Java
Lecture 8 –
Exceptions & Generics

IT Learning &
Outsourcing Center

www.pragmatic.bg

Lector: Peter Manolov
Skype: nsghost1
E-mail: p.manolov@gmail.com
Facebook: https://www.facebook.com/pmanolov

Exception Fundamentals - General Form


```
try {
    _this.throwNewCustomException();
    _this.throwNewIllegalArgumentException(); // this is
    _this.throwNewIOException();
} catch (CustomException e) {
    // handle exception here
} catch (IOException e) {
    // handle exception here
}finally{
    System.out.println("This is always performed");
}
```

Exception Handling keywords

- **throw** – We know that if any exception occurs, an exception object is getting created and then Java runtime starts processing to handle them. Sometime we might want to generate exception explicitly in our code, for example in a user authentication program we should throw exception to client if the password is null. **throw** keyword is used to throw exception to the runtime to handle it.

- Exception up = new Exception("Something is really wrong.");

  throw up; //ha ha

Exception Handling keywords

- **throws** – When we are throwing any exception in a method and not handling it, then we need to use **throws** keyword in method signature to let caller program know the exceptions that might be thrown by the method. The caller method might handle these exceptions or propagate it to it's caller method using throws keyword. We can provide multiple exceptions in the throws clause and it can be used with main() method also.

- public void buyFlowers() throws NoMoneyException {...}

Exception Handling keywords

- **try-catch** – We use try-catch block for exception handling in our code. try is the start of the block and catch is at the end of try block to handle the exceptions. We can have multiple catch blocks with a try and try-catch block can be nested also. catch block requires a parameter that should be of type Exception.

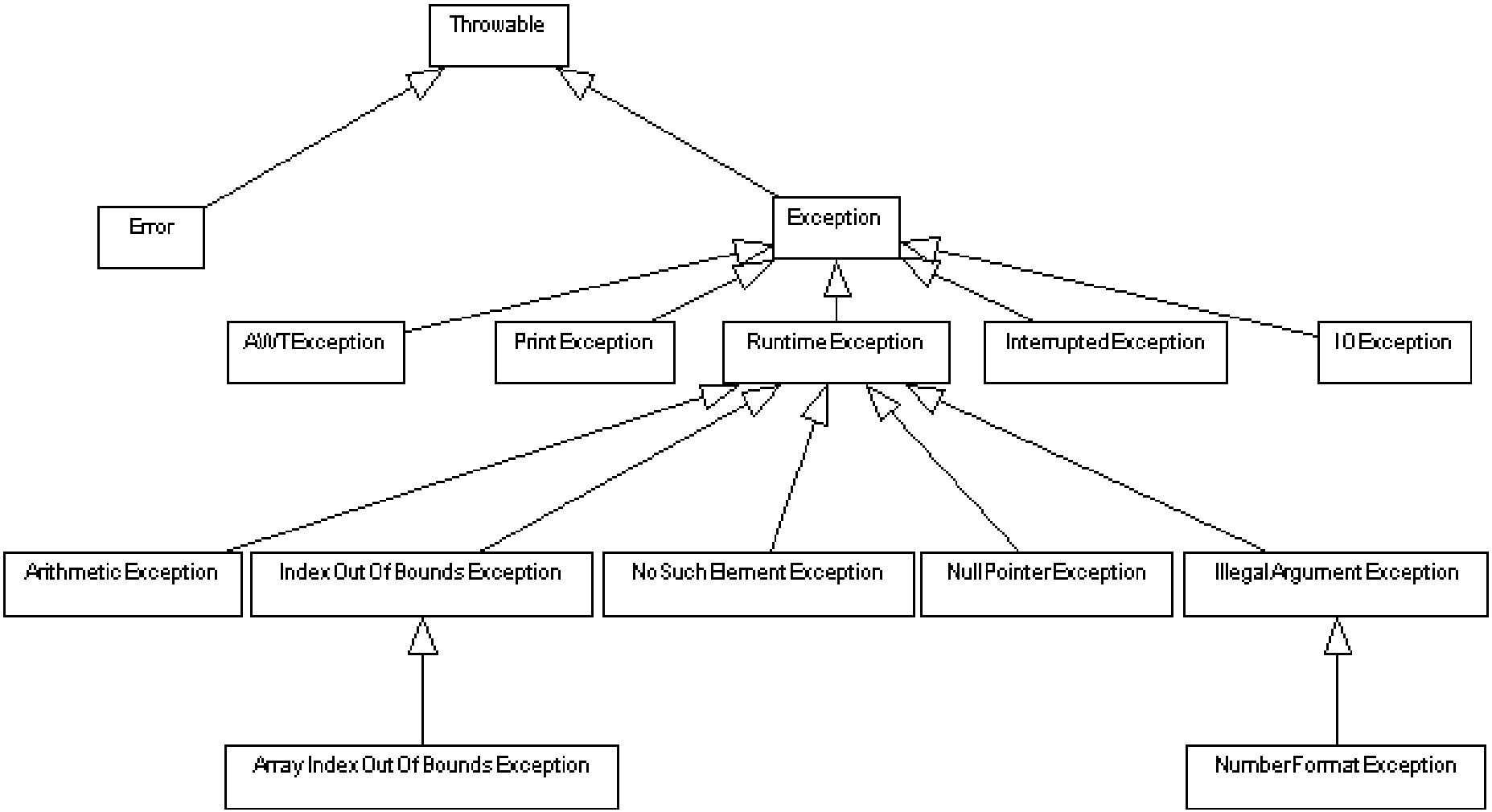
- ```
  try {
     // I am doing something
     // very dangerously
     // like listening to JB
  } catch(Exception e) {
     // do something about it
     // switch to Galena
  }
  ```
  ```

Exception Handling keywords

- **finally** – finally block is optional and can be used only with try-catch block. Since exception halts the process of execution, we might have some resources open that will not get closed, so we can use finally block. finally block gets executed always, whether exception occurred or not.

- ```
  try {
     ...
  } catch() {
     ...
  } finally {
     // do something ALWAYS
  }
  ```
  ```

Exception Fundamentals



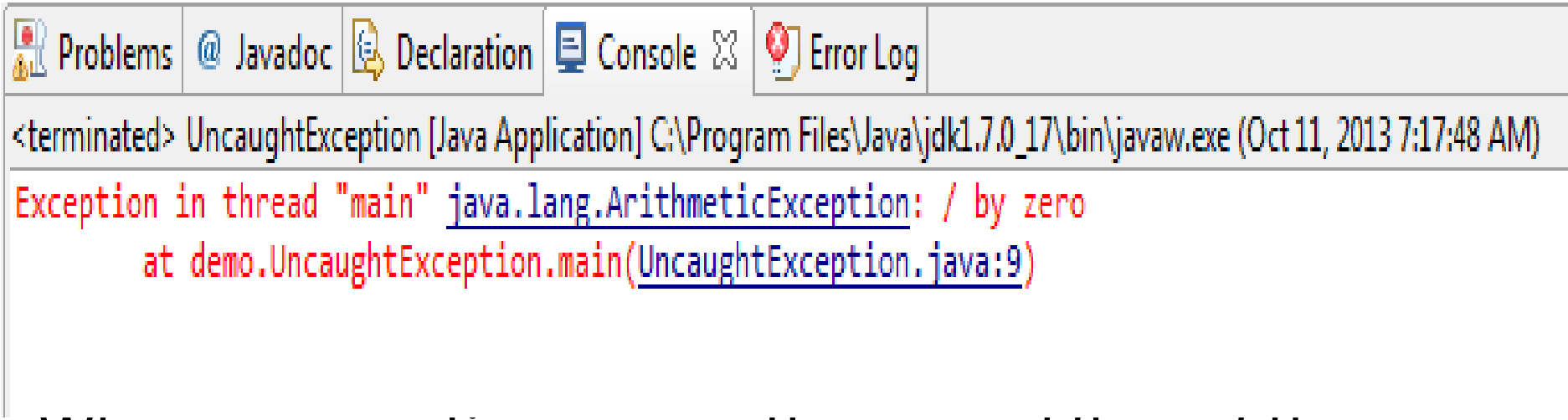
- Throwable - All exception types are subclasses of this class.
- Exception - This class represent an exceptional conditions that user programs should catch. This is also the class that need to be subclassed to create a new custom exception.
- RuntimeException - is the superclass of those exceptions that can be thrown during the normal operation of the Java Virtual Machine. RuntimeException and its subclasses are *unchecked exceptions.*
- Error – System related exception. Shouldn't be handled directly by the code.

Uncaught Exception


```
public static void main(String[] args) {
    int a = 5;
    int b = 0;

    System.out.println(a / b);
}
```

Uncaught Exception



- When an exception occurs, the normal flow of the program is terminated.
- Exceptions must be immediately dealt with
- Execution continues to the first available exception handler capable of handling the exception that just occurred

Chained Exceptions

- An application often responds to an exception by throwing another exception.
- In effect, the first exception causes the second exception.
- It can be very helpful to know when one exception causes another.
- Chained Exceptions help the programmer do this.

Chained Exceptions example

- In this example, when an IOException is caught, a new SampleException exception is created with the original cause attached and the chain of exceptions is thrown up to the next higher level exception handler.

```
try {
  //...
} catch (IOException e) {
   throw new SampleException("Other IOException", e);
}
```

More about Throwable class

- An instance of Throwable class contains
- Message
- Stacktrace
- Cause (instace of Throwable)

More about Throwable class

- Constructors:

```
public Throwable()
public Throwable(String message)
public Throwable(Throwable cause)
public Throwable(String message, Throwable cause)
```

- Important methods:

```
public String getMessage()
public Throwable getCause()
public void printStackTrace()
public StackTraceElement[] getStackTrace()
```

Exception Chaining


```
package other;

public class TestChainedException {
       public static void main(String[] args) {
         String s = null;
         testMethod(s);
       }

       public static void testMethod(String s) {
         try {
          System.out.println(s.length());
         } catch (NullPointerException npe) {
          throw new RuntimeException("Error when trying to
print the string's length", npe);
         }
       }
}
```

How exceptions should be shown to the end user

- The end user is not programmer
- So, it's not a good practice to show technical details (stacktrace) to the end user
- Instead, nice message should be shown
- If we want, we can add technical information but it should be shown only if the user want to see it

Question

- What happens with this code?

```
try {
  //..
} catch (Exception e) {
   e.printStackTrace();
} catch (IOException e) {
   e.printStackTrace();
}
```

Answer

- Compilaton error!

- Unreachable catch block for IOException. It is already handled by the catch block for Exception

- Because IOException extends class Exception, so the second catch block will never execute.

Multiple Exceptions


```
try {

}
catch (SQLException ex) {
    // Basically, without saying too much, you're screwed. Royally and totally.
}
catch(Exception ex)
{
    //If you thought you were screwed before, boy have I news for you!!!
}
```

Tips

- We can handle multiple exceptions using catch block with parent class.

- This is useful when we want to handle more than one exceptions in the same way
- (we use a (too) general exception handler)

Re-throwing exception

- Sometimes we want to handle the exception just for a moment, use it for something (write in the log) and then re-throw it, because we can't handle it at all.
- Keyword *throw* is used(we saw it in the previous slides)

```
try {
   //...
} catch (IOException e) {
 logger.log(Level.WARNING, "Error in testMethod: " + e.getMessage());
 throw new SampleException("Other IOException", e);
}
```

Defining own exceptions

- Just extends the class Exception
- Do not create a subclass of RuntimeException or throw a RuntimeException
- If we need, we can add some fields to these which is inherited by Exception
- It's good practice each module to throw only his own exceptions
- For readable code, it's good practice to append the string Exception to the names of all classes that inherit from the Exception class.

Defining own exceptions


```
public class CustomException extends Exception{

private static final long serialVersionUID = 905082714139195048 3L;

        public CustomException () {
          super();
        }
        public CustomException (String message, Throwable cause) {
          super(message, cause);
        }
        public CustomException (String message) {
          super(message);
        }
        public CustomException (Throwable cause) {
          super(cause);
        }
}
```

Finally block

- The finally block always executes when the try block exits.
- This ensures that the finally block is executed even if an unexpected exception occurs
- it allows the programmer to avoid having cleanup code accidentally bypassed by a return, continue, or break.
- Putting cleanup code in a finally block is always a good practice, even when no exceptions are anticipated.

Finally block

- The finally block is a key tool for preventing resource leaks. When closing a file or otherwise recovering resources, place the code in a finally block to ensure that resource is always recovered.

```
try {
  // some code which open PrintWriter out
} catch (Exception e) {
  //.. handle exception
} finally {
  if (out != null) {
    System.out.println("Closing PrintWriter");
    out.close();
  } else {
    System.out.println("PrintWriter not open");
  }
}
```

What is a Generic?

- A way to write code independent of a type

Generics Basics

- At its core - the term *generics* means *parameterized types*
- Using generics, it is possible to create a single class, that automatically works with different types of data. For example: Printer which has different type of Cartridges.
- A class, interface, or method that operates on a parameterized type is called *generic*, as in *generic class* or *generic method*
- *Why not just use Class Object?*

Generics Example


```
public class Generic<T> {

    private T field;

    public Generic(T field) {
        this.field = field;
    }

    public T getField() {
        return field;
    }

    public void setField(T field) {
        this.field = field;
    }

    public void printGenericType(){
        System.out.println("Generic Filed is of type  " + field.getClass().getName());
    }

    public static void main(String[] args) {
        Generic<String> str = new Generic<String>("This is my field");
        str.printGenericType();

        Generic<Number> num = new Generic<Number>(5D);
        num.printGenericType();

    }
```

Generic Levels

- **Class level**
  - Specify a type as a variable
  - Class of Type T
- **Method level**
  - Specify a type of a parameter
  - Parameter of Type T

Syntax

- Generic Class - accessor class ClassName<GenericDeclaration>
- ```
  public class Generic<T>
  ```
- Generic Method - accessor <GenericDeclaration> returnType name()
- ```
  public <P> showType(P arg)
  ```

Bounded types

- Sometimes we wish to restrict the type of the generic. We want to tell the compiler some how that we want to pass in only a family of classes and not all possible types of classes.
- To do so we use the keyword: extends
- An example would be:

```
public class Printer<T extends ICartridge> {
}
```

Erasure

- Java generics are erasure type
  - meaning that they exist only at compile-time after which they are “erased”
-
- Erasure types were created to preserve backward compatibility of the java bytecode(the generics does not exist in the bytecode, only compile-time). Old non generic programs need to be able to run on new modern virtual machines.

Generic Restrictions

- Type Parameters cannot be instantiated – meaning:
- ```
  T someReference = new T(); //compile error
  ```
- **static** fields cannot use a type parameter(i.e. T) declared by the enclosing class – meaning:
- ```
  private static T someReference; //compile error
  ```
  - - You can still create generic static methods, but they must specify their own generic type
- You cannot instantiate an array of elements from the generic type
- ```
  Box<String>[] someReference = new Box<String>[5]; //compile error
  ```
- and some other restrictions under:
  - http://docs.oracle.com/javase/tutorial/java/generics/restrictions.html
  ```