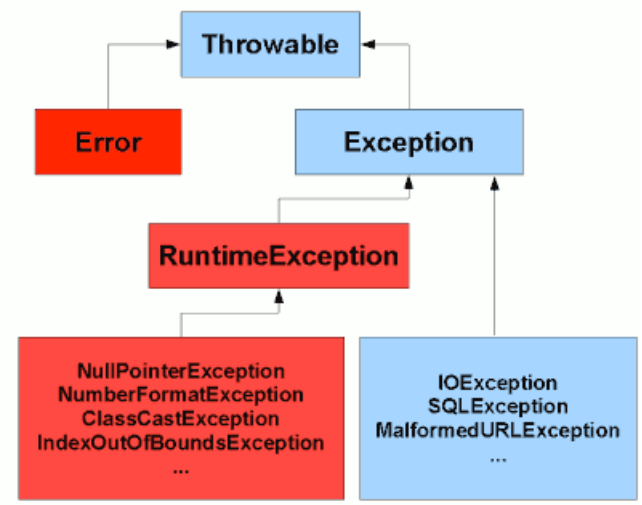
Exceptions

In the real world, programs are never perfect and never operate in a perfect environment. The types of things that can go wrong range from program bugs, such as having an array index out of bounds, to incorrect user actions, such as not putting data into a form TextField or not supplying a file to be read, to unforeseen circumstances such as network issues that don't allow the program to make a connection to a URL or database server. So it's a given that programs have to be able to deal with unexpected errors.

Java Exceptions are a way to systematically handle errors as much as possible by having error handling code put into programs that respond correctly to errors by doing the appropriate action, such as asking the user to put in the input or just making the program print error messages and quit.

Java has a system of very detailed Exceptions and they are arranged in a hierarchy so that you can choose to handle specific exceptions with a specific action or just generally handle any exception that can occur.



ref. Neil Coffey

The Exception hierarchy is part of a larger Throwable class that also has some errors we might consider as internal Java errors. These are actually called Errors and do not have to be handled by the programmer because the program is not expected to be able to recover from the error. The OutOfMemoryError is an example of this.

The other errors are classed as Exceptions. A subclass of these are the RuntimeExceptions which the programmer is not required to handle, but may choose to do so, such as NumberFormatException. Note that some of these, such as ArrayIndexOutOfBoundsException would be tedious to always handle in every program with arrays.

The programmer is required to handle the remaining types of Exceptions by adding try/catch blocks to their code. IOException is the name of the exception class with all the exceptions that

can occur during input/output of the program. These include FileNotFoundException and EOFException. (Note that MalformedURLException is also a subclass of IOException.)

Handling Exceptions

Exceptions are handled by what is usually called a "try-catch" block, which has the following form:

```
try {
<code containing methods that may cause an exception>
}
catch  (<exception class>  <exception variable name>) {   // may be 1 or more
<code to handle the exception>
}
finally {                                                 // optional
<code to finish up whether there is an exception or not>
}
```

The order of execution is:

- Execute the code in the try block. If any method causes an exception, quit this block immediately and go to the catch block. If no exception occurs, skip to the finally block.
- If an exception occurs, execute the catch block and then go to the finally block.

Example1:

Converting a String to a number inside an actionPerformed method:

```
   int number;
   try
{
   number = Integer.parseInt(jTextField1.getText());
   jLabel3.setText("Result = " + number
}
catch ( NumberFormatException e)
{
   // print out the Exception
   System.out.println(e.toString());
   // give the user a message
   javax.swing.JOptionPane.showMessageDialog(this,
         "Please enter a valid integer");
   // instead of quitting, return to the user to correct the textfields
   //    and try the button again
}
```

Example2:

Reading lines from a file and echoing them:

```
import java.io.*;

public class IOTest  {
        public static void readAndPrintLines( )  {
                // input stream variable
                BufferedReader inputStream = null;

                try {
                        // open a file for reading
                        inputStream = new BufferedReader( new FileReader("xanadu.txt"));

                        String line;
                        // read the next line of the file until there are none left
                        while (( line = inputStream.readLine()) != null)  {
                                // print out the line
                                System.out.println(line);
                        }
                }
                catch ( IOException e)  {
                        // display information about the exception and exit the program
                        e.printStackTrace();
                        System.exit(-1);
                }
                finally  {
                        // close the file
                        inputStream.close();
                }
        }
}
```

For all exceptions, there are several methods to display information. The one shown above prints what is called the stack trace: it gives the error and a list of all the methods that were called before the error. There are also:

```
e.getMessage()    // can print any message attached to the exception
e.toString()      // gives an idea of what caused the error and which method it was in
e.printStackTrace()    // prints out the sequence of programs where the error occurred
```

Of course, you can also put other messages either in the output using System.out.println, or giving information dialog boxes, using one of the methods like showMessageDialog.

In your program, there are some exceptions that you are required to catch (and the compiler will complain if you don't) and others you can leave if you wish (from the RuntimeExceptions) and the Java runtime will print out a stack trace as it closes the program.

How can you tell if a method will cause an Exception?

Each method that can cause an exception is required to have a "throw" clause in the header of the method. For Java system methods, we can look in an online resource called the Java API, which lists all packages, classes and methods of Java. For example, the Java SE6 API is at

http://docs.oracle.com/javase/6/docs/api/

For example, the parseInt method is in the class Integer, and its method header is:

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

In serious Java programs, the program can create its own exceptions and can have methods that throw exceptions in their code, for example, if you find that there is an error in the data. But this topic is outside the scope of this class.