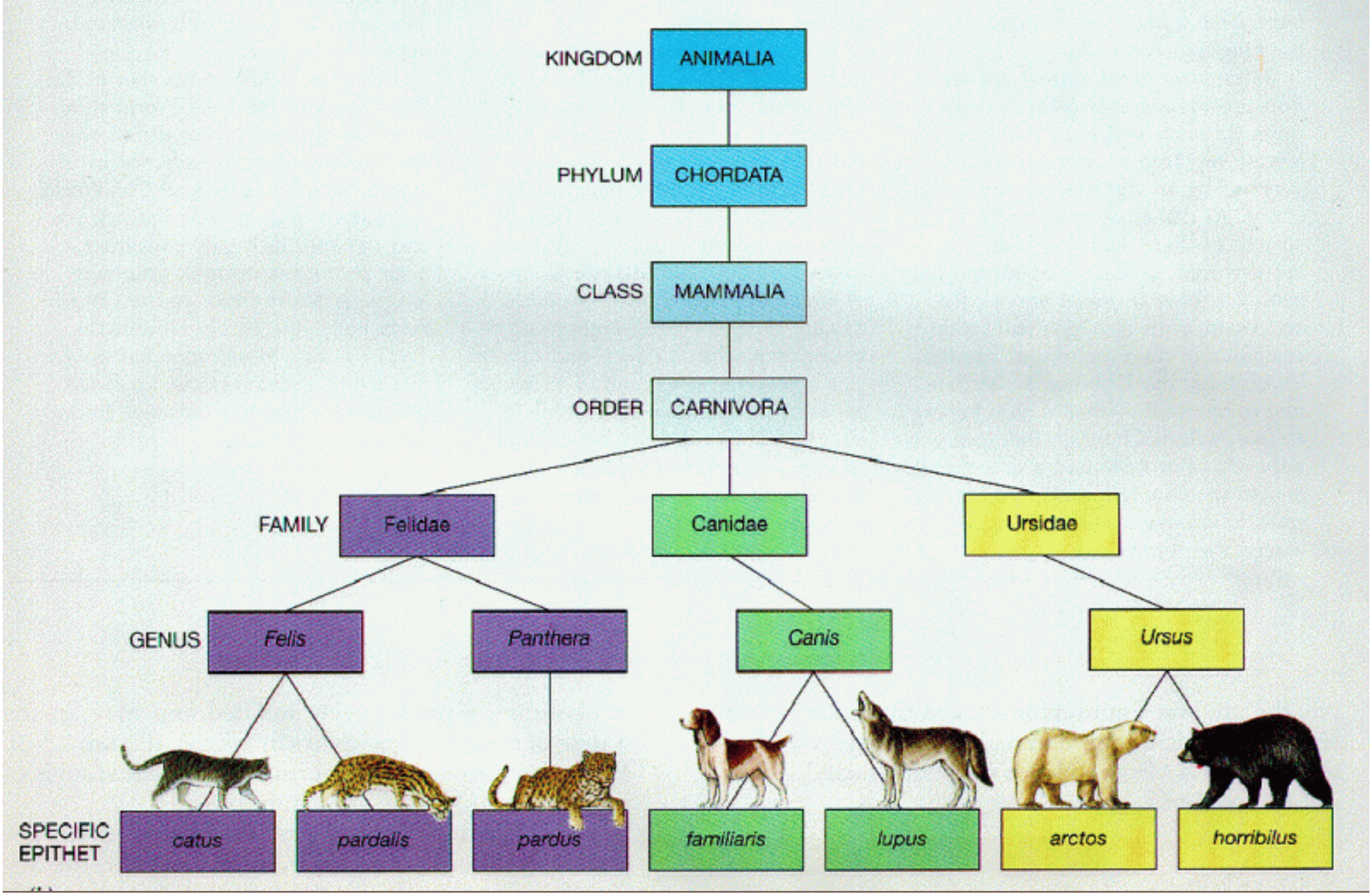


CS/ENGRD 2110
FALL2017

Lecture 4: The class hierarchy; static components

http://cs.cornell.edu/courses/cs2110

Announcements

- □ A1 Due Thursday
- □ A2 Out Today

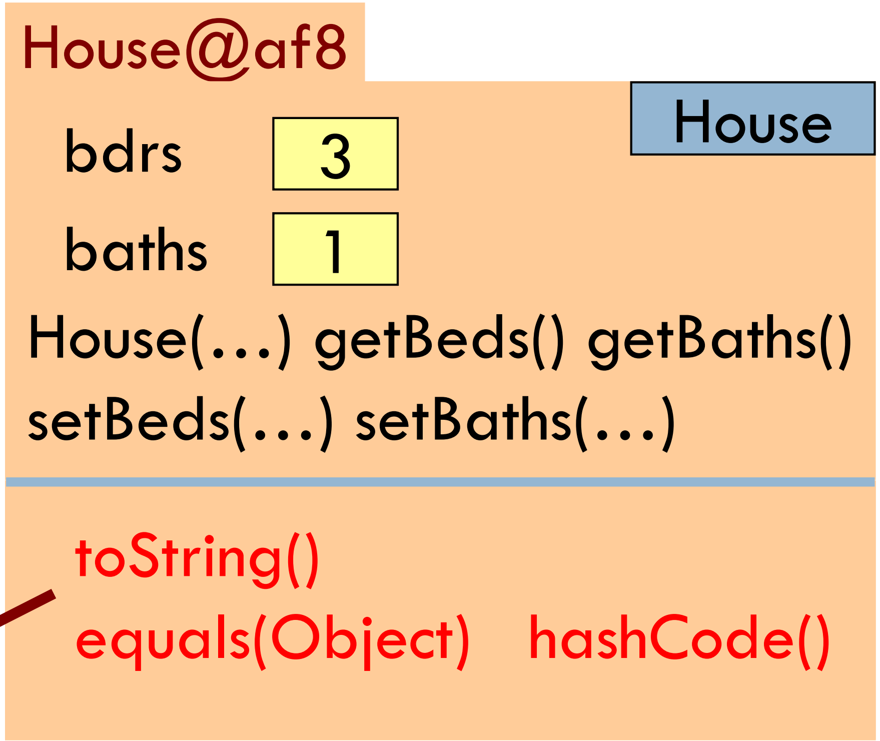
Where am I? Big ideas so far.

- Java variables have *types* (L1)
  - A type is a set of values and operations on them
    (`int`: `+, -, *, /, %,` etc.)
- *Classes* define new types (L2)
  - *Methods* are the operations on objects of that class.
  - *Fields* allow objects to contain data (L3)

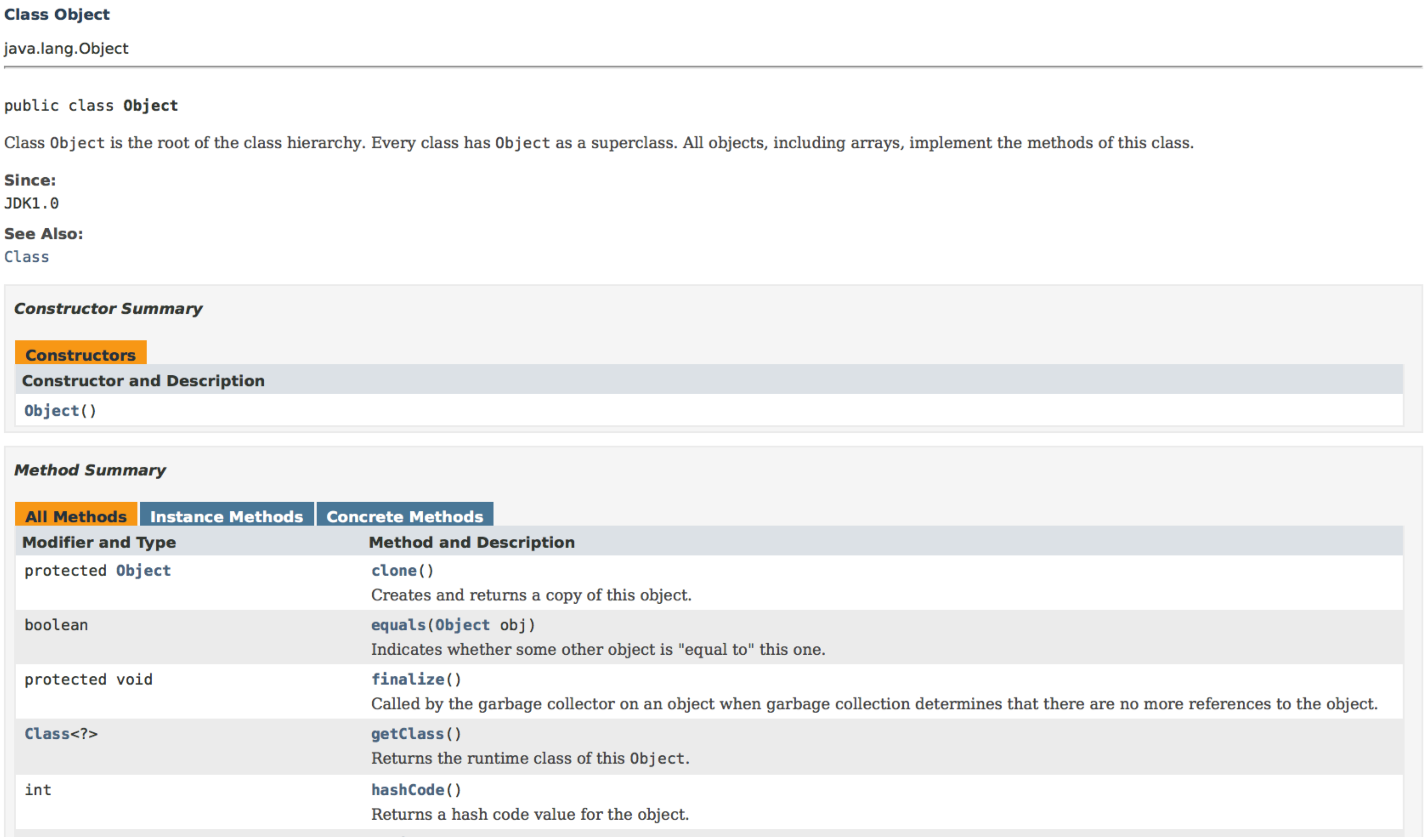
Class House

```
public class House {
    private int bdrs;    // number of bedrooms, >= 0.
    private int baths; // number of bathrooms, in 1..5

    /** Constructor: number of bedrooms b1, number of bathrooms b2
     *    Prec: b1 >= 0, 0 < b2 <= 5 */
    public House(int b1, int b2);

    /** Return number of bedrooms */
    public int getBeds() {
       return bdrs;
    }
    /** Return number of bathrooms */
    public int getBaths() {
       return baths;
    }
}
```

Contains other methods!



Class Object



Class Object

java.lang.Object

```
public class Object
```

Class `Object` is the root of the class hierarchy. Every class has `Object` as a superclass. All objects, including arrays, implement the methods of this class.

Since:
`JDK1.0`

See Also:
`Class`

Constructor Summary

Constructor and Description
`Object()`

Method Summary

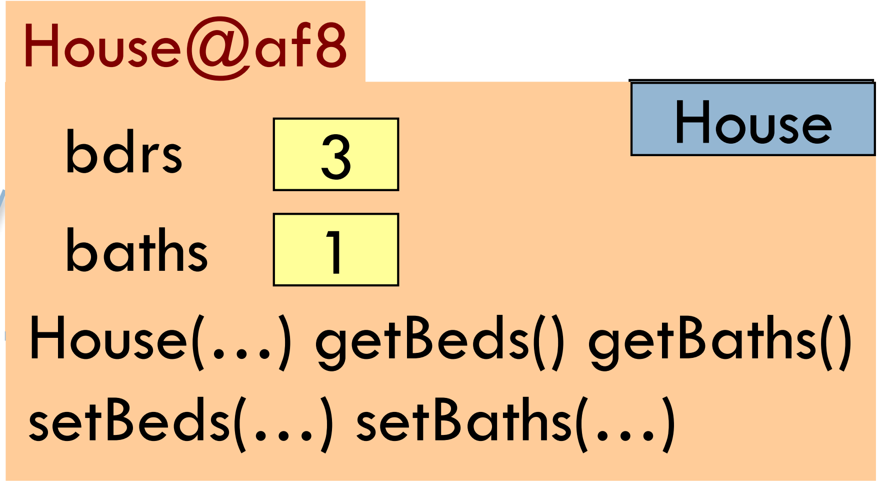
Modifier and Type	Method and Description
`protected Object`	`clone()` Creates and returns a copy of this object.
`boolean`	`equals(Object obj)` Indicates whether some other object is "equal to" this one.
`protected void`	`finalize()` Called by the garbage collector on an object when garbage collection determines that there are no more references to the object.
`Class<?>`	`getClass()` Returns the runtime class of this `Object`.
`int`	`hashCode()` Returns a hash code value for the object.

Class Object: the superest class of all

```
public class House  extends Object {
   private int bdrs;    // number of bedrooms, >
   private int baths; // number of bathrooms, in

   /** Constructor: number of bedrooms b1, nu
    *    Prec: b1 >= 0, 0 < b2 <= 5 */
   public House(int b1, int b2);


   /** Return number of bedrooms */
   public int getBeds() {
     return bdrs;
   }

   }
}
```

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

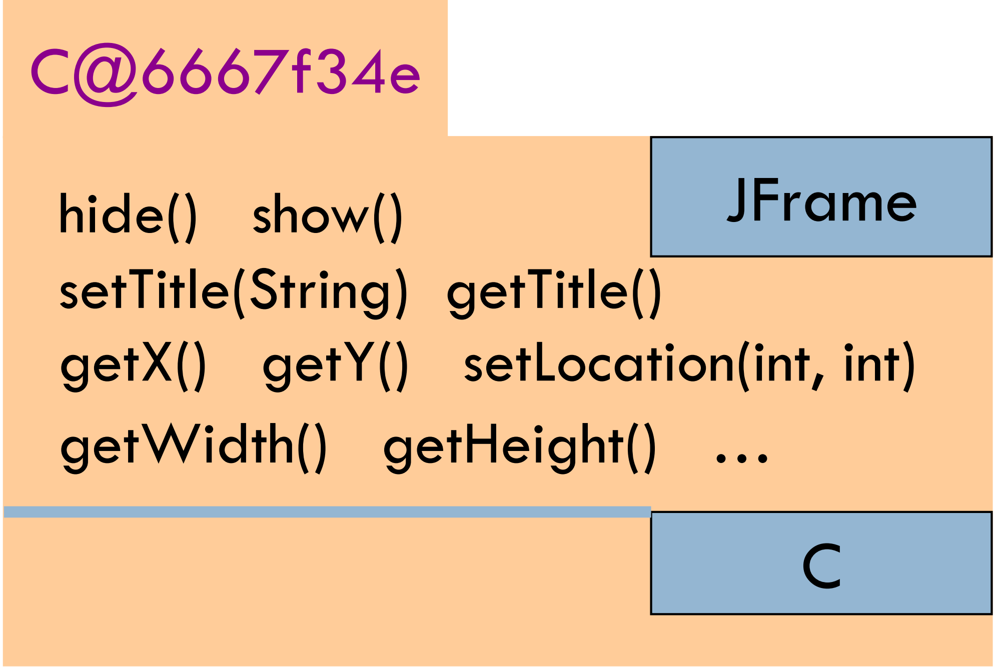
We often omit the Object partition to reduce clutter; we know that it is always there.



Classes can extend other classes

We saw this in L2!

```
/** An instance is a subclass of JFrame */
public class C extends javax.swing.JFrame {

}
```



C@6667f34e

JFrame

hide() show()
setTitle(String) getTitle()
getX() getY() setLocation(int, int)
getWidth() getHeight() …

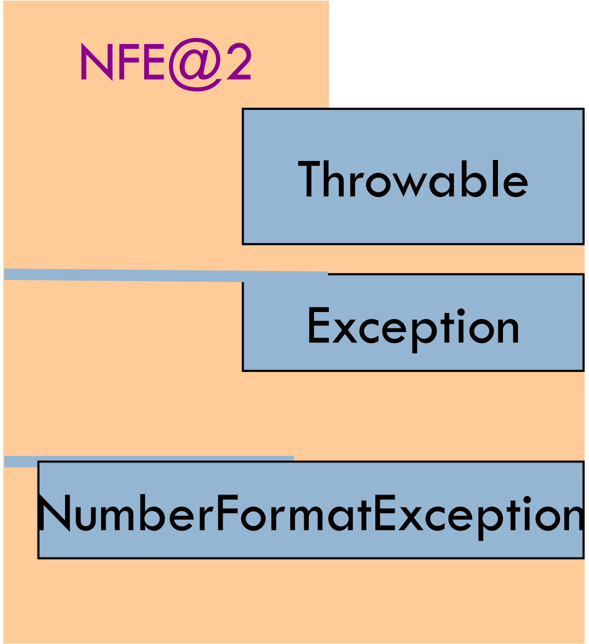
C

C: subclass of JFrame
JFrame: superclass of C
C *inherits* all methods
that are in a JFrame

Object has 2 partitions:
one for JFrame methods,
one for C methods

Classes can extend other classes

- You also saw this in the tutorial for this week's recitation
- There are subclasses of Exception for different types of exceptions



Accessing superclass things

- Subclasses are different classes
  - Public fields and methods can be accessed
  - Private fields and methods cannot be accessed
  - Protected fields can be access by subclasses

Keywords: 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 Apartment extends
House {
    private int floor;
    private Apartment downstairs;

    //constructor
    public Apartment(int floor,
        Apartment downstairs) {
         floor= floor;
         downstairs = downstairs;
    }
}
```

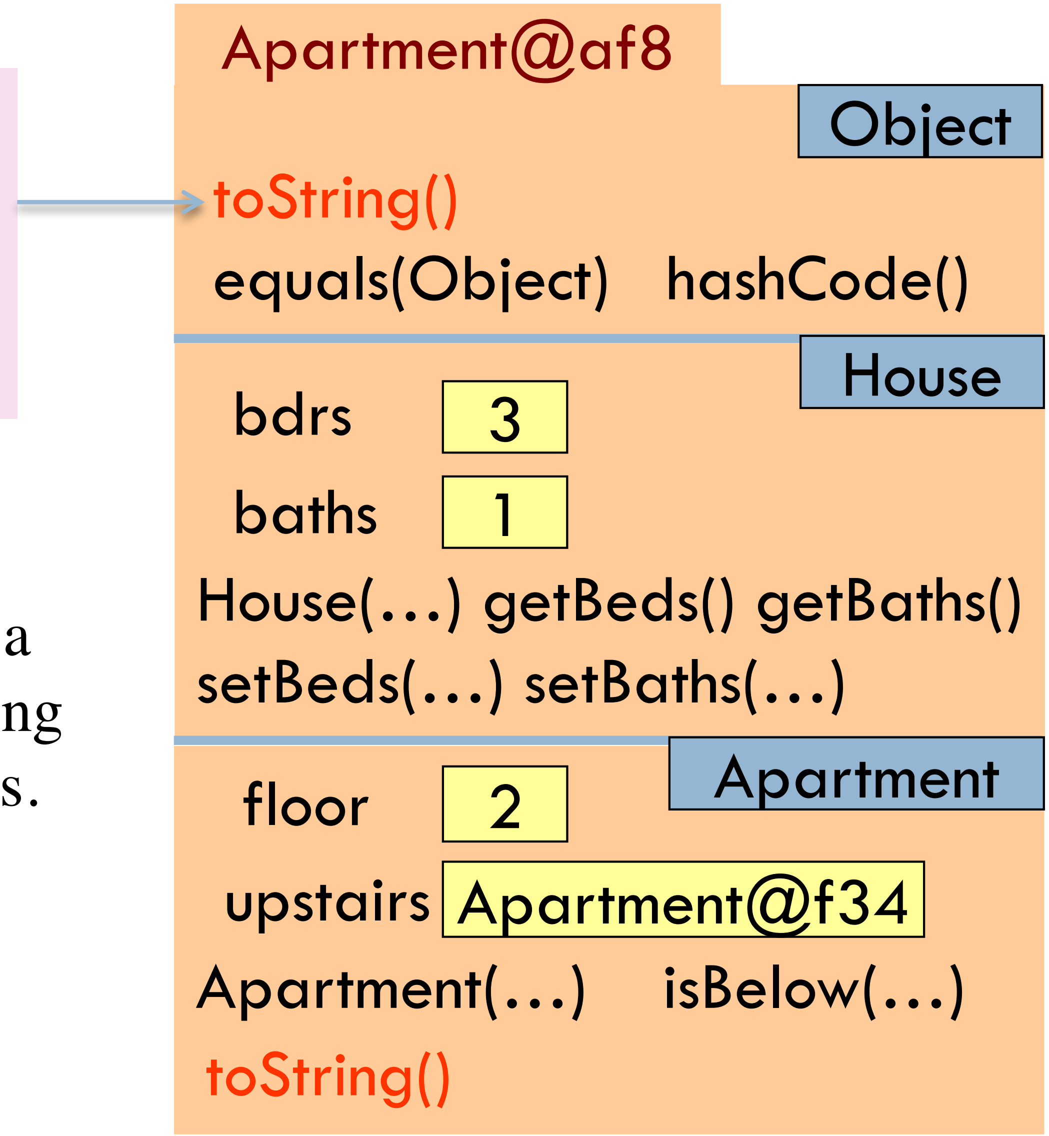
Inside-out rule shows that field x is inaccessible! 😢

```
public class Apartment extends
House {
    private int floor;
    private Apartment downstairs;

    //constructor
    public Apartment(int floor,
        Apartment downstairs) {
         this.floor= floor;
         this.downst
            downsta
    }
}
```

this avoids overshadowed field name

Overriding methods

Object defines a method toString() that returns the name of the object
Apartment@af8



Apartment@af8

Object

toString()

equals(Object) hashCode()

House

bdrs 3

baths 1

House(…) getBeds() getBaths()

setBeds(…) setBaths(…)

Apartment

floor 2

upstairs Apartment@f34

Apartment(…) isBelow(…)

toString()

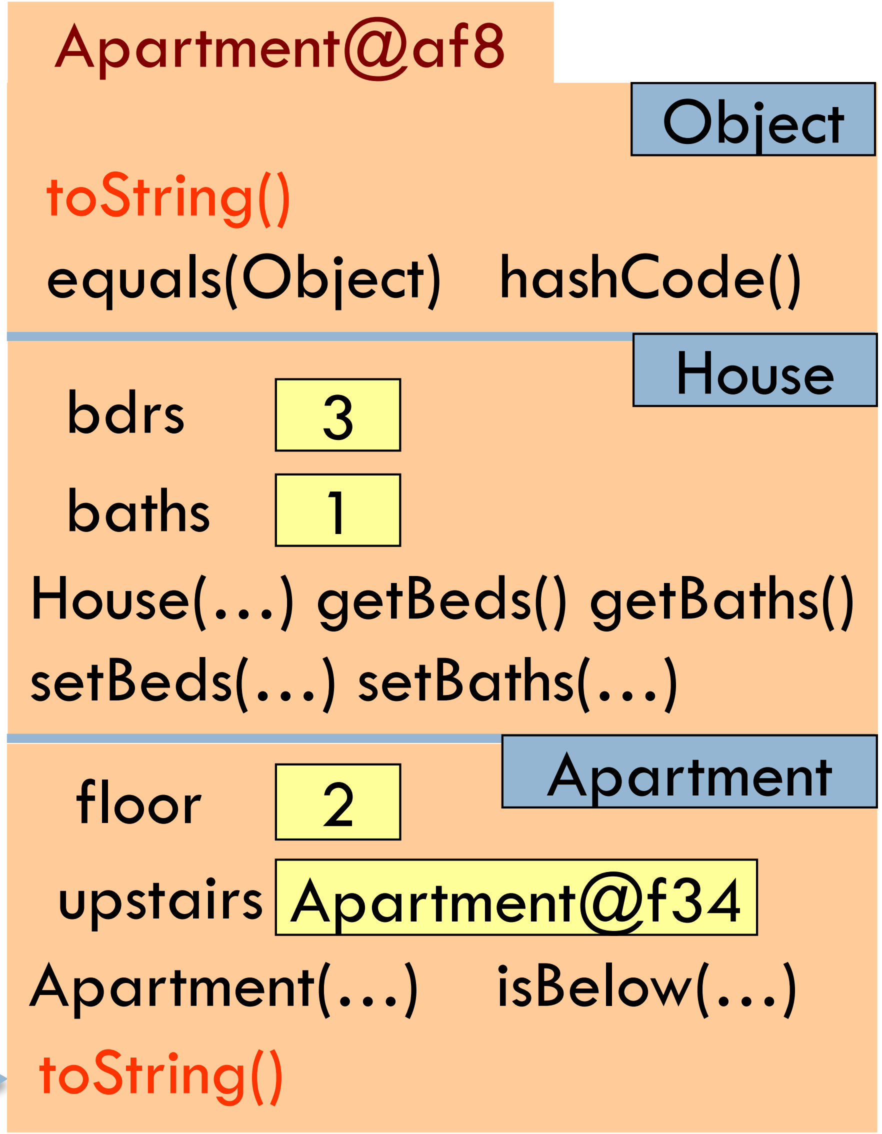
Java Convention: Define toString() in any class to return a representation of an object, giving info about the values in its fields.

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

Overriding methods

```
public class Apartment{

  …

   /** Return a representation of an
         Apartment*/
    @Override
    public String toString() {

        return "" +(getBeds() +getBaths())
+ " room  apartment on " + floor + "th
floor";

   }

}
```

a.toString() calls this method



When should you make a subclass?

- The inheritance hierarchy should reflect **modeling semantics**, not implementation shortcuts
- A should extend B if and only if **A "is a" B**
  - 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
- Don't use **extends** just to get access to protected fields!

When should you make a subclass?

- Which of the following seem like reasonable designs?
  A. Triangle extends Shape { … }
  B. PHDTester extends PHD { … }
  C. BankAccount extends CheckingAccount { … }

Static Methods

- Most methods are instance methods: every instance of the class has a copy of the method
- There is only one copy of a static method.
There is not a copy in each object.

You should make a method static if the body does not refer to any field or method in the object.

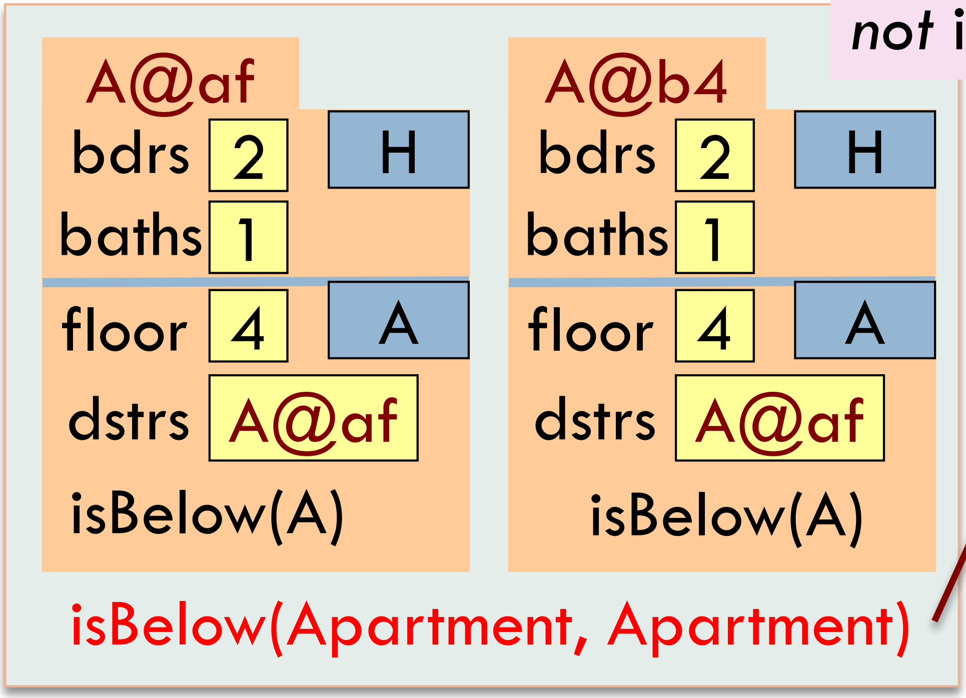
An Example

```
/** = “this object is below”.
    Pre: a is not null. */
public boolean
isBelow(Apartment a){
    return this == a.downstairs;
}
```

```
/** = “a is below b”.
    Pre: b and c are not null. */
public static boolean
isBelow(Apartment b, Apartment a){
    return b == a.downstairs;
}
```

Referencing a static method

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



Container for Apartment

contains: objects, static components

```
public static void main(String[] args) {
    Apartment.isBelow(a, b);
}
```

Good example of static methods

- □ java.lang.Math

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

- □ Or find it by googling

  Java 8 Math

Static Fields

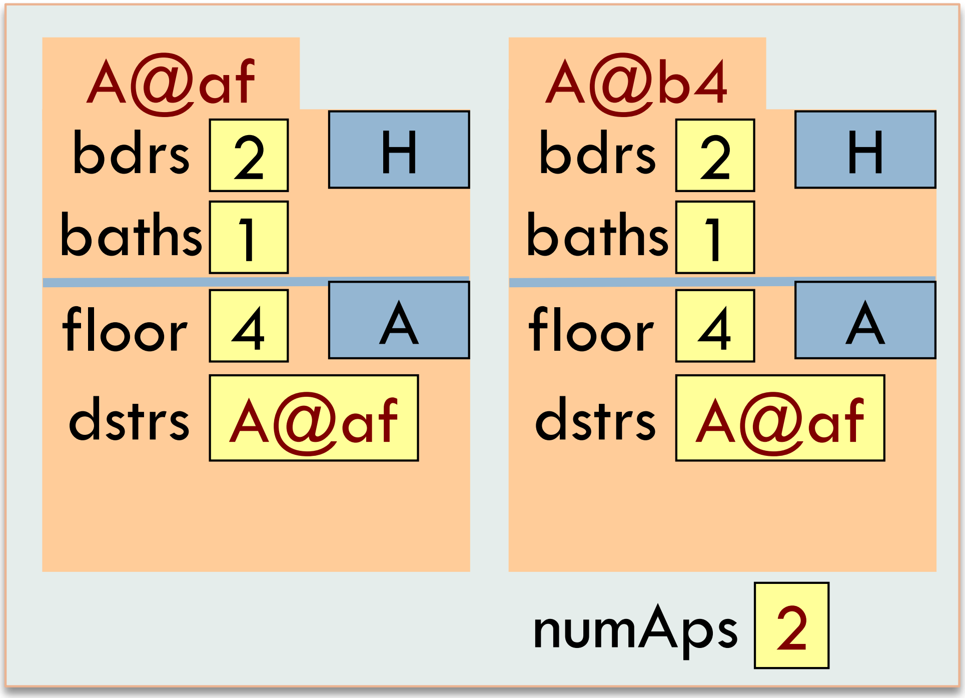
- There is only one copy of a static method.
  There is not a copy in each object.
- There is only one copy of a static field.
  There is not a copy in each object.

What are static fields good for?

Use of static variables: Maintain info about created objects

```
public class Apartment extends House {
  public static int numAps; // number of Apartments created

  /** Constructor:   */
  public Apartment(…) {
     …
     numAps=  numAps + 1;
  }

}
```

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



numAps stored in the Container for Apartment

To access: Apartment.numAps

Class java.awt.Color uses static variables

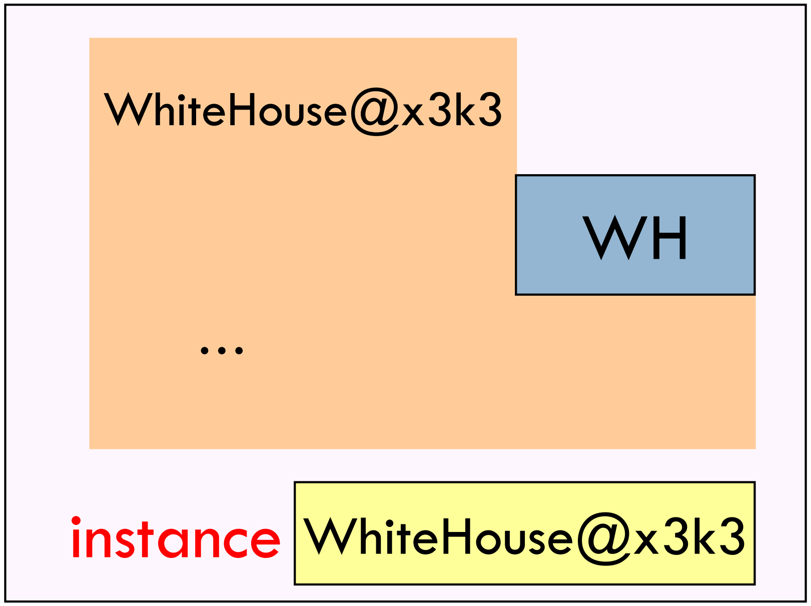
An instance of class Color describes a color in the RGB (Red-Green-Blue) color space. The class contains about 20 static variables, each of which is (i.e. contains a pointer to) a non-changeable Color object for a given color:

```
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 = …;
…
```

Uses of static variables:
Implement the singleton pattern

Only one WhiteHouse can ever exist.

```
public class WhiteHouse extends House{
    private static final WhiteHouse instance= new WhiteHouse();

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

    public static WhiteHouse getInstance()
        return instance;
    }

    // ... methods
}
```



Box for WhiteHouse