Programming Languages and Techniques (CIS120)

Lecture 31

April 3, 2013

Overriding, Equality, and Casts

Announcements

- HW 09 due Tuesday at midnight

- More information about exam 2 available on Friday

Unfinished Business

Histogram.java and WordScanner.java

Problem Statement

- Write a command-line program that, given a filename for a text file as input, calculates the frequencies (i.e. number of occurrences) of each distinct word of the file. The program should then print the frequency distribution to the console as a sequence of "word: freq" pairs (one per line).

Histogram result:

The : 1
Write : 1
a : 4
as : 2
calculates : 1
command : 1
console : 1
distinct : 1
distribution : 1
e : 1
each : 1
file : 2
filename : 1
for : 1
freq : 1
frequencies : 1
frequency : 1
given : 1
i : 1
input : 1
line : 2
number : 1
occurrences : 1
of : 4
one : 1
pairs : 1
per : 1
print : 1
program : 2
sequence : 1
should : 1
text : 1
that : 1
the : 4
then : 1
to : 1
word : 2

Method Overriding

A Subclass can *Override* its Parent

```
public class C {
  public void printName() { System.out.println("I'm a C"); }
}

public class D extends C {
  public void printName() { System.out.println("I'm a D"); }
}

C c = new D();
c.printName();   // what gets printed?
```

- Our ASM model for dynamic dispatch already explains what will happen when we run this code.
- Useful for changing the default behavior of classes.
- But… can be confusing and difficult to reason about if not used carefully.

Overriding Example

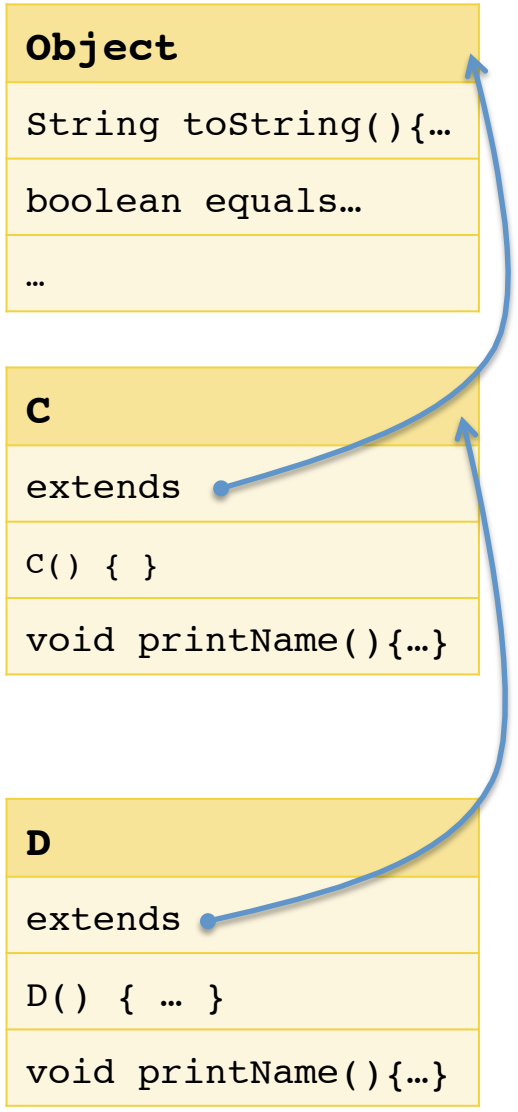
Workspace

```
C c = new C();
c.printName();
```

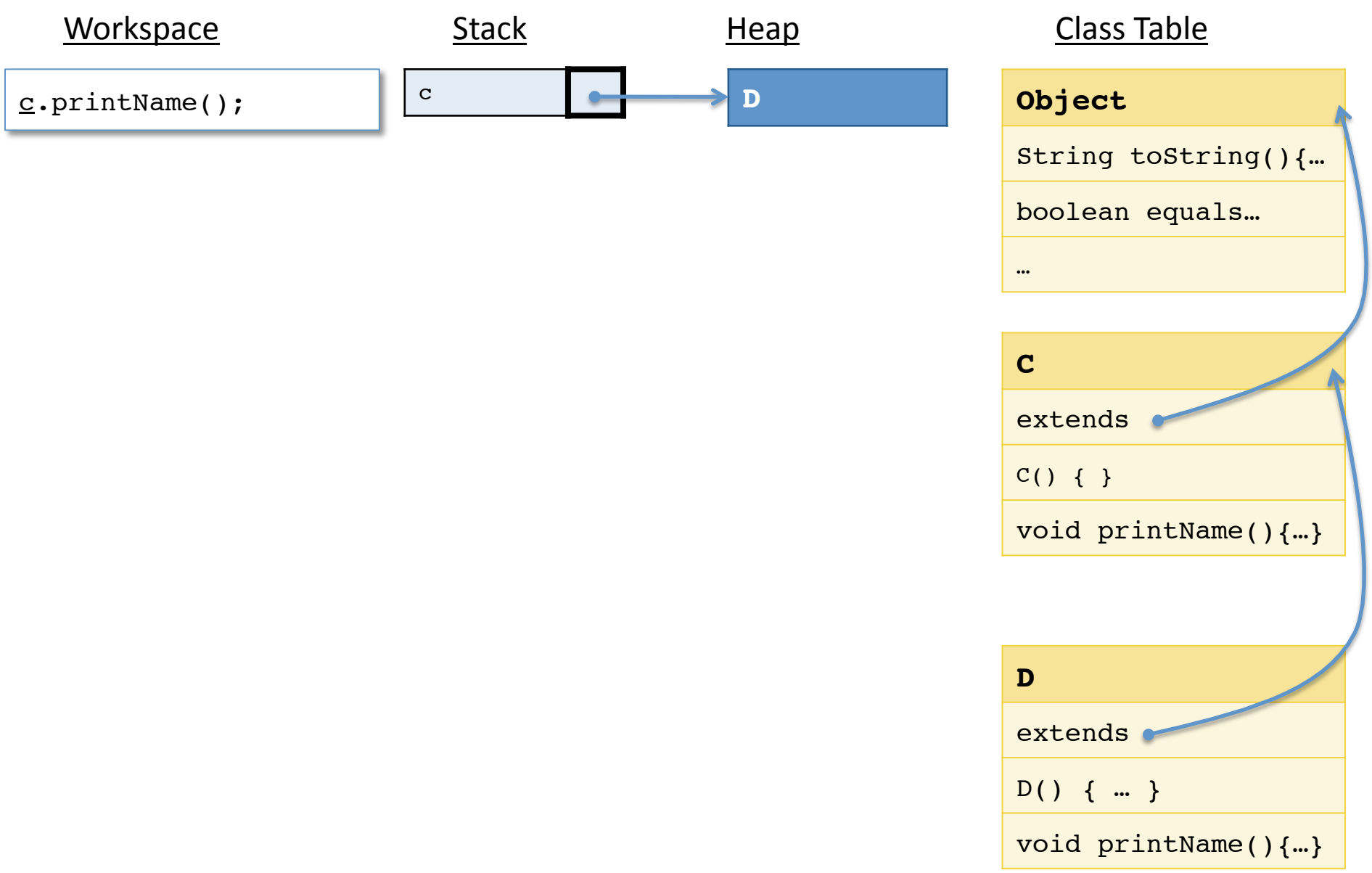
Stack

Heap

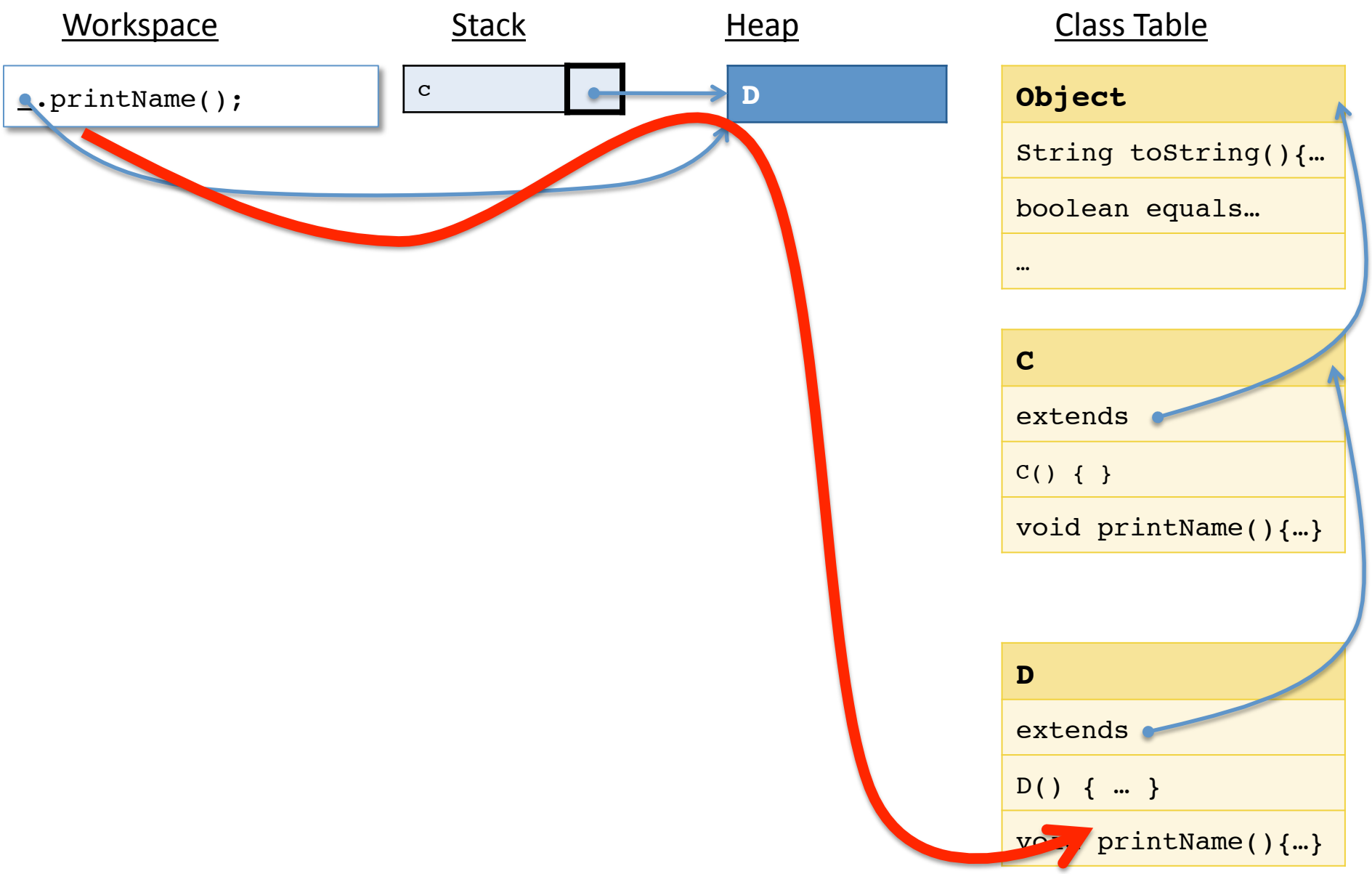
Class Table



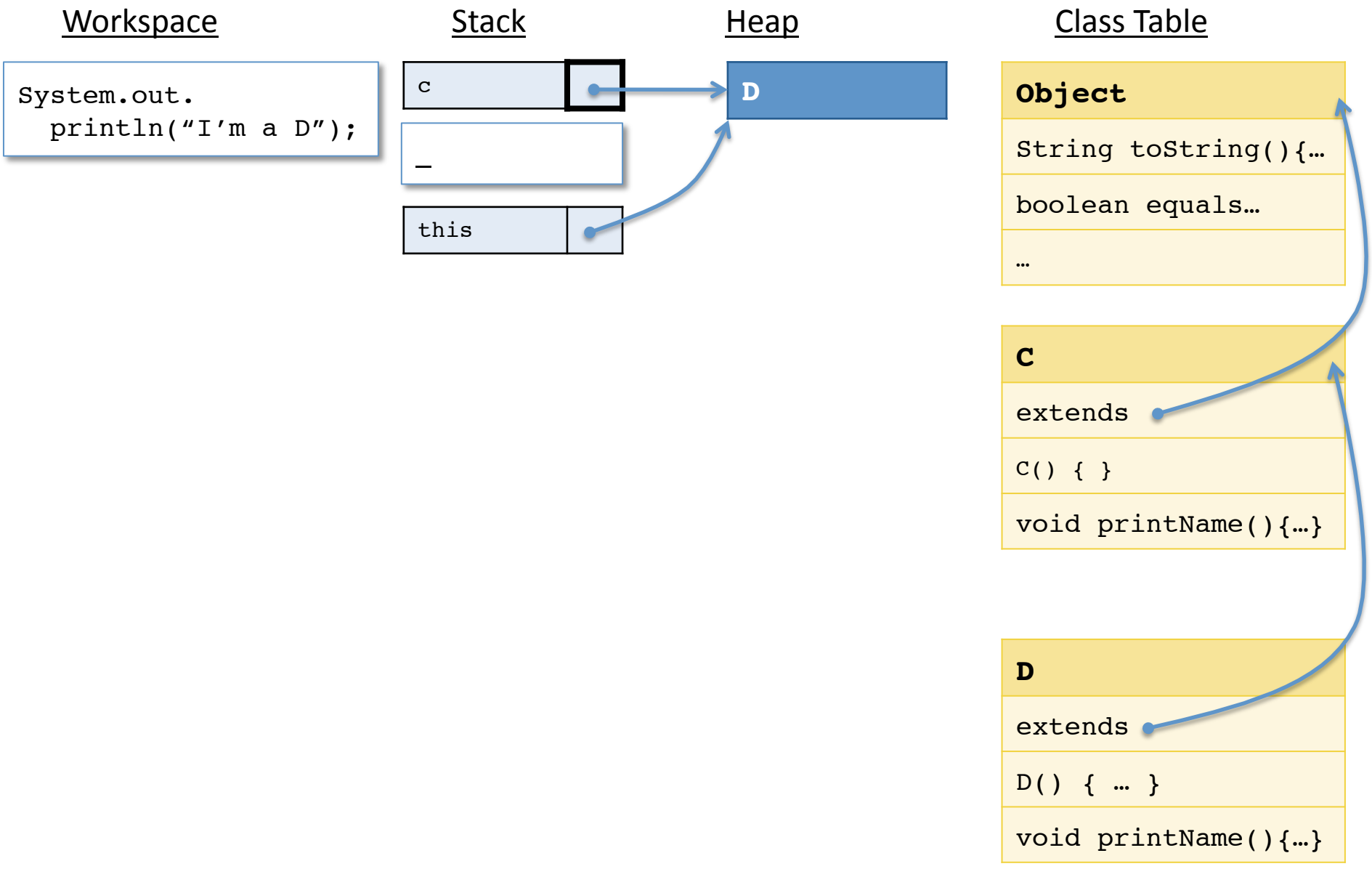
Overriding Example



Overriding Example



Overriding Example



Dangers of Overriding

```
public class C {
  Exam exam2 = …
  public void printTest() {
    if (onDate("March 29th")) {
      System.out.println("as scheduled");
    } else { System.out.prinln("postponed"); }
  }
  public boolean onDate(String s) {
    return exam2.date().equals(s);
  }
}

public class D extends C {
  Exam final = …
  public boolean onDate(String s) {
    return final.date().equals(s);
  }
}

C c = new D();
c.printTest();   // what gets printed?
```

The C class might be in another package, or a library...

Whoever wrote D might not be aware of the implications of changing `onDate`.

Overriding the method can cause the behavior of `printTest` to change!

- Overriding can break invariants/abstractions relied upon by the superclass.

When To Override?

- Only override methods when the parent class is designed specifically to support such modifications:
  - If you're writing the code for both the parent and child class (and will maintain control of both parts as the software evolves) it might be OK to overrride.
  - If the library designer specifically describes the behavioral contract that the parent methods assume about overridden methods (and the child follows that contract).
  - Either way: document the design.
  - Use the `@Override` annotation to mark intentional overriding

- Look for other means of achieving the desired outcome:
  - Use composition & delegation (i.e. wrapper objects) rather than overriding.

The `final` modifier

- By default, fields and local variables are mutable and methods can be overridden*.
- The `final` modifier changes that.
- Final fields and local variables:
  - Must be initialized (either by a static initializer or in the constructor) and cannot thereafter be modified.
  - Act like the immutable name bindings in OCaml
  - `static final` fields are useful for defining constants (e.g. `Math.PI`)
- Final methods *cannot* be overridden in subclasses.
  - Also useful in combination with `static`
  - Prevents subclasses from changing the "behavioral contract" between methods by overriding.

*Technically, fields can also be re-declared in a subclass (i.e. C has field x and D extends C and also declares a field x, not even necessarily of the same type!). Don't do this! But be aware that you can introduce bugs by inadvertently using this "feature".

When to override: Equality

Consider this example

```
public class Point {
    private final int x;
    private final int y;
    public Point(int x, int y) { this.x = x; this.y = y; }
    public int getX() { return x; }
    public int getY() { return y; }
}

// somewhere in main
List<Point> l = new LinkedList<Point>();
l.add(new Point(1,2));
System.out.println(l.contains(new Point(1,2)));
```

- What is printed to the terminal? Why?

Equality*

1. Identity vs. Equality
2. Pitfalls with overriding equals
3. Recipe for overriding equals

*See the very nicely written article “How to write an Equality Method in Java” by Oderski, Spoon, and Venners (June 1, 2009) at http://www.artima.com/lejava/articles/equality.html

Identity vs. Equality

- Object *identity* is "pointer equality" a.k.a. "reference equality"
  - Indicates where in the heap the object is located
  - Tested using ==
- Object *equality* is "value", "logical", "structural" or "deep" equality
  - Indicates when two objects are "the same" as values
  - Tested using the `equals` method inherited from `Object`

- In Java, the default implementation of `equals` *is* ==
  - In this case, instances are equal only to themselves

- Classes *can* override the default implementation to provide a different "structural" notion of equality.
  - e.g. String tests for identical sequences of characters.

Logical Equality

- What does it mean for two things to be equal?
  - "that depends on what your definition of is is"
  - In what way is the equality being used?

- Answer 1: Mutable objects are (usually) only equal to themselves
  - Why?

- Answer 2: Two immutable objects (of the same type) are equal if their corresponding fields are equal
  - What if there are "unimportant" fields?
  - What if the objects are of different types?

- What is a reasonable definition of equality?

The contract for equals

- The equals method implements an *equivalence relation* on non-null objects.
- It is *reflexive*:
  - for any non-null reference value x, x.equals(x) should return true
- It is *symmetric*:
  - for any non-null reference values x and y, x.equals(y) should return true if and only if y.equals(x) returns true
- It is *transitive*:
  - for any non-null reference values x, y, and z, if x.equals(y) returns true and y.equals(z) returns true, then x.equals(z) should return true.
- It is consistent:
  - for any non-null reference values x and y, multiple invocations of x.equals(y) consistently return true or consistently return false, provided no information used in equals comparisons on the object is modified
- For any non-null reference x, x.equals(null) should return false.

Directly from: http://docs.oracle.com/javase/6/docs/api/java/lang/Object.html#equals(java.lang.Object)