1

CS/ENGRD 2110
SPRING 2016

Lecture 4: The class hierarchy; static components
http://courses.cs.cornell.edu/cs2110

Announcements

2

- We're pleased with how many people are already working on **A1**, as evidenced by Piazza activity
  - Please be sure to look at **Piazza note @44** every day for frequently asked questions and answers
  - **Groups:** Forming a group of two? Do it **<u>well before</u>** you submit – at least one day before. **Both members must act:** one invites, the other accepts. Thereafter, only ***one*** member has to submit the files.

That pesky -ea flag!

- **A2:** Practice with strings
  - We will give you our test cases soon!

References to text and JavaSummary.pptx

3

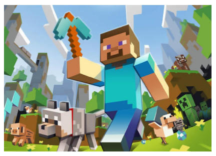
- A bit about testing and test cases
- Class Object, superest class of them all.
  Text: C.23 slide 30
- Function toString() C.24 slide 31-33
- Overriding a method C15–C16 slide 31-32
- Static components (methods and fields) B.27 slide 21, 45
- Java application: a program with a class that declares a method with this signature:

  public static void main(String[])

Homework

4

1. Read the text, about applications: Appendix A.1–A.3
2. Read the text, about the if-statement: A.38–A.40
3. Visit course website, click on Resources and then on Code Style Guidelines. Study
   2. Format Conventions
   4.5 About then-part and else-part of if-statement



A bit about testing

5

Test case: Set of input values, together with the expected output.

Develop test cases for a method from its specification --- even before you write the method's body.

```
/** returns the number of vowels in word w.
Precondition: w contains at least one letter and nothing but letters */
public int numberOfVowels(String w) {
   …
}
```

Developing test cases first, in "critique" mode, can prevent wasted work and errors

How many vowels in each of these words?
creek
syzygy
yellow

Class W (for Worker)

6

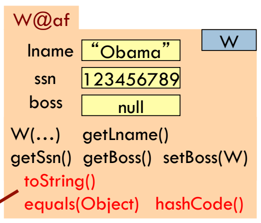
```
/** Constructor: worker with last name n,  SSN s, boss b (null if none).
    Prec:  n not null,  s in 0..999999999 with no leading zeros.*/
public W(String n, int s, W b)

/** = worker's last name */
public String getLname()

/** = last 4 SSN digits */
public String getSsn()

/** = worker's boss (null if none) */
public W getBoss()

/** Set boss to b */
public void setBoss(W b)
```



Contains other methods!

Class Object: the superest class of them all

Java: Every class that does not extend another extends class Object. That is,

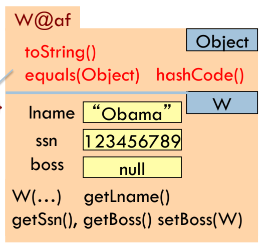
public class W {…}

is equivalent to

public class W **extends** Object {…}

We often omit this partition to reduce clutter; we know that it is always there.

We draw object like this



A note on design

- Don't use **extends** just to get access to hidden members!
- A should extend B if and only if **A “is a” B**
  - A PhDTester is *not* a PhD Student!
  - An elephant is an animal, so Elephant **extends** Animal
  - A car is a vehicle, so Car **extends** Vehicle
  - An instance of any class is an object, so AnyClass **extends** java.lang.Object
- The inheritance hierarchy should reflect **modeling semantics**, not implementational shortcuts

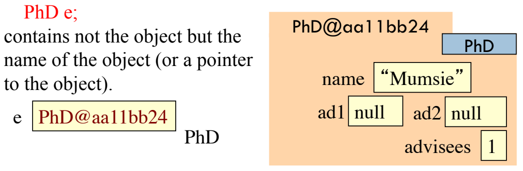
What is “the name of” the object?

The name of the object below is

PhD@aa11bb24

It contains a pointer to the object –i.e. its address in memory, and you can call it a pointer if you wish. But it contains more than that.

Variable e, declared as
PhD e;
contains not the object but the name of the object (or a pointer to the object).



Method toString

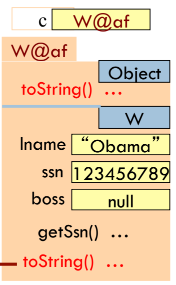
toString() in Object returns the name of the object: W@af

Java Convention: Define toString() in any class to return a representation of an object, giving info about the values in its fields.

New definitions of toString() **override** the definition in Object.toString()

In appropriate places, the expression c automatically does c.toString()

c.toString() calls this method

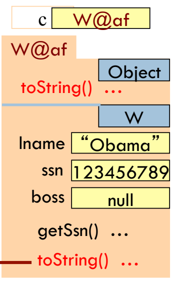


Method toString

toString() in Object returns the name of the object: W@af

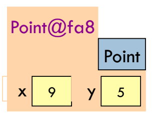
```
public class W {
  …
  /** Return a representation of this object */
  public String toString() {
    return "Worker " + lname
           + " has SSN ???-??-" + getSsn()
           + (boss == null
                  ? ""
                  : " and boss " + boss.lname);
}
```

c.toString() calls this method



Another example of toString()

```
/** An instance represents a point (x, y) in the plane */
public class Point {
  private int x;  // x-coordinate
  private int y;  // y-coordinate
  …
  /** = repr. of this point in form "(x, y)" */
  public String toString() {
     return "(" + x + "," + y + ")";
  }
}
```



(9, 5)

Function toString should give the values in the fields in a format that makes sense for the class.

What about **this**

- **this** keyword: **this** evaluates to the name of the object in which it occurs
- Makes it possible for an object to access its own name (or pointer)
- Example: Referencing a shadowed class field

```
public class Point {
    public int x = 0;
    public int y = 0;

    //constructor
    public Point(int x, int y) {
        x = x;
        y = y;
    }
}
```

Inside-out rule shows that field x is inaccessible!

```
public class Point {
    public int x = 0;
    public int y = 0;

    //constructor
    public Point(int x, int y) {
        this.x = x;
        this.y = y;
    }
}
```

Intro to static components

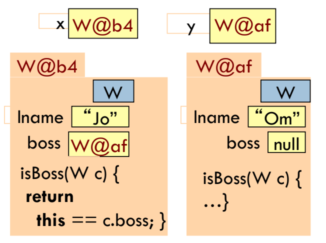
```
/** = "this object is c' s boss".
    Pre: c is not null. */
public boolean isBoss(W c) {
    return this == c.boss;
}
```

x.isBoss(y) is **false**

y.isBoss(x) is **true**

Spec: return the value of that true-false sentence. True if this object is c's boss, false otherwise

keyword **this** evaluates to the name of the object in which it appears

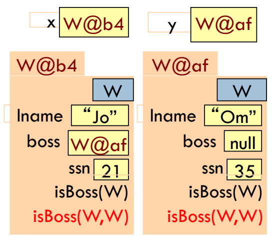


Intro to static components

```
/** = "b is c' s boss".
    Pre: b and c are not null. */
public boolean isBoss(W b, W c) {
    return b == c.getBoss();
}
```

Body doesn't refer to any field or method in the object. Why put method in object?

```
/** = "this object is c' s boss".
    Pre: c is not null. */
public boolean isBoss(W c) {
    return this == c.boss;
}
```



Intro to static components

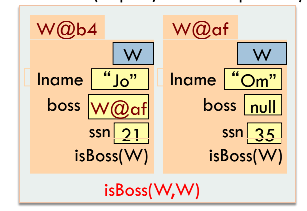
```
/** = "b is c' s boss".
    Pre: b and c are not null. */
public static boolean isBoss(W b, W c) {
    return b == c.getBoss();
}
```

static: there is only one copy of the method. It is *not* in each object

~~x.isBoss(x, y)~~
~~y.isBoss(x, y)~~

Preferred:
W.isBoss(x, y)

Box for W (objects, static components)



Good example of static methods

- java.lang.Math

http://docs.oracle.com/javase/8/docs/api/java/lang/Math.html

Java application

Java application: bunch of classes with at least one class that has this procedure:

```
public static void main(String[] args) {
    …
}
```

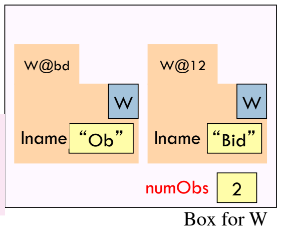
Type String[]: array of elements of type String. We will discuss later

Running the application effectively calls method main
Command line arguments can be entered with args

Use of static variables: Maintain info about created objects

```
public class W {
   private static int numObs; // number of W objects created
   /** Constructor:  */
   public W(…) {
      …
      numObs= numObjs + 1;
   }
}
```

To have numObs contain the number of objects of class W that have been created, simply increment it in constructors.



Uses of static variables: Implement the Singleton pattern

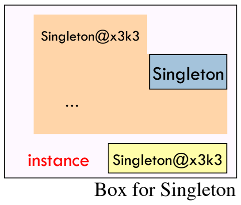
Only one Singleton can ever exist.

```
public class Singleton {
   private static final Singleton instance= new Singleton();

   private Singleton() { }  // ... constructor

   public static Singleton getInstance() {
      return instance;
   }

   // ... methods
}
```



Class java.awt.Color uses static variables

An instance of class Color describes a color in the RGB (Red-Green-Blue) color space. The class contains about 20 static variables, each of which is (i.e. contains a pointer to) a non-changeable Color object for a given color:

```
public static final Color black = …;
public static final Color blue = …;
public static final Color cyan = new Color(0, 255, 255);
public static final Color darkGray = …;
public static final Color gray = …;
public static final Color green = …;
…
```