Recitation 4.

2-D arrays.

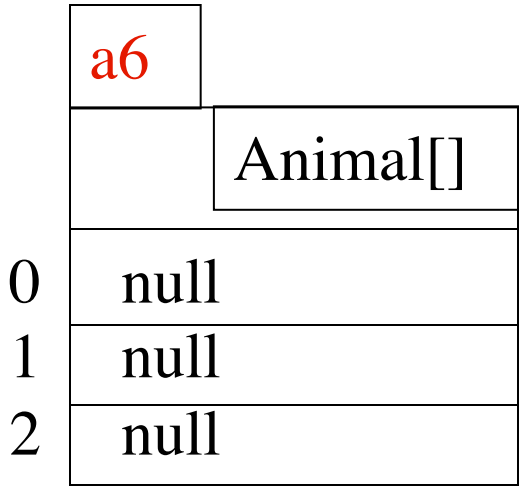
Exceptions

Animal[] v= **new** Animal[3];

declaration of array v

Create array of 3 elements

Assign value of new-exp to v



Assign and refer to elements as usual:

```
v[0]= new Animal(…);
…
a= v[0].getAge();
```

v.length is the size of the array

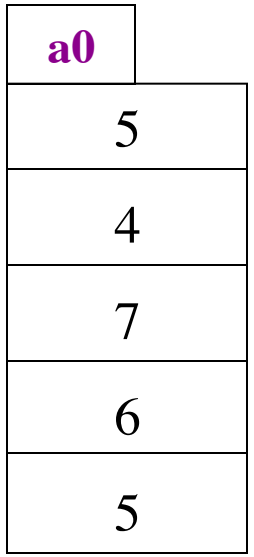
(Review: showed this in Lecture 6)

Array initializers

Instead of

int[] c= **new** int[5];

c[0]= 5; c[1]= 4; c[2]= 7; c[3]= 6; c[4]= 5;



Use an array initializer:

int[] c= **new int**[ ] {5, 4, 7, 6, 5};

No expression between brackets [ ].

array initializer: gives values to be in the array initially. Values must have the same type, in this case, **int**. Length of array is number of values in the list

Two-dimensional arrays

int[] c= **new int**[5];

c is a 1-dimensional array

~~**int[][]** d= **new int**[5, 8];~~

You would think this gives an array/ table with 5 rows and 8 columns. BUT Java does it differently

int[][] d= **new int**[5][8];

Java does it like this

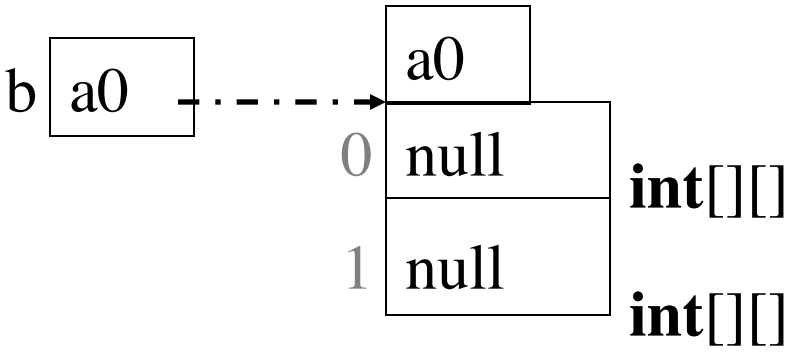
d.length	number of rows (5)
d[0].length	number of columns in row 0 (8)
d[1].length	number of columns in row 1 (8)
d[2][0]= 6;	Store 6 in element d[2][0].

Java has only 1-dimensional arrays —whose elements can be arrays

int[][] b; Declare variable b of type **int**[][]

b= **new int**[2][] Create a 1-D array of length 2 and store its name in b. Its elements have type **int**[] (and start as **null**).

In Java, there are really only 1-dimensional arrays, whose elements can be arrays!



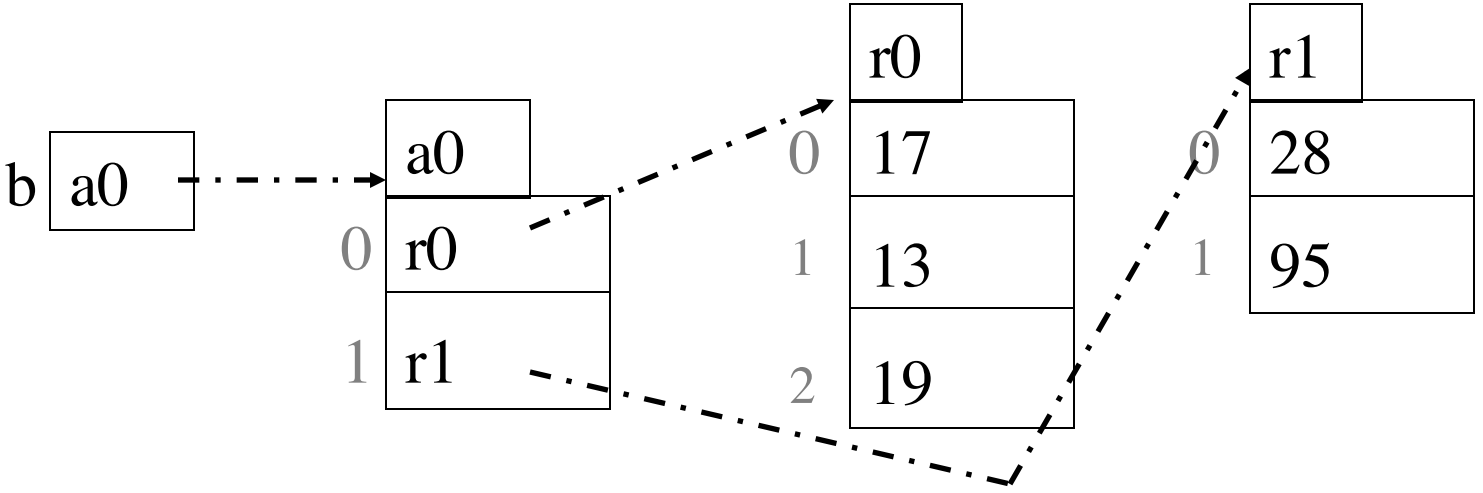
Ragged arrays: rows have different lengths

int[][] b; Declare variable b of type **int**[][]

b= **new int**[2][] Create a 1-D array of length 2 and store its name in b. Its elements have type **int**[] (and start as **null**).

b[0]= **new int**[] {17, 13, 19}; Create **int** array, store its name in b[0].

b[1]= **new int**[] {28, 95}; Create **int** array, store its name in b[1].



Exceptions

```
public static void main(String[] args) {
    int b= 3/0;
}
```

This is line 7

Division by 0 causes an “Exception to be thrown”.
program stops with output:

```
Exception in thread "main"
        java.lang.ArithmeticException: / by zero
    at C.main(C.java:7)
```

Happened in main, line 7

The “Exception” that is “thrown”

parseInt throws a NumberFormatException

```
/** Parse s as a signed decimal integer and return
    the integer. If s does not contain a signed decimal
    integer, throw a NumberFormatException. */
public static int parseInt(String s)
```

parseInt, when it find an error, does not know what caused the error and hence cannot do anything intelligent about it. So it "throws the exception" to the calling method. The normal execution sequence stops! *See next slide*

```
public static void main(String[] args) {
    …code to store a string in s —expected to be an int
    int b= Integer.parseInt(s);
}
```

parseInt throws a NumberFormatException

```
public static void main(String[] args) {
    int b= Integer.parseInt(“3.2”);
}
```

3.2 not an int

Output is:

```
Exception in thread "main" java.lang.NumberFormatException: For input string: "3.2"
  at java.lang.NumberFormatException.forInputString(NumberFormatException.java:48)
  at java.lang.Integer.parseInt(Integer.java:458)
  at java.lang.Integer.parseInt(Integer.java:499)
  at C.main(C.java:6)
```

called from C.main, line 6

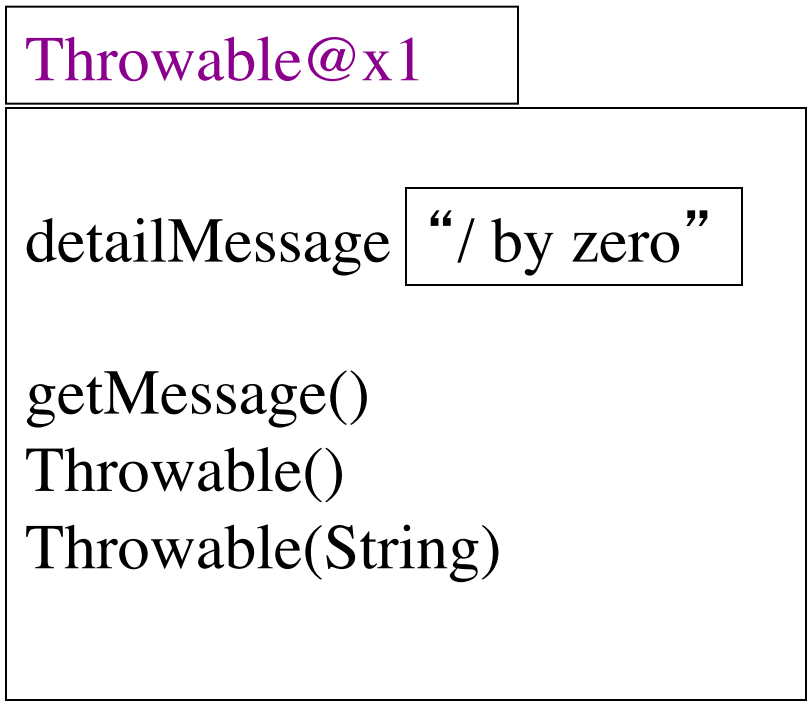
called from line 499

Found error on line 458

We see stack of calls that are not completed!

Exceptions and Errors

In Java, there is a class Throwable:



When some kind of error occurs, an Exception is "thrown" —you'll see what this means later.

An Exception is an instance of class Throwable

(or one of its subclasses)

Two constructors in class Throwable. Second one stores its String parameter in field detailMessage.

Exceptions and Errors

So many different kind of exceptions that we have to organize them.

Throwable@x1

Throwable() Throwable(String)

detailMessage "/ by zero"
getMessage()

Exception

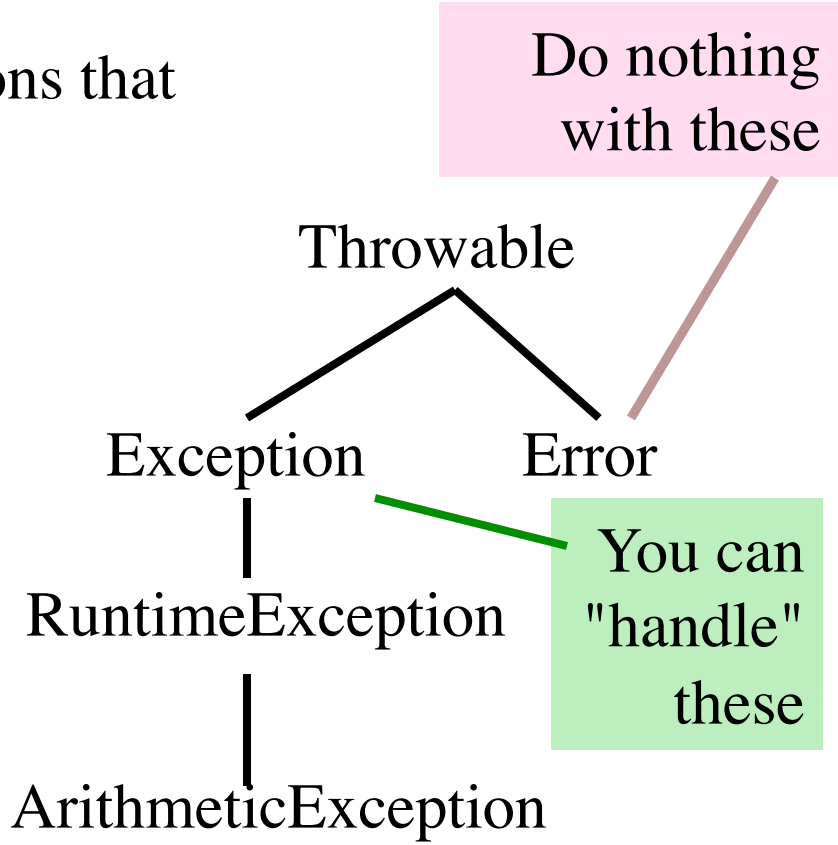
Exc…() Exc…(..)

RuntimeException

RunTimeE…() RunTimeE…(…)

ArithmeticException

Arith…E…() Arith…E…(…)



Subclass: 2 constructors, no other methods, no fields. Constructor calls superclass constructor

Creating and throwing and Exception

Class:

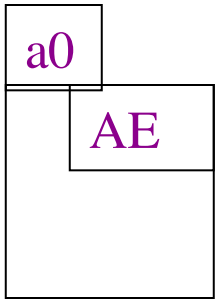
Call

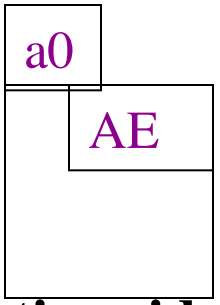
Ex.main();

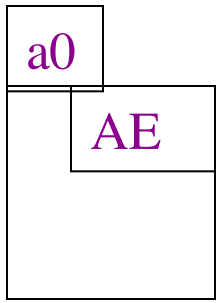
Output

```
ArithmeticException: / by zero
  at Ex.third(Ex.java:13)
  at Ex.second(Ex.java:9)
  at Ex.main(Ex.java:5)
  at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
  at sun.reflect.NativeMethodAccessorImpl.invoke(…)
  at sun.reflect.DelegatingMethodAccessorImpl.invoke(…)
  at java.lang.reflect.Method.invoke(Method.java:585)
```

```
03  public class Ex {
04      public static void main(…) {
05          second();
06      }
07
08      public static void second() {
09          third();
10      }
11
12      public static void third() {
13          int x= 5 / 0;
14      }
15  }
```







throw statement

Class:

Call

Ex.main();

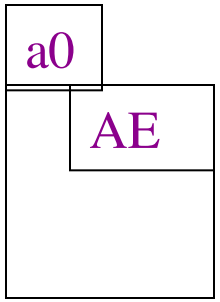
Output

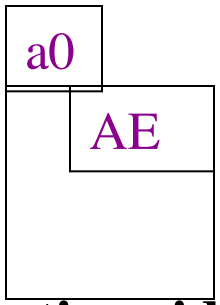
```
ArithmeticException: I threw it
  at Ex.third(Ex.java:14)
  at Ex.second(Ex.java:9)
  at Ex.main(Ex.java:5)
  at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
  at sun.reflect.NativeMethodAccessorImpl.invoke(…)
  at sun.reflect.DelegatingMethodAccessorImpl.invoke(…)
  at java.lang.reflect.Method.invoke(Method.java:585)
```

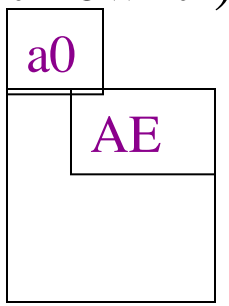
```
public class Ex {
    public static void main(…) {
        second();
    }

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

    public static void third() {
        throw new ArithmeticException("I threw it");
    }
}
```







How to write an exception class

```
/** An instance is an exception */
public class OurException extends Exception {

    /** Constructor: an instance with message m*/
    public OurException(String m) {
        super(m);
    }

    /** Constructor: an instance with no message */
    public OurException() {
        super();
    }
}
```

Won't compile. Needs a "throws clause, see next slide

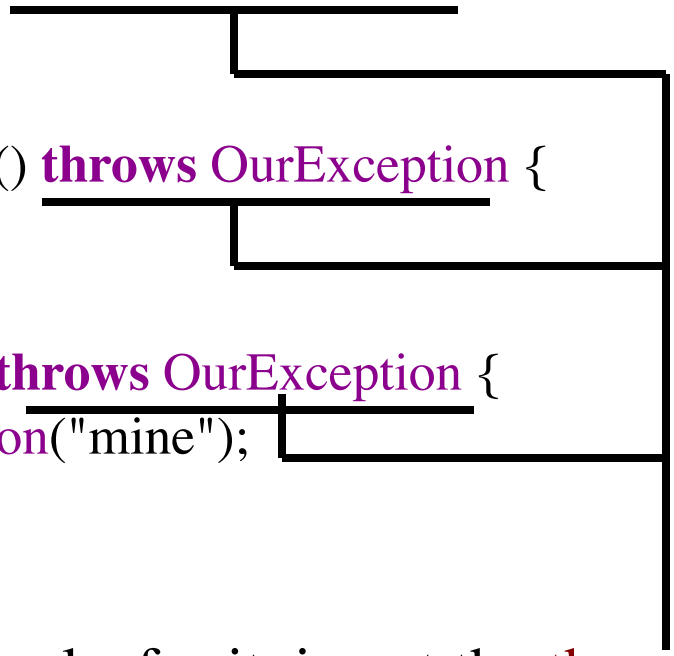
If a method throws an Exception that is not a subclass of RuntimeException, the method needs a throws clause.

Don't be concerned with this issue. Just write your method and, if Java says it needs a throws clause, put one in

```
/** Illustrate exception handling */
public class Ex {
    public static void main() {
        second();
    }
    public static void second() {
      third();
    }
    public static void third() {
        throw new
            OurException("mine");
    }
}
```

The "throws" clause

```
/** Class to illustrate exception handling */
public class Ex {
   public static void main() throws OurException {
      second();
   }
   public static void second() throws OurException {
      third();
   }
   public static void third() throws OurException {
      throw new OurException("mine");
   }
```



If Java asks for it, insert the throws clause.
Otherwise, don't be concerned with it.

Try statement: catching a thrown exception

```
public class Ex1 {
    public static void main() throws MyException{
        try {
            second();
        }
        catch (MyException ae) {
            System.out.println
              ("Caught MyException: " + ae);
        }
        System.out.println
            ("procedure first is done");
    }
    public static void second() throws MyException {
        third();
    }
    public static void third() throws MyException {
        throw new MyException("yours");
    }
}
```

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

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

```
/** Input line supposed to contain an int. (whitespace on either side OK).
    Read line, return the int. If line doesn't contain int, ask user again
   */
public static int readLineInt() {
      String input= readString().trim();
      // inv: input contains last input line read; previous
      // lines did not contain a recognizable integer.
      while (true) {
         try {
            return Integer.valueOf(input).intValue();
         }
         catch (NumberFormatException e) {
            System.out.println( "Input not int. Must be an int like");
            System.out.println("43 or -20. Try again: enter an int:");
            input= readString().trim();
         }
      }
  }
```

Useful example of catching thrown object

readLineInt continues to read a line from keyboard until user types and integer