CHULA ENGINEERING
Foundation toward Innovation
COMPUTER

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Exception Handling

Outlines

- Common Errors by Java Programmers
- Exception
- Categories of Exceptions
- Exception Handling: try-catch & throws
- Try/Catch
  - Comparing to if-else
  - Finally
- Throw
- Create a new exception
- JUnit with exception

Common Errors by Java Programmers

10
- Accessing non-static member variables from static methods (such as main)

9
- Mistyping the name of a method when overriding

8
- Comparison assignment (= rather than ==)

7
- Comparing two objects (== instead of .equals)

6
- Confusion over passing by value, and passing by reference

from: C. Patanothai & http://www.javacoffeebreak.com/articles/toptenerrors.html

Common Errors by Java Programmers (cont.)

5
- Writing blank exception handlers

4
- Forgetting that Java is zero-indexed

3
- Preventing concurrent access to shared variables by threads

2
- Capitalization errors

1
- **Null pointers!**
  - Commonly caused by uninitialized objects

from: C. Patanothai & http://www.javacoffeebreak.com/articles/toptenerrors.html

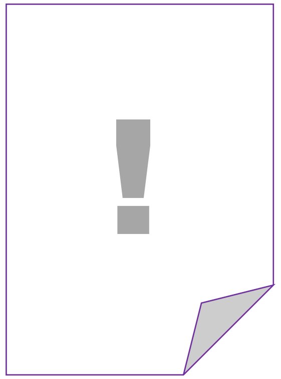
Common Errors by Java Programmers (cont.)

- Syntax error
  - cannot compile
- Logic error
  - wrong formula, wrong step, integer division, ...
  - unit test
  - fixed by programmer
- Status of environment
  - network down
  - cannot open file
  - out of control by programmer

Though it is impossible to completely eliminate errors from the coding process, with care and practice you can avoid repeating the same ones.

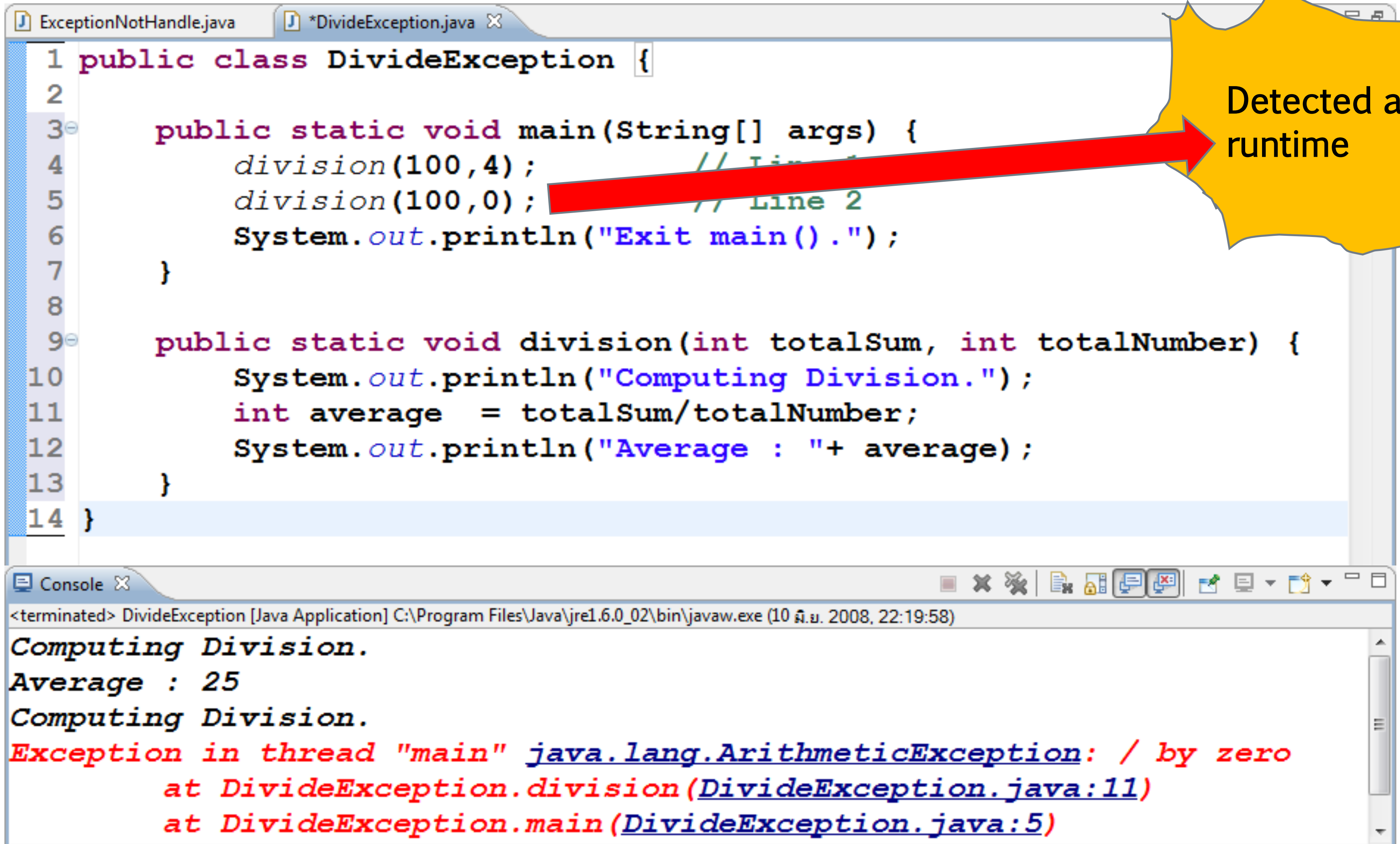
Exception

Exception



- **An exception** is a problem that arises during the execution of a program.
- There are many types of exceptions.
- Therefore, there are many classes of Exception objects.
- For example,
  - ArithmeticException
  - ArrayIndexOutOfBoundsException
  - FileNotFoundException

Exception (cont.): ArithmeticException



ExceptionNotHandle.java | *DivideException.java

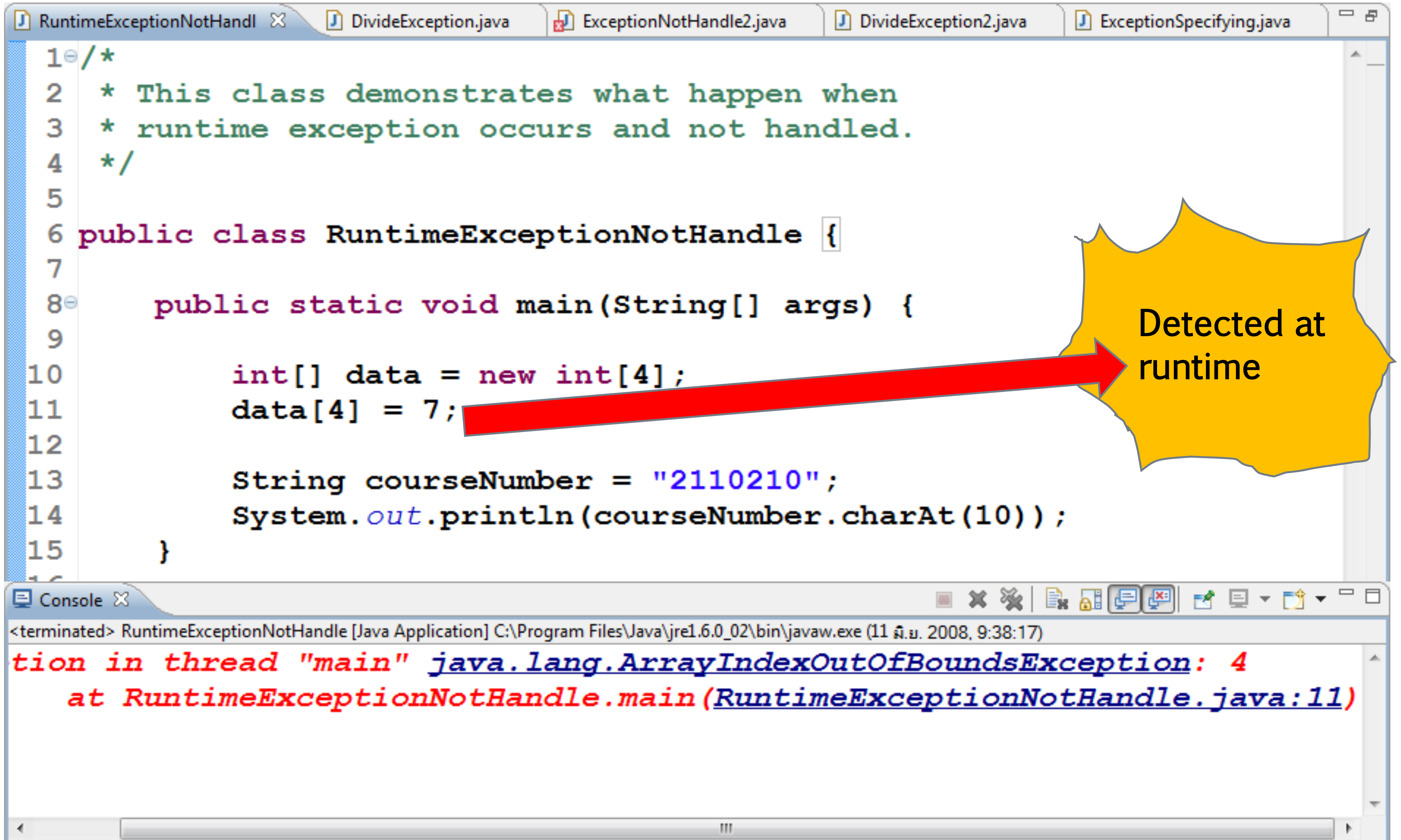
```
 1 public class DivideException {
 2
 3     public static void main(String[] args) {
 4         division(100,4);          // Line 1
 5         division(100,0);          // Line 2
 6         System.out.println("Exit main().");
 7     }
 8
 9     public static void division(int totalSum, int totalNumber) {
10         System.out.println("Computing Division.");
11         int average  = totalSum/totalNumber;
12         System.out.println("Average : "+ average);
13     }
14 }
```

Detected at runtime

Console

```
<terminated> DivideException [Java Application] C:\Program Files\Java\jre1.6.0_02\bin\javaw.exe (10 มี.ย. 2008, 22:19:58)
Computing Division.
Average : 25
Computing Division.
Exception in thread "main" java.lang.ArithmeticException: / by zero
        at DivideException.division(DivideException.java:11)
        at DivideException.main(DivideException.java:5)
```

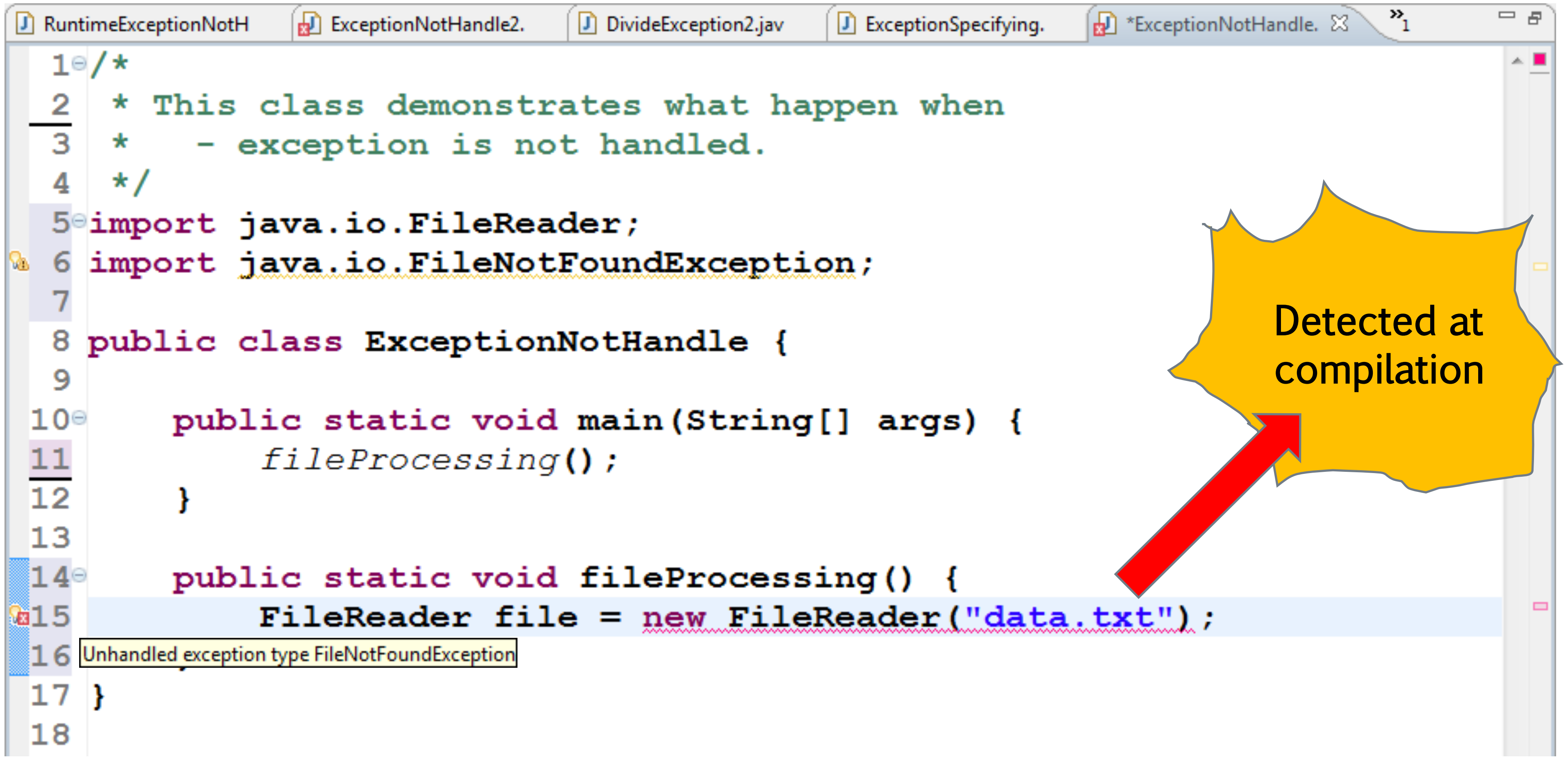
Exception (cont.): ArrayIndexOutOfBoundsException



```
/*
 * This class demonstrates what happen when
 * runtime exception occurs and not handled.
 */

public class RuntimeExceptionNotHandle {

    public static void main(String[] args) {

        int[] data = new int[4];
        data[4] = 7;

        String courseNumber = "2110210";
        System.out.println(courseNumber.charAt(10));
    }
```

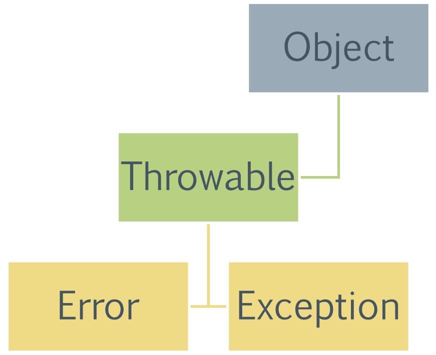
```
<terminated> RuntimeExceptionNotHandle [Java Application] C:\Program Files\Java\jre1.6.0_02\bin\javaw.exe (11 ก.ย. 2008, 9:38:17)
tion in thread "main" java.lang.ArrayIndexOutOfBoundsException: 4
    at RuntimeExceptionNotHandle.main(RuntimeExceptionNotHandle.java:11)
```

Exception (cont.): FileNotFoundException



```
/*
 * This class demonstrates what happen when
 *     - exception is not handled.
 */
import java.io.FileReader;
import java.io.FileNotFoundException;

public class ExceptionNotHandle {

    public static void main(String[] args) {
        fileProcessing();
    }

    public static void fileProcessing() {
        FileReader file = new FileReader("data.txt");
Unhandled exception type FileNotFoundException
}
```

Categories of Exceptions



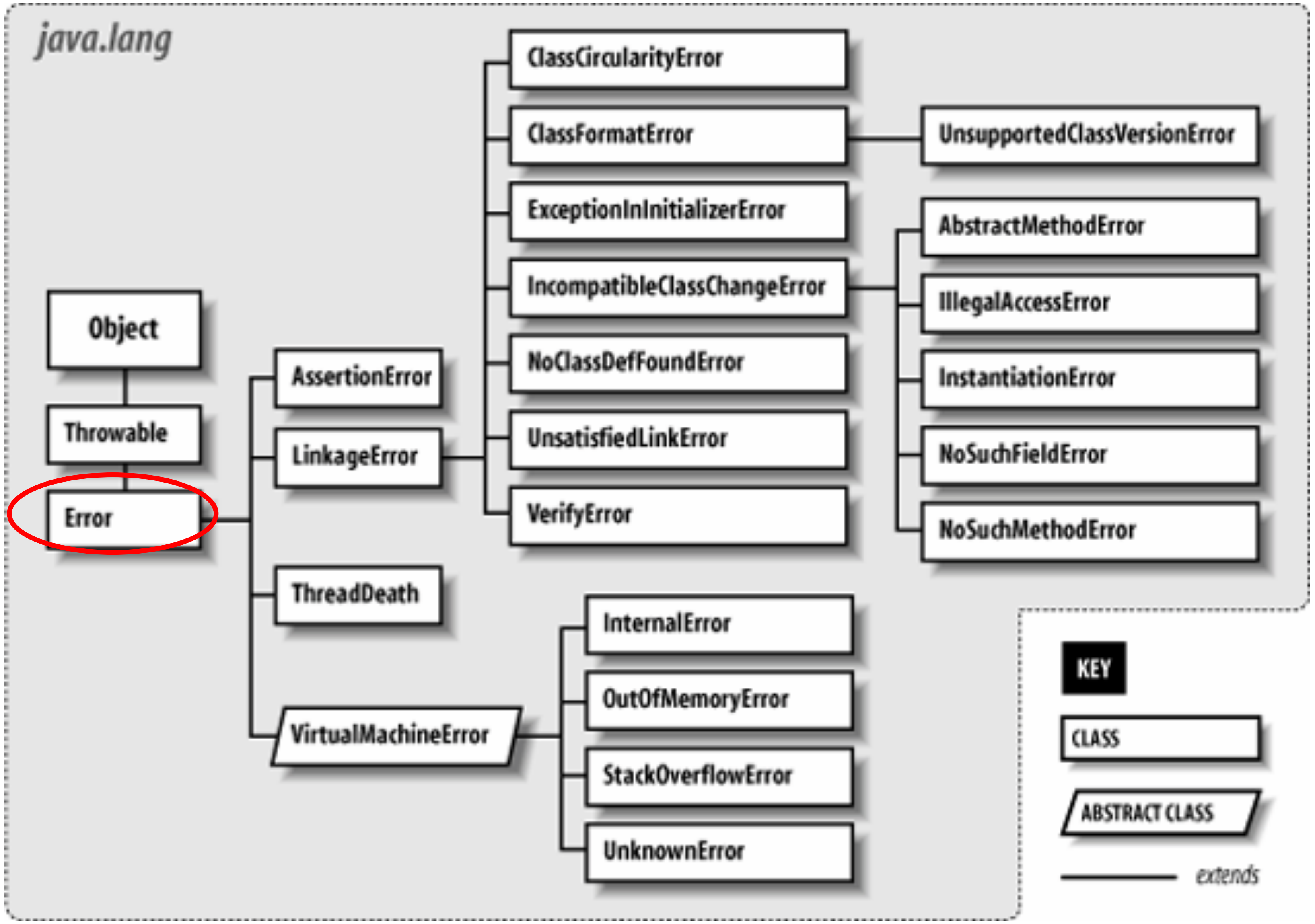
ERROR

- It is a serious problem that arise beyond the control of the user or the programmer.
- It is typically ignored in your code because you can rarely do anything about an error

EXCEPTION

- It is an error that is <u>less</u> serious than the Error class and can be control by the program.
  - Allow to "try/catch" or "throw"
- There are two types:
  - Unchecked Exception
  - Checked Exception

Categories of Exceptions (cont.): Error



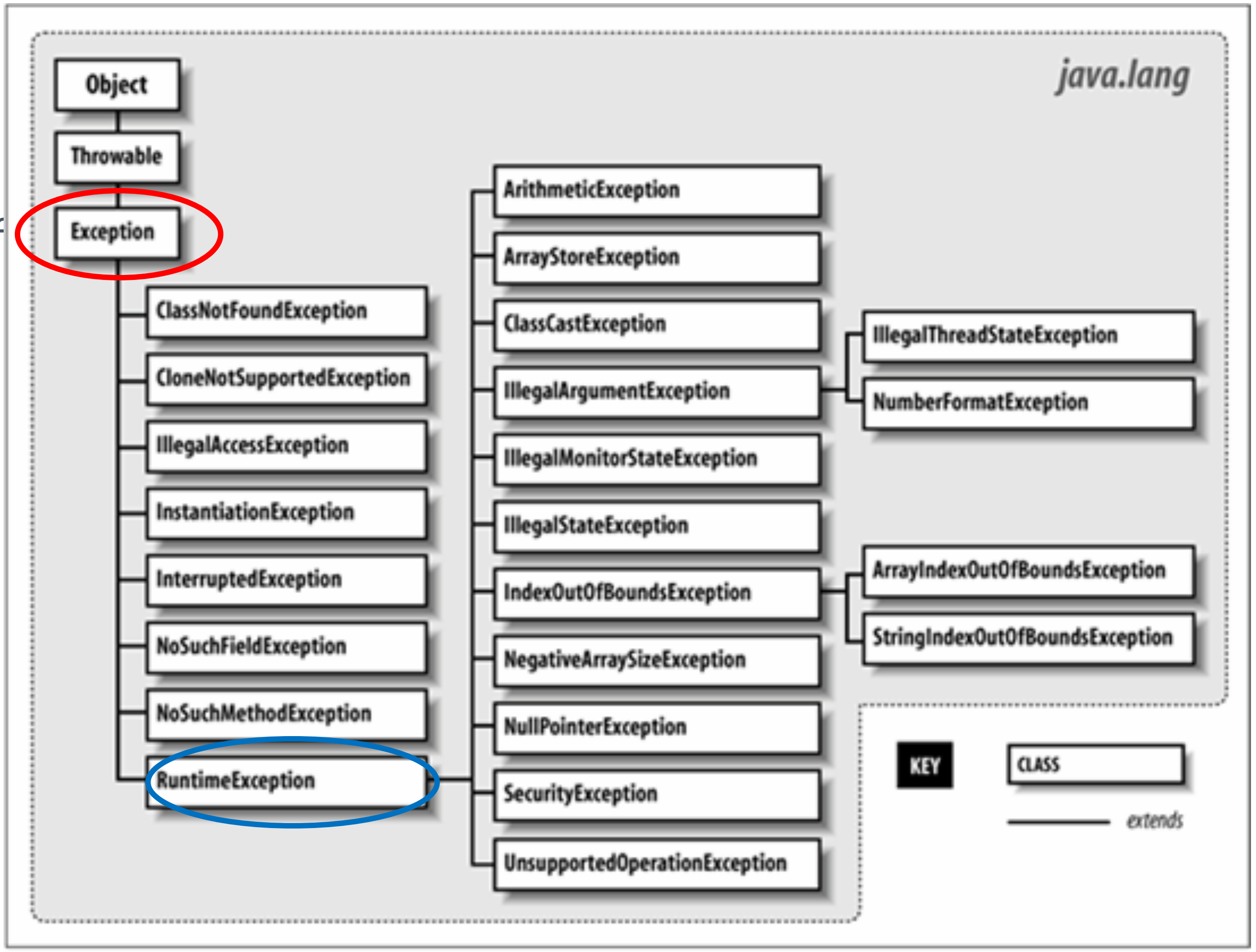
Categories of Exceptions (cont.): Exception

run time checking

- Unchecked exceptions:
  - They are ignored at the compilation time.
  - They are any subclasses of RuntimeException.

compile time checking

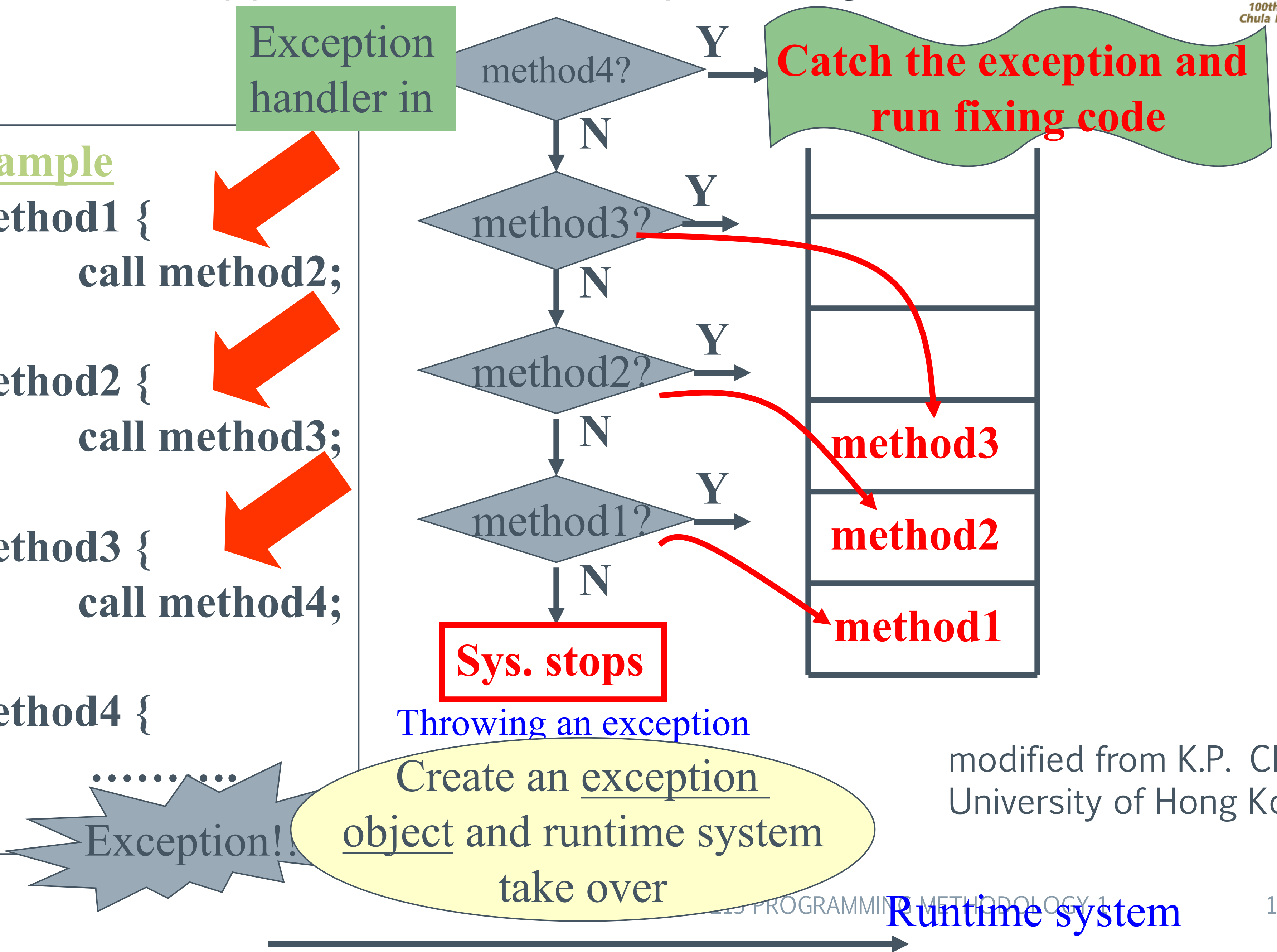
- Checked exceptions:
  - These exceptions cannot simply be ignored at the time of compilation.
  - They must be handled (try-catch or throw).
  - They are Exception's subclasses, except RuntimeException.



What happens when an exception is generated?

Example

```
method1 {
        call method2;
}
method2 {
        call method3;
}
method3 {
        call method4;
}
method4 {
        ..........
}
```



modified from K.P. Chow
University of Hong Kong

Exception Handling

› Try-catch

```
try {
    block of statements
} catch (ExceptionType name) {
        exception handler 1
} catch (ExceptionType name) {
        exception handler 2
}
```

› Throws

in Integer class:

```
public static int parseInt(String s)
        throws NumberFormatException;
```

› No handling at all
 - unchecked exceptions only
 - need to be carefully checked by programmers

› try/catch/finally
 - handle normally

› Specifying the exception
 - throws the exception to the caller
 - Used when we don't want to catch the exception in this method

Try-Catch: Usage

System.out.println(aE.getMessage());

```
/ by zero
End
```

System.out.println(aE.toString());

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

aE.printStackTrace()

```
java.lang.ArithmeticException: / by zero
End
at Exception1.main(Exception1.java:7)
```

Exception1.java

```java
public class Exception1 {
  public static void main(String[] args) {
    int s[] = new int[2];
    try {
      for (int i = 0; i < 3; ++i) {
        s[i] = 1/i;
        System.out.println(s[i]);
      }
    } catch (ArrayIndexOutOfBoundsException arrE) {
      System.out.println(arrE.toString());
    } catch (ArithmeticException aE) {
      System.out.println(aE.toString());
    } catch (Exception e) {
      System.out.println(e.toString());
    }
    System.out.println("End");
  }
}
```

Try-Catch: Comparing to if-else

ReadFile1.java (pseudo code)

```
errorCodeType readFile {
  initialize errorCode = 0;
  open the file;
  if (theFileIsOpen) {
    determine the length of the file;
    if (gotTheFileLength) {
      allocate that much memory;
      if (gotEnoughMemory) {
        read the file into memory;
        if (readFailed) errorCode = -1;    // read failed
      } else errorCode = -2;               // not enough memor
    } else errorCode = -3;                 // file size can't be determined
    close the file;
    if (theFileDidntClose && errorCode == 0) {
      errorCode = -4;                      // can't close file
    } else errorCode = errorCode and -4;   // can't close file + error
  } else errorCode = -5;                   // can't open file
  return errorCode;
}
```

Pseudo code to read file

```
readFile {
  open the file;
  determine its size;
  allocate that much memory;
  read the file into memory;
  close the file;
}
```

- Spaghetti code
  - difficulty to read
- What if a method needs to return value?
  - a method can return only a single value

Try-Catch: Comparing to if-else (cont.)

ReadFile2.java (pseudo code)

```
readFile {
  try {
    open the file;
    determine its size;
    allocate that much memory;
    read the file into memory;
    close the file;
  } catch (fileOpenFailed) {
      doSomething;
  } catch (sizeDeterminationFailed) {
      doSomething;
  } catch (memoryAllocationFailed) {
      doSomething;
  } catch (readFailed) {
      doSomething;
  } catch (fileCloseFailed) {
      doSomething;
  }
}
```

Pseudo code to read file

```
readFile {
  open the file;
  determine its size;
  allocate that much memory;
  read the file into memory;
  close the file;
}
```

Comparing ReadFile1.java & ReadFile2.java, which one is better?

Try-Catch: Finally

TestFinally.java (main)

```
public class TestFinally {
    public static void main(String[] args) {
        functionWithFinally();
    }
}
```

Result (return)

```
catch
finally
```

Result (System.exit(-1))

```
catch
```

Why do we need “finally”?
Can’t we just move “finally code” to be after the try-catch statement.

TestFinally.java (functionWithFinally)

```
public static void functionWithFinally() {
  int result = 0;
  for (int i = 0; i < 4; ++i) {
    try {
      result = 10 / i;
      System.out.println("i=" + i + " and result=" + result);
      if (i == 2) break;
    } catch (ArithmeticException ae) {
      System.out.println("catch");
      return;
    } finally {
      System.out.println("finally");
    }
    System.out.println("End Step\n");
  }
  System.out.println("End Main Loop");
}
```

```
public void writeList() {
  try {
        PrintWriter out = new PrintWriter(new FileWriter("out.txt"));
            for (int i=0; i<SIZE; i++) {
                    out.println(v.elementAt(i));
            }
        out.close( ):
  } catch (ArrayIndexOutOfBoundsException e) {
        System.err.println("Caught ArrayIndexOutOfBoundsException");
  } catch (IOException e) {
        System.err.println("Caught IOException");
  }
}
```

May not get executed!

use a finally block
(always will execute, even if
we jump out of try block)

Throws

- When an exception occurs in the method, it will be *thrown* to the caller.
- add throws clause to the method declaration if we do not want to catch exception within the current method.
- Throw1.java
  - Caller: main()
  - Callee: greet()
    - Checked Exception: ClassNotFoundException, InterruptedException
- Caller must handle ALL checked exception in the callee!

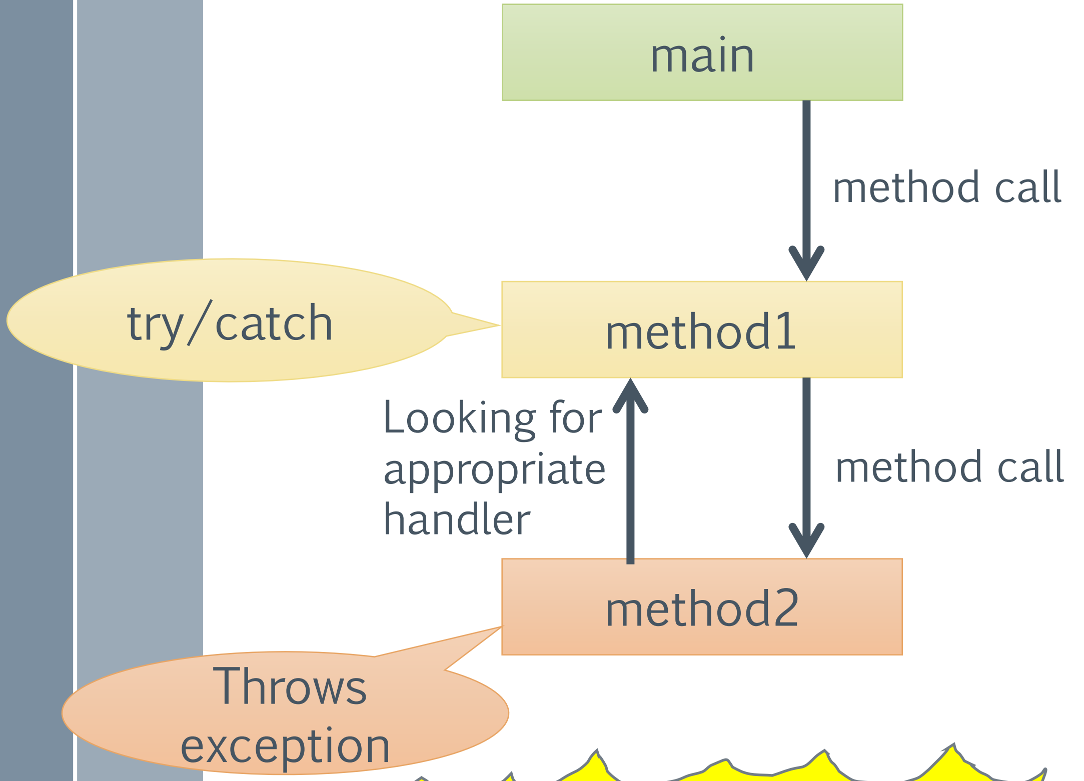
Throw1.java

```java
public class Throw1 {

  static void greet(String name) throws ClassNotFoundException,
InterruptedException {

      if (name.equals("John"))

          throw new InterruptedException();

      System.out.println("Hello! " + name);

  }

  public static void main(String[] args) throws
ClassNotFoundException{

    try {

      greet("John");

    } catch (InterruptedException e) {

      System.out.println("Bye.");

    }

  }

}
```

Result

```
Bye
```

Throws: Chain Caller



It allows us to write try/catch block in one location

ChainCaller.java

```java
public class ChainCaller {
  public static void main(String[] args) {
    ChainCaller t = new ChainCaller();
    t.method1(6, 3);
    t.method1(6, 0);
  }
  public void method1(double a, double b) {
    try {
      System.out.println(method2(a, b));
    } catch (ArithmeticException ae) {
      System.out.println("Divided by zero not allowed");
    }
  }
  public String method2(double a, double b)
    throws ArithmeticException {
    if (b == 0) throw new ArithmeticException();
    else return a + "/" + b + "=" + a / b;
  }
}
```

Result

```
6.0/3.0=2.0
Divided by zero not allowed
```

What happens if we don't want to catch at all

```
import java.io.*;
 public void m1( ){
        m2( );
 }
 public void m2( ){
        m3( );
 }
 public void m3( ) throws IOException {
        int b = System.in.read( );
 }
```

```
public void m1( ) throws IOException {
       m2( );
}
```

```
public void m2( ) throws IOException {
       m3( );
}
```

Compile ok, but do not handle the exception….

Error!!
m2 has to either catch or throw IOException

Error!!
m1 has to either catch or throw IOException

modified from K.P. Chow
University of Hong Kong

Create a new exception

TestMyException.java: MyException

```java
class MyException extends Exception {
    public MyException(String s) {
        System.out.println("MyException = " + s);
    }
}
```

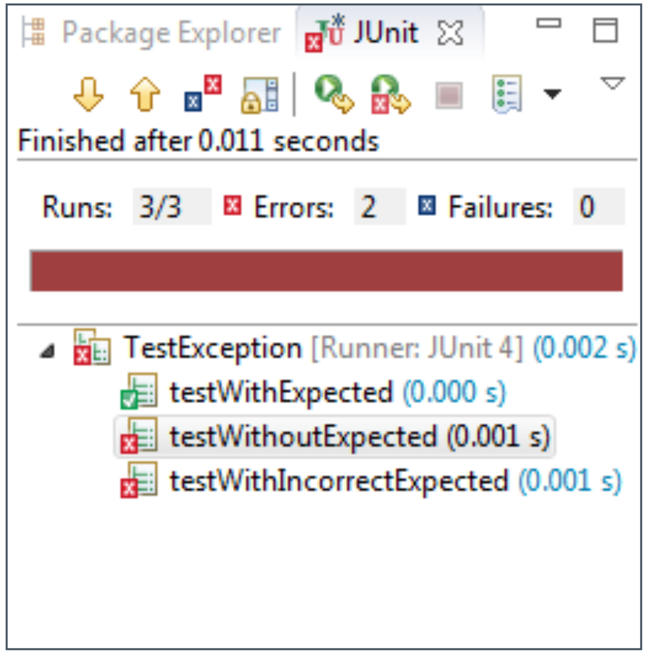
TestMyException.java

```java
public class TestMyException {
  static void welcome(String s) throws MyException {
    if (s.equals("JAVA"))
      System.out.println("Welome to JAVA World");
    else
      throw new MyException(s + " not allowed here");
}
  public static void main(String[] args) {
    try {
      welcome(“C#");
    } catch (MyException e1) {
      System.out.println("MyException.");
    }
  }
}
```

Result

```
MyException = C# not allowed here

MyException.
```

JUnit4 with exception


Package Explorer JUnit

Finished after 0.011 seconds

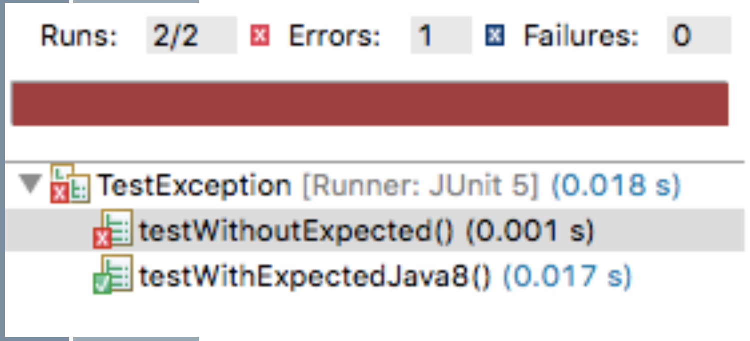
Runs: 3/3 Errors: 2 Failures: 0

```
TestException [Runner: JUnit 4] (0.002 s)
    testWithExpected (0.000 s)
    testWithoutExpected (0.001 s)
    testWithIncorrectExpected (0.001 s)
```

JUnit: TestException

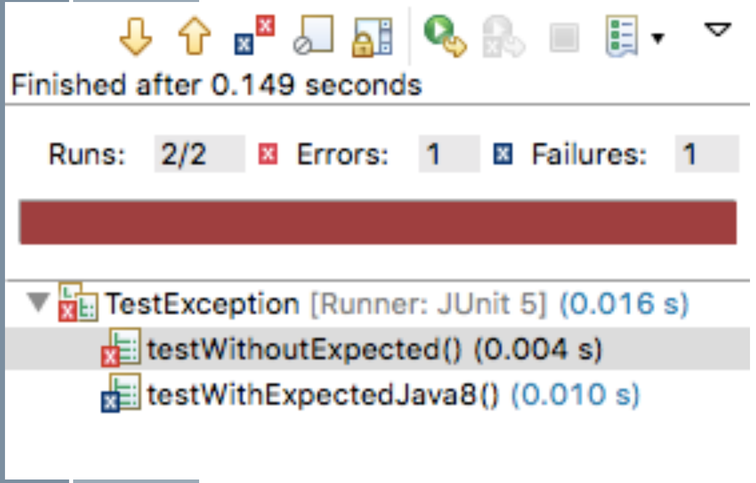
```
import org.junit.Test;
public class TestException {
  @Test(expected=ArithmeticException.class)
  public void testWithExpected() {
    double a = 10/0;
  }
  @Test
  public void testWithoutExpected() {
    double a = 10/0;
  }
  @Test(expected=ArrayIndexOutOfBoundsException.class)
  public void testWithIncorrectExpected() {
    double a = 10/0;
  }
}
```

JUnit5 with exception



Runs: 2/2 Errors: 1 Failures: 0

TestException [Runner: JUnit 5] (0.018 s)
testWithoutExpected() (0.001 s)
testWithExpectedJava8() (0.017 s)



Finished after 0.149 seconds

Runs: 2/2 Errors: 1 Failures: 1

TestException [Runner: JUnit 5] (0.016 s)
testWithoutExpected() (0.004 s)
testWithExpectedJava8() (0.010 s)

Junit 5: TestException

```java
import org.junit.jupiter.api.Test;
import org.junit.jupiter.api.function.Executable;
import static org.junit.jupiter.api.Assertions.assertThrows;

public class TestException {
  @Test
  public void testWithExpectedJava8() {
  Executable e = () -> System.out.println(10/0);
  assertThrows(ArithmeticException.class, e);
  }

  @Test
  public void testWithExpectedJava8() {
  assertThrows(ArithmeticException.class,
      () -> {int x = 10/0;});
  }
}
```