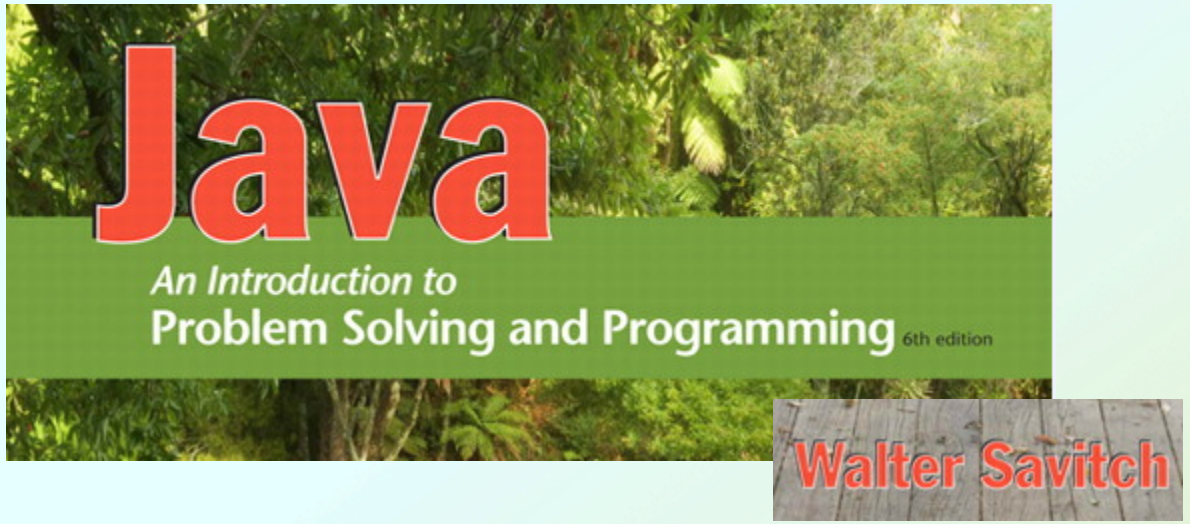


Exception Handling

Chapter 9

*JAVA: An Introduction to Problem Solving & Programming, 6*th Ed. By Walter Savitch
ISBN 0132162709

Objectives

- Describe the notion of exception handling
- React correctly when certain exceptions occur
- Use Java's exception-handling facilities effectively in classes and programs

Basic Exception Handling: Outline

- Exceptions in Java
- Predefined Exception Classes

Exceptions in Java

- An exception is an object
  - Signals the occurrence of unusual event during program execution
- Throwing an exception
  - Creating the exception object
- Handling the exception
  - Code that detects and deals with the exception

Exceptions in Java

- Consider a program to assure us of a sufficient supply of milk
- View possible solution, listing 9.1

`class GotMilk`

```
Enter number of donuts:
2
Enter number of glasses of milk:
0
No milk!
Go buy some milk.
End of program.
```

Sample screen output

Exceptions in Java

- Now we revise the program to use exception-handling
- View new version, listing 9.2

`class ExceptionDemo`

Sample screen output 1

```
Enter number of donuts:
3
Enter number of glas
2
3 donuts.
2 glasses of milk.
You have 1.5 donuts
End of program.
```

Sample screen output 2

```
Enter number of donuts:
2
Enter number of glasses of milk:
0
Exception: No milk!
Go buy some milk.
End of program.
```

Exceptions in Java

- Note try **`block`**
  - Contains code where something could possibly go wrong
  - If it does go wrong, we *throw an exception*
- Note **`catch`** block
  - When exception thrown, **`catch`** block begins execution
  - Similar to method with parameter
  - Parameter is the thrown object

Exceptions in Java

- Note flow of control when no exception is thrown
- View demo with no exception, listing 9.3

`class ExceptionDemo`

```
Enter number of donuts:
3
Enter number of glasses of milk:
2
3 donuts.
2 glasses of milk.
You have 1.5 donuts for each glass of milk.
End of program.
```

Sample screen output with no exception

Exceptions in Java

- Note flow of control when exception IS thrown
- View demo with exception, listing 9.4

`class ExceptionDemo`

```
Enter number of donuts:
2
Enter number of glasses of milk:
0
Exception: No milk!
Go buy some milk.
End of program.
```

Sample screen output when exception is thrown

Predefined Exception Classes

- Java has predefined exception classes within Java Class Library
  - Can place method invocation in `try` block
  - Follow with `catch` block for this type of exception
- Example classes
  - `BadStringOperationException`
  - `ClassNotFoundException`
  - `IOException`
  - `NoSuchMethodException`

Predefined Exception Classes

- Example code

```
SampleClass object = new SampleClass();
try
{
     <Possibly some code>
     object.doStuff(); //may throw IOException
     <Possibly some more code>
}
catch(IOException e)
{
     <Code to deal with the exception, probably including the following:>
     System.out.println(e.getMessage());
}
```

Defining Your Own Exception Classes

- Must be derived class of some predefined exception class
  - Text uses classes derived from class **`Exception`**
- View sample class, listing 9.5

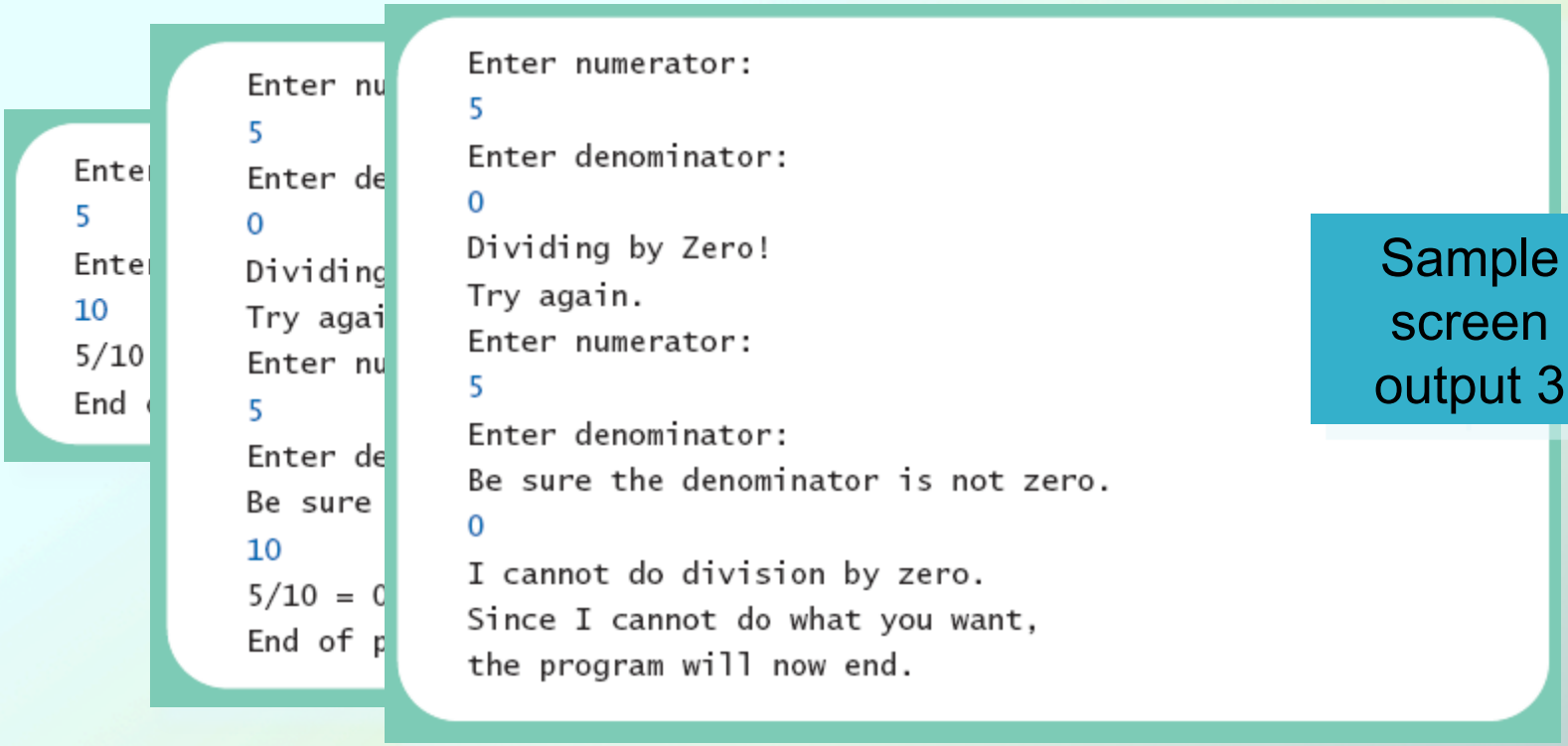
```
class DivideByZeroException
        extends Exception
```

- View demo program, listing 9.6

```
class DivideByZeroDemo
```

Defining Your Own Exception Classes

- Different runs of the program



Defining Your Own Exception Classes

- Note method **`getMessage`** defined in exception classes
  - Returns string passed as argument to constructor
  - If no actual parameter used, default message returned
- The type of an object is the name of the exception class

Defining Your Own Exception Classes

Guidelines

- Use the **`Exception`** as the base class
- Define at least two constructors
  - Default, no parameter
  - With **`String`** parameter
- Start constructor definition with call to constructor of base class, using **`super`**
- Do not override inherited **`getMessage`**

More About Exception Classes: Outline

- Declaring Exceptions (Passing the Buck)
- Kinds of Exceptions
- Errors
- Multiple Throws and Catches
- The `finally` Block
- Rethrowing an Exception
- Case Study: A Line-Oriented Calculator

Declaring Exceptions

- Consider method where code throws exception
  - May want to handle immediately
  - May want to delay until something else is done
- Method that does not catch an exception
  - Notify programmers with **`throws`** clause
  - Programmer then given responsibility to handle exception

Declaring Exceptions

- Note syntax for throws clause

```
public Type Method_Name(Parameter_List) throws List_Of_Exceptions
Body_Of_Method
```

- Note distinction
  - Keyword **`throw`** used to throw exception
  - Keyword **`throws`** used in method heading to declare an exception

Declaring Exceptions

- If a method throws exception and exception not caught inside the method
  - Method ends immediately after exception thrown
- A throws clause in overriding method
  - Can declare fewer exceptions than declared
  - But not more
- View program example, listing 9.7

```
class DoDivision
```

Kinds of Exceptions

- In most cases, exception is caught …
  - In a **`catch`** block … or
  - Be declared in **`throws`** clause
- But Java has exceptions you do not need to account for
- Categories of exceptions
  - Checked exceptions
  - Unchecked exceptions

Kinds of Exceptions

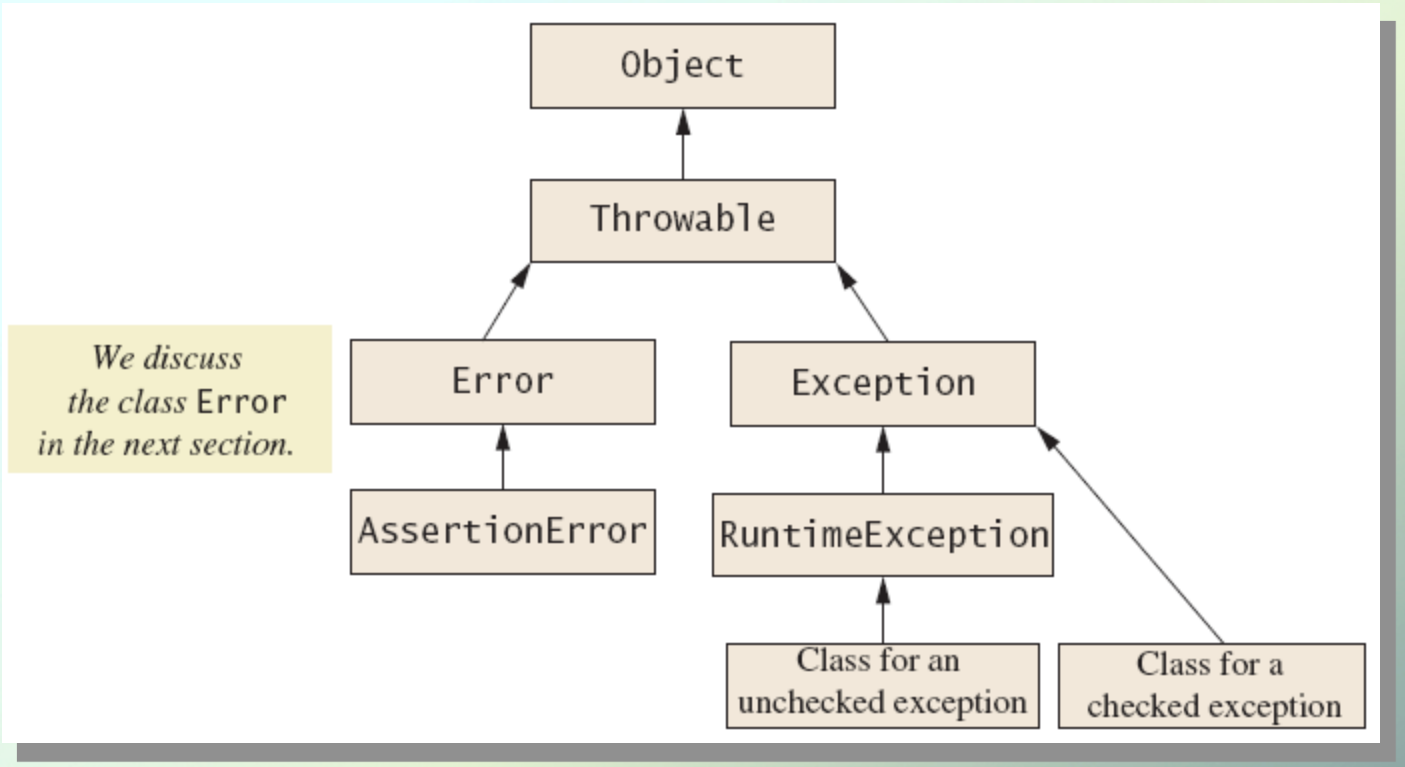
- *Checked* exception
  - Must be caught in **`catch`** block
  - Or declared in **`throws`** clause
- *Unchecked* exception
  - Also called *run-time*
  - Need not be caught in **`catch`** block or declared in **`throws`**
  - Exceptions that coding problems exist, should be fixed

Kinds of Exceptions

- Examples why unchecked exceptions to are thrown
  - Attempt to use array index out of bounds
  - Division by zero
- Uncaught runtime exception terminates program execution

Kinds of Exceptions

- Figure 9.1 Hierarchy of the predefined exception classes



Errors

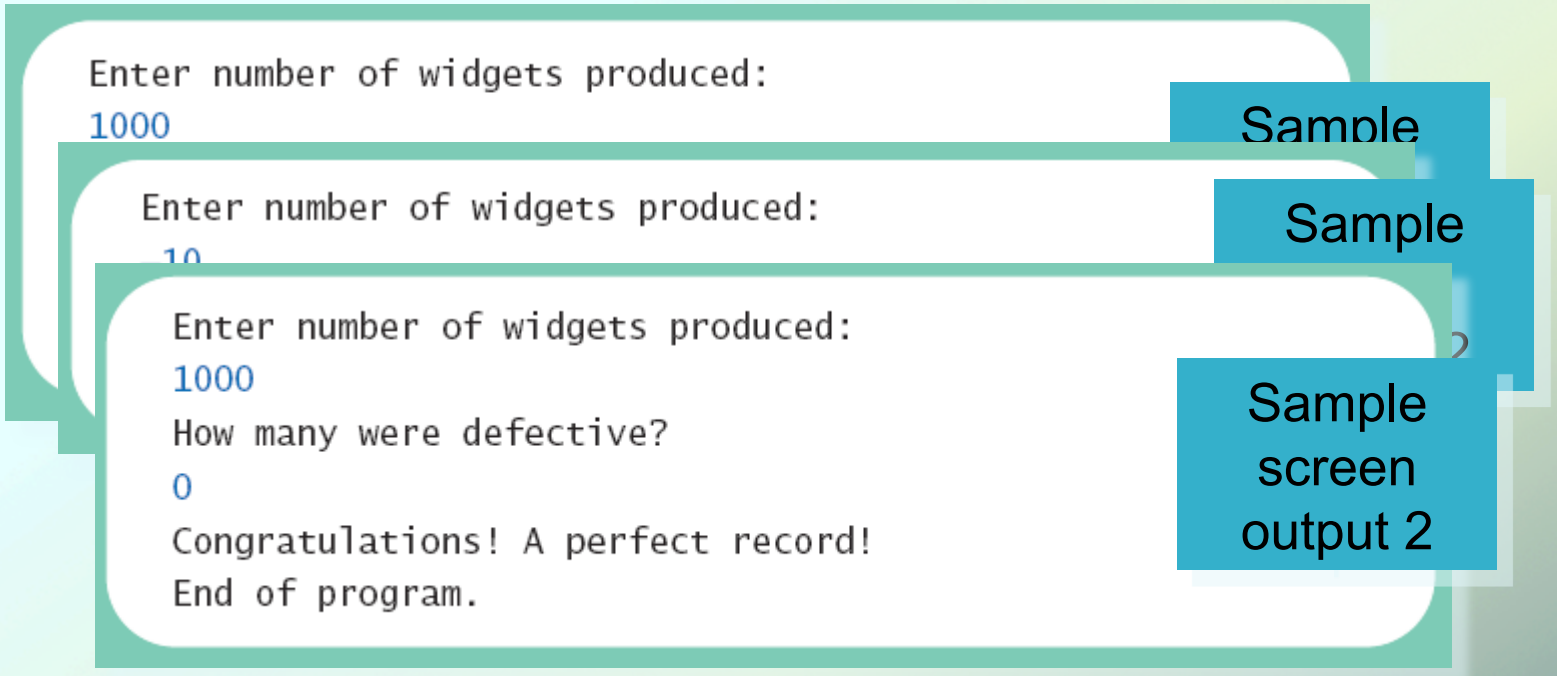
- An *error* is an object of class **`Error`**
  - Similar to an unchecked exception
  - Need not catch or declare in throws clause
  - Object of class **`Error`** generated when abnormal conditions occur
- Errors are more or less beyond your control
  - Require change of program to resolve

Multiple Throws and Catches

- A try block can throw any number of exceptions of different types
- Each catch block can catch exceptions of only one type
  - Order of catch blocks matter
- View example program, listing 9.8
  `class TwoCatchesDemo`
- View exception class used, listing 9.9
  `class NegativeNumberException`

Multiple Throws and Catches

- Note multiple sample runs



Multiple Throws and Catches

- Exceptions can deal with invalid user input
- To handle an exception thrown by a method
  - It does not matter where in the method the **`throw`** occurs
- Use of **`throw`** statement be should be reserved for cases where it is unavoidable
- Text suggests separate methods for throwing and catching of exceptions
- Nested try-catch blocks rarely useful

The `finally` Block

- Possible to add a `finally` block after sequence of `catch` blocks
- Code in `finally` block executed
  - Whether or not execution thrown
  - Whether or not required `catch` exists

Rethrowing an Exception

- Legal to throw an exception within a **`catch`** block
- Possible to use contents of **`String`** parameter to **`throw`** same or different type exception

Case Study

- A Line-Oriented Calculator
  - Should do addition, subtraction, division, multiplication
  - Will use line input/output
- User will enter
  - Operation, space, number
  - Calculator displays result

Case Study

- Proposed initial methods
  - Method to **`reset`** value of **`result`** to zero
  - Method to **`evaluate`** result of one operation
  - Method **`doCalculation`** to perform series of operations
  - Accessor method **`getResult`**: returns value of instance variable **`result`**
  - Mutator method **`setResults`**: sets value of instance variable **`result`**

Case Study

- View exception class, listing 9.10
  `class UnknownOpException`
- View first version of calculator, listing 9.11
  `class PreLimCalculator`

```
Calculator is on.
Format of each line: operator space number
For example: + 3
To end, enter the letter e.
result = 0.0
+ 4
result + 4.0 = 4.0
updated result = 4.0
* 2
result * 2.0 = 8.0
updated result = 8.0
e
The final result is 8.0
Calculator program ending.
```

Sample screen output

Case Study

- Final version adds exception handling
- Ways to handle unknown operator
  - Catch exception in method **`evaluate`**
  - Let **`evaluate`** throw exception, catch exception in **`doCalculation`**
  - Let **`evaluate`**, **`doCalculation`** both throw exception, catch in **`main`**
- Latter option chosen

Case Study

- View final version, listing 9.12

`class Calculator`

```
Calculator is on.
  % 4
    -2
    result - 2.0 = 78.0
    updated result = 78.0
    * 0.04
    result * 0.04 = 3.12
    updated result = 3.12
    e
    The final result is 3.12
    Calculator program ending.
```

Sample screen output

Graphics Supplement: Outline

- Exceptions in GUIs
- Programming Example: a `JFrame` GUI Using Exceptions

Exceptions in GUIs

- Not good practice to use **`throws`** clauses in the methods
  - In **`JFrame`** GUI or applet, uncaught exception does not end the program
  - However GUI may not cope correctly, user may receive sufficient instructions
- Thus most important to handle all checked exceptions correctly

Programming Example

- A **`JFrame`** GUI using exceptions
- View GUI class, listing 9.13
  `class ColorDemo`
- Note exception class, listing 9.14
  `class UnknownColorException`
- View driver program, listing 9.15
  `class ShowColorDemo`

Programming Example

Summary

- An exception is an object derived from class **`Exception`**
  - Descendants of class **`Error`** behave like exceptions
- Exception handling allows design of normal cases separate from exceptional situations
- Two kinds of exceptions
  - Checked and unchecked

Summary

- Exceptions can be thrown by
  - Java statements
  - Methods from class libraries
  - Programmer use of **`throw`** statement
- Method that might **`throw`** but not **`catch`** an exception should use **`throws`** clause
- Exception is caught in **`catch`** block

Summary

- A `try` block followed by one or mor `catch` blocks
  - More specific exception `catch` types should come first
- Every exception type has `getMessage` method usable to recover description of caught description
- Do not overuse exceptions