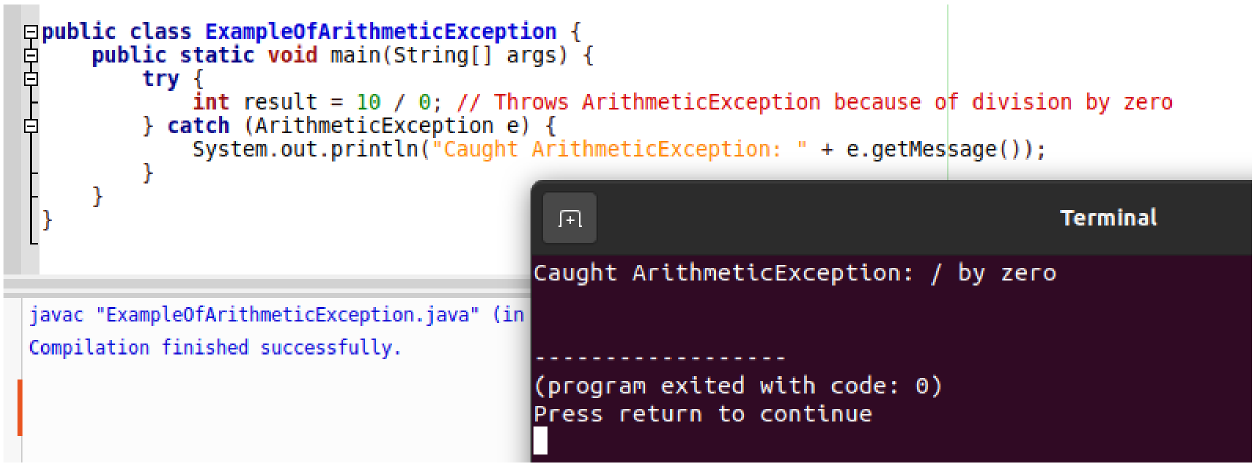


Different Scenarios of Exception:

1. ArithmeticException

   It occurs when there is exceptional condition in arithmetic operations such as division or modulo. Example: Division by zero or modulo operation with a zero divisor.

   int a=10/0;
   Program:



```
public class ExampleOfArithmeticException {
    public static void main(String[] args) {
        try {
            int result = 10 / 0; // Throws ArithmeticException because of division by zero
        } catch (ArithmeticException e) {
            System.out.println("Caught ArithmeticException: " + e.getMessage());
        }
    }
}
```

```
javac "ExampleOfArithmeticException.java" (in
Compilation finished successfully.
```

Terminal

```
Caught ArithmeticException: / by zero


------------------
(program exited with code: 0)
Press return to continue
```

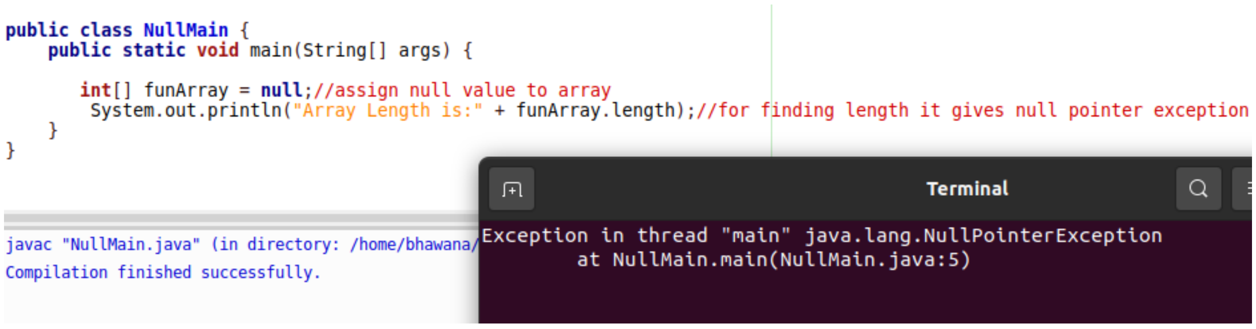
2. NullPointerException

   It occurs when you try to access an object reference that is null. For eg. if we try to call a method or access a field on a variable that is not initialized as:

   String name=null;

   System.out.println(name.length());

   Program Example:



```
public class NullMain {
    public static void main(String[] args) {

        int[] funArray = null;//assign null value to array
         System.out.println("Array Length is:" + funArray.length);//for finding length it gives null pointer exception
    }
}
```

```
javac "NullMain.java" (in directory: /home/bhawana/
Compilation finished successfully.
```

Terminal

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

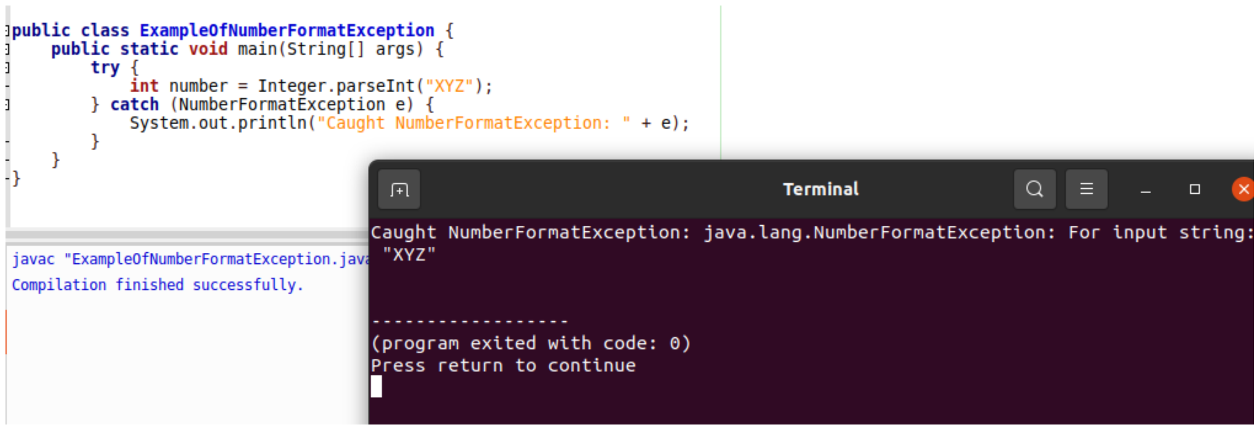
3. NumberFormatException

   It occurs when you try to convert a string to a numeric type, but the string donot have a valid numeric format.
   Eg. parsing a non-numeric string using Integer.parseInt() or Double.parseDouble().

   String name="abc";

   int i=Integer.parseInt(name);

   Program Example:



```
public class ExampleOfNumberFormatException {
    public static void main(String[] args) {
        try {
            int number = Integer.parseInt("XYZ");
        } catch (NumberFormatException e) {
            System.out.println("Caught NumberFormatException: " + e);
        }
    }
}
```

```
javac "ExampleOfNumberFormatException.java
Compilation finished successfully.
```

```
Caught NumberFormatException: java.lang.NumberFormatException: For input string:
 "XYZ"


------------------
(program exited with code: 0)
Press return to continue
```

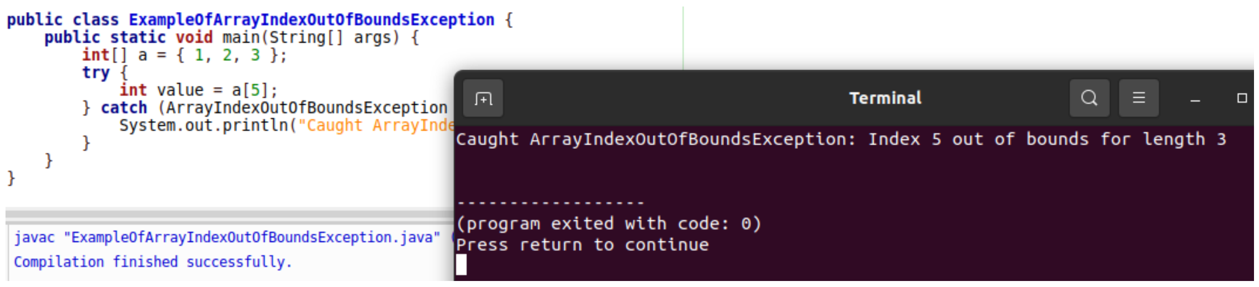
4. ArrayIndexOutOfBoundsException

   It occurs when we try to access an invalid index of an array. Eg. Accessing an element at an index that is outside the bounds of the array as:

   int a[]=new int[5];

   a[7]=12;

   Program Example:



```
public class ExampleOfArrayIndexOutOfBoundsException {
    public static void main(String[] args) {
        int[] a = { 1, 2, 3 };
        try {
            int value = a[5];
        } catch (ArrayIndexOutOfBoundsException
            System.out.println("Caught ArrayInde
        }
    }
}
```

```
javac "ExampleOfArrayIndexOutOfBoundsException.java"
Compilation finished successfully.
```

```
Caught ArrayIndexOutOfBoundsException: Index 5 out of bounds for length 3


------------------
(program exited with code: 0)
Press return to continue
```

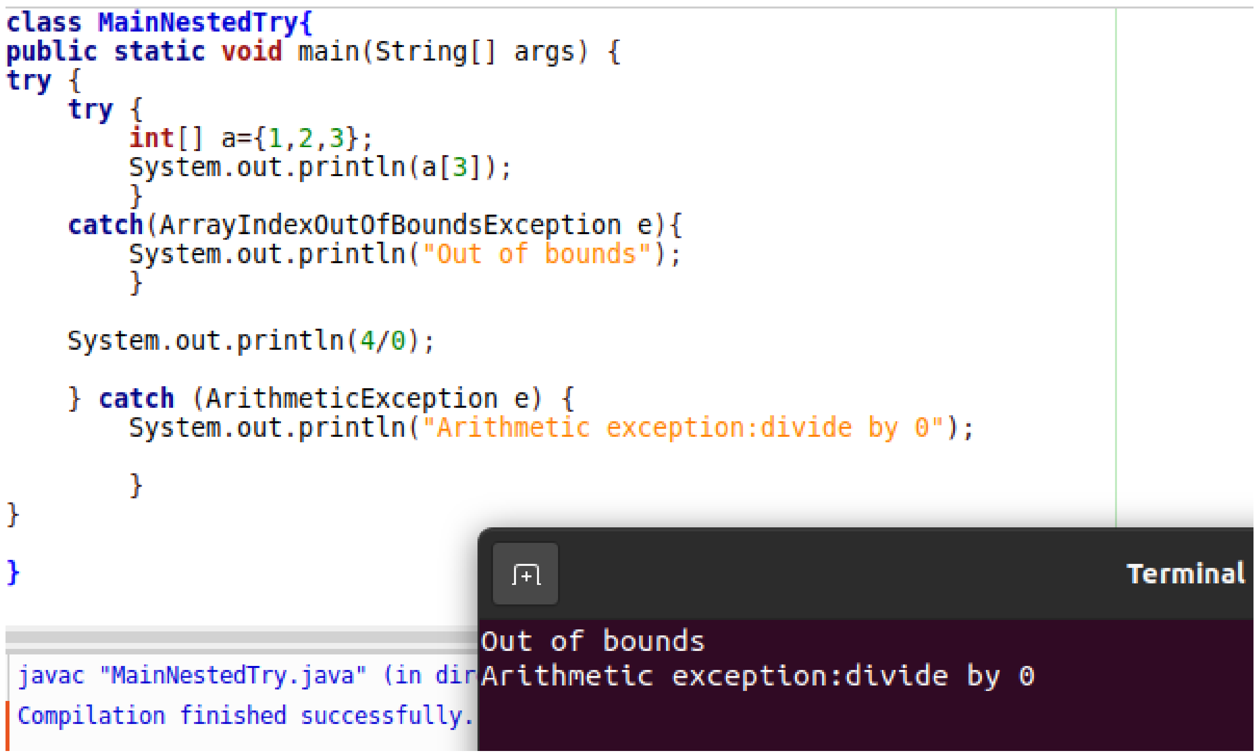
There are other exceptions like as IllegalArgumentException, ClassNotFoundException, UnsupportedOperationException etc.

Nested try block:

It is used to specify a try block inside try block where we should place exception code.

We can one type of exception in inner block and another type of exception in outer block.

Example:



```
class MainNestedTry{
public static void main(String[] args) {
try {
    try {
        int[] a={1,2,3};
        System.out.println(a[3]);
        }
    catch(ArrayIndexOutOfBoundsException e){
        System.out.println("Out of bounds");
        }

    System.out.println(4/0);

    } catch (ArithmeticException e) {
        System.out.println("Arithmetic exception:divide by 0");

        }
}

}
```

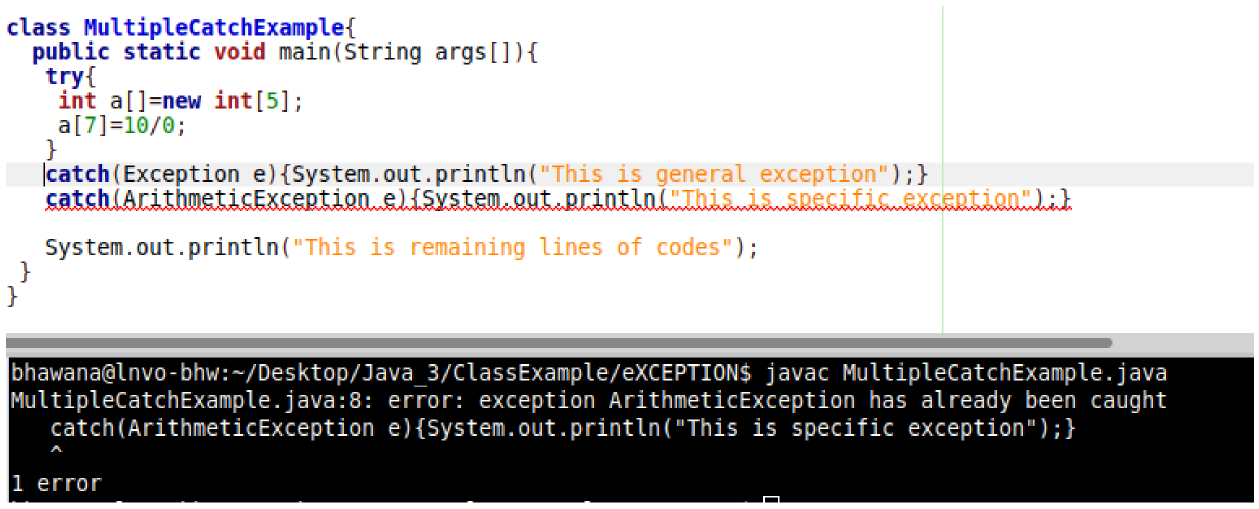
```
javac "MainNestedTry.java" (in dir
Compilation finished successfully.
```

```
Out of bounds
Arithmetic exception:divide by 0
```

Multi catch block

- We can use multiple catch blocks followed by try block.
- For performing different tasks during different exception, multi-catch block is used.
- Each catch block should have different exception handler.
- During one time, only one exception handler is executed. Also, all catch blocks must be specified from specific to general.

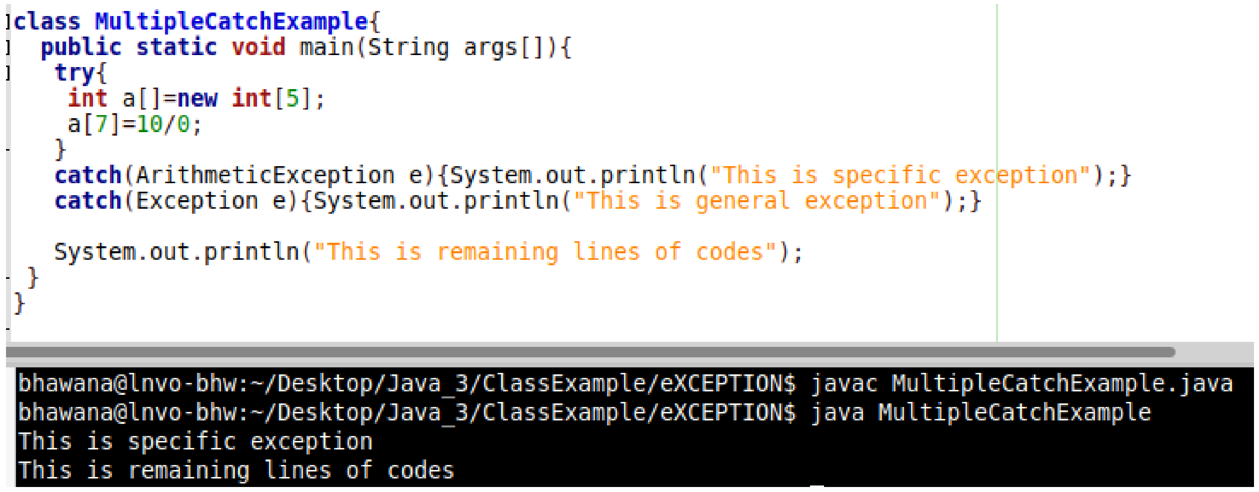
Example 1:



```
class MultipleCatchExample{
  public static void main(String args[]){
   try{
    int a[]=new int[5];
    a[7]=10/0;
   }
   catch(Exception e){System.out.println("This is general exception");}
   catch(ArithmeticException e){System.out.println("This is specific exception");}

   System.out.println("This is remaining lines of codes");
  }
}
```

```
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ javac MultipleCatchExample.java
MultipleCatchExample.java:8: error: exception ArithmeticException has already been caught
   catch(ArithmeticException e){System.out.println("This is specific exception");}
   ^
1 error
```

Corrected code :



```
class MultipleCatchExample{
  public static void main(String args[]){
   try{
    int a[]=new int[5];
    a[7]=10/0;
   }
   catch(ArithmeticException e){System.out.println("This is specific exception");}
   catch(Exception e){System.out.println("This is general exception");}

   System.out.println("This is remaining lines of codes");
  }
}
```

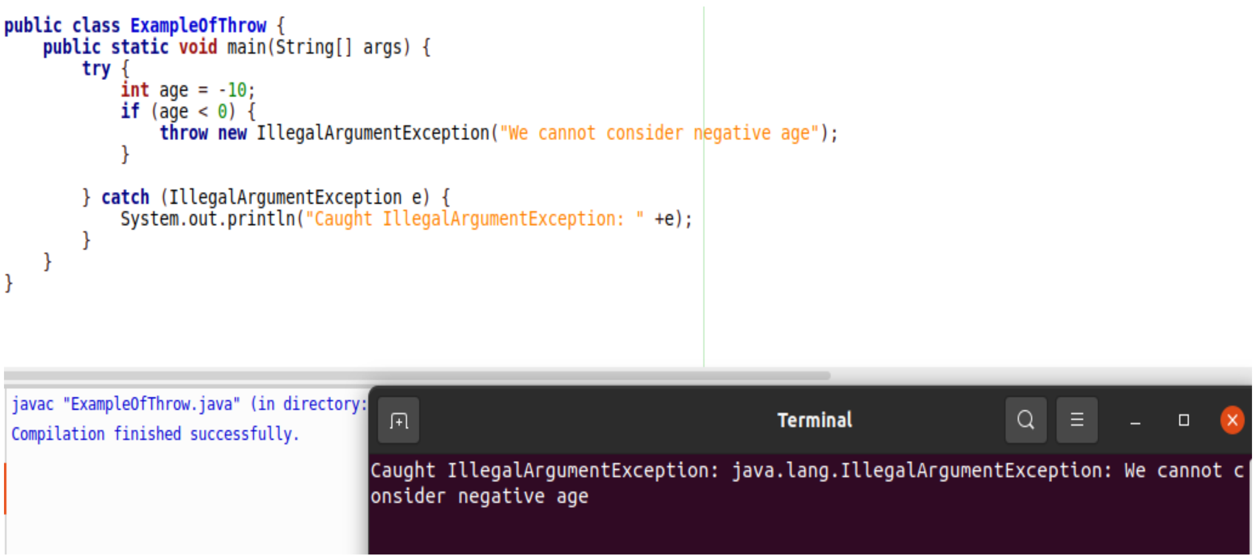
```
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ javac MultipleCatchExample.java
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ java MultipleCatchExample
This is specific exception
This is remaining lines of codes
```

Throw and throws in exception handling:

Throw:

- The ‘throw’ keyword is used to throw an exception in Java.
- Syntax: throw exceptionObject;
- Eg. throw new IllegalArgumentException(“Invalid Input”);

Program Example1:



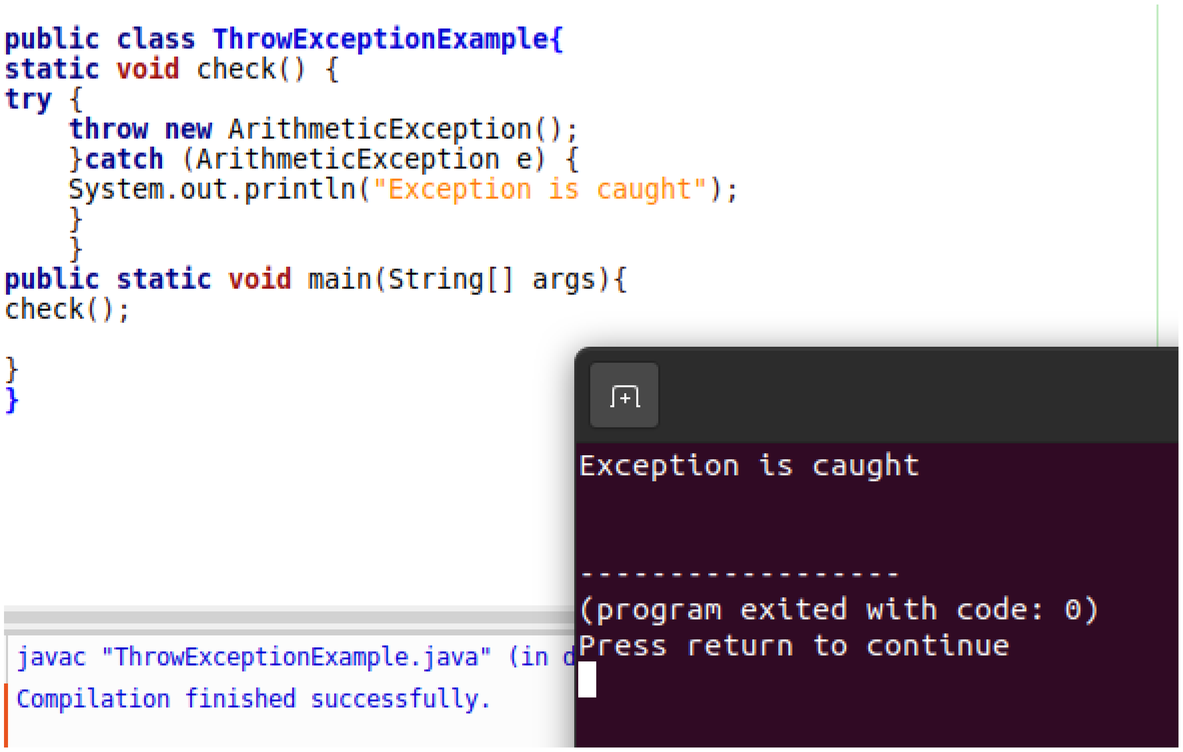
```
public class ExampleOfThrow {
    public static void main(String[] args) {
        try {
            int age = -10;
            if (age < 0) {
                throw new IllegalArgumentException("We cannot consider negative age");
            }

        } catch (IllegalArgumentException e) {
            System.out.println("Caught IllegalArgumentException: " +e);
        }
    }
}
```

```
javac "ExampleOfThrow.java" (in directory:
Compilation finished successfully.
```

Terminal

```
Caught IllegalArgumentException: java.lang.IllegalArgumentException: We cannot c
onsider negative age
```

Program Example 2:



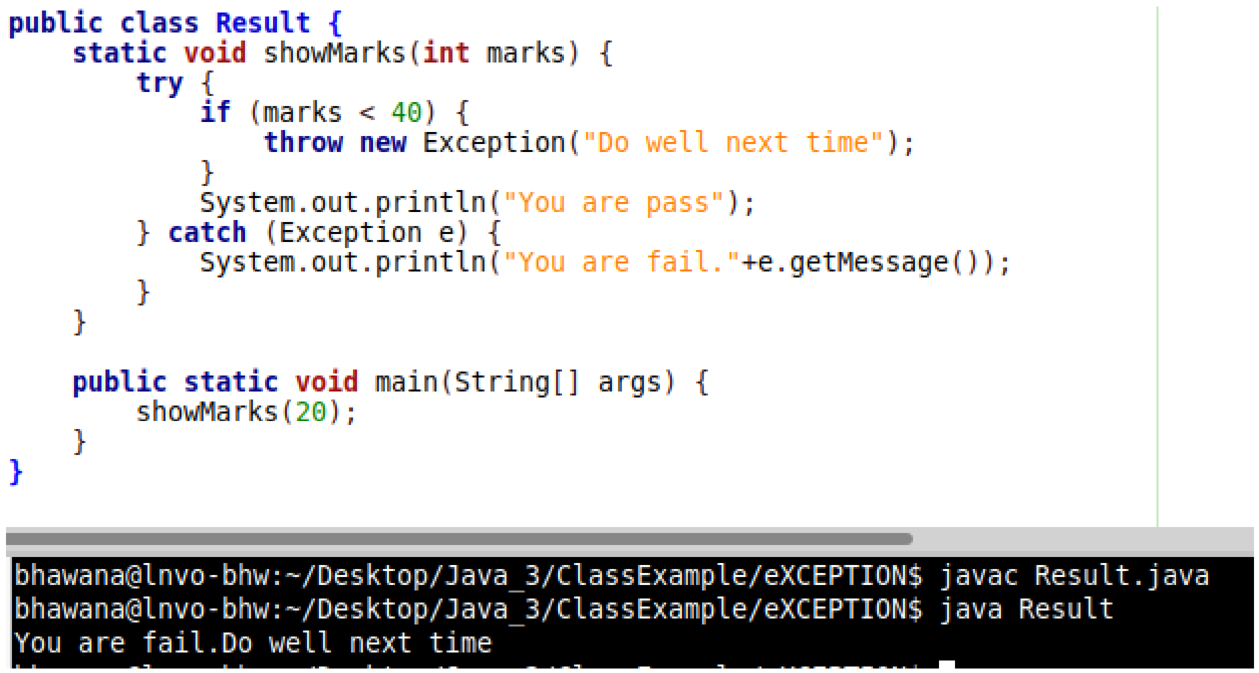
```
public class ThrowExceptionExample{
static void check() {
try {
    throw new ArithmeticException();
    }catch (ArithmeticException e) {
    System.out.println("Exception is caught");
    }
    }
public static void main(String[] args){
check();

}
}
```

```
javac "ThrowExceptionExample.java" (in d
Compilation finished successfully.
```

```
Exception is caught


------------------
(program exited with code: 0)
Press return to continue
```

Example 3:

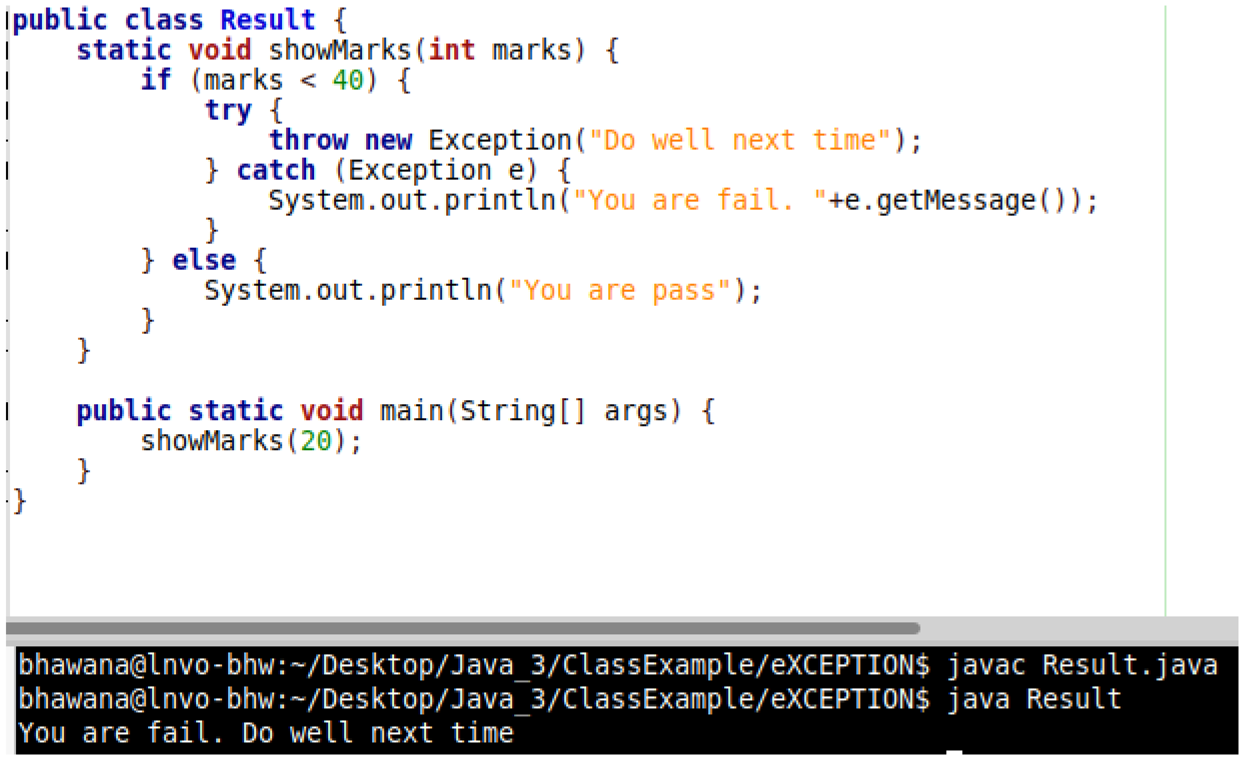
Method 1:



```java
public class Result {
    static void showMarks(int marks) {
        try {
            if (marks < 40) {
                throw new Exception("Do well next time");
            }
            System.out.println("You are pass");
        } catch (Exception e) {
            System.out.println("You are fail."+e.getMessage());
        }
    }

    public static void main(String[] args) {
        showMarks(20);
    }
}
```

```
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ javac Result.java
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ java Result
You are fail.Do well next time
```

Method 2:

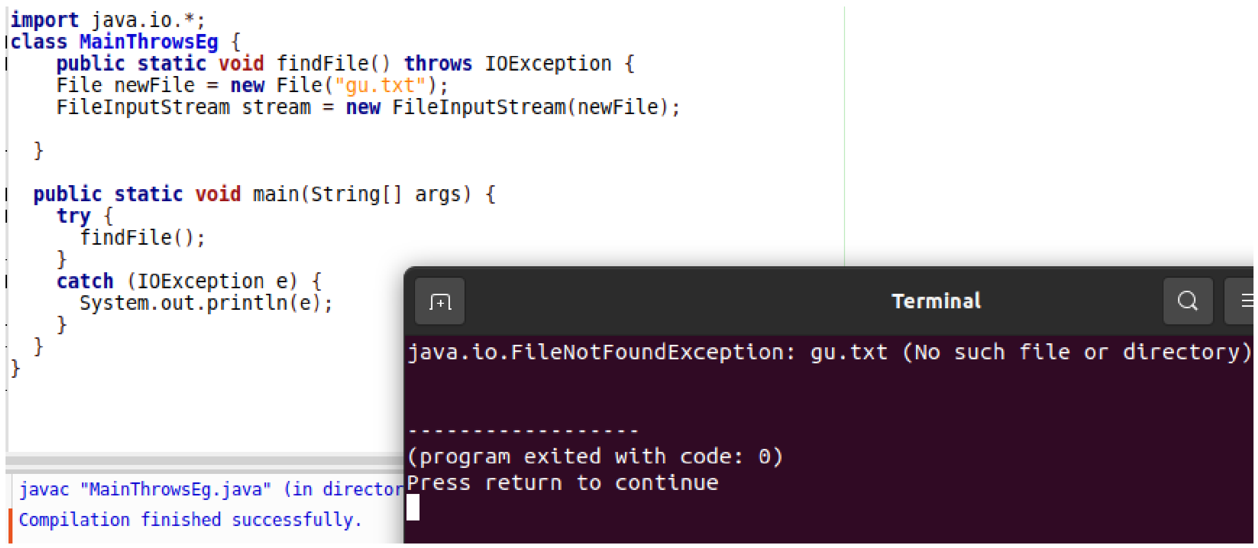


```java
public class Result {
    static void showMarks(int marks) {
        if (marks < 40) {
            try {
                throw new Exception("Do well next time");
            } catch (Exception e) {
                System.out.println("You are fail. "+e.getMessage());
            }
        } else {
            System.out.println("You are pass");
        }
    }

    public static void main(String[] args) {
        showMarks(20);
    }
}
```

```
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ javac Result.java
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ java Result
You are fail. Do well next time
```

Throws keyword:

The ‘throws’ keyword is used in method signature for declaring the checked exception that a method might throw.
Syntax: returnType methodname(parameters) throws exceptiontype;
Program Example1:



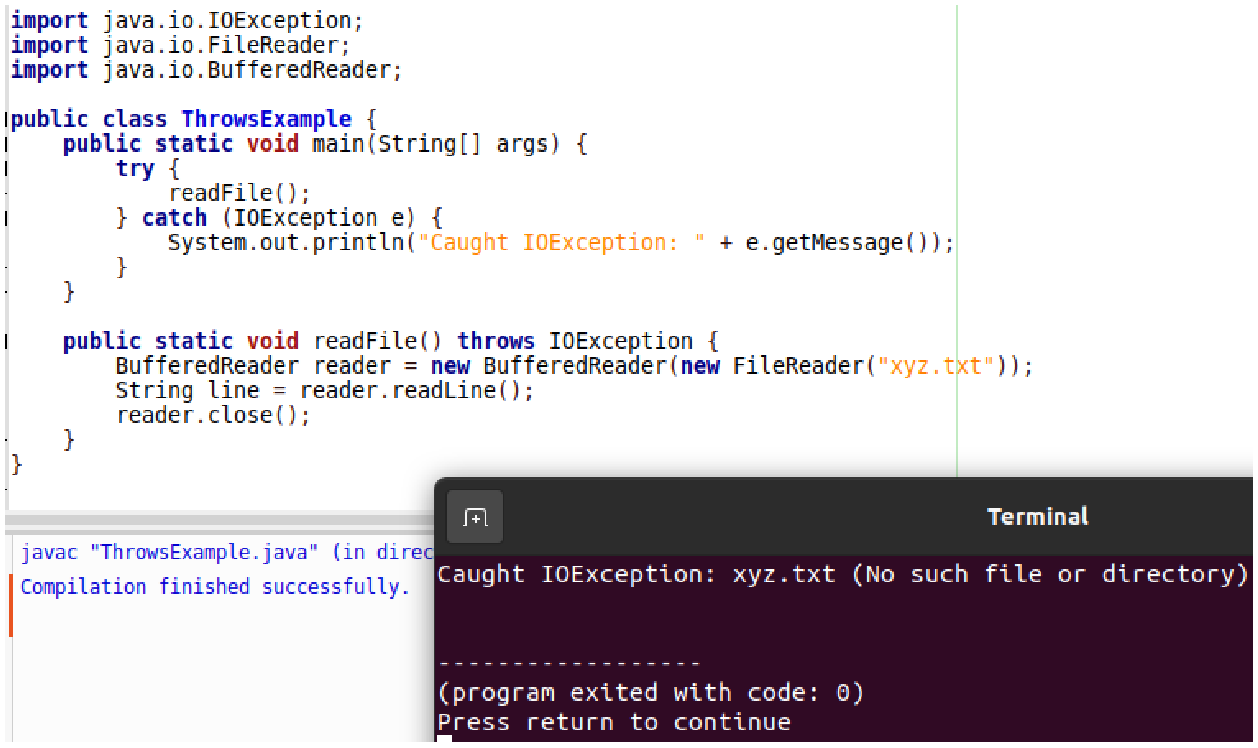
```
import java.io.*;
class MainThrowsEg {
    public static void findFile() throws IOException {
    File newFile = new File("gu.txt");
    FileInputStream stream = new FileInputStream(newFile);

  }

  public static void main(String[] args) {
    try {
      findFile();
    }
    catch (IOException e) {
      System.out.println(e);
    }
  }
}
```

```
javac "MainThrowsEg.java" (in director
Compilation finished successfully.
```

Terminal

```
java.io.FileNotFoundException: gu.txt (No such file or directory)


------------------
(program exited with code: 0)
Press return to continue
```

Program Example 2:



```
import java.io.IOException;
import java.io.FileReader;
import java.io.BufferedReader;

public class ThrowsExample {
    public static void main(String[] args) {
        try {
            readFile();
        } catch (IOException e) {
            System.out.println("Caught IOException: " + e.getMessage());
        }
    }

    public static void readFile() throws IOException {
        BufferedReader reader = new BufferedReader(new FileReader("xyz.txt"));
        String line = reader.readLine();
        reader.close();
    }
}
```

```
javac "ThrowsExample.java" (in direc
Compilation finished successfully.
```

Terminal

```
Caught IOException: xyz.txt (No such file or directory)


------------------
(program exited with code: 0)
Press return to continue
```

Differences between throw and throws

	Throw	Throws
1.	It is used inside method to throw exception explicitly.	It is used in method signatures to declare that methods may throw checked exceptions.
2.	It is used to raise custom or built in exception when needed.	It is used to declare checked exception that can be handled by calling code.
3.	It cannot throw multiple exception at a time.	It can declare multiple exceptions.
4.	Checked exception can't be propagated using throw only.	Checked exception can be propagated.

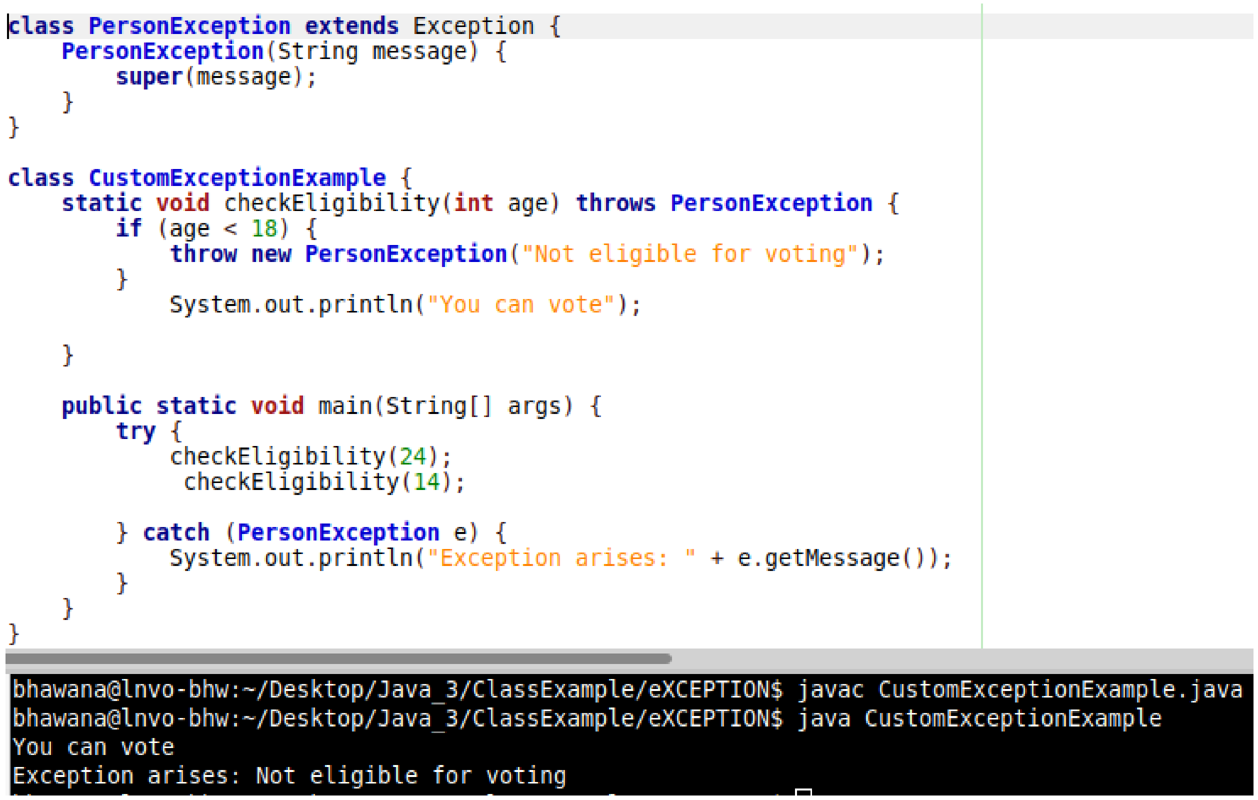
Custom Exception:

We can create our own exceptions in Java.

Syntax:

```
class CustomExample extends Exception {}
```

Example:



```
class PersonException extends Exception {
    PersonException(String message) {
        super(message);
    }
}

class CustomExceptionExample {
    static void checkEligibility(int age) throws PersonException {
        if (age < 18) {
            throw new PersonException("Not eligible for voting");
        }
            System.out.println("You can vote");

    }

    public static void main(String[] args) {
        try {
            checkEligibility(24);
             checkEligibility(14);

        } catch (PersonException e) {
            System.out.println("Exception arises: " + e.getMessage());
        }
    }
}
```

```
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ javac CustomExceptionExample.java
bhawana@lnvo-bhw:~/Desktop/Java_3/ClassExample/eXCEPTION$ java CustomExceptionExample
You can vote
Exception arises: Not eligible for voting
```

Questions of Exception Handling:

1. Write a program that takes two integers as input from the user and divides them. Handle the ArithmeticException in case of division by zero.
2. Write a program that reads a name from the user and greets including "Welcome first semester students". Handle the IOException in case of an error while reading the input.

Assignment:

3. Write a program to read a string from the user and convert it to an integer. Handle the NumberFormatException in case the input is not a valid integer.
4. Write a program that reads two strings from the user and concatenates them. If either of the strings is null, throw a NullPointerException.
5. Write a program that reads a list of numbers from the user and calculates their sum. Handle the NumberFormatException and ArithmeticException in case of invalid input or division by zero.
6. Write a program with a method divide(int x, int y) that takes two integers as input and returns their division. If the second integer b is zero, throw an IllegalArgumentException.
7. Define exception handling in Java. Why is exception handling needed in Java programming?
8. How can you handle the exceptions in Java? Explain.
9. Write a Java program illustrating try, catch and finally blocks for exception handling.
10. Write a Java program illustrating the use of multiple catch blocks for handling different types of exception.
11. Write a Java program making the use of throw keyword for manually throwing an exception.
12. Explain checked and unchecked exceptions with example of each.