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Java Foundations

8-3

Exception Handling

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Objectives

- This lesson covers the following objectives:
  - Explain the purpose of exception handling
  - Handle exceptions with a try/catch construct
  - Describe common exceptions thrown in Java

What Is an Exception?

- To understand exception handling, you need to first understand what is an exception
- An exception is an error that occurs during the execution of a program(run-time) that disrupts the normal flow of the Java program
- However, you can handle such conditions within your program and take necessary corrective actions so that the program can continue with its execution(exception handling)

Why Should You Handle Exceptions?

- If an exception occurs while your program is executing:
  - Execution of the program is terminated
  - A stack trace, with the details of the exception, is printed in the console

When You Don't Handle Exceptions: Example

- In Java, the following code throws an exception because you can't divide an integer by zero:

```
1 public class ExceptionHandling {
2
3   public static void main(String args[]) {
4       int d = 0;
5       int a = 10 / d;
6       System.out.print(a);
7   }//end method main
8 }//end class ExceptionHandling
```

Exception occurs at this statement

This statement isn't executed

- A stack trace, with the details of the exception, is printed in the console
- Execution of the program is terminated at line 4, and so the statement at line 5 isn't executed

In this example, the following stack trace is printed:

```
Exception in thread "main" java.lang.ArithmeticException: / by
zero at
com.example.ExceptionHandling.main(ExceptionHandling.java:4)
```

When You Don’t Handle Exceptions

- When Java encounters an error or condition that prevents execution from proceeding normally, Java "throws" an exception
- If the exception isn't "caught" by the programmer, the program crashes
- The exception description and current stack trace are printed to the console

Dealing with Exceptions

- One way to deal with exceptions is to simply avoid them in the first place
- For example, avoid an ArithmeticException by using conditional logic:
  - Test to see if the condition will arise before you attempt the potentially risky operation

```
int divisor = 0;

if(divisor == 0){
   System.out.println("Can't be zero!");
}
else {
   System.out.println(5 / divisor);
}//endif
```

Exception Categories

- Java exceptions fall into two categories:
- Checked Exceptions:
  - Compiler checks and deals with exceptions
  - If the exceptions aren't handled in the program, it gives a compilation error
  - Examples:
    - `FileNotFoundException`, `IOException`
- Unchecked Exceptions:
  - Compiler does not check and deal with exceptions
  - Examples:
    - `ArrayIndexOutOfBoundsException`, `NullPointerException`, `ArithmeticException`

Exercise 1

- Import and open the `ExceptionsEx` project
- Examine `ExceptionEx1.java`:
  - Execute the program and observe the output:
  - ArrayIndexOutOfBoundsException occurs
  - Is it a good practice to handle the exception for this program?
  - Modify the program to compute the sum of the array

Handling Exceptions with the try/catch Block

- But not all exceptions can be prevented because you don't always know whether a given operation will fail before it's invoked
- Another strategy is to use the try/catch block for exception handling

Understanding the try/catch Block

- For code that's likely to cause an exception, you can write the code inside a special "try" block
- You associate exception handlers with a try block by providing one or more catch blocks after the try block
- Each catch block handles the type of exception indicated by its argument
- The ExceptionType argument type declares the type of exception

Flow Control in try/catch Blocks: Success

- If the try block succeeds, no exception occurs

```
try {
    // risky code that is likely to cause
    // an exception
}
catch(ExceptionType ex) {
    // exception handling code
}
System.out.println("We made it");
```

1

2

First the try block runs, and then the code after the catch block runs

Flow control skips over the `catch` block. The execution continues with the rest of the code outside the `catch` block.

Flow Control in try/catch Blocks: Failure

- If the try block fails, an exception occurs

```
try {
    //risky code that is likely to cause
    //an exception
}
catch(ExceptionType ex) {
    //exception handling code
}
System.out.println("We made it");
```

1
2
3

The try block runs, an exception occurs, and the rest of the try block doesn't run

The catch block runs, and then the rest of the code runs

Flow control immediately moves to the `catch` block. When the `catch` block is completed, execution of the rest of the code continues.

Flow Control in try/catch Blocks: Example

```
1 public static void main(String args[]) {
2    int a = 100, res;
3    try{
4        System.out.println("Enter the value for b");
5        Scanner console = new Scanner(System.in);
6        int b = console.nextInt();
7        System.out.println("Enter the value for c");
8        int c = console.nextInt();
9        res = 10 / (b - c);
10       System.out.println("The result is " + res);
11   }
12   catch(Exception e){
13       String errMsg = e.getMessage();
14       System.out.println(errMsg);
15   }//end try catch
16   System.out.println("After catch block");
17 }//end method main
```


In this example, a `try/catch` block was added to catch `ArithmeticException`. The example illustrates the program flow when the exception is handled with `try/catch`. `ArithmeticException` occurs at line 9.

- The control immediately passes to the `catch` block.
- Statement #10 in the `try` block isn't executed.
- Statements in the `catch` block are executed instead.
- The execution program continues with the statement outside the `catch` block, and "`After catch block`" is displayed in the console.

Examples of Exceptions

- java.lang.ArrayIndexOutOfBoundsException
  - Attempt to access a nonexistent array index
- java.lang.NullPointerException
  - Attempt to use an object reference that wasn't instantiated
- java.io.IOException
  - Failed or interrupted I/O operations

Here are just a few of the exceptions that Java can throw. You've probably seen one or more of these exceptions when you worked on the practices or exercises in this class.

Understanding Common Exceptions

- Unchecked Exceptions - due to programming mistake :
  - Example:
  - ArrayIndexOutOfBoundsException exception

```
01  int[] intArray = new int[5];
02  intArray[5] = 27;
```

  - Stack trace:

```
Exception in thread "main"
    java.lang.ArrayIndexOutOfBoundsException: 5
         at TestErrors.main(TestErrors.java:17)
)
```


This code shows a common mistake made when accessing an array. Remember that arrays are zero based (the first element is accessed by a zero index). Therefore, in an array with five elements, the last element is actually `intArray[4]`.
`intArray[5]` tries to access an element that doesn't exist, Java responds to this programming mistake by throwing an `ArrayIndexOutOfBoundsException` and the stack trace is printed to the console.
Because accessing an invalid index in the array is an unchecked exception, you don't have to handle the exception with the `try/catch` block.

Identifying NullPointerException

- This unchecked exception is thrown when an application attempts to use null when an object is required
- These include:
  - Calling the instance method of a null object
  - Accessing or modifying the field of a null object

Invoking the length method on a null object

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

    String name = null;
    System.out.print("Length of the string " + name.length());

}//end method main
```


A `NullPointerException` is thrown because a method is being invoked on a null value.

Identifying IOException

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

   try {
      File testFile = new File("//testFile.txt");
      testFile.createNewFile();
      System.out.println("testFile exists:“
                          + testFile.exists());
    }
    catch (IOException e) {
       System.out.println(e);
    }//end try catch
}//end method main
```


The slide example is handling the possible raised exception by:

- Throwing the exception from the `testCheckedException` method
- Catching the exception in the caller method

In this example, the `catch` block catches the exception because the path to the text file isn't correctly formatted. `System.out.println(e)` calls the `toString` method of the exception, and the result is `java.io.IOException`. That is, the file name, directory name, or volume label syntax is incorrect.

Best Practices for Exception Handling

- Try to be as specific as possible with the type of error you're trying to catch
- This allows the program to provide you with specific feedback on what went wrong
- Catch a generic exception is often too imprecise to be useful, but can be done as a last resort

```
catch (Exception e) {
     System.out.println(e);
}
```

Example of Bad Practice

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

   try {
      File testFile = new File("//testFile.txt");
      testFile.createNewFile();
      System.out.println("testFile exists:"
                         + testFile.exists());
    }
    catch (Exception e) {
      System.out.println("Error Creating File");
    }//end try catch
}//end method main
```

Catching any exception

No processing of exception class?

The code in the slide illustrates two poor exception-handling practices.

1. The `catch` clause catches an `Exception` type rather than an `IOException` type.
2. The `catch` clause doesn't analyze the `Exception` object. Instead, it simply assumes that the expected exception was thrown from the `File` object.

As a result of this careless programming style, the code prints the following message to the console:

```
There is a problem creating the file!
```

The message suggests that the file wasn't created, and indeed any further code in the `catch` block will run. But what's actually happening in the code?

Somewhat Better Practice

```
public static void main(String[] args) {
   try {
      File testFile = new File("//testFile.txt");
      testFile.createNewFile();
      System.out.println("testFile exists:"
                         + testFile.exists());
   }
   catch (IOException e) {
      System.out.println(e);
   }//end try catch
}//end method main
```

Catching specific exception

The toString() is called on this object

The code illustrates two good exception-handling practices:

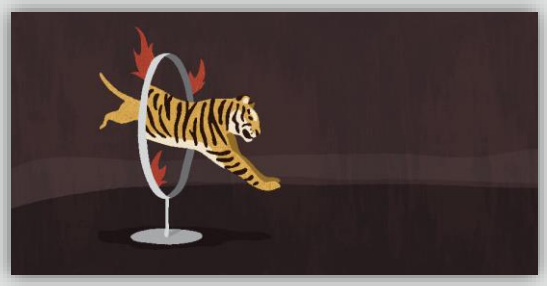
1. The `catch` clause catches an `IOException` type.
2. The `catch` clause prints the exception details to the console.

Exercise 2

- Import and open the `ExceptionsEx` project
- Examine `Calculator.java` and `ShoppingCart.java`
- Modify the programs to implement exception handling:
  - `Calculator.java`:
    - Identify the exception that might occur
    - Change the divide method signature to indicate that it throws an exception
  - `ShoppingCart.java`:
    - Catch the exception in the class that calls the divide method

Summary

- In this lesson, you should have learned how to:
  - Explain the purpose of exception handling
  - Handle exceptions with a try/catch construct
  - Describe common exceptions thrown in Java

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