CS1110 Lec 24 23 November 2010 Exceptions in Java

Reading for today: 10. Next lecture: Ch 9.3

A7: remember, "Don't look at any other student/group's code, in any form; don't show any other student/group your code".

(The similarity software turned up a few problems on A6, which we are about to start the Academic Integrity violation process for. Note that the checker essentially performs variable-name substitutions, etc., so syntactic modification of the same original program is generally flagged.)

No labs this week, no TA office hours Wed-Fri, see consultant calendar for the updated schedule.

There *are* "labs" *next* week, but they will serve as office hours plus an optional exercise on exceptions (covered on final).

Final: Friday Dec 10th, 9-11:30am, Statler Auditorium.
Register conflicts (same time, or 3 finals in 24 hours) on CMS assignment "final exam conflicts" *by Tuesday November 30th*.

Please check that your grades on CMS match what you think they are. [For lab-grade issues, contact your lab TA, not the instructors.]

Today’s (and next week's lab’s) topic : when things go wrong (in Java)

Q1: What happens when an error causes the system to abort?

(NullPointerException, ArrayIndexOutOfBoundsException, …)

Understanding this helps you debug.

Q2: Can we make use of the "problem-signaling mechanism" to handle unusual situations in a more appropriate way?

Understanding this helps you write more flexible code.

Important example: a “regular person” enters malformed input.

It is sometimes better to warn and re-prompt the user than to have the program crash (even if the user didn’t follow your exquisitely clear directions or preconditions).

```
       /** Exception example */
       public class Ex {
           public static void first() {
line 5         second();
           }

           public static void second() {
  9          third();
           }

           public static void third() {
  13           int x= 5 / 0;
           }
       }
```

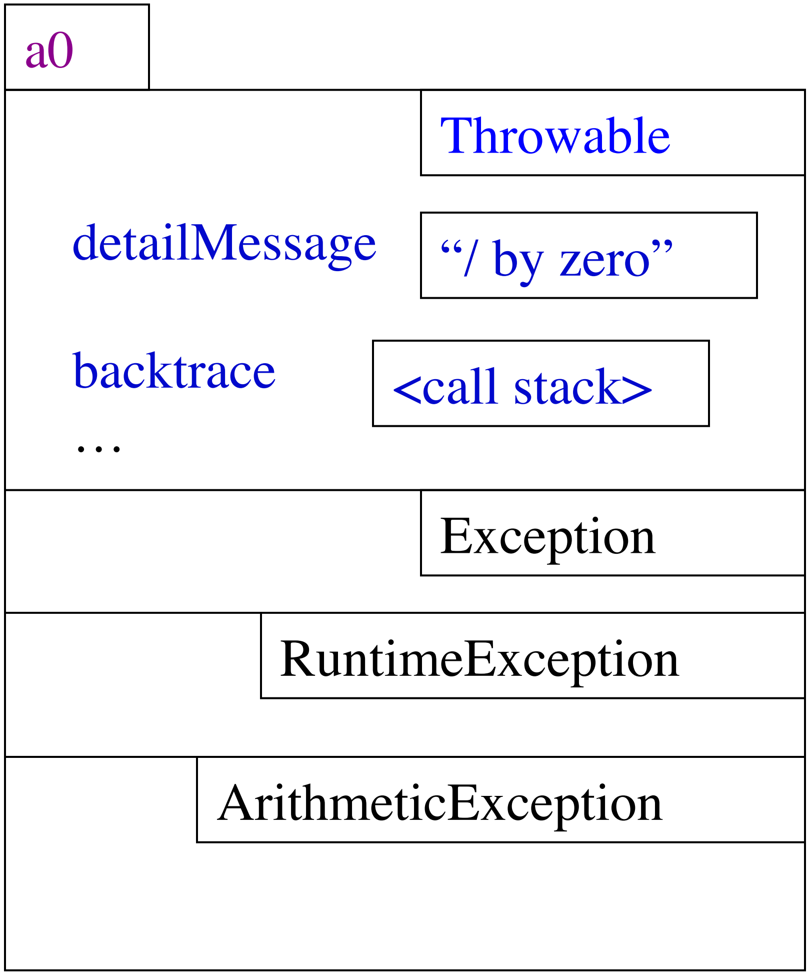
Call: **Ex.first();**

System prints the call-stack trace:

```
ArithmeticException: / by zero
  at Ex.third(Ex.java:13)
  at Ex.second(Ex.java:9)
  at Ex.first(Ex.java:5)
```

Same structure as our demo:
StockQuoteGUI's actionPerformed calls StockQuote's getQuote,
which calls In's constructor and readAll methods.

errors (little e) cause Java to *throw* a Throwable object as a “distress signal”



a0

Throwable

detailMessage “/ by zero”

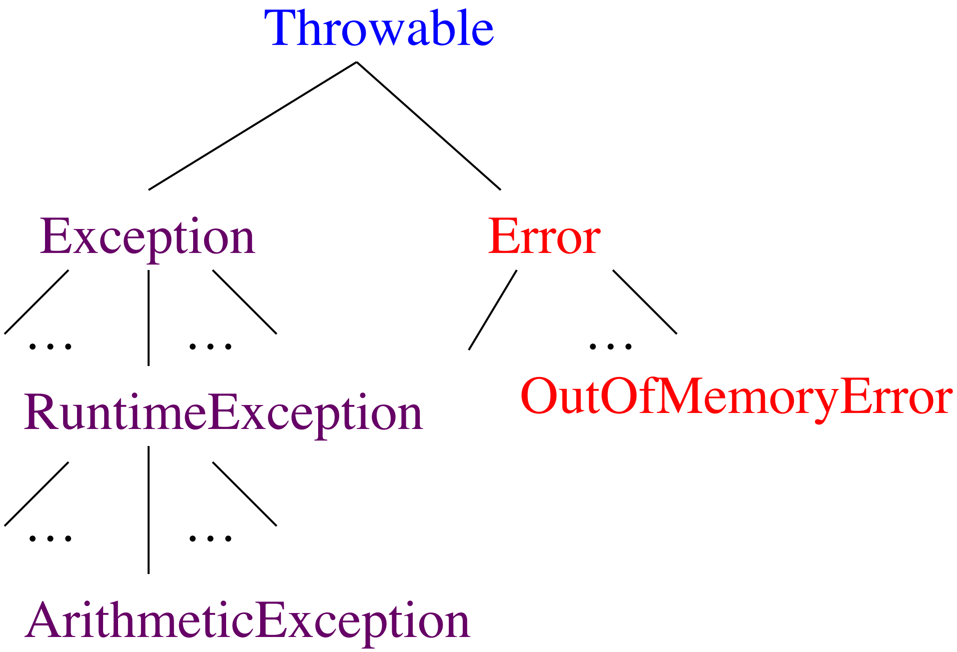
backtrace <call stack>

…

Exception

RuntimeException

ArithmeticException



Throwable

Exception … … RuntimeException … … ArithmeticException

Error … OutOfMemoryError

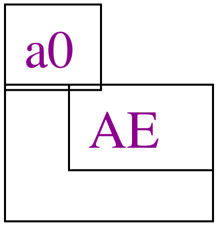
Exceptions are signals that intervention may still be possible; they can be “handled”.

Errors are signals that things are beyond help.

```
/** Exception example */
public class Ex {
    public static void first() {
        second();
    }

    public static void second() {
      third();
    }

    public static void third() {
        int x= 5 / 0;
    }
}
```



Call: **Ex.first();**

Throwable object --- request for help --- is thrown to successive "callers" until *caught* by a method that declares that it can provide help. (This is a form of communication between methods.)

In this example, the Java system catches it because nothing else does, it just prints the call-stack trace and aborts.

```
ArithmeticException: / by zero
  at Ex.third(Ex.java:13)
  at Ex.second(Ex.java:9)
  at Ex.first(Ex.java:5)
```

How can *we* catch/handle Throwables? With *Try/catch* blocks.

```
/** = reciprocal of x.  Thows an ArithmeticException if x is 0.
 (Assume this is third-party code that you can't change.)*/
public static double reciprocal(int x) {
      …;
}

/** = reciprocal(x), or -1 if x is 0.
  Assume you can't change this spec. */
public static double ourReciprocal(int x) {
  try {
          return reciprocal(x);
  }
      catch (ArithmeticException ae) {
          return -1;
      }
}
```

Execute the try-block. If it finishes without throwing anything, fine.

If it throws an ArithmeticException object, catch it (execute the catch block); else throw it out further.

Try-statements vs. if-then checking

```
/** =  reciprocal(x), or -1 if x is 0*/
public static double ourReciprocal2(int x) {
  if (x != 0) {
        return reciprocal(x);
  }  else {
         return -1;
     }
}
```

The previous slide was just to show try/catch syntax. Use your judgment:

•For (a small number of) simple tests and “normal” situations, if-thens are usually better. For more “abnormal” situations, try-catches are better.

[In this case, given the specification, if/then is *maybe* slightly better; anyone reading the code would expect to see a check for 0.]

•There are some canonical try/catch idioms, such as processing malformed input.

How can we create our own signals?

- We can create new Throwable objects, via new-statements.
- We can write our own Exception subclasses (see demo)

```
Ex.initArray(-1);
```

```
java.lang.IllegalArgumentException:
initArray: bad value for n, namely -1
        at Ex.initArray(Ex.java:20)
```

```
/** Illustrate exception handling*/
public class Ex {

   /** = array of n -1's.
     Throws an
IllegalArgumentException if n <=0*/
   private static int[] initArray(int n)
{
  if (n <= 0) {
       throw new
           IllegalArgumentException
                 ("initArray: bad
                 value for n, namely "
                 + n);
     }
     …
}
```

A technical point: we may need a “throws” clause to compile

tell the system that an OurException might get thrown

```
/** Class to illustrate exception handling */
public class Ex2 {
   public static void first() throws OurException {
      second();
   }
   public static void second() throws OurException {
      third();
   }
   public static void third() throws OurException {
      throw new OurException(“intentional error at
            third”);
   }
```

Don’t worry about whether to put a throws-clause in or not. Just put it in when it is needed in order for the program to compile.

[runtime exceptions don't require a throws-clause; other kinds do]