
MAHARISHI UNIVERSITY of MANAGEMENT
Engaging the Managing Intelligence of Nature
Computer Science Department
CS390 Foundamental Programming Practices (FPP)
Professor Paul Corazza

Lecture 12: Exception-Handling in Java

Wholeness of the Lesson

Prior to the emergence of OO languages, error-handling was typically done using an unsystematic use of error codes. This approach led to confusion, programming errors, and costly maintenance. Java's exception-handling model (which is similar to those in other OO languages) systematizes the task of handling error conditions and integrates it with the OO paradigm supported by the language. This advance in programming practice illustrates the theme that “deeper knowledge has more profound organizing power.”

Outline of Topics(Do you agree?)

- What Is Exception-Handling All About?
- The Old (Non-OO) Way of Doing It
- An Object-Oriented Error-Handling Strategy
- Classification of Error-Condition Classes
  - Objects of Type Error
  - Other Unchecked Exceptions
  - Checked Exceptions
- Using/Creating Exception Classes
- Best Practices: When to Handle, When to Throw, When to Log
- Some Syntax Rules For Try/Catch
- The finally Keyword

What Is Exception-Handling All About?

- Problems can arise during execution of an application.
- Examples:
  - Try to open a file but can't
  - Try to access a database, but it's unavailable
  - Try to save data, but disk is full
  - Try to call a method on an uninitialized object
  - Try to access an array index beyond the defined array length
  - Try to divide a number by zero

- All error conditions should be handled in one of two ways:

1. Return to a safe state and enable the user to execute other commands

   Example: A user accidentally inputs incorrect data, such as an incomplete phone number – the application should ask the user to try again

2. Allow the user to save all work and terminate the application gracefully

   Example: A database may not be accessible, so the user should be allowed to try again later

But what is the right way to accomplish this objective?

The Old (Non-OO) Way of Doing It

Passing Error Codes. In languages like C, errors were handled using these steps:

1. Developers agree in advance on the meaning of certain error codes (-1 might mean "resource not found", -2 might mean "input error")
2. During execution, when an error arises, the appropriate error code is returned to the caller
3. The error code is parsed, and some action is invoked.

Problems with Passing Error Codes

Problem 1: *Violation of Open-Closed Principle*. Suppose when a piece of code is first written, the developer can think of just two possible problems that might arise. So his function is defined so that if one problem arises, the code returns –1, and if the other problem arises, it returns –2. Then he writes error-handling code in the calling function to handle each error condition.

Scenario: Development begins with just two error codes, to handle two known error conditions.

```
callingFunction(String s) {
   int code = saveData(s);
   if(code == -1) {
      handleOpenFileError();
   }
   else if(code == -2) {
      handleWriteToFileError();
   }
   else {
      doTheNormalThing(s);
   }
}
int saveData(String s) {
   int result = openFile("Special File");
   if(result == -1) return -1;
   else {
      result = writeToFile(s);
      if(result == -1) return -2;
      else return 0;
   }
}
```

New error condition: File may fail to close. Need to introduce a third error code -3. Adding the new code is error-prone and new code is hard to read and maintain

```
callingFunction(String s) {
    int code = saveData(s);
    if(code == -1) {
      handleOpenFileError();
    }
    else if(code == -2) {
      handleWriteToFileError();
    }
    else if(code == -3) {
      handleCloseFileError();
    }
    else {
      doTheNormalThing(s);
    }
}
```

```
int saveData(String s) {
  int result = openFile(
                 "Special File");
  if(result == -1) return -1;
  else {
    result = writeToFile(s);
    if(result == -1) return -2;
    else {
      result = closeFile();
      if(result==-1) {
        return -3;
      }
      else return 0;
    }
  }
}
```

Problem 2: *Confusion of data.* Sometimes numbers used as error codes may also happen to be valid return values.

Example:

```
complexDivide(int a, int b, int c) {
   int temp = a / b;
   return temp / c;
}
```

Design Decision: Developers decide to return -1 if inputs b or c are zero

Introduce error-handling with error codes. Developers decide to return -1 if inputs b or c are zero

```
complexDivide(int a, int b, int c) {
        if(b == 0 || c == 0) return -1;
        int temp = a / b;
        return temp / c;
}
```

But if this is done, how can the calling function distinguish between an error condition and the result of a legitimate execution of the function, as in

```
contrivedDivide(1, -1, 1); // returns -1, but no error
```

Oops! If inputs are 1, -1, 1, then -1 is a valid return value, but would be interpreted as an error code

```
//returns -1
complexDivide(1, -1, 1);
```

An Object-Oriented Error-Handling Strategy

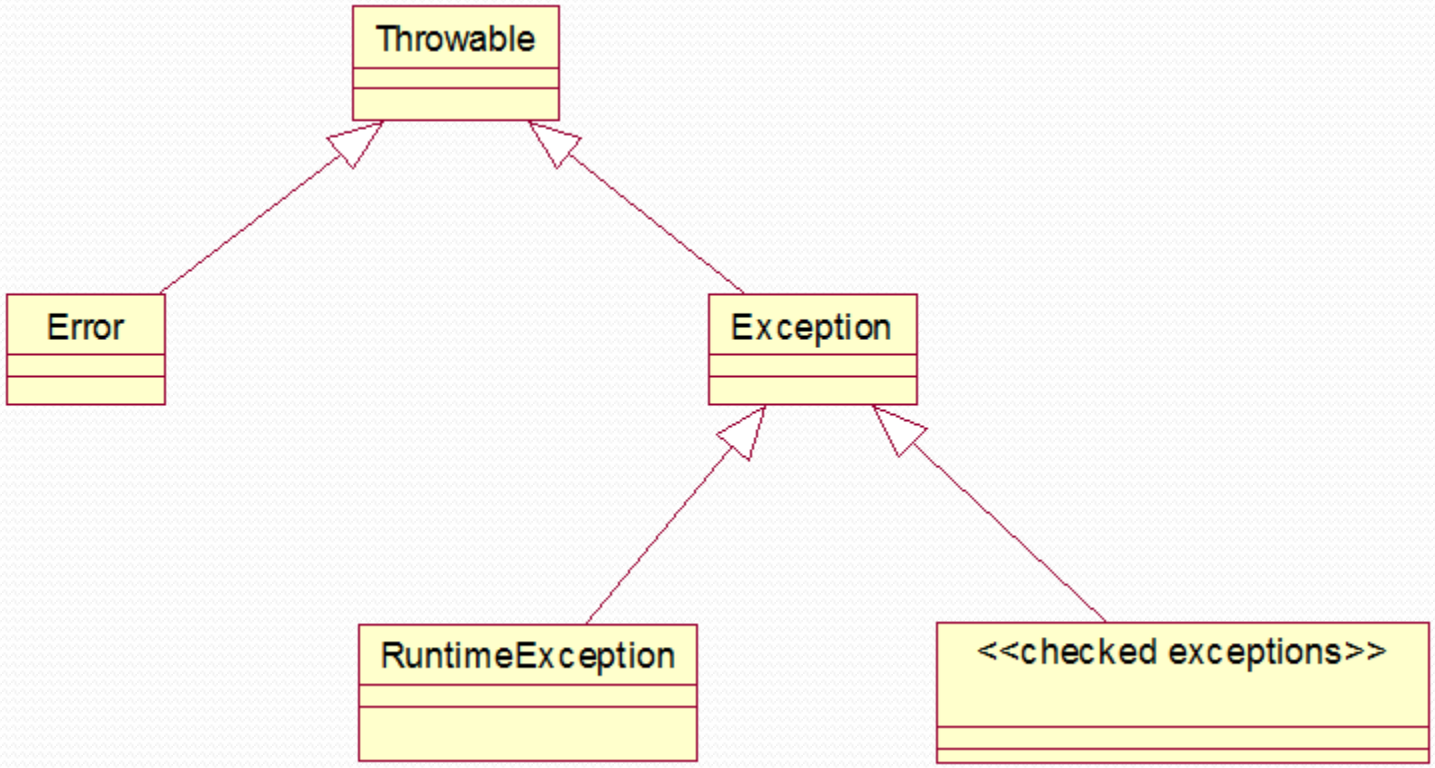
Java's solution to the problem is very similar to the solution offered in most OO languages:

- An error of any kind is represented as a special kind of object
- When an error condition arises, an instance of the object is created by the Java runtime and "thrown" (similar to the way an "event" is triggered by a button click or other user action on a GUI)
- Code written by the developer then "catches" the error-related object, analyzes the information in this object as needed, and performs some action to handle it.

Main Point

Java's exception-handling model supports best practices in handling exceptions that arise during program execution. Likewise, establishing awareness at the level where Nature operates, an individual can gracefully handle the variety of conditions that arise in a human life.

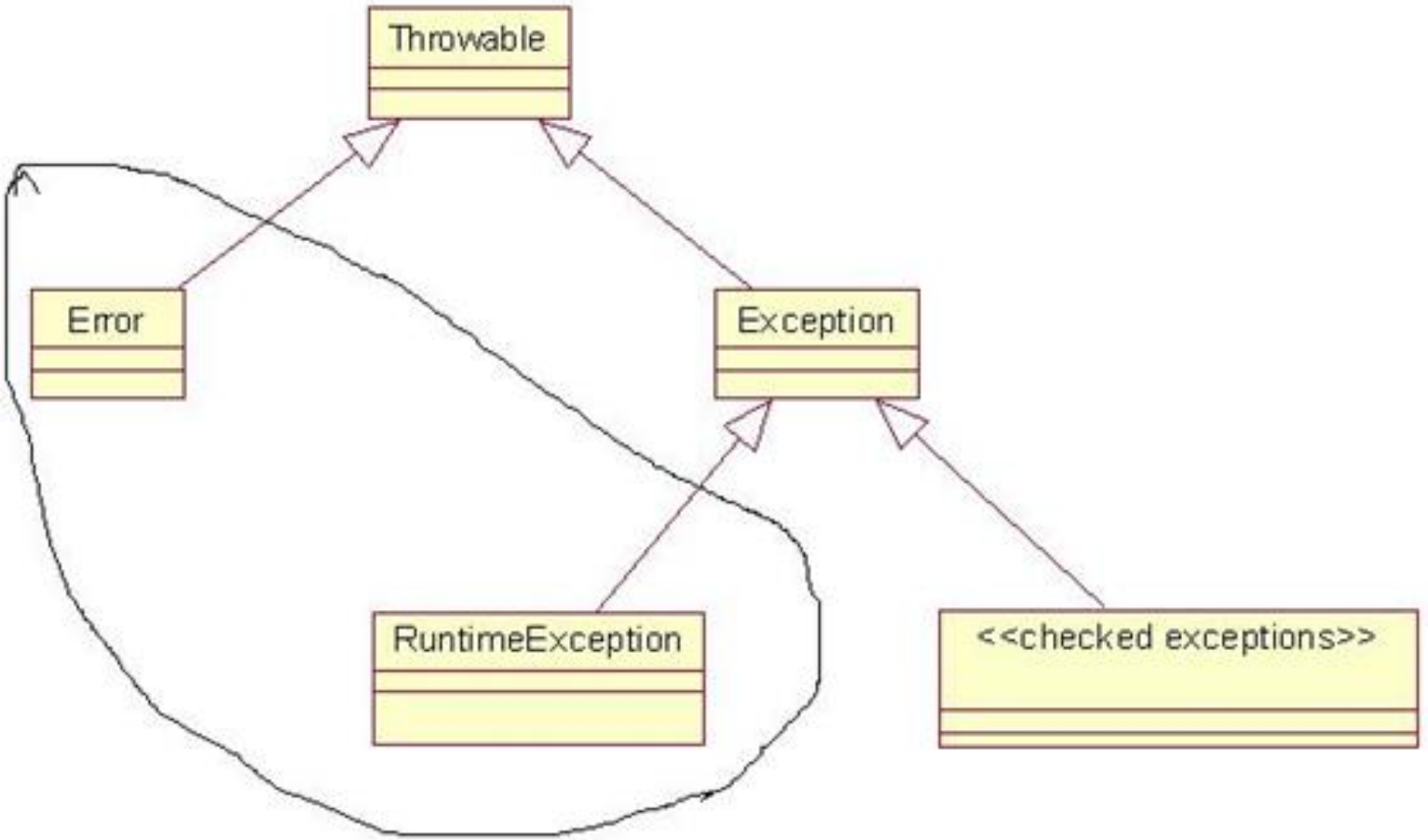
The Hierarchy of Classes That Represent Error Conditions



Classification of Error-Condition Classes

In Java, error-condition classes belong to one of three categories:

- *Error* – Objects in this category belong to the inheritance hierarchy headed by the `Error` class
- *Other Unchecked Exceptions* – Besides `Error` objects, unchecked exceptions include all objects that belong to the inheritance hierarchy headed by the class `RuntimeException`.
- *Checked Exceptions* – Exceptions in this category are subclasses of `Exception` but not subclasses of `RuntimeException`.



"Unchecked Exceptions"

Objects of type Error

- `Error` objects describe internal errors, JVM execution errors, or resource exhaustion. They occur rarely, but usually, if they do occur, the application must be terminated.

- No handling necessary. Errors of this kind indicate conditions that cannot be resolved in a "catch" block, so developers do not attempt to handle Errors that might be thrown in an application.

  Example: `StackOverflowError` is an example of an Error that can typically be handled by rewriting the code, but nothing can be done to solve this problem (or any other Error) during program execution.

- JVM displays stack trace When one of these errors occurs, the JVM *throws* an `Error` object. Since the Error is not caught, a stack trace is displayed in the console (showing the chain of method calls leading to the error).

Example: (From Lesson 4 – Recursion). If you create an illegal recursion, you will typically cause a `StackOverflowError` to occur because the sequence of self-calls overflows the call stack.

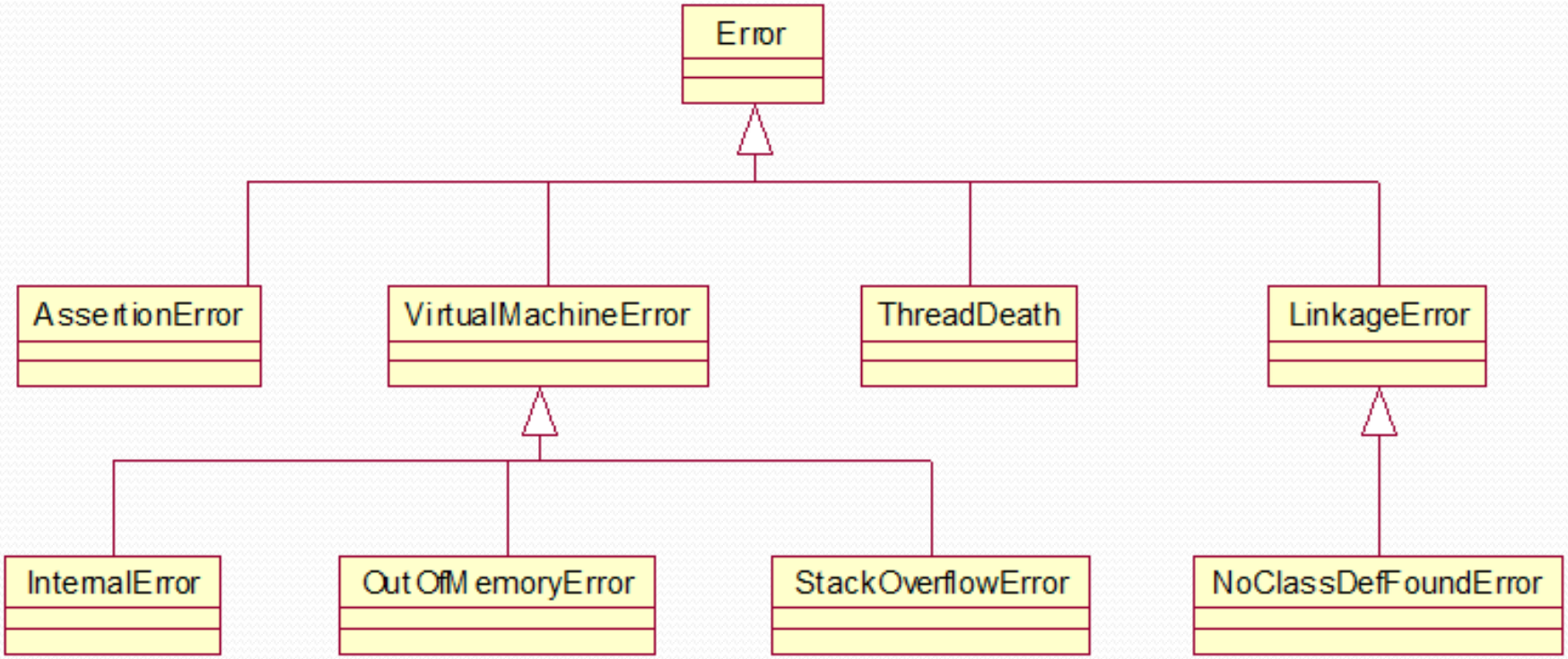
```
class MyClass {
   public static void main(String[] args) {
      new MyClass();
   }
   MyClass() {
      recurse("Hello");
   }
   String recurse(String s) {
      if (s == null)
         return null;
      int r = RandomNumbers.getRandomInt();
      int n = s.length();
      if (r % 2 == 0)
         return recurse(s.substring(0, n / 2));
      else {
         return recurse(s.substring(n / 2, n));
      }
   }
}
```

Running this code leads to the following output:

```
Exception in thread "main" java.lang.StackOverflowError
    at java.util.Random.nextInt(Unknown Source)
    at
pencil_4.prob1.RandomNumbers.getRandomInt(RandomNumbers.java:20)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:15)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:20)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:20)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:18)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:20)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:20)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:20)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:18)
    at pencil_4.prob1.MyClass.recurse(MyClass.java:20)

//output abbreviated
```

The Error Hierarchy



Other Unchecked Exceptions

- ***`RuntimeException` Hierarchy***. Subclasses of `RuntimeException` are also unchecked, and when one is thrown, a stack trace is displayed.

- ***RuntimeExceptions Indicate Failed Programming Logic.***

  Examples:

```
NullPointerException  //uninitialized object
ClassCastException    //improper cast
ArrayIndexOutOfBoundsException //adjust loop bounds
NumberFormatException  //e.g. try to change a
                       //non-numeric string to an integer.
```

- ***How to Handle***
  - Developer does not attempt to catch these exceptions during execution
  - Instead, during development, before releasing software, developers handle runtime exceptions by "fixing the bugs" that give rise to them .

Examples

```
class Test1 {
    private Employee emp;
    public static void main(String[] args) {
        Test1 test = new Test1();
        //NullPointerException at runtime
        String name = test.emp.getName();

    }
}

class Test2 {
    public static void main(String[] args) {
        List employees = new ArrayList();
        employees.add(new Employee("Joe"));
        employees.add(new Employee("Tim"));

        //ClassCastException at runtime
        Employee first = (Manager)employees.get(0);

    }
}
```

Throwing Runtime Exceptions

Because exceptions of type `RuntimeException` are unchecked, they can also be used by developers to indicate a problem that needs to be corrected (useful during development, not for production code).

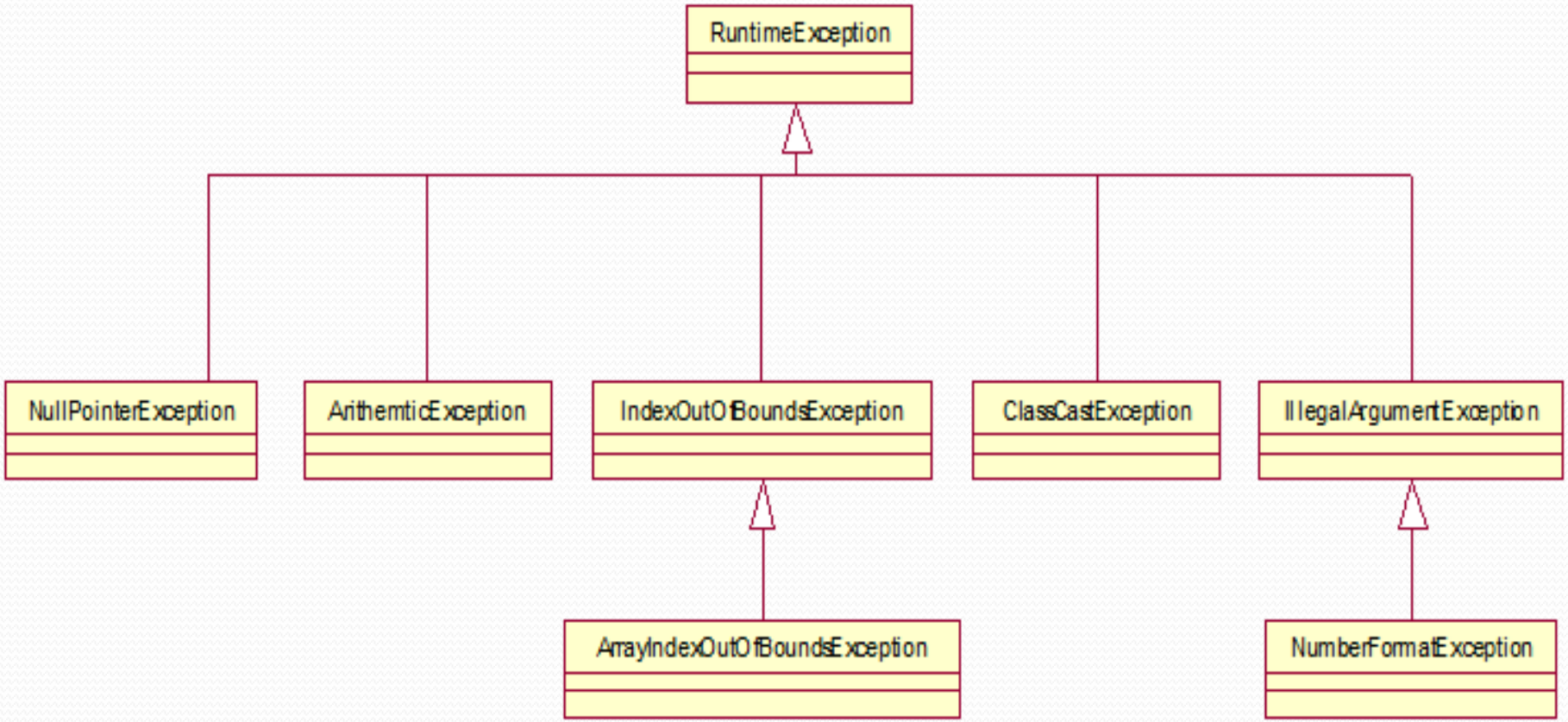
Two examples are `IllegalArgumentException` and `IllegalStateException`.

Example: (From the `Rational` class that was described in an earlier lab)

```
public Rational(int num, int denom){
     if(denom <= 0) {
       throw new IllegalArgumentException("Denominator must be
                                                  positive");
     }
     this.num=num;
     this.denom=denom;
}
```

[We will discuss what it means for exceptions to be "thrown" later in this lesson]

Hierarchy of RuntimeException



Checked Exceptions

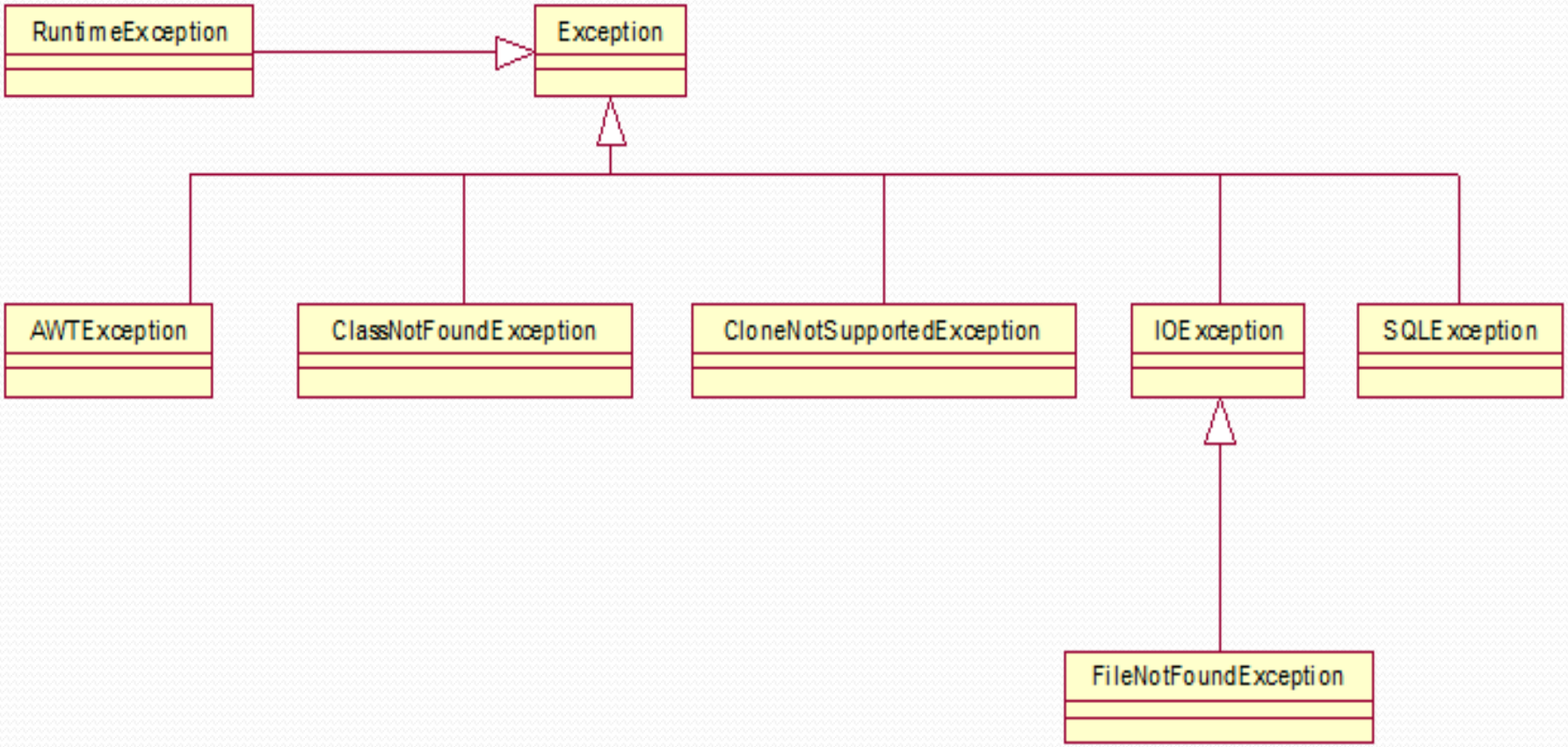
- This kind of exception is considered by the JVM to be the kind of error a developer must be prepared to handle. Examples:

```
CloneNotSupportedException
FileNotFoundException
SQLException
AWTException
```

- Often, these exceptions arise when something goes wrong with the application's environment (can't find a file or class) or with an external system (an SQL query can't be executed).

- The JVM expects the developer to *handle* any exception of this type that could possibly be thrown, and will *issue a compiler error if you fail to do so.* (This is the reason for the terminology "checked exception".)

Hierarchy of Checked Exceptions



Dealing With Checked Exceptions

- Every method in the Java API (and, as we discuss shortly, any user-created method) that is capable of throwing an `Exception` belonging to the Checked Exception Hierarchy indicates this fact with a `throws` clause in its declaration.

- Examples:
  - The `clone` method in `Object`:

```
protected clone() throws CloneNotSupportedException
```

  - The constructor of the class `FileWriter` (which is used for writing text to a file)

```
public FileWriter(File file) throws FileNotFoundException
```

Four Ways to Deal with Checked Exceptions

1. Do not attempt to handle directly; instead, declare that *your* method **throws** this kind of exception too

2. Surround the calling code in a **try** block, and then do one of the following:

   a. write exception-handling code in a **catch** block

   b. partially handle the exception in a **catch** block, and then *re-throw* the exception to allow other methods in the call stack to handle it further

   c. **throw** a new kind of exception from within the **catch** block

Question: What is the difference between **throw** and **throws** ?

Examples: Overriding the `clone` method

```
//Here exception is not handled directly
//Instead, declare that your method also
//throws this type of exception
class Employee implements Cloneable {
        .  .  .  .  .

    public Employee clone() throws CloneNotSupportedException {
        Employee copy = (Employee)super.clone();
        copy.hireDate = (Date)hireDate.clone();
        return copy;
    }
            .  .  .  .  .
}

class OtherClass {
    void callingMethod() {
        Employee e = new Employee();
        e.clone();  //compiler error - must enclose in try/catch
                //or declare that the method throws
                //CloneNotSupportedException
    }
}
```

```
//Here, we enclose the calling code in a try block, and
//then write exception-handling code in a catch block

class Employee implements Cloneable {
      .  .  .  .  .

   public Object clone(){
      try {
         Employee copy = (Employee)super.clone();
         copy.hireDate = (Date)hireDate.clone();
         return copy;
      }
      catch(CloneNotSupportedException ex) {
         System.err.println("Unable to make a copy");
      }
   }

         .  .  .  .  .
}
class OtherClass {
   void callingMethod() {
      Employee e = new Employee();
      e.clone();  //this is ok - Exception already handled
   }
}
```

```
//Here we enclose the calling code in a try block,
//then, in a catch block,
//write some exception-handling code
//and then re-throw the exception

class Employee implements Cloneable {
                .  .  .  .  .

   public Object clone() throws CloneNotSupportedException{
      try {
         Employee copy = (Employee)super.clone();
         copy.hireDate = (Date)hireDate.clone();
         return copy;
      }
      catch(CloneNotSupportedException ex) {
         System.err.println("Unable to make a copy");
         throw ex;
      }
   }

                .  .  .  .  .
}
```

```
class OtherClass {
   void callingMethod() {
      Employee e = new Employee();
      //must handle or pass on the exception
      try {
         e.clone();
      }
      catch(CloneNotSupportedException ex) {
         System.exit(1);
      }
      //this code will not execute if catch
   //clause is invoked
      System.out.println(e.getName());
   }
}
```

```
//Here we enclose the calling code in a try block, then
//in catch block, optionally write
//write some exception-handling code
//and throw an application-specific Exception object

class Employee implements Cloneable {
      .  .  .  .  .

   public Object clone() throws ApplicationSpecificException{
      try {
         Employee copy = (Employee)super.clone();
         copy.hireDate = (Date)hireDate.clone();
         return copy;
      }
      catch(CloneNotSupportedException ex) {
         String msg = ex.getMessage() +
            " Inside Employee.clone()."
         throw new ApplicationSpecificException(msg);
      }
   }

         .  .  .  .  .
}
```

```
class OtherClass {
   void callingMethod() {
      Employee e = new Employee();
      //must handle or pass on the exception
      try {
         e.clone();
      }
      //compiler error - no such Exception is thrown
      //catch(CloneNotSupportedException ex) {}

      catch(ApplicationSpecificException ex) {
         System.err.println("Call for help");
      }
      //other code will execute since catch clause
      //does not force an exit of the method
      System.out.println(e.getName());
   }
}
```

What Happens in Each Case

1. Whenever an exception is thrown at runtime, the JVM looks to see if the active method has a `catch` clause whose `Exception` type matches the type of the thrown `Exception`. If not, it moves up the call stack to see if any calling methods provide a `catch` clause with a match.

2. Two possibilities:

   - If the method is declared with a `throws` clause, as in

     ```
     . . . throws XXException
     ```

     then if an `Exception` of type `XXException` is thrown at runtime (and no `catch` clause has been provided for this type of `Exception`), the `Exception` object is passed up to the caller of this method.

   - If `try/catch` blocks have been provided, and the `catch` block's parameter matches `XXException`, then:
     - the program skips the remainder of code in the `try` block
     - the program executes the code in the `catch` block

(continued)

3. The code inside a `catch` block may

   a) gracefully handle the error condition – in which case the program will continue to run immediately after the `catch` block, or

   b) cause the application to terminate (using `System.exit()`), or

   c) re-throw the `Exception` that it just caught, or

   d) throw a new `Exception` of a different type

In cases b-d, the method immediately exits (unless there is a `finally` block—see below)

Main Point

Methods whose declaration includes a *throws* clause can be called by another method only if the calling method is declared with the same *throws* clause, or if a try/catch block is included to catch any of the declared exceptions that are thrown. This phenomenon is reminiscent of the Principle of Diving: once the initial conditions have been met, a correct dive into the depths occurs automatically. (The *throws* clause is the initial condition; the compiler then automatically requires additional coding in order to handle exceptions that may occur.)

Summary of Exception Types

- *Errors.* When an `Error` is thrown, it indicates an internal JVM error or other problem beyond the control of the developer. No attempt should be made to catch `Errors` and typically, no adjustment to the code needs to be done to prevent them (*except* for `StackOverflowError`, which is usually thrown because of an illegal recursion).

- *Other unchecked exceptions* are thrown as objects of type `RuntimeException`, or one of its subclasses. These exceptions indicate a programming error needs to be fixed (like `NullPointerException`, `ClassCastException`, and `ArrayIndexOutOfBoundsException`). These objects should not be "caught" (i.e. used in conjunction with `try/catch` blocks), though for debugging purposes, this can be done.

- *Checked exceptions* are exceptions that are subclasses of `Exception` but that are not part of the `RuntimeException` hierarchy. They must be dealt with in code by the developer. Failure to write such code results in a compiler error. Each call of a method that declares that it `throws` such an exception must either explicitly handle (in a `try/catch` block) exceptions that may arise from the call, or must pass the exception object up the call stack (using a `throws` declaration).

Using/Creating Exception Classes

- Sometimes in designing/coding an application, you may wish to indicate that an error condition has arisen, and you may find that one of Java's pre-defined exception classes will provide a sensible implementation.

Using One of Java's Exception Classes

Example: You have a method `readData` that reads in a file and one day, for a file whose header promised

Content-length: 1024

you discover that the end of file is reached after only 733 characters.

Using One of Java's Exception Classes (continued)

- Wish to equip `readData` with an exception. API docs say that the `EOFException` ***signals that an EOF has been reached unexpectedly during input***

- Rewrite your `readData` method as follows:

```
String readData(Scanner in) throws EOFException {
    . . .
    while(true) {
      if(!in.hasNext()) {  //EOF encountered—may be ok

        //something bad has happened
        if(actualLen < PROMISED_LEN){
             String msg = "expected " + PROMISED_LEN +
                          " but got only " + actualLen;
             throw new EOFException(msg);
        }
        else {
              . . . //normal execution
        }
     }
    }
}
```

User-Defined Exception Classes

- User-defined exception classes are always a subclass of `Exception`.
- `Exception` has two main constructors – a default constructor and a one-argument constructor (of `String` type) designed to store an error message. Typically, you override both of these:

```
public class MyException extends Exception {
    public MyException() {
        super();
    }
    public MyException(String msg) {
        super(msg);
    }
}
//throw one of your exceptions like this
throw new MyException("An exception has occurred");
//catch one like this:
try {
        . . .
}
catch(MyException e) {
    System.out.println(e.getMessage());//read stored msg
```

Best Practices:
When to Handle, When to Throw, When to Log

Which Class Should Handle an Exception?

- Exceptions are thrown at the exact point during execution where a problem arises
- Exceptions should be handled by a class that has among its responsibilities the proper knowledge about what should be done.
- One or more classes in an application should be delegated the responsibility of knowing what to do in case an exception occurs. Often, this responsibility entails nothing more than displaying an appropriate message to the user if an exception occurs.

Example of Handling Exceptions

```
//From Driver in Store Directory Problem
void displayNumberOfBooks() {
   try {
      //getNumberOfBooks "throws" an IllegalAccessException
      int numbooks = directory.getNumberOfBooks();
      userIO.setOutputString("Number of books is: "+
                        numbooks);
      userIO.setOutputValue();
   }
   catch(IllegalAccessException e){
      userIO.displayErrorMessage(e.getMessage());
   }
}

//From UserIO in Store Directory Problem
void displayErrorMessage(String msg){
   JOptionPane.showMessageDialog(this,
                     msg,
                     "Error",
                      JOptionPane.ERROR_MESSAGE);

}
```

Best Practices: How to Set up Your Own Exception Classes

This example illustrates a good programming practice: For production-level applications, it is good practice to pre-define a set of application-specific Exception classes as part of an overall error-handling policy. These classes should represent a simple classification of the kinds of errors that might occur, and a mapping of these to a classification of the kinds of information you want to log and/or present to the user.

Example: In a small application, you may need only two kinds of exception: a UserException and a SystemException.

`UserException`: When the user makes a mistake

`SystemException`: When something goes wrong that is not the user's fault

Once this design decision has been made, then all exceptions that could arise in the application would be caught and either a `UserException` or `SystemException` would then be thrown.

Importance of Logging

- When an exception occurs, it is usually important to record this fact for later review by interested parties (developers, business team, etc). Messages presented to the user or printed to the console are not adequate for this purpose. What is needed is a *Log file*.

- Pattern
  - Log a warning or error message when the exception first occurs
  - Throw an appropriate `Exception` up call stack to appropriate controller
  - Controller either handles or creates a user exception with a user-appropriate message

Using Java's Logger

- jdk 1.4 introduced the `Logger` class
- Create an instance like this:

```
private static Logger LOG =
        Logger.getLogger("com.mycompany.myapp");
```

- Permits setting of level (`SEVERE, WARNING, INFO, FINE`), handlers and formatters. Adjust values in a properties file located in `<java_home>\jre\lib`.
- When an event occurs during runtime that needs to be logged, insert a line like this:

```
LOG.warning("Unauthorized user has attempted "
                + "to perform an action.");
```

Example

```
private static final Logger LOG =
   Logger.getLogger(Bookstore.class.getPackage());

Bookstore(String id){
   this.id = id;
}
int getNumBooks() throws BadIdException {
   if(!isBadId(id)){
       return numBooks;
   }
   else {
       LOG.warning(LOG_WARN_BAD_ID);
       throw new BadIdException(BAD_ID_MSG);
   }
}
```

See demo package lesson12.exceptionsdemo

Main Point

To use Exceptions effectively, when an Exception is thrown, a message should be *logged* so that the support team can review later; the Exception should be *thrown* up the call stack until a class that knows how to handle the Exception is reached; and this final class should *catch* and *handle* the Exception in an appropriate way (often, this means presenting an error message to the user). In a similar way, creation itself is structured in layers; the activity at each layer has its own unique set of governing laws; laws that pertain to one level or layer may no longer be applicable at another level.

Some Syntax Rules For Try/Catch

1. Every use of try must have at least one corresponding `catch` (or `finally` – see below) clause.

2. When an exception object is thrown, it will be caught be the nearest catch clause for which the catch clause parameter matches the class of the exception object, or *is a superclass of this class*

   Example: The following produces a compiler error – 2nd catch clause is unreachable

```
try {
        . . .
}
catch(IOException ex1) {
        . . .
}
catch(FileNotFoundException ex2) {
        . . .
}
```

The following however is legal

```
try {
            . . .
}
catch(FileNotFoundException ex1) {
            . . .
}
catch(IOException ex2) {
    . . .
}
```

This also explains why you never catch an "`Exception`" object directly – otherwise, you could end up catching all kinds of unchecked exceptions (by accident).

```
//bad programming style
try {
    . . .
}
catch(Exception e) {
    . . .
}
```

3. It is legal to have `try/catch` blocks inside other `try` blocks and inside other `catch` blocks (sometimes this is necessary)

```
try{
  try {
        . . .
  }
  catch(AnExceptionType ex1) {
        . . .
  }
}
catch(AnotherExceptionType ex2) {
  try {
        . . .
  }
  catch(ThirdExceptionType ex3) {
        . . .
  }
}
```

The finally Keyword

- A `finally` clause can be introduced after all `catch` clauses.
- Any `finally` block is guaranteed to run after a `try/catch` block, even if a `return` or `break` occurs; even if another exception is thrown inside those blocks.
- Exception to the rule: If `System.exit()` occurs in one of the blocks, the `finally` clause is skipped.
- A `finally` clause is used to cleanup resources (like database connections, open files)

finally Exercise

```
class FinallyTest{
    public static void test() throws Exception {
        try {
            // return;                    // 1
            // System.exit(0);            // 2
            // throw new Exception("first");   // 3a
        }
        catch (Exception x){
        System.out.println(x.getMessage());
            // throw new Exception("second");   // 3b
        }
        finally {
            System.out.println("finally!");
        }

        System.out.println("last statement");
    }
    public static void main(String[] args){
        try{
            test();
        }
        catch(Exception x){
            System.out.println(x.getMessage());
        }
    }
}
```

Program Output

```
0:
finally!
last statement


1:
finally!


2:   no output

3a:  first
finally!
last statement

3a + 3b:
first
finally!
second
```

Examples of Proper Use of Java's Exception-Handling Model

Needs Improvement

```
//Triangle constructor
public Triangle(double side1, double side2, double side3)  {
    double[] arr = sort(side1,side2,side3);
    double x = arr[0];
    double y = arr[1];
    double z = arr[2];
    if(x + y < z) {
        System.out.println("Illegal sizes for a triangle:
                    "+side1+", "+side2+", "+side3);
        System.out.println("Using default sizes.");

    setValues(DEFAULT_SIDE,DEFAULT_SIDE,DEFAULT_SIDE);
        computeBaseAndHeight(DEFAULT_SIDE,
                                DEFAULT_SIDE,
                                DEFAULT_SIDE);
    }
    else {
        setValues(x,y,z);
        computeBaseAndHeight(x,y,z);
    }
}
```

```
//from Test class
public static void main(String[] args) {

   ClosedCurve[] objects = {new Triangle(4,5,6),
                            new Square(3),
                            new Circle(3)};
   //compute areas
   for(ClosedCurve cc : objects) {
      System.out.println(cc.computeArea());
   }

}
```

Improved Version

```
private final static Logger LOG
   = Logger.getLogger("closedcurve.good");

//Triangle constructor
public Triangle(double side1, double side2, double side3)  {
   double[] arr = sort(side1,side2,side3);
   double x = arr[0];
   double y = arr[1];
   double z = arr[2];
   if(x + y < z) {
      LOG.warning("Illegal sizes of sides passed in");
      throw new IllegalTriangleException("Illegal sizes for a
                     triangle: "+"+side1+", "+side2+", "+side3);
   }
   else {
      setValues(x,y,z);
      computeBaseAndHeight(x,y,z);
   }
}
```

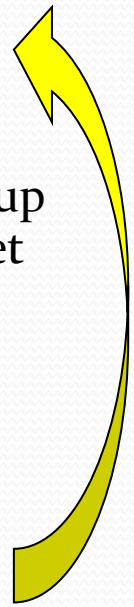
```
//from Test class
public static void main(String[] args) {
    ClosedCurve[] objects = null;
    Triangle t = null;
    try {
        t = new Triangle(4,5,6);
    }
    catch(IllegalTriangleException e) {
        String msg = e.getMessage();
        JOptionPane.showMessageDialog(this, msg, "Error",
                                      JOptionPane.ERROR_MESSAGE);
        System.exit(0);
    }
    objects = { t, new Square(3), new Circle(3)};
    //compute areas
    for(ClosedCurve cc : objects) {
        System.out.println(cc.computeArea());

    }
}
```

Connecting the Parts of Knowledge With the Wholeness of Knowledge

Right action in the field of exception-handling

1. If a Java method has a throws clause in its declaration, the compiler requires the developer to (write code to) handle potential exceptions whenever the method is called.
2. To handle exceptions in the best possible way, logging should occur as soon as an exception is thrown, and the exception should be re-thrown up the call stack until a method belonging to a class with an appropriate set of responsibilities is reached – and within this method, the exception should be caught and handled.



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3. **Transcendental Consciousness:** TC is the home of all the laws of nature, the home of "right action".
4. **Wholeness moving within itself**: Action in the state of Unity Consciousness is spontaneously right and uplifting to the creation as a whole.