Introduction to Computer Programming (Java A)

LAB14

Suppose that you want to use a `java.io.BufferedReaderto` read the text from a disk file.

The program did not handle the exception declared, which resulted in compilation error.

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

class ReadTextFile
{
    public static void main ( String[] args )
    {
        String fileName = "sample.txt" ;
        String line;

        // Create a BufferedReader and Attach a file
        BufferedReader in = new BufferedReader( new FileReader( fileName  ) );

        // while not end of file
        while ((line=in.readLine())!=null)
            System.out.println(line);

        // close the file
        in.close();


    }
}
```

Run result:

```
G:\2020Spring\CS102A\LAB14\LAB14_CODE\src>javac ReadTextFile.java
ReadTextFile.java:15: 错误：未报告的异常错误FileNotFoundException; 必须对其进行捕获或声明以便抛出
            BufferedReader in = new BufferedReader( new FileReader( fileName  ) );
                                                    ^
ReadTextFile.java:18: 错误：未报告的异常错误IOException; 必须对其进行捕获或声明以便抛出
            while ((line=in.readLine())!=null)
                                       ^
ReadTextFile.java:23: 错误：未报告的异常错误IOException; 必须对其进行捕获或声明以便抛出
            in.close();
                     ^
3 个错误
```

Why?

Because the FileReader's constructor, the readLine() , and the close () declare exceptions.

If a method declares an exception in its signature, you cannot use this method without handling the exception - you can't compile the program.

Fortunately, there are two ways to solve this problem.

Method 1

Catch the exception via a "try-catch" (or "try-catch-finally") construct.

```
try {
   // Main logic here
   open file;
   process file;
   ......
} catch (FileNotFoundException ex) {   // Exception handlers below
   // Exception handler for "file not found"
} catch (IOException ex) {
   // Exception handler for "IO errors"
} finally {
  close file;      // always try to close the file
}
```

try-cathc-finally construct

Rewrite the previous code according to this structure to add exception handling.

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

class ReadTextFileWithCatch
{
    public static void main ( String[] args )
    {
        String fileName = "sample.txt" ;
        String line;
        BufferedReader in = null;
        try
        {
            // Create a BufferedReader and Attach a file
            in = new BufferedReader( new FileReader( fileName  ) );

            // while not end of file
            while ((line=in.readLine())!=null)
                System.out.println(line);

        }
        catch (FileNotFoundException ex )
        {
            System.out.println("There is no this file!");
        }
        catch (IOException ex){
            System.out.println("Read file exception!");
        }
        // close the file
        finally {
            System.out.println("close the file ");
            if (in != null)
            {
                try{
                    in.close();
                }
```

```
                catch (IOException ex){
                    System.out.println("file close IOException ");
                }

            }
        }
    }
}
```

Take note that the main logic in the try-block is separated from the error handling codes in the catch-block.

Method2

You decided not to handle the exception in the current method, but throw the exception up the call stack for the next higher-level method to handle.

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

class ReadTextFileWithThrow
{
    public static void main ( String[] args ) throws IOException
    {
        String fileName = "sample.txt" ;
        String line;
        // Create a BufferedReader and Attach a file
        BufferedReader in = new BufferedReader( new FileReader( fileName  ) );
        // while not end of file
        while ((line=in.readLine())!=null){
            System.out.println(line);
        }
        // close the file
        in.close();

    }
}
```

In this case, the next higher-level method of `main()` is the `JVM`.

Call Stack for exception

Run the following code to see call stack of the exception.

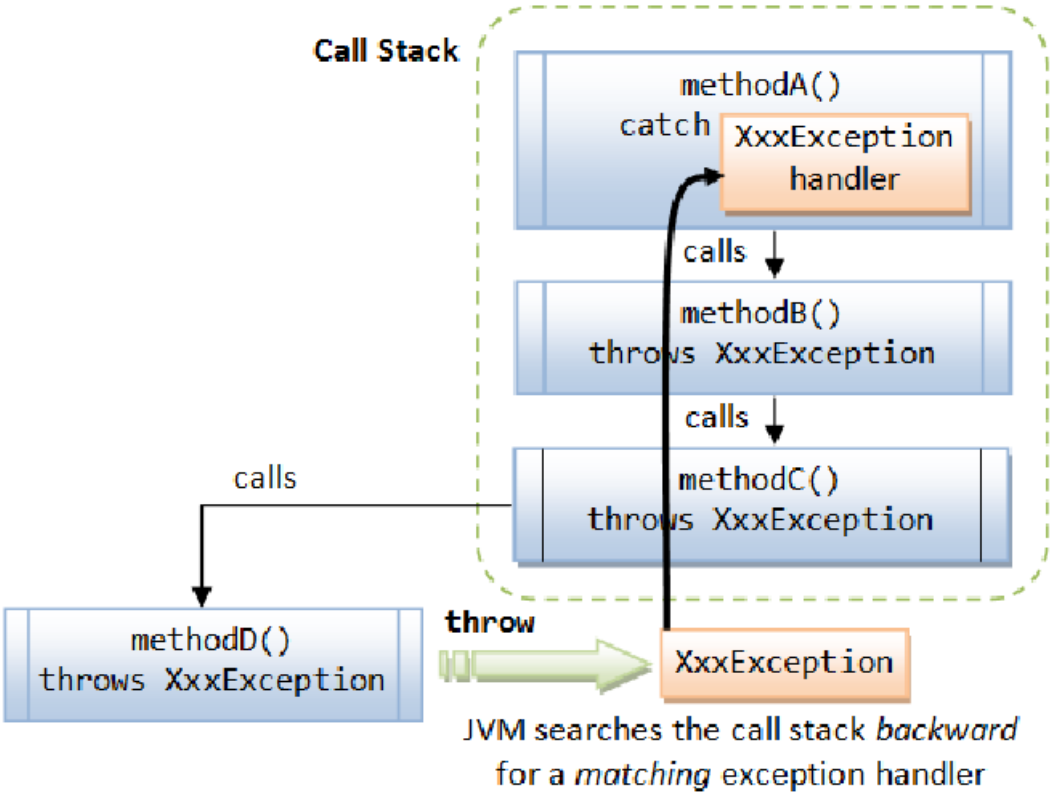
```
public class MethodCallStackDemo {
     public static void main(String[] args) {
          System.out.println("Enter main()");
          methodA();
          System.out.println("Exit main()");
       }

       public static void methodA() {
          System.out.println("Enter methodA()");
          try {
```

```
            methodB();
        }catch(ArithmeticException ex) {
            System.out.println(ex.toString());
        }

        System.out.println("Exit methodA()");
    }
    public static void methodB() throws ArithmeticException{
        System.out.println("Enter methodB()");
        methodC();
        System.out.println("Exit methodB()");
    }
    public static void methodC() throws ArithmeticException {
        System.out.println("Enter methodC()");
         methodD();
        System.out.println("Exit methodC()");
    }

    public static void methodD() throws ArithmeticException {
        System.out.println("Enter methodD()");
        // divide-by-0 triggers an ArithmeticException
        System.out.println(1 / 0);
        System.out.println("Exit methodD()");
    }
}
```

Run result:

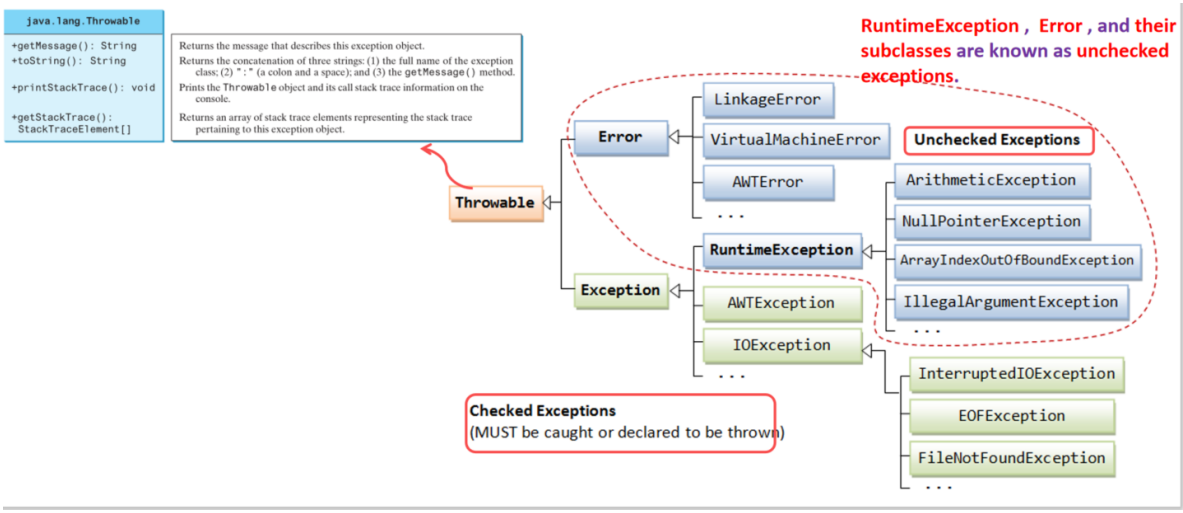
```
Enter main()
Enter methodA()
Enter methodB()
Enter methodC()
Enter methodD()
java.lang.ArithmeticException: / by zero
Exit methodA()
Exit main()
```

The following picture is a good explanation of the procedure for calling the stack of exceptions.



Exception Classes - Throwable, Error, Exception & RuntimeException

The figure below shows the hierarchy of the Exception classes. The base class for all Exception objects is `java.lang.Throwable`, together with its two subclasses `java.lang.Exception` and `java.lang.Error`.



- The `Error` class describes internal system errors.
- The `Exception` class describes the error caused by your program.

- `RuntimeException` , `Error`, and their subclasses are known as unchecked exceptions.
- All other exceptions are known as checked exceptions, meaning the compiler forces the programmer to check and deal with them in a try-catch block or declare it in the method header

Five keywords are used in exception handling: **try, catch, finally, throws** and **throw** (take note that there is a difference between `throw` and `throws`).

Java's exception handling consists of three operations:

1. Declaring exceptions;
2. Throwing an exception; and
3. Catching an exception.

The exception info is helpful to debug, it tells:

1) Exception type

- Arithmetic
- ArrayIndexOutOfBound
- NegativeArraySizeException
- NullPointerException
- NumberFormatException

2) Exception reason

- Dived by zero
- out of array Index bounds
- ...

3) Exception place

To further familiarize you with common exceptions, we define common exceptions as enumerations and write a program that selectively trigger exceptions.

```
public class CommonExceptionDemo {

    public static void main(String[] args) {

        ExceptionEnum exceptionIndex = ExceptionEnum.CLASSCAST;
        switch(exceptionIndex)
        {
        case ARITHMETIC:
            {
                System.out.println(1/0);
            }
            break;

        case INDEXOUTOFBOUNDS:
            {
                int[] anArray = new int[3];
                System.out.println(anArray[3]);
            }

            break;
        case NEGATIVEARRAYSIZE:
            {
                int[] anArray = new int[-1];
            }
            break;
        case NULLPOINTER:
            {
                String[] strs = new String[3];
                System.out.println(strs[0].length());
            }

            break;
```

```
        case NUMBERFORMAT:
            {
                Integer.parseInt("abc");
            }
            break;
        case CLASSCAST:
            {
                Object o = new Object();
                Integer i = (Integer)o;
            }

            break;
        }

    }
}

enum ExceptionEnum {
    ARITHMETIC,
    INDEXOUTOFBOUNDS,
    NEGATIVEARRAYSIZE,
    NULLPOINTER,
    NUMBERFORMAT,
    CLASSCAST
   ;
}
```

You can change the value of `exceptionIndex` to learn about the various common exceptions.

Lab exercise

Modify the program `CommonExceptionDemo.java` to accomplish the following tasks:

1. Display the info(name and ordinal value) of every element in a enum “ExceptionEnum”.
2. Ask user to input a integer.
3. According to the value of user’s input, trigger the Exception and show its information.
4. While get the input value use `try` and `catch` to check:
    - If the input is not a number trigger `InputMismatchException`, Catch it and print the Exception message.
    - If the input is in a number but its value is not Between 0 and 5,Throw an `IllegalArgumentException`,Catch it and print the exception message.

The sample inputs and outputs are as follows:

```
Exception:
    ARITHMETIC(0)
    INDEXOUTOFBOUNDS(1)
    NEGATIVEARRAYSIZE(2)
    NULLPOINTER(3)
    NUMBERFORMAT(4)
    CLASSCAST(5)

Please INPUT an integer to select the TYPE OF EXCEPTION(0~5):1
Here is End
Exception in thread "main" java.lang.ArrayIndexOutOfBoundsException: 3
    at CommonExceptionDemo.main(CommonExceptionDemo.java:29)
```

```
Exception:
    ARITHMETIC(0)
    INDEXOUTOFBOUNDS(1)
    NEGATIVEARRAYSIZE(2)
    NULLPOINTER(3)
    NUMBERFORMAT(4)
    CLASSCAST(5)

Please INPUT an integer to select the TYPE OF EXCEPTION(0~5):6
java.lang.IllegalArgumentException
Here is End
```

```
Exception:
    ARITHMETIC(0)
    INDEXOUTOFBOUNDS(1)
    NEGATIVEARRAYSIZE(2)
    NULLPOINTER(3)
    NUMBERFORMAT(4)
    CLASSCAST(5)

Please INPUT an integer to select the TYPE OF EXCEPTION(0~5):c
java.util.InputMismatchException
Here is End
```