Access Control, Class scope, Packages and Java APIs

Lets review the static objects again

Overview

- Review
- Access control
- Class scope
- Packages
- Java API

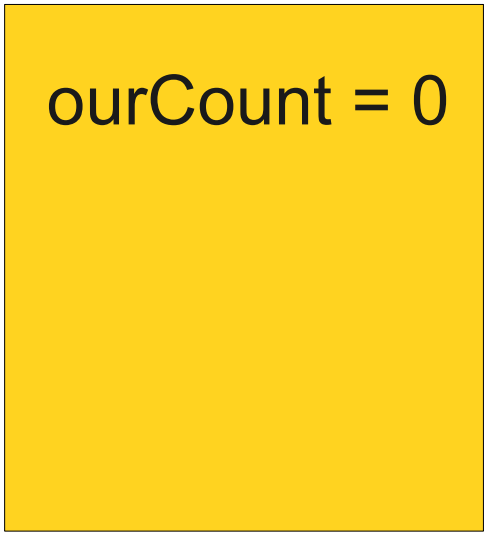
```java
public class Counter {
   int myCount = 0;
   static int ourCount = 0;
   void increment() {
      myCount++;
      ourCount++;
   }
   public static void main(String[] args) {
      Counter counter1 = new Counter();
      Counter counter2 = new Counter();
      counter1.increment();
      counter1.increment();
      counter2.increment();
      System.out.println("Counter 1: " +
counter1.myCount + " " + counter1.ourCount);
      System.out.println("Counter 2: " +
counter2.myCount + " " + counter2.ourCount);
   }
}
```

```java
public class Counter {
   int myCount = 0;
   static int ourCount = 0;
   void increment() {
      myCount++;
      ourCount++;
   }
   public static void main(String[] args) {
      Counter counter1 = new Counter();
      Counter counter2 = new Counter();
      counter1.increment();
      counter1.increment();
      counter2.increment();
      System.out.println("Counter 1: " +
counter1.myCount + " " + counter1.ourCount);
      System.out.println("Counter 2: " +
counter2.myCount + " " + counter2.ourCount);
   }
}
```

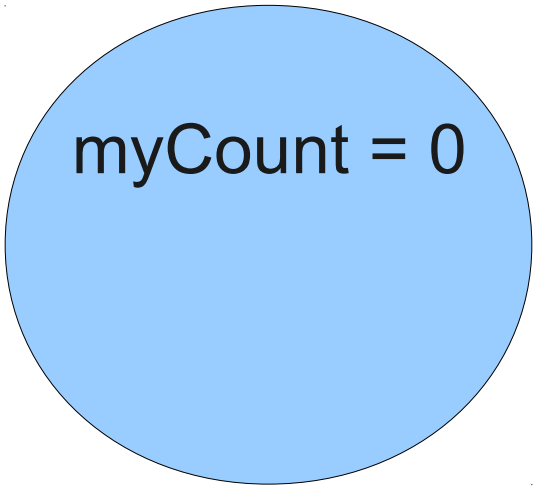
Fields

Method

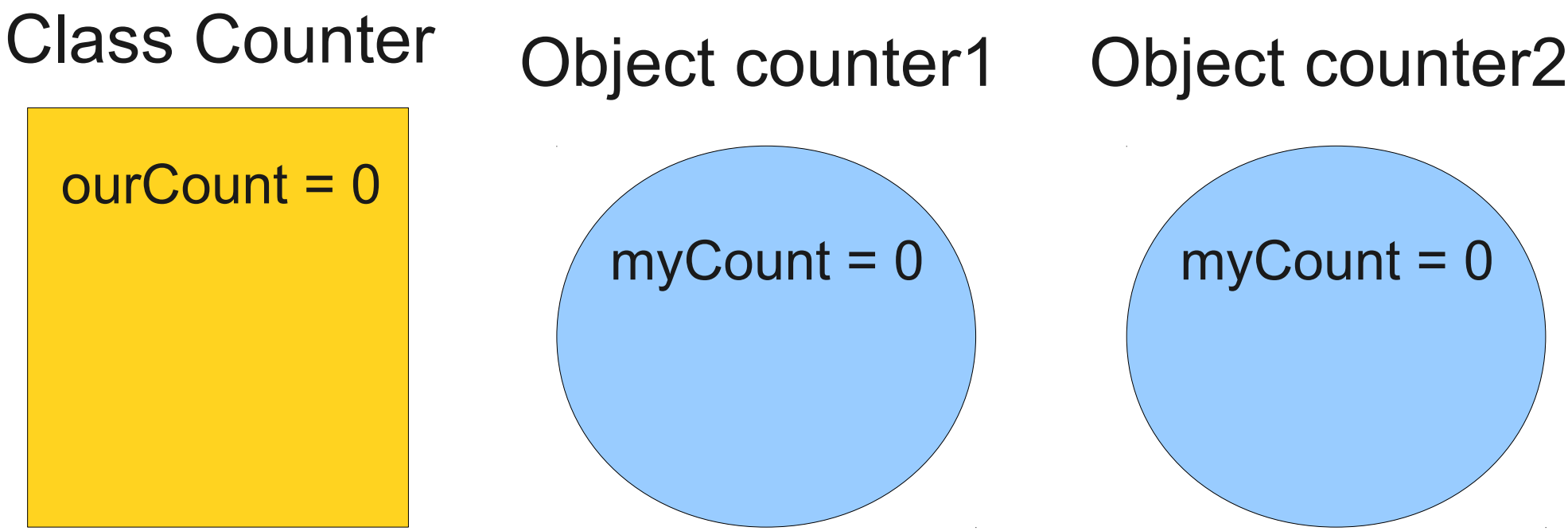
Class Counter



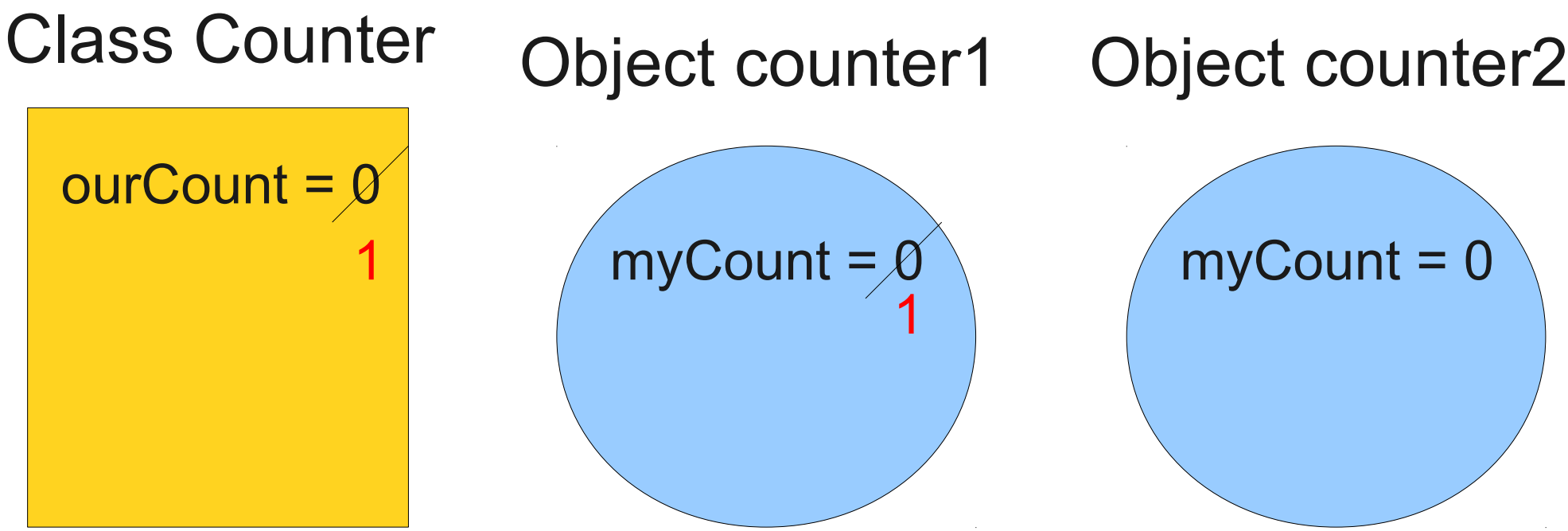
Object counter1



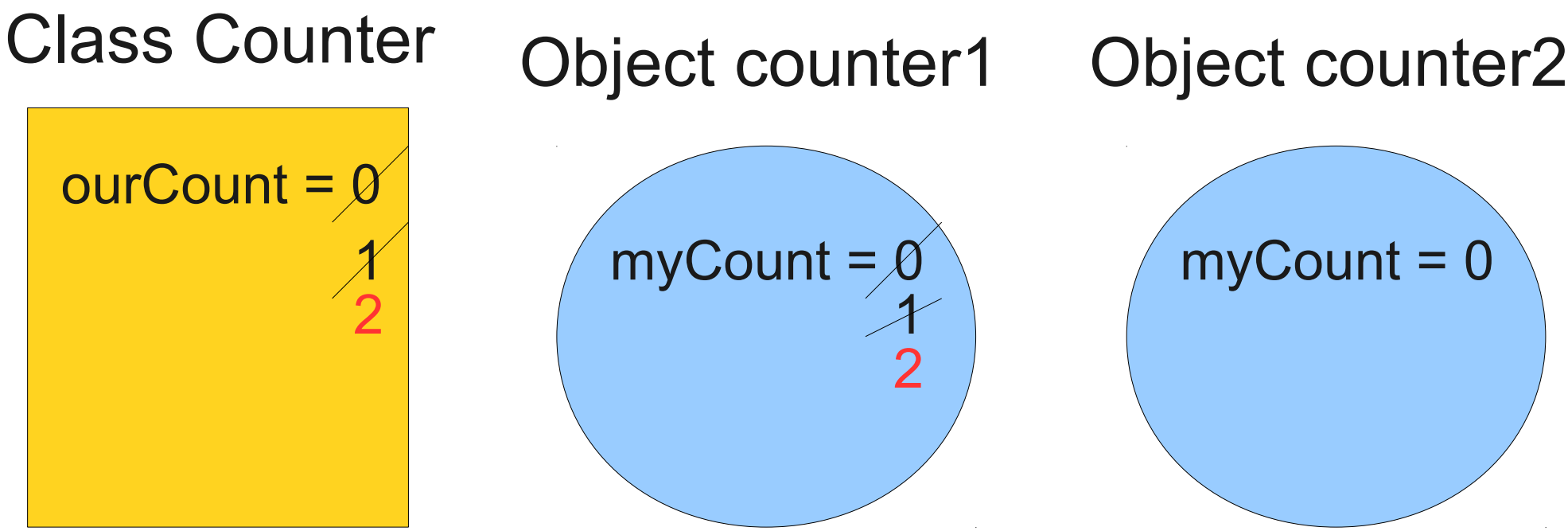

```
Counter counter1 = new Counter();
```



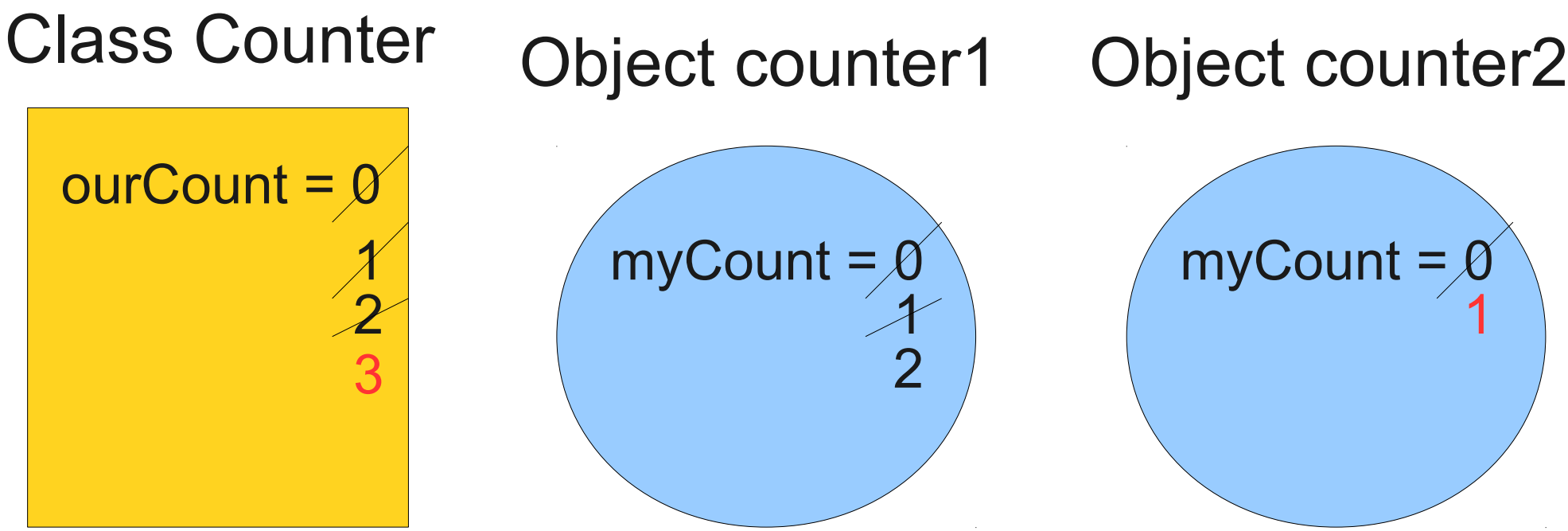

```
Counter counter1 = new Counter();
Counter counter2 = new Counter();
```




```
Counter counter1 = new Counter();
Counter counter2 = new Counter();
counter1.increment();
```




```
Counter counter1 = new Counter();
Counter counter2 = new Counter();
counter1.increment();
counter1.increment();
```




```
Counter counter1 = new Counter();
Counter counter2 = new Counter();
counter1.increment();
counter1.increment();
counter2.increment();
```

Why Access Control

- Protect private information (sorta)
- Clarify how others should use your class
- Keep implementation separate from interface

Overview

- Review
- Access control
- Class scope
- Packages
- Java API

Scope Review

```
public class ScopeReview {
   void scopeMethod(int var1) {
      String var2;
      if (var1 > 0) {
         var2 = "above 0";
      } else {
         var2 = "less than or equal to 0";
      }
      System.out.println(var2);
   }
}
```

Scope Review

```
public class ScopeReview {
  private int var3;
  void scopeMethod(int var1) {
    var3 = var1;
    String var2;
    if (var1 > 0) {
      var2 = "above 0";
    } else {
      var2 = "less than or equal to 0";
    }
    System.out.println(var2);
  }
}
```

Class Scope

```
public class ScopeReview {
  private int var3;
  void scopeMethod(int var1) {
    var3 = var1;
    String var2;
    if (var1 > 0) {
      var2 = "above 0";
    } else {
      var2 = "less than or equal to 0";
    }
    System.out.println(var2);
  }
}
```

Scope

Just like methods, variables are accessible inside {}

- Previous lessons: method-level scope

```
void method(int arg1) {
    int arg2 = arg1 + 1;
}
```

- This lesson: class-level scope

```
class Example {
    int memberVariable;
    void setVariable(int newVal) {
        memberVariable += newVal;
    }
}
```

Only method-level 'servings' is updated

```
public class Baby {
  int servings;
  void feed(int servings) {
    servings = servings + servings;
  }
  void poop() {
    System.out.println("All better!");
    servings = 0;
  }
}
```

'this' keyword

- Clarifies scope
- Means 'my object'

Usage:

```
class Example {
    int memberVariable;
    void setVariable(int newVal) {
        this.memberVariable += newVal;
    }
}
```

Only method-level 'servings' is updated

```
public class Baby {
  int servings;
  void feed(int servings) {
    servings = servings + servings;
  }
  void poop() {
    System.out.println("All better!");
    servings = 0;
  }
}
```

Object-level 'servings' is updated

```
public class Baby {
  int servings;
  void feed(int servings) {
    this.servings =
      this.servings + servings;
  }
  void poop() {
    System.out.println("All better!");
    servings = 0;
  }
}
```

Overview

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Packages

- Each class belongs to a package
- Classes in the same package serve a similar purpose
- Packages are just directories
- Classes in other packages need to be imported

Defining Packages

```
package path.to.package.foo;
class Foo {
    ...
}
```

Using Packages

```
import path.to.package.foo.Foo;
import path.to.package.foo.*;
```

```
package parenttools;

public class BabyFood {

}
```

```
package parenttools;

public class Baby {

}
```

```
package adult;

import parenttools.Baby;
import parenttools.BabyFood;

public class Parent {
 public static void main(String[] args) {
    Baby baby = new Baby();
    baby.feed(new BabyFood());
 }
}
```

Why Packages?

- Combine similar functionality
  - org.boston.libraries.Library
  - org.boston.libraries.Book
- Separate similar names
  - shopping.List
  - packing.List

Special Packages

All classes “see” classes in the same package (no import needed)

All classes “see” classes in java.lang

Example: java.lang.String; java.lang.System

Overview

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Java API

Java includes lots of packages/classes

Reuse classes to avoid extra work

http://java.sun.com/javase/6/docs/api/

Arrays with items

Create the array bigger than you need

Track the next “available” slot

```
Book[] books = new Book[10];
int nextIndex = 0;

books[nextIndex] = b;
nextIndex = nextIndex + 1;
```

Arrays with items

Create the array bigger than you need

Track the next “available” slot

```
Book[] books = new Book[10];
int nextIndex = 0;

books[nextIndex] = b;
nextIndex = nextIndex + 1;
```

What if the library expands?

ArrayList

Modifiable list

Internally implemented with arrays

Features

- Get/put items by index
- Add items
- Delete items
- Loop over all items

Array → ArrayList

```
Book[] books =
     new Book[10];
int nextIndex = 0;

books[nextIndex] = b;
nextIndex += 1;
```

→

```
ArrayList<Book> books
= new ArrayList<Book>();

books.add(b);
```

```java
import java.util.ArrayList;
class ArrayListExample {
    public static void main(String[] arguments) {
        ArrayList<String> strings = new ArrayList<String>();
        strings.add("Evan");
        strings.add("Eugene");
        strings.add("Adam");

        System.out.println(strings.size());
        System.out.println(strings.get(0));
        System.out.println(strings.get(1));

        strings.set(0, "Goodbye");
        strings.remove(1);



        for (String s : strings) {
            System.out.println(s);
        }
    }
}
```

Sets

Like an ArrayList, but

- Only one copy of each object, and
- No array index

Features

- Add objects to the set
- Remove objects from the set
- Is an object in the set?

TreeSet: Sorted (lowest to highest)

HashSet: Unordered (pseudo-random)

```java
import java.util.TreeSet;

class SetExample {
    public static void main(String[] arguments) {
        TreeSet<String> strings = new TreeSet<String>();
        strings.add("Evan");
        strings.add("Eugene");
        strings.add("Adam");

        System.out.println(strings.size());
        System.out.println(strings.first());
        System.out.println(strings.last());

        strings.remove("Eugene");

        for (String s : strings) {
            System.out.println(s);
        }
    }
}
```

Maps

Stores a (*key*, *value*) pair of objects

Look up the *key*, get back the *value*

Example: Address Book

- Map from names to email addresses

TreeMap: Sorted (lowest to highest)

HashMap: Unordered (pseudo-random)

```java
public static void main(String[] arguments) {
    HashMap<String, String> strings = new HashMap<String, String>();
    strings.put("Evan", "email1@mit.edu");
    strings.put("Eugene", "email2@mit.edu");
    strings.put("Adam", "email3@mit.edu”);

    System.out.println(strings.size());
    strings.remove("Evan");
    System.out.println(strings.get("Eugene"));

    for (String s : strings.keySet()) {
        System.out.println(s);
    }
    for (String s : strings.values()) {
        System.out.println(s);
    }
    for (Map.Entry<String, String> pairs : strings.entrySet()) {
        System.out.println(pairs);
    }
}
```

Warnings

Using TreeSet/TreeMap?

Read about Comparable interface

Using HashSet/HashMap?

Read about equals, hashCode methods

Note: This only matters for classes you build, not for java built-in types.

Summary

- Review
- Access control
- Class scope
- Packages
- Java API

An Oval Sprite

```
public class Oval implements Sprite {
    private int width, height;
    private Color color;

    public Oval(int width, int height, Color color) {
        // set the fields ...
    }

    public void draw(Graphics surface, int x, int y) {
        surface.setColor(color);
        surface.fillOval(x, y, width, height);
        surface.drawOval(x, y, width, height);
    }
   ...
}
```

A Mover that doesn’t bounce

```
public class StraightMover {
    private int x, y, xDirection, yDirection;
    private Sprite sprite;

    public StraightMover(int startX, int startY, Sprite sprite) {
        x = startX;
        y = startY;
        this.sprite = sprite;
    }
    public void setMovementVector(int xIncrement, int yIncrement) {
        xDirection = xIncrement;
        yDirection = yIncrement;
    }
    public void draw(Graphics graphics) {
        sprite.draw(graphics, x, y);
        x += xDirection;
        y += yDirection;
    }
}
```

Inheritance

Exceptions

I/O

Inheritance

Very *Very* Basic Inheritance

- Making a Game

```
public class Dude {
    public String name;
    public int hp = 100
    public int mp = 0;

    public void sayName() {
          System.out.println(name);
    }
    public void punchFace(Dude target) {
          target.hp -= 10;
    }
}
```

Inheritance..

- Now create a Wizard…

```
public class Wizard {
    // ugh, gotta copy and paste
    // Dude's stuff
}
```

Inheritance?

- Now create a Wizard…

But Wait!

A Wizard does and has everything a Dude does and has!

Inheritance?

- Now create a Wizard…

Don’t Act Now!

You don’t have to Copy & Paste!

Buy Inheritance!

- Wizard is a **subclass** of Dude

```
public class Wizard extends Dude {
}
```

Buy Inheritance!

- Wizard can use everything* the Dude has!

```
wizard1.hp += 1;
```

- Wizard can do everything* Dude can do!

```
wizard1.punchFace(dude1);
```

- You can use a Wizard like a Dude too!

```
dude1.punchface(wizard1);
```

*except for private fields and methods

Buy Inheritance!

- Now augment a Wizard

```
public class Wizard extends Dude {
    ArrayList<Spell> spells;
    public class cast(String spell) {
        // cool stuff here
        ...
        mp -= 10;
    }
}
```

Inheriting from inherited classes

- What about a Grand Wizard?

```
public class GrandWizard extends Wizard {
    public void sayName() {
      System.out.println("Grand wizard" + name)
    }
}

grandWizard1.name = "Flash"
grandWizard1.sayName();
((Dude)grandWizard1).sayName();
```

How does Java do that?

- What Java does when it sees

```
grandWizard1.punchFace(dude1)
```

1. Look for `punchFace()` in the GrandWizard class
2. It's not there! Does GrandWizard have a parent?
3. Look for `punchFace()` in Wizard class
4. It's not there! Does Wizard have a parent?
5. Look for `punchFace()` in Dude class
6. Found it! Call `punchFace()`
7. Deduct hp from dude1

How does Java do that? pt2

- What Java does when it sees

```
((Dude)grandWizard1).sayName()
```

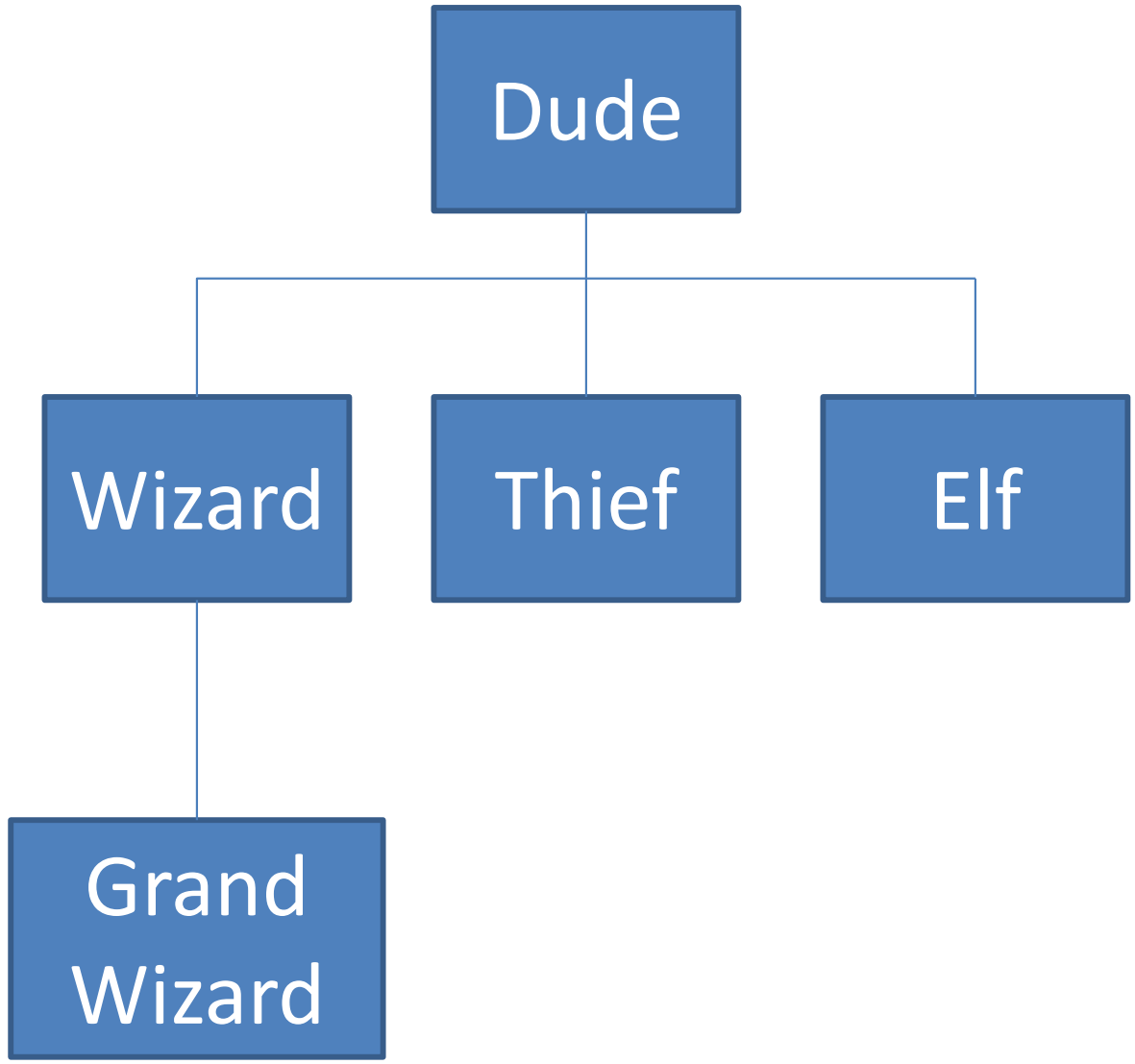
1. Cast to `Dude` tells Java to start looking in `Dude`
2. Look for `sayName()` in Dude class
3. Found it! Call `sayName()`

What's going on?

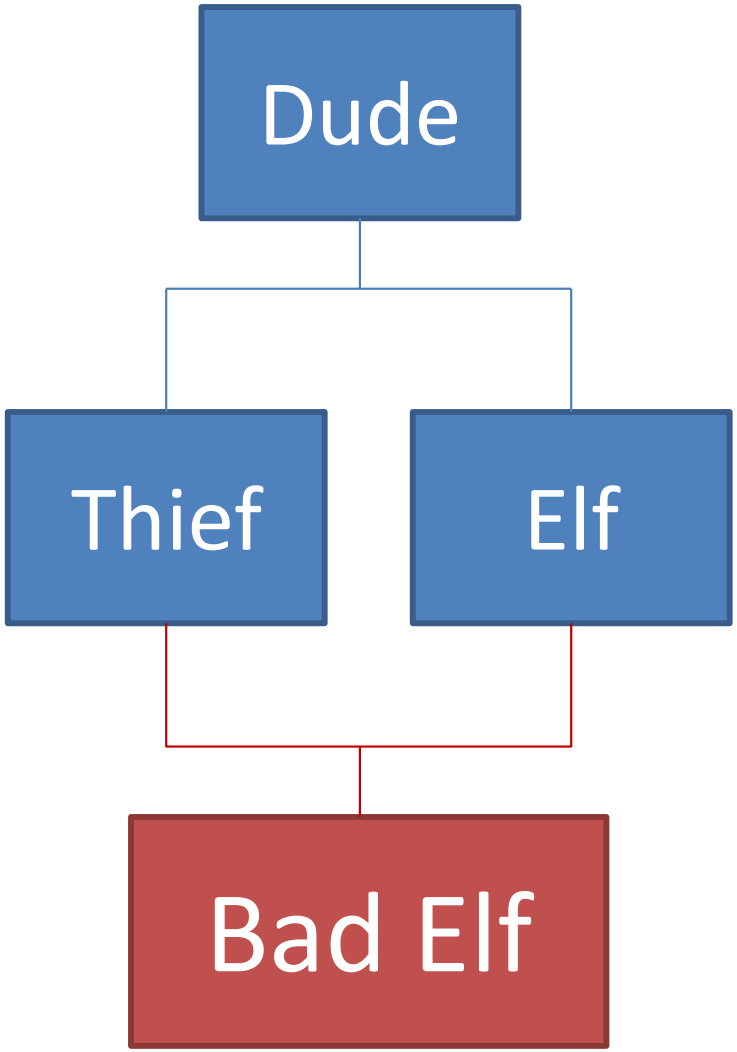
Parent of Wizard, Elf..

Subclass of Dude

Subclass of Wizard



You can only inherit from one class



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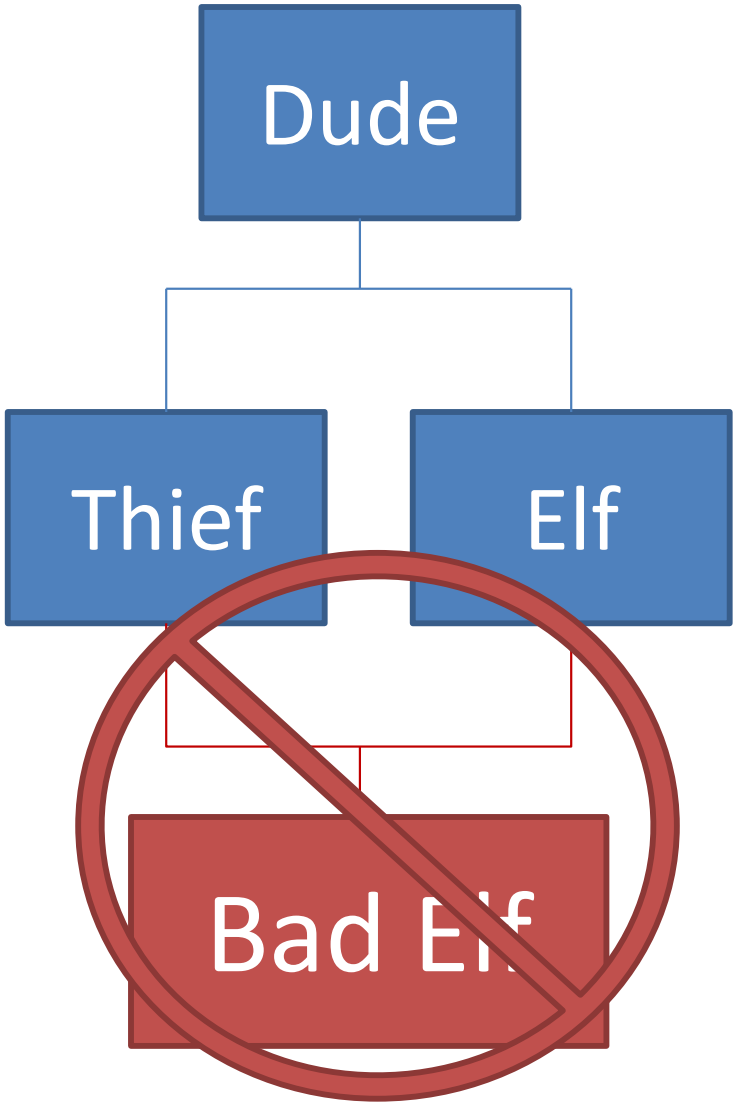


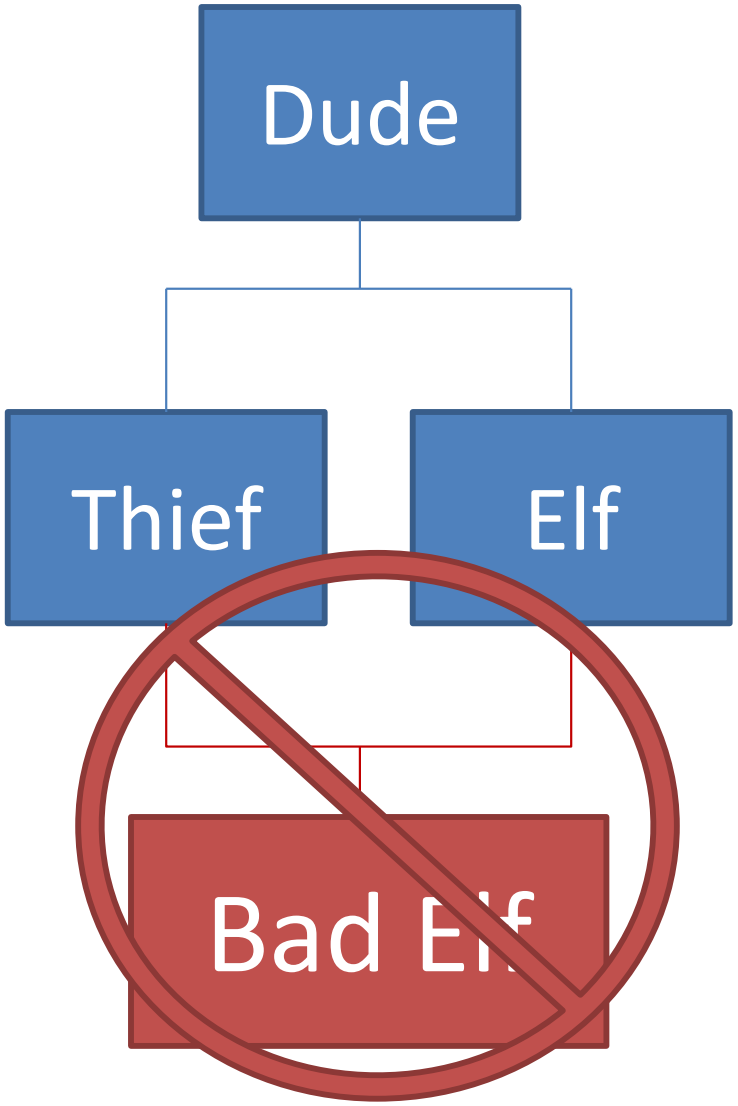
You can only inherit from one class

What if Thief and Elf both implement

```
public void sneakUp()
```

If they implemented differently, which `sneakUp()` does BadElf call?

Java Doesn't Know!!



Inheritance Summary

- class A extends B {} == A is a subclass of B
- A has all the fields and methods that B has
- A can add it's own fields and methods
- A can only have 1 parent
- A can replace a parent's method by re-implementing it
- If A doesn't implement something Java searches ancestors

So much more to learn!

- http://java.sun.com/docs/books/tutorial/java/IandI/subclasses.html
- http://home.cogeco.ca/~ve3ll/jatutor5.htm
- http://en.wikipedia.org/wiki/Inheritance_(computer_science)
- http://www.google.com

Exceptions

Exceptions

- NullPointerException
- ArrayIndexOutOfBoundsException
- ClassCastException
- RuntimeException

What is an “Exception”?

- Event that occurs when something “unexpected” happens
  - null.someMethod();
  - (new int[1])[1] = 0;
  - int i = “string”;

Why use an Exception?

- To tell the code using your method that something went wrong

```
Exception in thread "main"
  java.lang.ArrayIndexOutOfBoundsException: 5
  at RuntimeException.main(RuntimeException.java:8)
```

Accessed index 5, which isn't in the array

The method that called it was main

- Debugging and understanding control flow

How do exceptions “happen”?

- Java doesn’t know what to do, so it
  - Creates an Exception object
  - Includes some useful information
  - “throws” the Exception

- You can create and throw Exceptions too!

public class Exception

- Exception is a class
- Just inherit from it!

```
public class MyException extends Exception
{
}
```

- Or use existing ones
  - http://rymden.nu/exceptions.html

Warn Java about the Exception

```
public Object get(int index) throws
  ArrayOutOfBoundsException {
   If (index < 0 || index >= size())
      throw new
        ArrayOutOfBoundsException("”+index);
}
```

- **`throws`** tells Java that `get` may throw the ArrayOutOfBoundsException
- **throw** actually throws the Exception (sorry)

Catching an Exception

- Java now expects code that calls `get` to deal with the exception by
  - Catching it
  - Rethrowing it

Catching it

- What it does
  - `try` to run some code that may throw an exception
  - Tell Java what to do if it sees the exception (`catch`)

```
try {
  get(-1);
} catch (ArrayOutOfBoundsException err) {
  System.out.println("oh dear!");
}
```

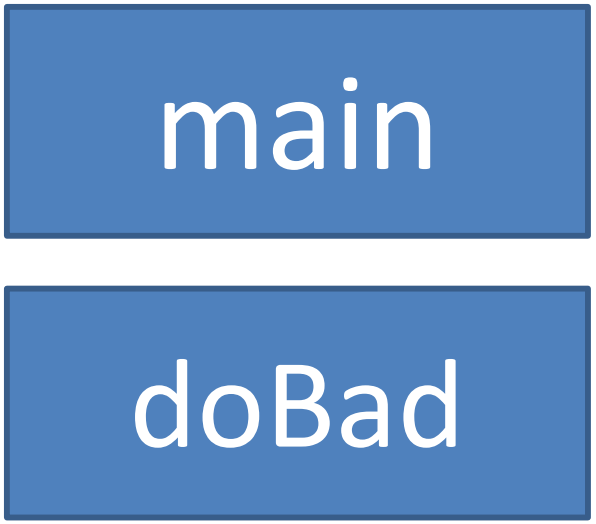
Rethrowing it

- Maybe you don’t want to deal with the Exception
- Tell Java that your method throws it too

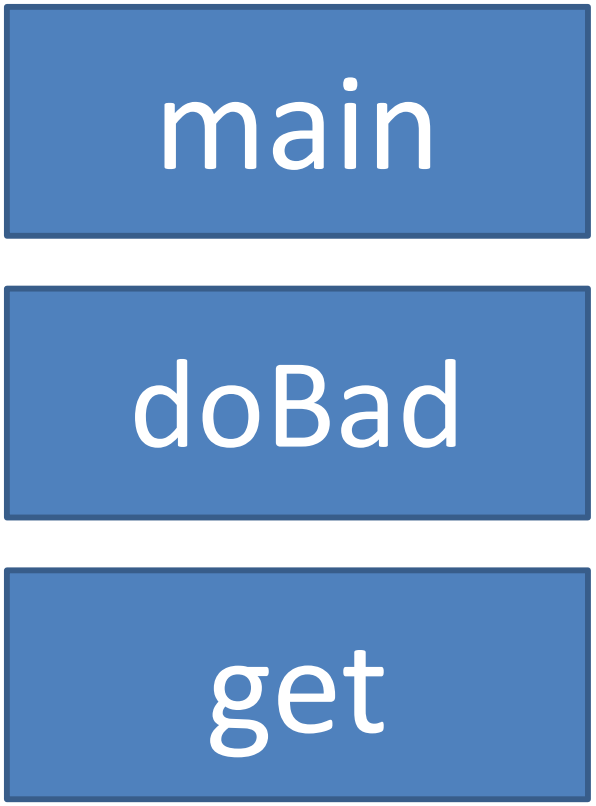
```
void doBad() throws ArrayOutOfBoundsException {
    get(-1);
}
```

Rethrowing it

Rethrowing it



Rethrowing it



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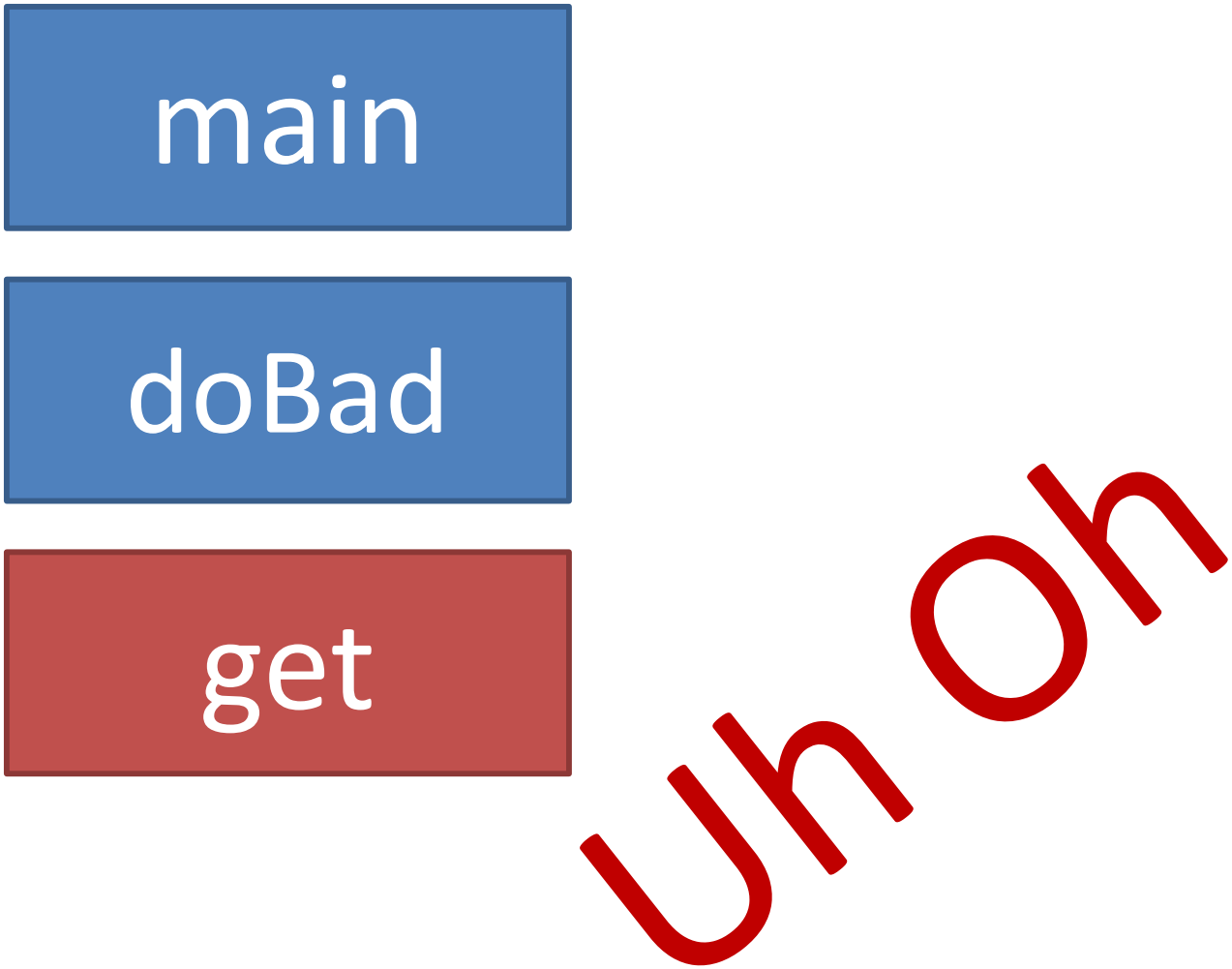

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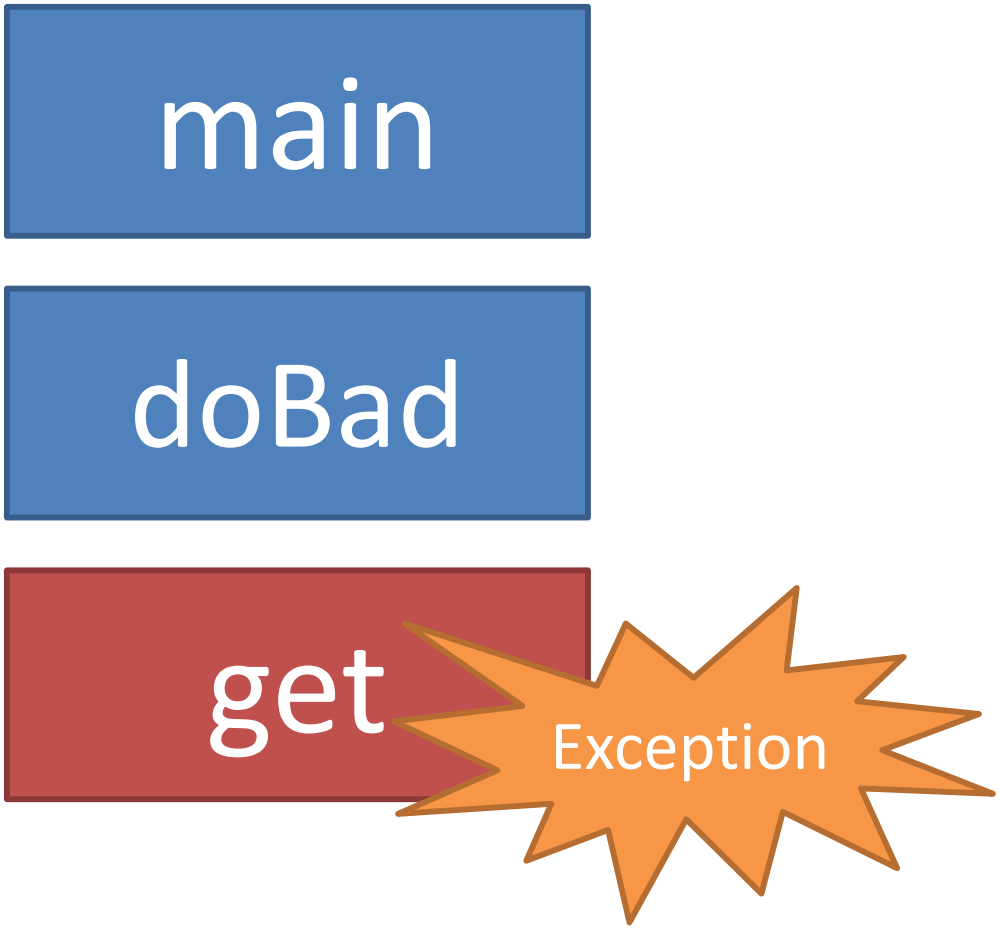

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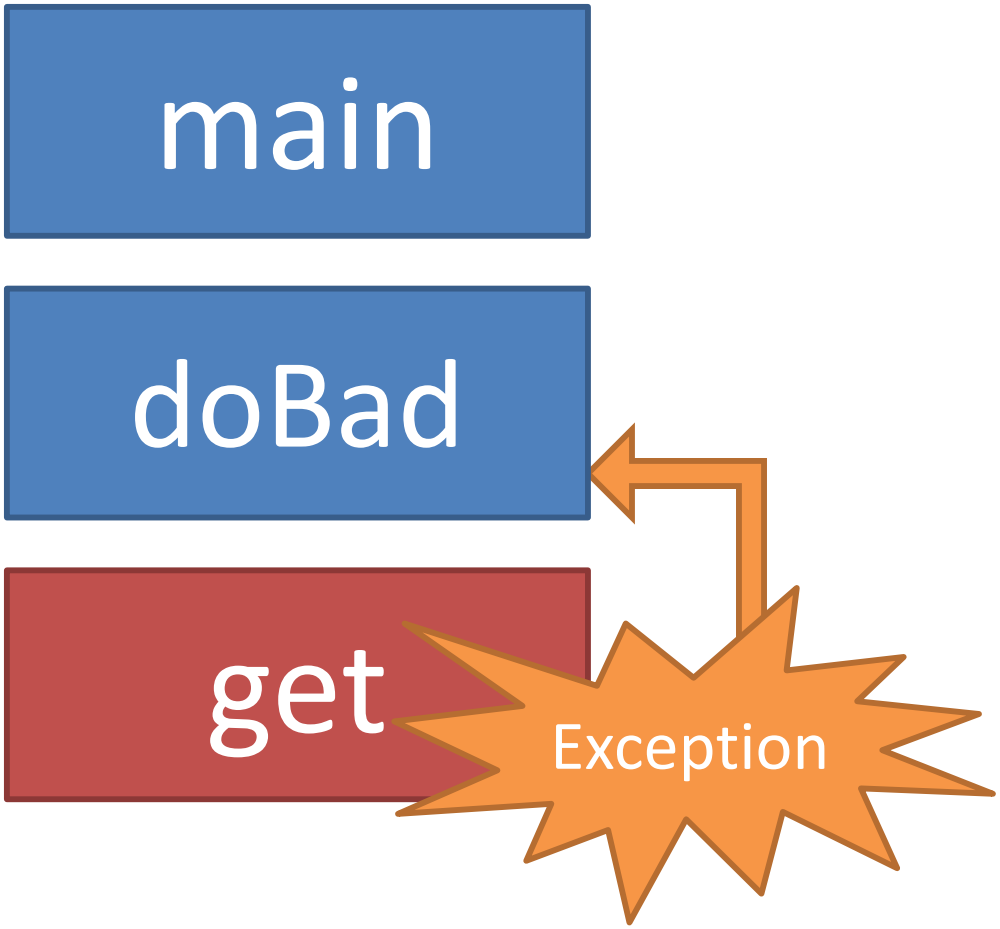

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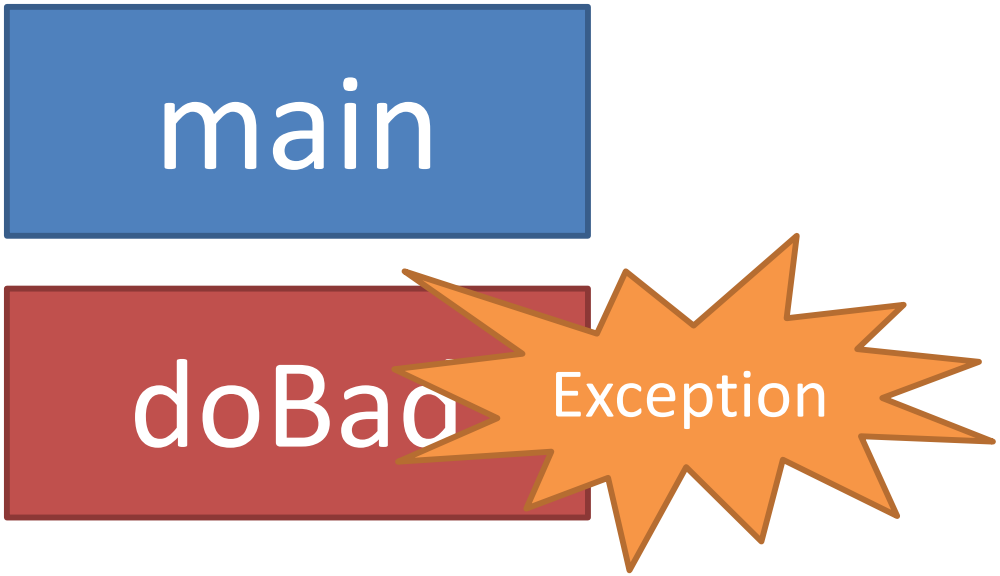
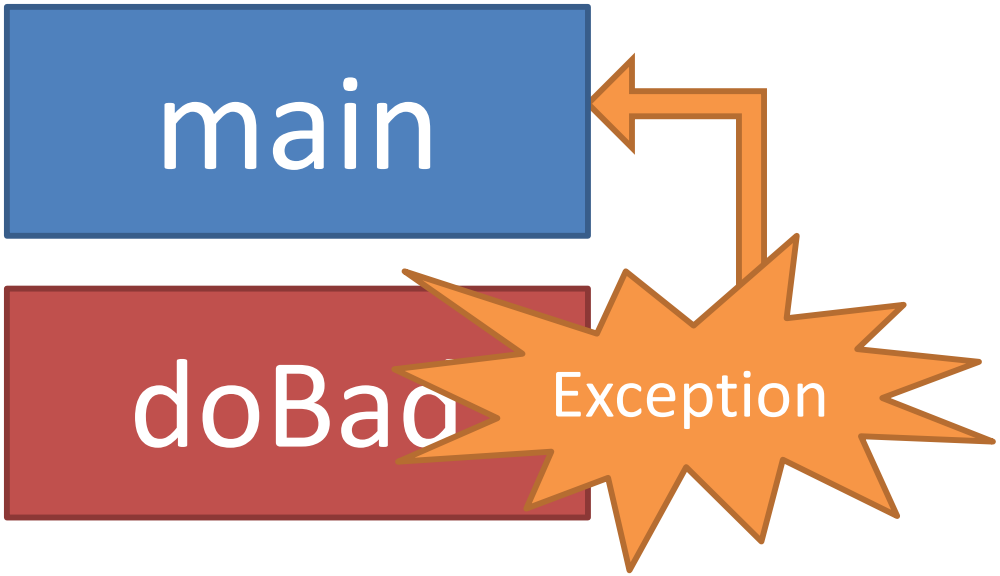
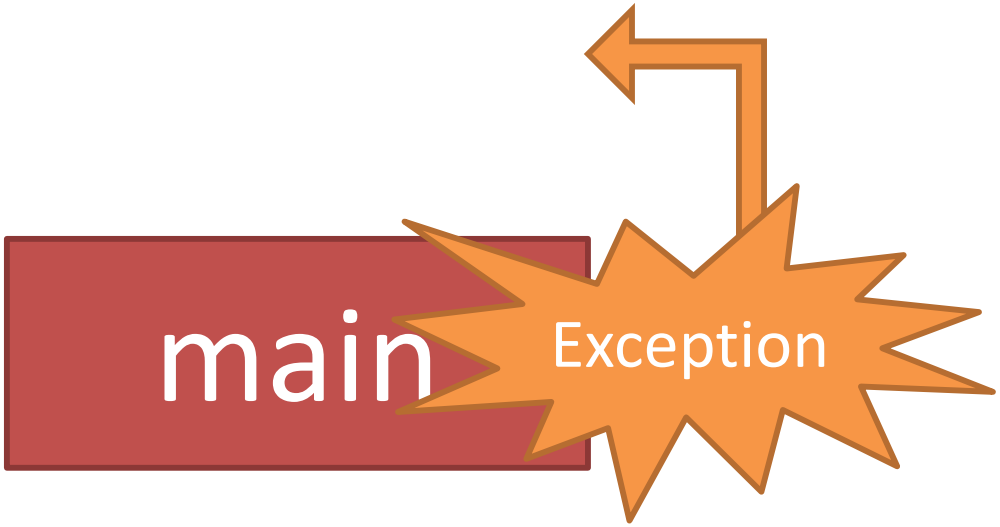


Rethrowing it



Rethrowing it

Rethrowing it



What it no one catches it?

- If you ran

```
public static void main(String[] args) throws Exception {
  doBad();
}
```

- Java will print that error message you see

```
Exception in thread "main"
java.lang.ArrayIndexOutOfBoundsException: -1
    at YourClass.get(YourClass.java:50)
    at YourClass.doBad(YourClass.java:11)
    at YourClass.main(YourClass.java:10)
```

More Info?

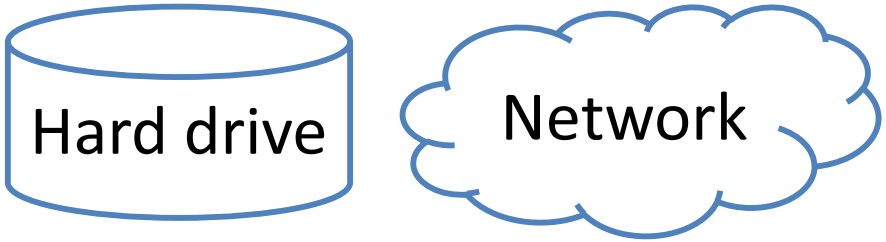
- http://java.sun.com/docs/books/tutorial/essential/exceptions
- http://en.wikipedia.org/wiki/Exceptions

I/O

We’ve seen Output

```
System.out.println(“some string”);
```

The Full Picture



10010101010101000101 …

InputStream

`System.in`

‘O’ ‘k’ ‘a’ ‘y’ ‘ ‘ ‘a’ ‘w’ ‘e’ …

InputStreamReader

“Okay awesome, cool\n” …

BufferedReader

InputStream

- InputStream is a stream of bytes
  - Read one byte after another using `read()`
- A byte is just a number
  - Data on your hard drive is stored in bytes
  - Bytes can be interpreted as characters, numbers..

```
InputStream stream = System.in;
```

InputStreamReader

- Reader is a class for character streams
  - Read one character after another using `read()`
- InputStreamReader takes an InputStream and converts bytes to characters
- Still inconvenient
  - Can only read a character at a time

```
new InputStreamReader(stream)
```

BufferedReader

- BufferedReader buffers a character stream so you can read line by line
  - `String readLine()`

```
new BufferedReader(
    new InputStreamReader(System.in));
```

User Input

```
InputStreamReader ir = new
    InputStreamReader(System.in);
BufferedReader br = new BufferedReader(ir);

br.readLine();
```

FileReader

- FileReader takes a text file
  - converts it into a character stream
  - FileReader(“PATH TO FILE”);

- Use this + BufferedReader to read files!

```
FileReader fr = new FileReader(“readme.txt”);
BufferedReader br = new BufferedReader(fr);
```

FileReader Code

```
import java.io.BufferedReader;
import java.io.FileReader;
import java.io.IOException;

public class ReadFile {

  public static void main(String[] args)  throws IOException{
    // Path names are relative to project directory (Eclipse Quirk )
    FileReader fr = new FileReader("./src/readme");
    BufferedReader br = new BufferedReader(fr);
    String line = null;
    while ((line = br.readLine()) != null) {
      System.out.println(line);
    }
    br.close();

  }
}
```

More about I/O

- http://java.sun.com/docs/books/tutorial/essential/io/