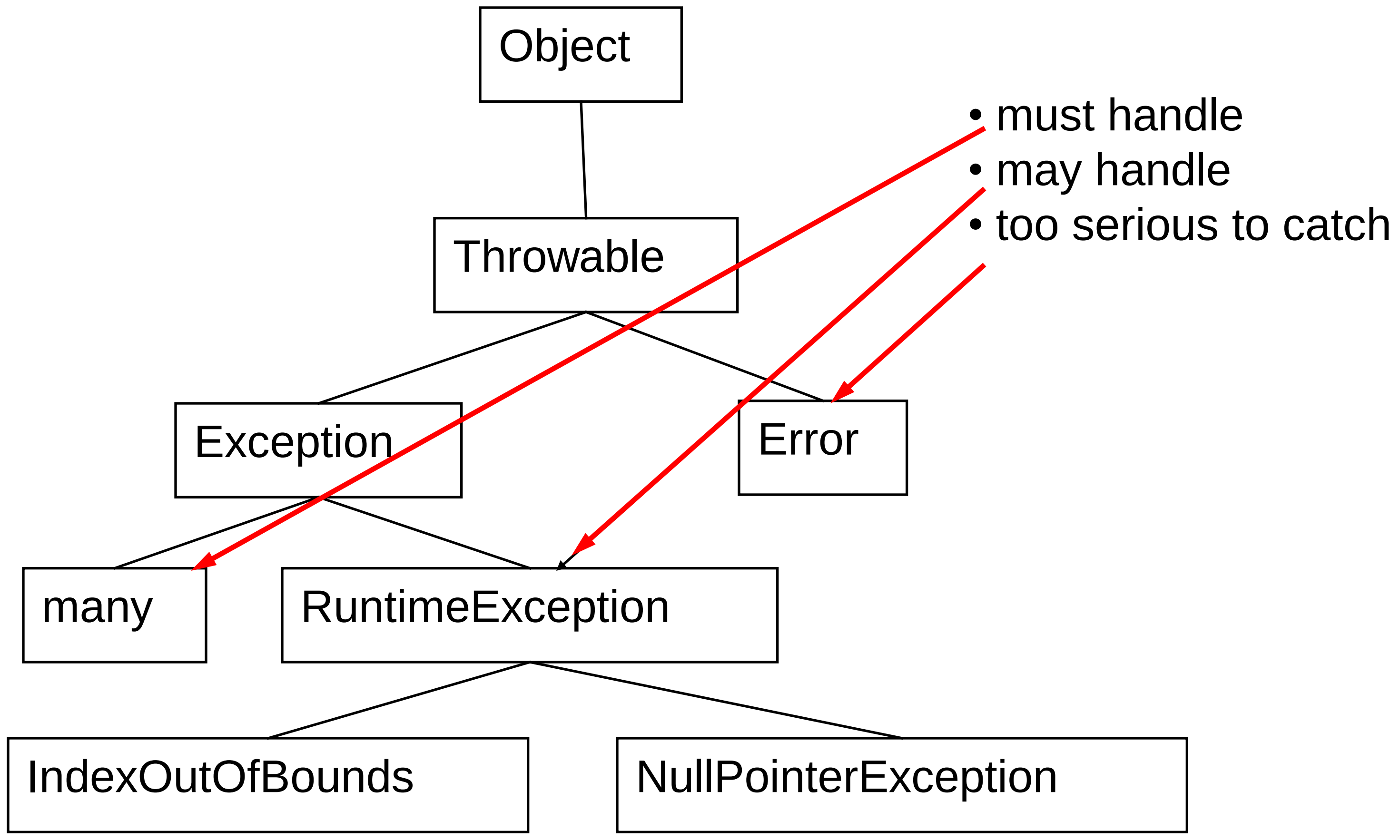
Java Exceptions

Intro to Exceptions

- What are exceptions?
  - Events that occur during the execution of a program that interrupt the normal flow of control.
- One technique for handling Exceptions is to use return statements in method calls.
- This is fine, but java provides a much more general and flexible formalism that forces programmers to consider exceptional cases.
- e.g. Opening a file, does not exist.

Exception Class hierarchy



`Throwable hierarchy`

- All exceptions extend the class `Throwable`, which splits into two branches:

`Error` and `Exception`

  - `Error:` internal errors and resource exhaustion inside the Java runtime system. Little you can do.
  - `Exception`: splits further into two branches. `RuntimeException` and other exceptions

Focus on the `Exception` branch

- Two branches of **`Exception`**
  - exceptions that derived from **`RuntimeException`**
    - examples: a bad cast, an out-of-array access
    - happens because errors exist in your program. Your fault.
  - those not in the type of **`RuntimeException`**
    - example: trying to open a malformed URL
    - program is good, other bad things happen. Not your fault.

Focus on the `Exception` branch

- Checked exceptions vs. unchecked exceptions
  - *Unchecked exceptions*: exceptions derived from the class **`Error`** or the class **`RuntimeException`**
  - *Checked **exceptions***: all other exceptions that are not unchecked exceptions
    - If they occur, they must be dealt with in some way.
    - The compiler will check whether you provide exception handlers for checked exceptions which may occur

Approaches to handling an exception

1. Prevent the exception from happening
2. Catch it in the method in which it occurs, and either
   1. Fix up the problem and resume normal execution
   2. Rethrow it
   3. Throw a different exception
3. Declare that the method throws the exception
4. With 1. and 2.a. the caller never knows there was an error.
5. With 2.b., 2.c., and 3., if the caller does not handle the exception, the program will terminate and display a stack trace

Exception Handling Basics

- Three parts to Exception handling
  1. claiming exception
  2. throwing exception
  3. catching exception

- A method has the option of *throw*ing one or more exceptions when specified conditions occur. This exception must be *claim*ed by the method. Another method calling this method must either *catch* or re*throw* the exception.

Example

```
public class myexception{
    public static void main(String args[]){
            try{
                File f = new File(“myfile”);
                FileInputStream fis = new FileInputStream(f);
            }catch(FileNotFoundException ex){
                 File f  = new File(“Available File”);
                 FileInputStream fis = new FileInputStream(f);
            } finally{                    // the finally block
            }   //continue processing here.
    }}
```

- In this example we are trying to open a file and if the file does not exists we can do further processing in the catch block.
- The try and catch blocks are used to identify possible exception conditions. We try to execute any statement that might throw an exception and the catch block is used for any exceptions caused.
- If the try block does not throw any exceptions, then the catch block is not executed.
- The finally block is always executed irrespective of whether the exception is thrown or not.

Using throws clause

Use the throws to handle the exception in the calling function.

```
public class myexception{
    public static void main(String args[]){
        try{
                checkEx();
        } catch(FileNotFoundException ex){
        }
    }
    public void checkEx() throws FileNotFoundException{
        File f = new File(“myfile”);
        FileInputStream fis = new FileInputStream(f);
        //continue processing here.
}
}
```

Using throws clause

- In this example, the main method calls the checkex() method and the checkex method tries to open a file, If the file in not available, then an exception is raised and passed to the main method, where it is handled.

Catching Multiple exceptions

```
public class myexception{
     public static void main(String args[]){
               try{
               File f = new File(“myfile”);
               FileInputStream fis = new FileInputStream(f);
               }
               catch(FileNotFoundException ex){
                         File f  = new File(“Available File”);
                         FileInputStream fis = new FileInputStream(f);
               }catch(IOException ex){
                         //do something here
               }
finally{
// the finally block
}
//continue processing here.
     }
}
```

Throwing Exception

- To throw an Exception, use the *throw* keyword followed by an instance of the Exception class

```
void foo() throws SomeException{
  if (whatever) {...}
  else{ throw new SomeException(...)}
```

- Note that if a method foo has a throw clause within it, that the Exception that is thrown (or one of its superclasses) must be claimed after the signature.

Catching Exceptions

- The third piece of the picture is catching exceptions.
- This is what you will do with most commonly, since many of java's library methods are defined to throw one or more runtime exception.
- Catching exceptions:
  - When a method is called that throws and Exception e.g SomeException, it must be called in a try-catch block:

```
try
{
   foo();
 }
catch(SomeException se)
{
  ...
}
```

Example1

```
import java.io.*;

public class Exception1{
    public static void main(String[] args){
    InputStream f;
    try{
            f = new FileInputStream("foo.txt");
     }
     catch(FileNotFoundException fnfe){
            System.out.println(fnfe.getMessage());
     }
  }
}
```

Example2

```
import java.io.*;
public class Exception2{
    public static void main(String[] args){
    InputStream fin;
    try{
            fin = new FileInputStream("foo.txt");
            int input = fin.read();
        }
    catch(FileNotFoundException fnfe){
            System.out.println(fnfe.getMessage());
     }
     catch(IOException ioe){
            System.out.println(ioe.getMessage());
     } }}
```

Catching exceptions

- Checked exceptions handling is strictly enforced. If you invoke a method that lists a checked exception in its throws clause, you have three choices
  1. Catch the exception and handle it
  2. Declare the exception in your own `throws` clause, and let the exception pass through your method (you may have a `finally` clause to clean up first)
  3. Catch the exception and map it into one of your exceptions by throwing an exception of a type declared in your own `throws` clause

`finally` clause

- You can use a `finally` clause without a `catch` clause
- Sometimes the `finally` clause can also thrown an exception

Example

```
 public boolean searchFor(String file,
String word)
    throws StreamException
 {
    Stream input = null;
    try {
        some code which may throw an
StreamException
    } finally {
        input.close(); // this may throw anIOException
    }
 }
```

`finally` clause

- You may want to do some actions whether or not an exception is thrown. `finally` clause does this for you

```
    Graphics g = image.getGraphics();
    try {
        //1
        code that might throw exceptions
        //2
    } catch (IOException e) {
        //3
        show error dialog (// some code which may throw exceptions)
        //4
    } finally {
        g.dispose(); (// some code which will not throw exceptions)
        //5
    } //6
```

  - No exception is thrown: 1, 2, 5, 6
  - An exception is thrown and caught by the `catch` clause
    - The `catch` clause doesn't throw any other exception: 1, 3, 4, 5, 6
    - The `catch` clause throws an exception itself: 1, 3, 5, and the exception is thrown back to the caller of this method
  - An exception is thrown but not caught by the `catch` clause: 1, 5 , and the exception is thrown back to the caller of this method

Creating new exception types

- Exceptions are objects. New exception types should extend `Exception` or one of its subclasses
- Why creating new exception types?
  1. describe the exceptional condition in more details than just the string that `Exception` provides

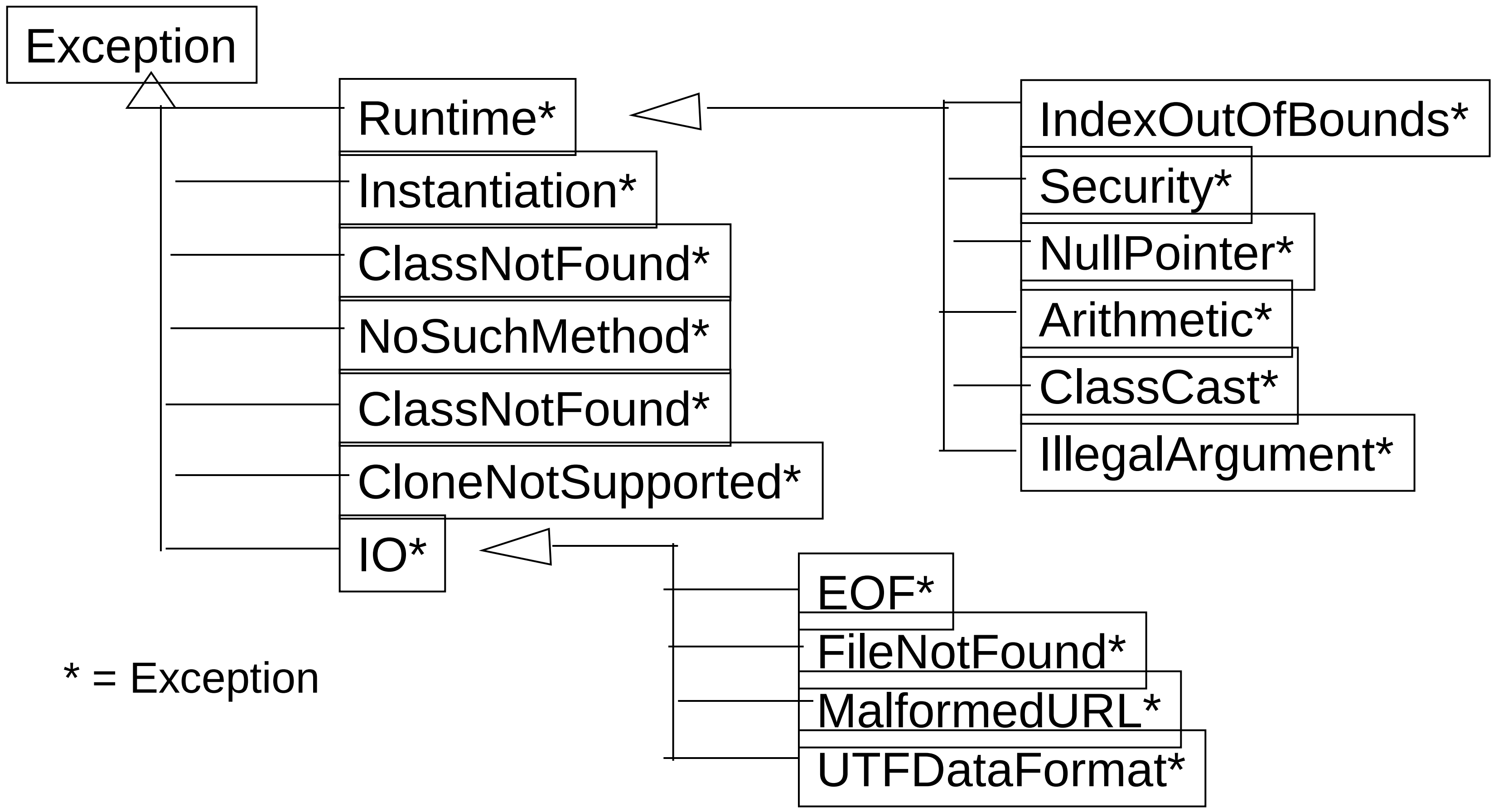
E.g. suppose there is a method to update the current value of a named attribute of an object, but the object may not contain such an attribute currently. We want an exception to be thrown to indicate the occurring of if such a situation

```
public class NoSuchAttributeException extends Exception {
   public String attrName;
   public NoSuchAttributeException (String name) {
        super("No attribute named \"" + name + "\" found");
        attrName = name;
   }
}
```

  2. the type of the exception is an important part of the exception data – programmers need to do some actions exclusively to one type of exception conditions, not others

Throwing Your Own Exceptions

- There are many exceptions and you should get to know them



* = Exception