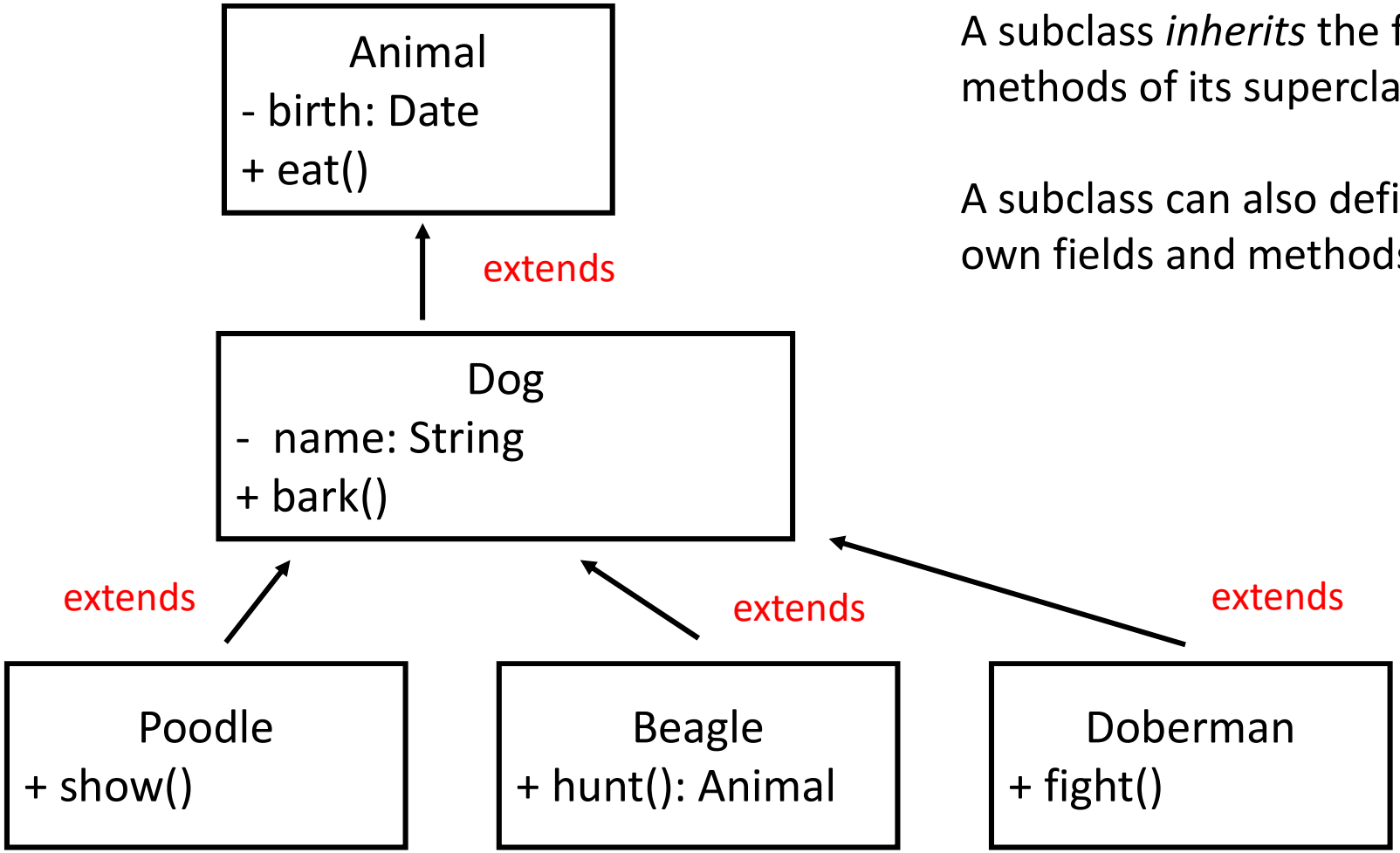
COMP 250

Lecture 14

Inheritance 2: visibility modifiers, Object: `hashCode`, `toString`, type conversion

Feb. 7, 2022

Last lecture: Inheritance

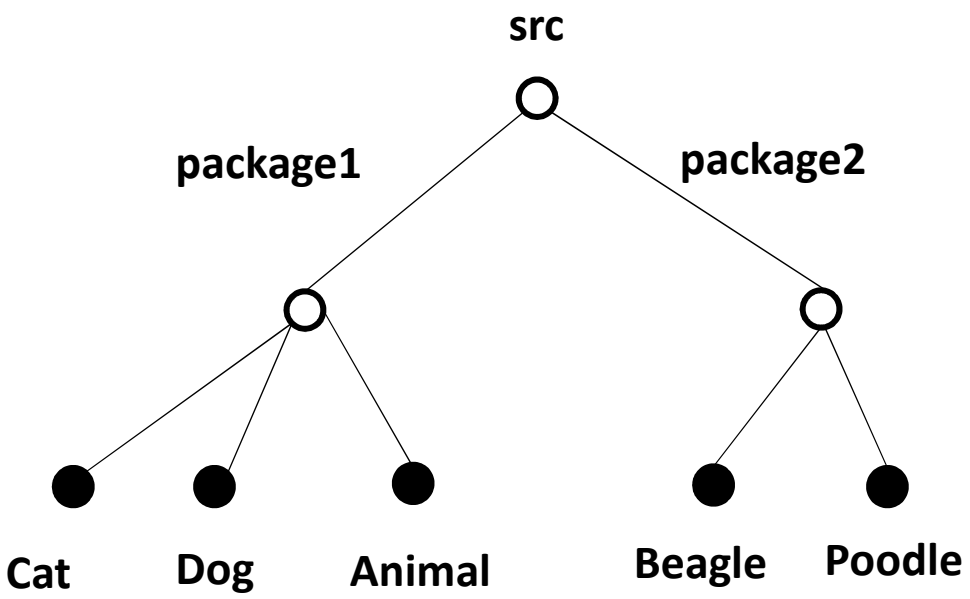


A subclass *inherits* the fields and methods of its superclass.

A subclass can also define its own fields and methods.

Inheritance relationships are not the same as package relationships.

e.g. a subclass can be in a different package than a superclass.



I'm not saying you would *want* to organize these classes as shown. I'm just saying that you *could*.

Let's briefly go over some examples for how *visibility modifiers* (public, private, ...) interact with inheritance relationships.

Inheritance and visibility : classes

For Class B to *extend* class A, it is necessary that class A is visible from class B. (Visibility was discussed in lecture 8.)

For example: two classes in the same package...

```
package package1;

class A {
        :
}
```

```
package package1;

class B extends A{
        :
}
```

Inheritance and visibility : classes

For Class B to *extend* class A, it is necessary that class A is visible from class B. (Visibility was discussed in lecture 8.)

For example: two classes in different packages ...

```
package package1;

public class A {
        :
}
```

```
package package2;
import package1.A;

class B extends A{
        :
}
```

Inheritance and visibility : classes

For Class B to *extend* class A, it is necessary that class A is visible from class B. (Visibility was discussed in lecture 8.)

For example: two classes in different packages ...

```
package package1;

class A {
        :
}
```

```
package package2;
import package1.A;

class B extends A{
        :
}
```

Cannot import. Therefore cannot extend.

package (“package-private”) visibility

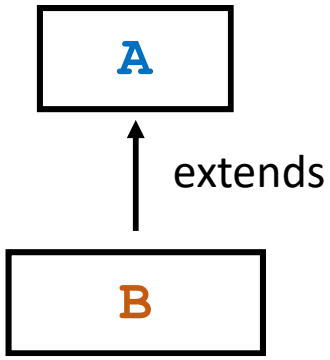
Suppose class B extends class A (thus, class A is visible from class B).

Which class A **members** are visible from class B?

"members" of a class A ≡ fields, methods, inner classes of A.

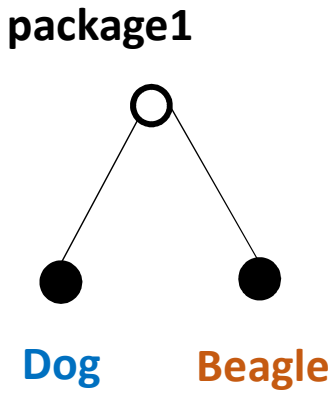
"visible" here means that a class B method can name/refer to the class A member

The rules were given in lecture 8:

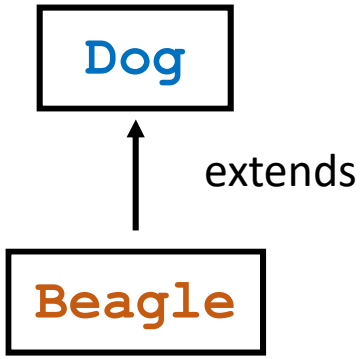


- `public` members of a class A are visible to class B.
- `private` members of a class A are *not visible* to class B.
- Package (called "package-private") members of a class A are visible to class B only if classes A and B are in the same package.

See here for more details.



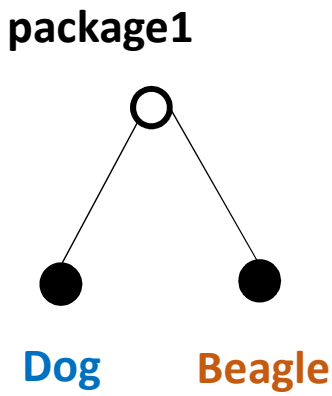
Example



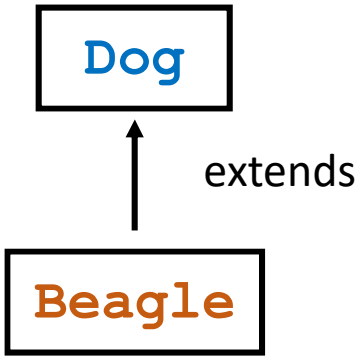

```
package package1;

class Dog{
      String name;

          :
}
```

```
package package1;

class Beagle extends Dog {

      Beagle(String name){
        this.name = name;
      }
}
```

The class Beagle inherits the field/member name from class Dog.



Example



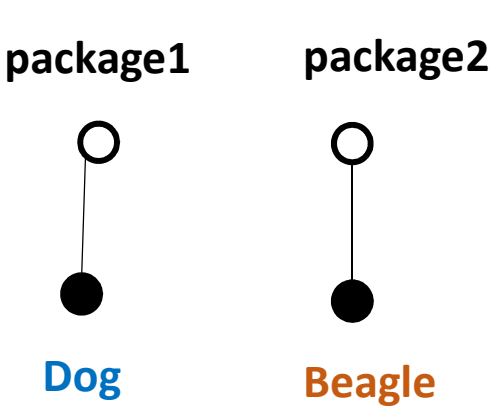

```
package package1;

class Dog{
   private String name;

         :
}
```

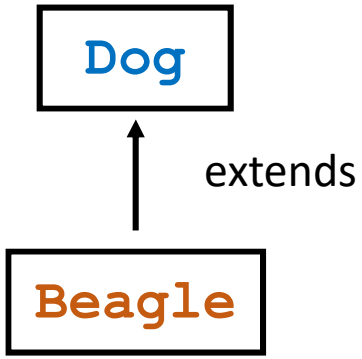
```
package package1;

class Beagle extends Dog {

      Beagle(String name){
        this.name = name;
      }
}
```

name not visible

Officially, the class Beagle does not inherit the field/member name from class Dog. (see lecture notes). But this just means that the **name** field isn't visible. In fact, Beagle objects will have a name field.

Example



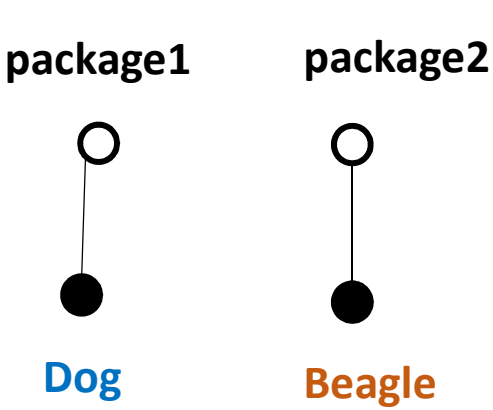


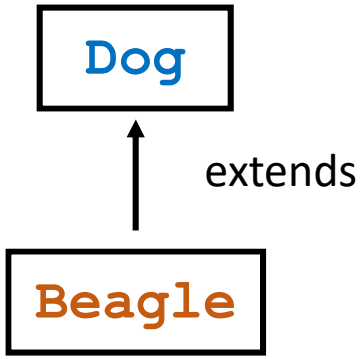

```
package package1;

public class Dog{
   public String name;

         :
}
```

```
package package2;
import package1.Dog;

class Beagle extends Dog {

     Beagle(String name){
       this.name = name;
     }
}
```

The class Beagle inherits the field/member name from class Dog.

Example





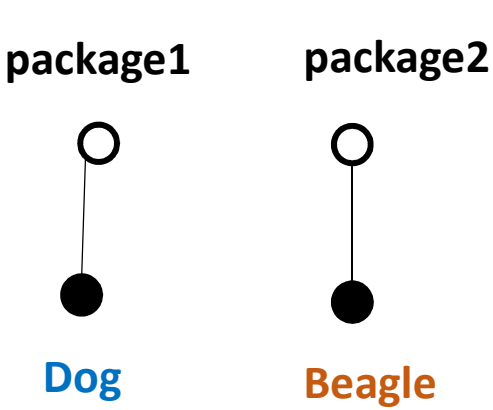

```
package package1;

public class Dog{
   private String name;

          :
}
```

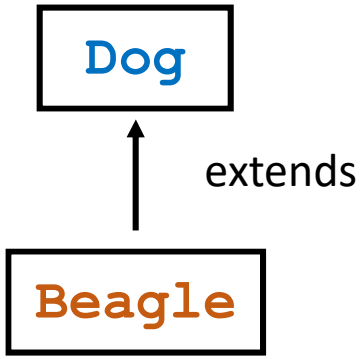
```
package package2;
import package1.Dog;

class Beagle extends Dog {

     Beagle(String name){
       this.name = name;
     }
}
```

name not visible

See similar case from two slides ago. The only difference now is that the classes are in two different packages.

Example



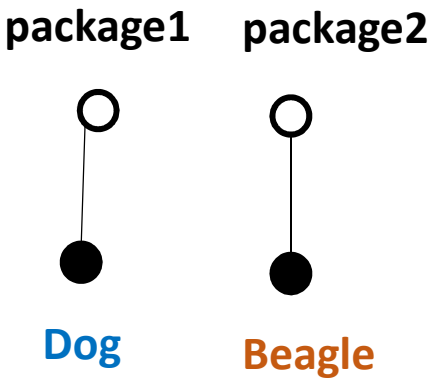



```
package package1;

public class Dog{
  private String name;

  public void setName(
                String name){
     this.name = name;
  }
}
```

```
package package2;
import package1.Dog;

class Beagle extends Dog {

      Beagle(String name){
        this.setName(name);
      }
}
```

The Beagle object can set its **name** field using the inherited **setName()** method.

ASIDE: the `protected` modifier



It is less restrictive than the package ("package-private") .

Use the `protected` modifier for a class member (field or method), if you want to allow the member to be visible to any class **within the same package** (like "package-private") **and also to a *subclass in another* package.**

```
package package1;

public class Dog{
   protected String name;

         :
}
```

```
package package2;
import package1.Dog;

class Beagle extends Dog {

     Beagle(String name){
        this.name = name;
     }
}
```

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Lecture 14

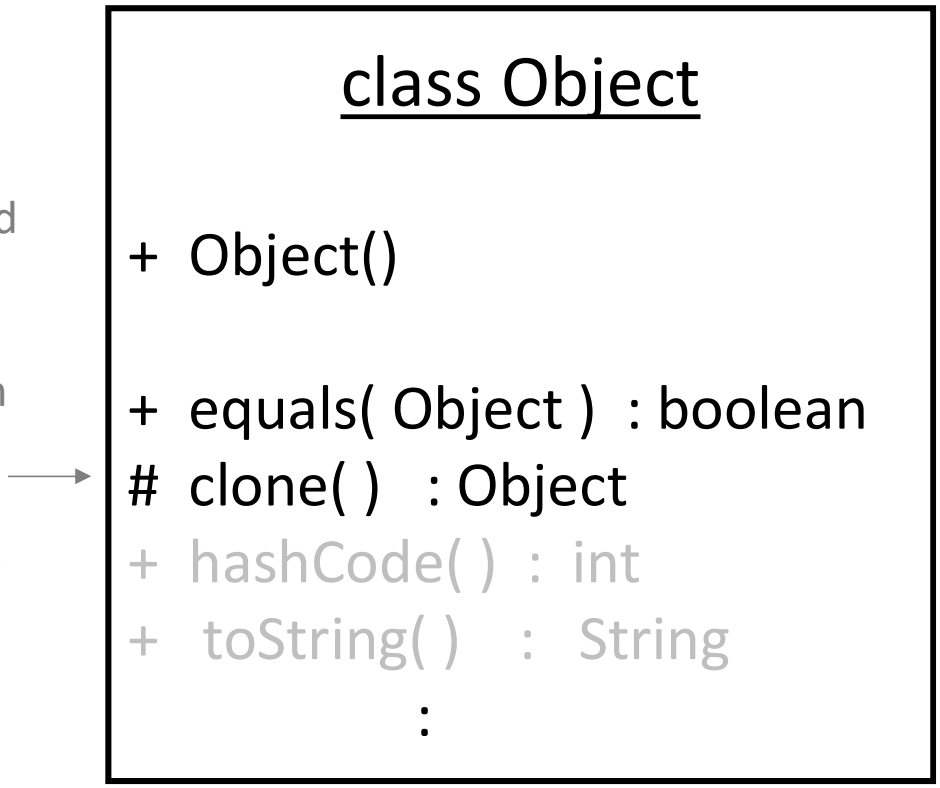
Inheritance 2: visibility modifiers, Object: `hashCode`, `toString`, type conversion

Feb. 7, 2022

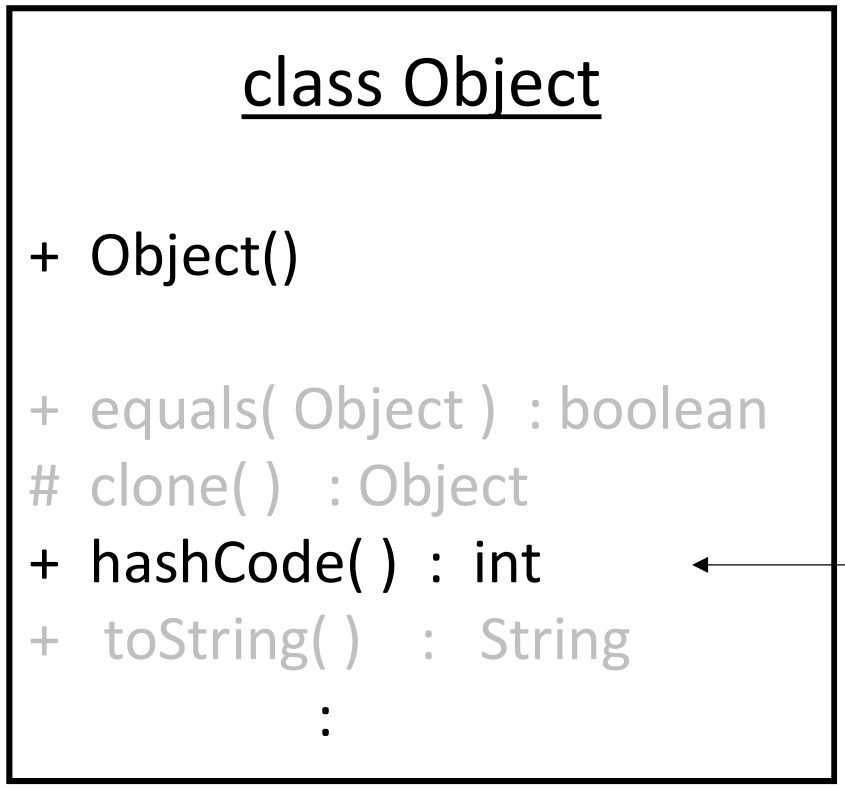
Last lecture: `Object` class

ASIDE:
the clone() method is `protected` and so we use a different symbol in the UML.

The reason clone() is protected are obscure and beyond scope of this course.



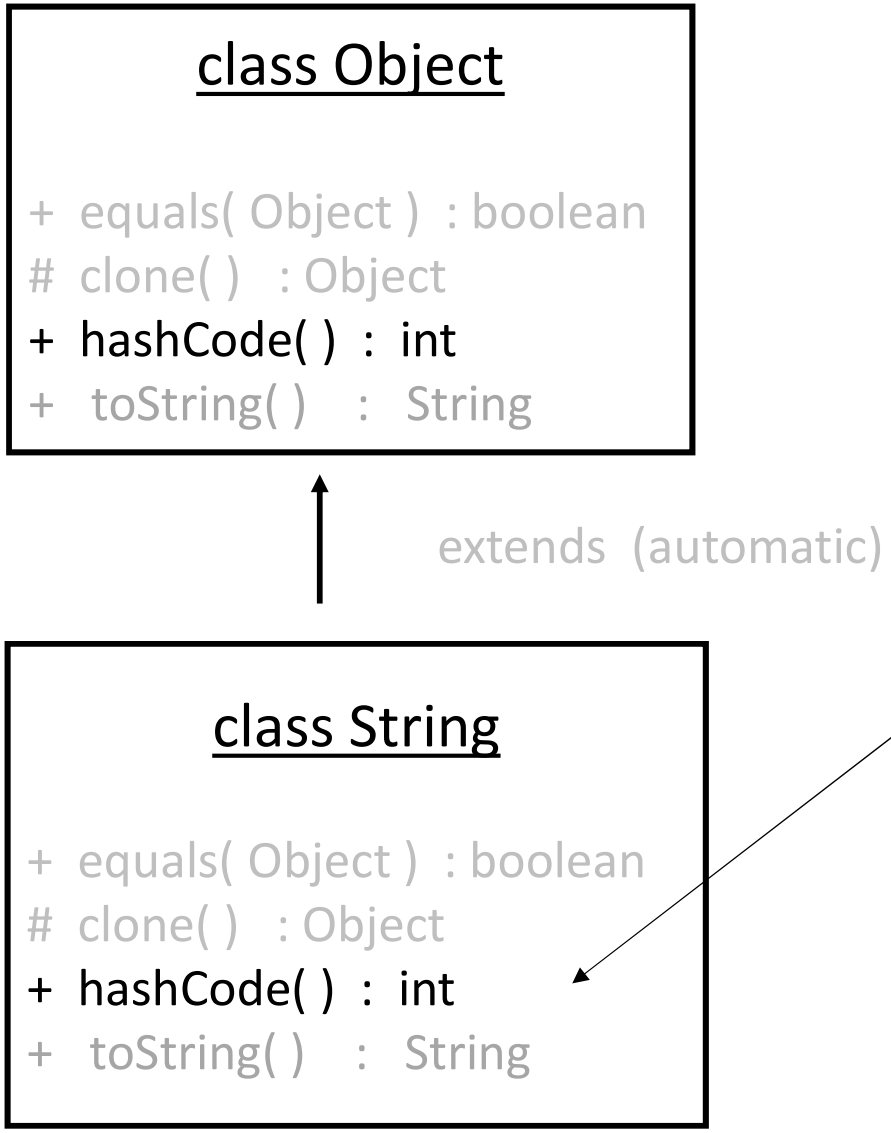
Object.hashCode()



Returns a (positive) integer.

You can think of it as the address of the object, although this is not required in any technical sense.

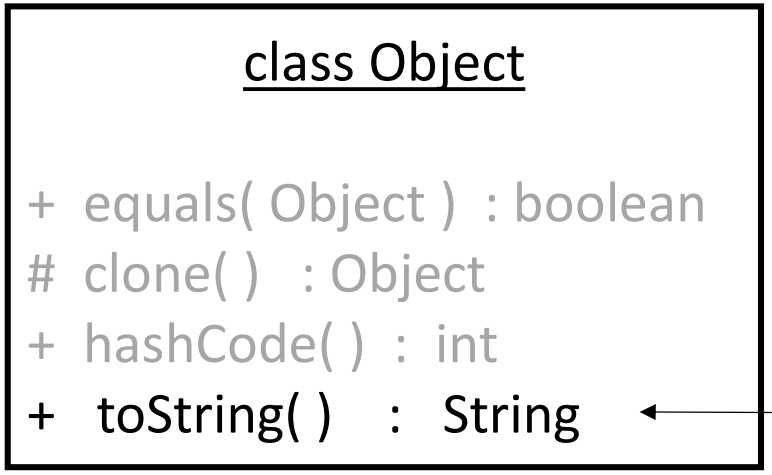
Example: `hashCode()`



String.hashCode() overrides Object.hashCode().

We will discuss String.hashCode()'s and other hashCode's in a few weeks, when we see how they are used.

Object.toString()

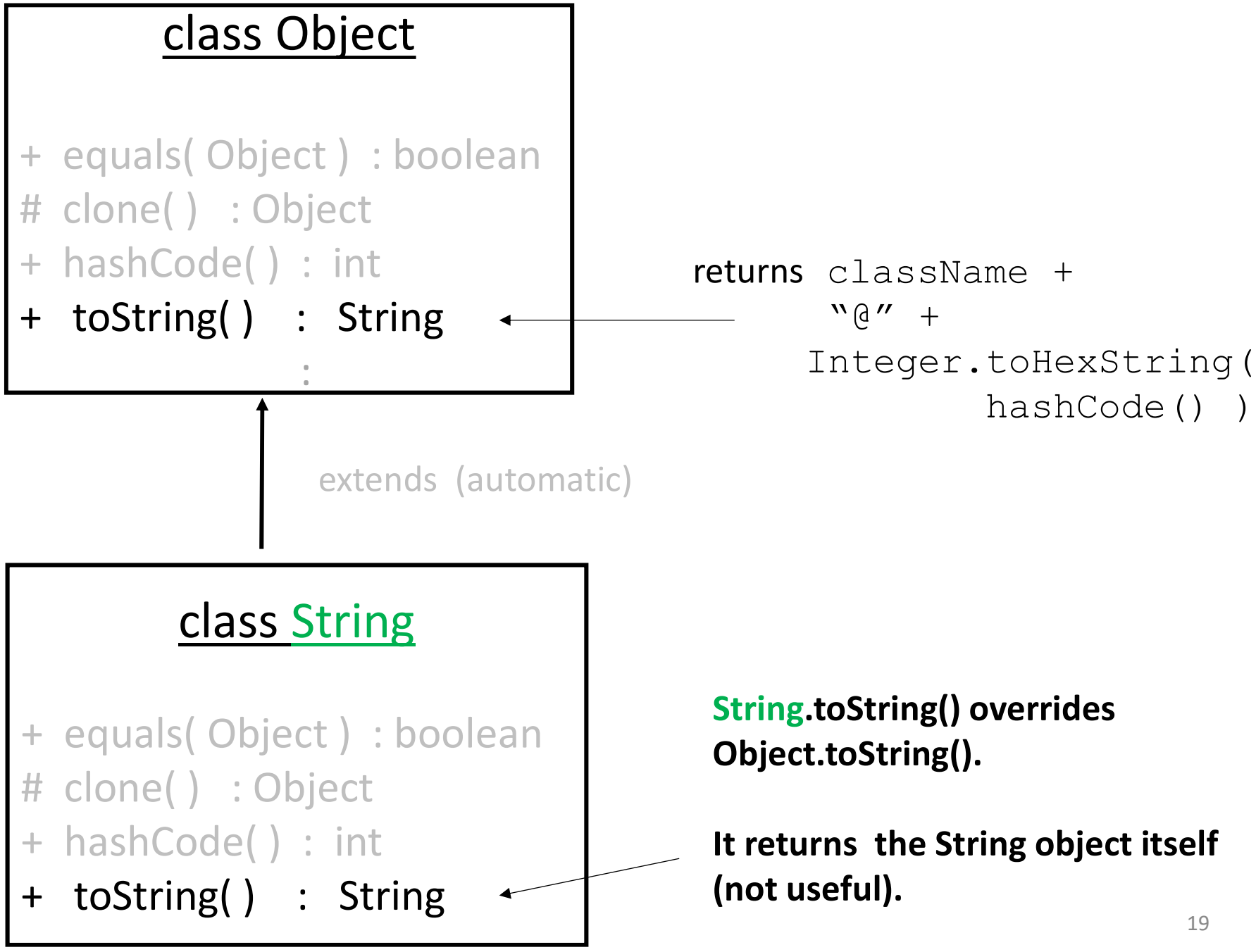


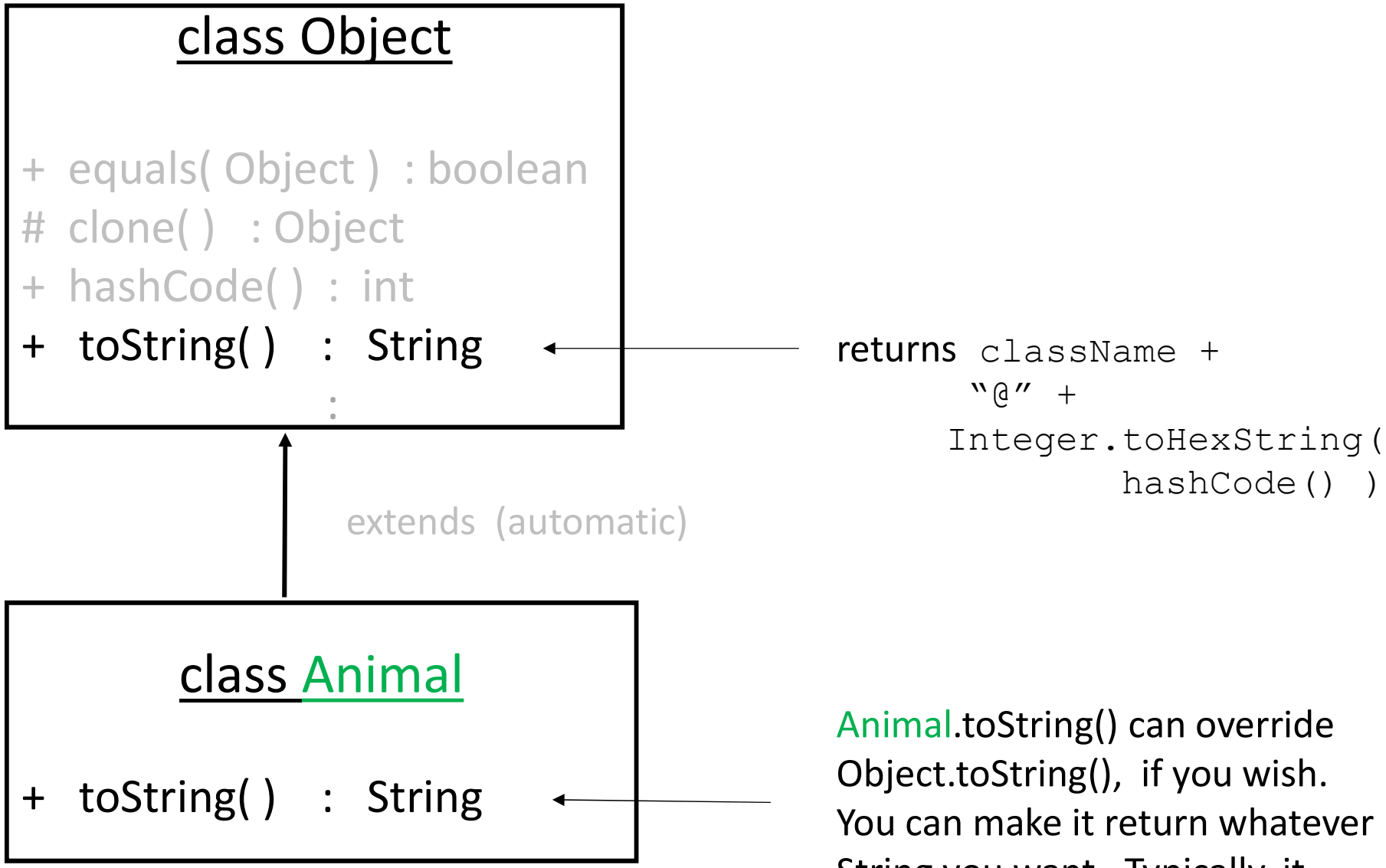
returns **className +**
"@" +
Integer.toHexString(
hashCode())

Example:

```
Object obj = new Object();
System.out.println( obj );
```

Returned for me: **java.lang.Object@5305068a**


class Object
+ equals(Object) : boolean
# clone( ) : Object
+ hashCode( ) : int
+ toString( ) : String
:
returns className +
"@" +
Integer.toHexString(
hashCode())
extends (automatic)
class String
+ equals(Object) : boolean
# clone( ) : Object
+ hashCode( ) : int
+ toString( ) : String
String.toString() overrides Object.toString().
It returns the String object itself (not useful).


class Object
+ equals(Object) : boolean
# clone( ) : Object
+ hashCode( ) : int
+ toString( ) : String
:
returns className +
"@" +
Integer.toHexString(
hashCode())
extends (automatic)
class Animal
+ toString( ) : String
Animal.toString() can override
Object.toString(), if you wish.
You can make it return whatever
String you want. Typically, it
contains info about that
particular object.

See Hector's discussion board posting for Assignment 1.

```
Course comp250 = new Course("COMP250", 3);

//   add  three students  (Patty, Sam, Miranda)  ....

System.out.println( comp250 );
```

```
Course: COMP250
--------
|0      |
|   ------->
--------
|1      |
|   -------> 1: Sam --> 4: Miranda -->
--------
|2      |
|   -------> 2: Patty -->
```

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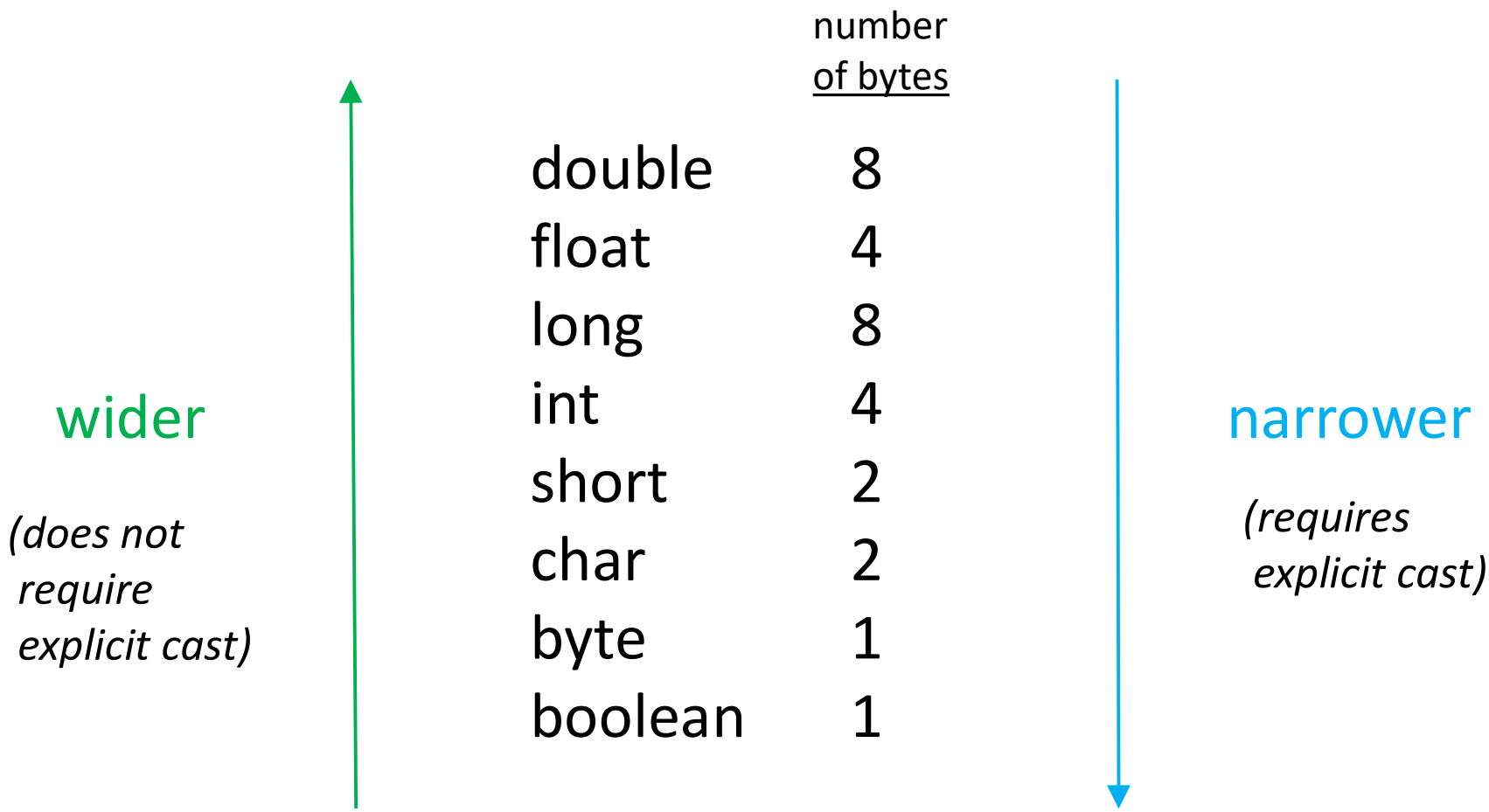
Lecture 14

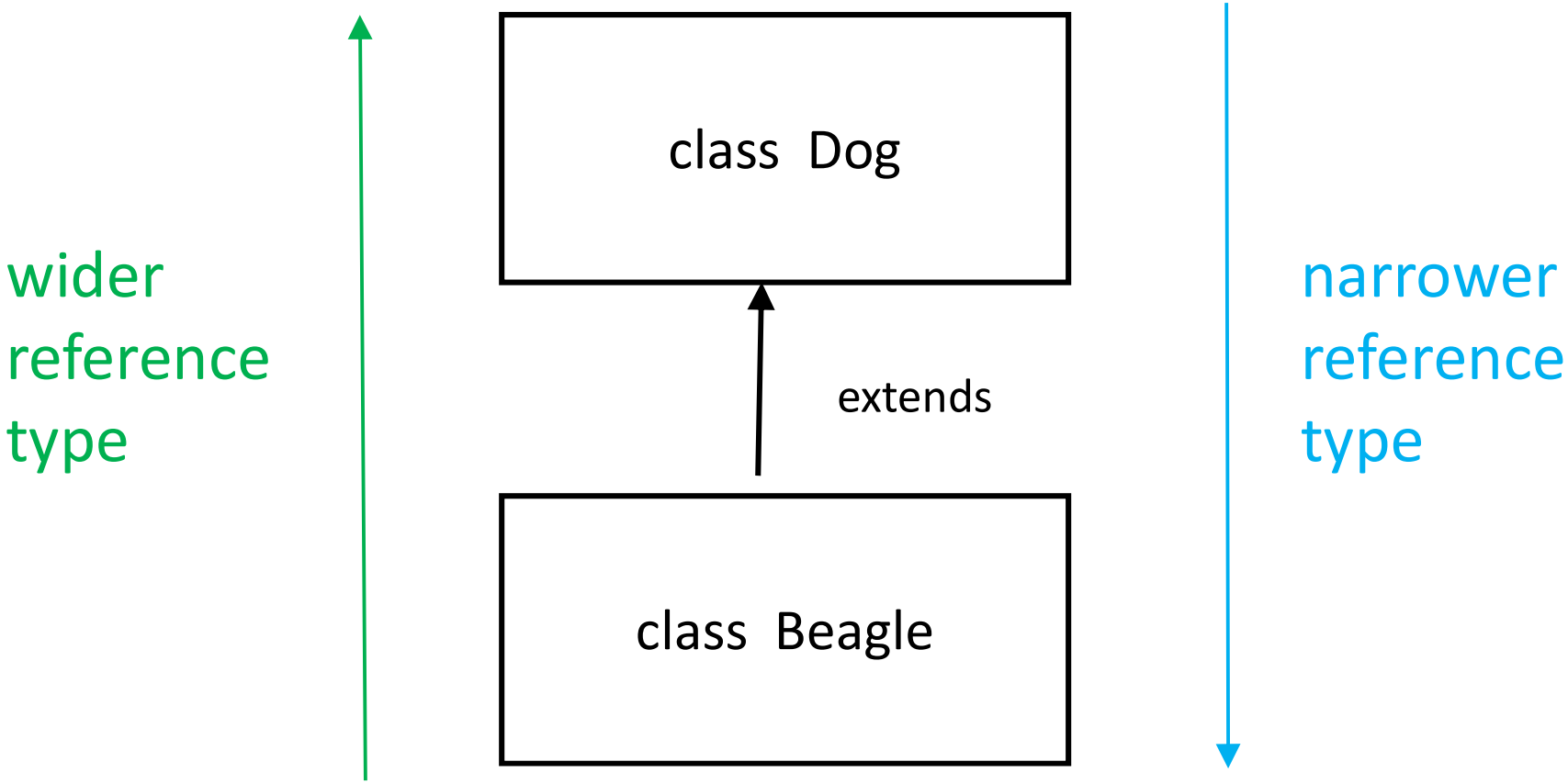
Inheritance 2:
visibility modifiers,
Object: `hashCode`, `toString`,
type conversion (or casting)

Feb. 7, 2022

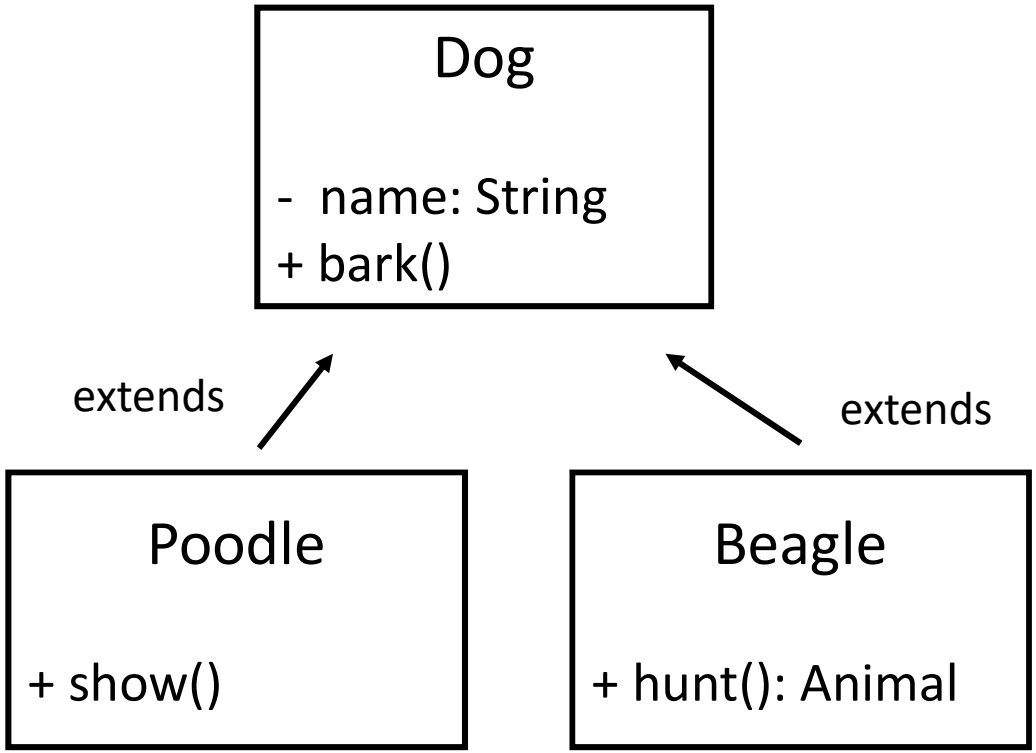
Recall: Primitive Type Conversion (or Casting)



Casting can be used for reference types also.

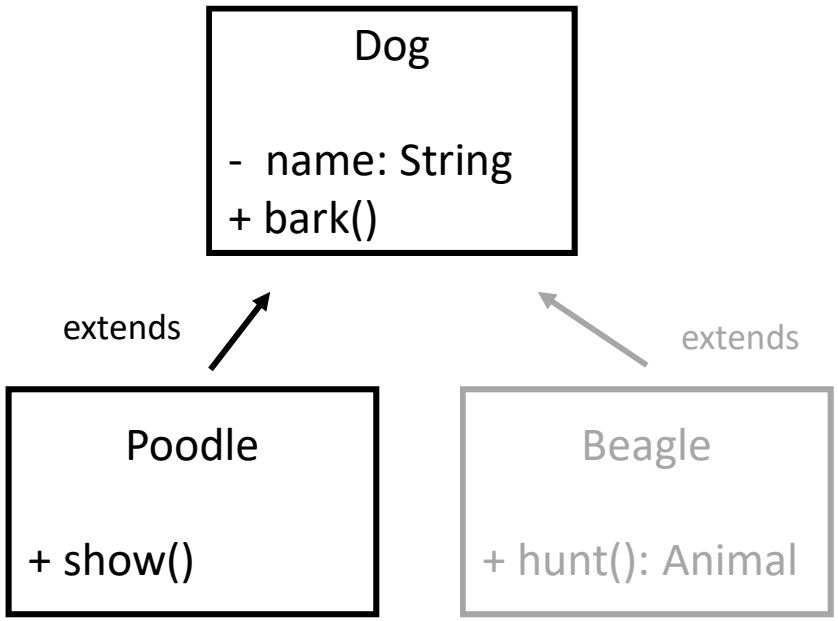


Heads up! Although a subclass is narrower, it actually has more fields and methods than the superclass (since it inherits all fields and methods from superclass).


Dog
- name: String
+ bark()
extends
extends
Poodle
+ show()
Beagle
+ hunt(): Animal

```
Dog    myDog   =   new Poodle();        ✓        // upcast, widening

       myDog.show();                    ✗
```

compile-time error!
Poodle has show() method, but Dog does not.



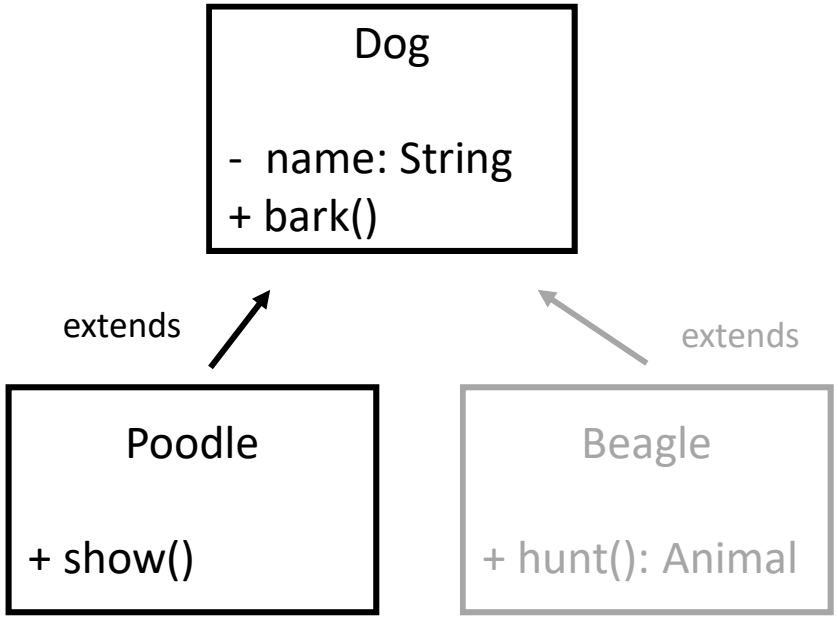
```
Dog    myDog   =   new Poodle();
```

// upcast, widening

```
Poodle   myPoodle  =   myDog;
```

compile-time error!

Implicit downcast Dog to Poodle is not allowed.



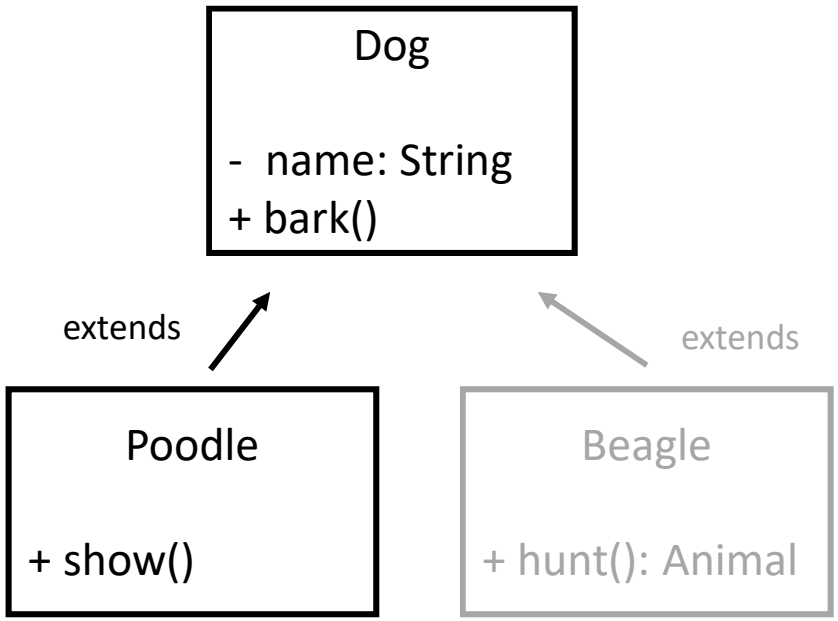
```
Dog    myDog   =   new Poodle();
```
✓ compiles fine

```
Poodle   myPoodle   =   (Poodle)   myDog;
```
✓ compiles fine

```
myPoodle.show();
```
✓ compiles fine

```
((Poodle)  myDog).show();
```
✓ compiles fine

What about runtime ?
(next slide)



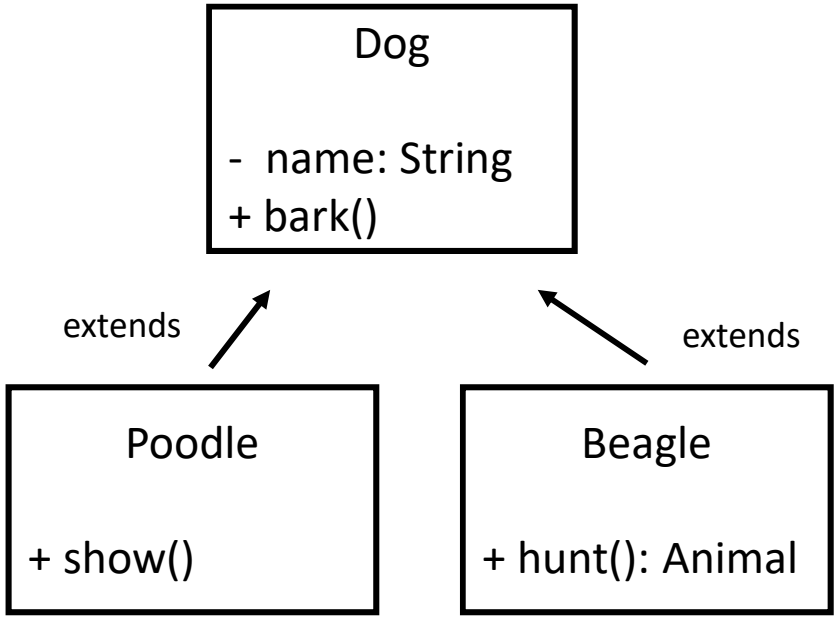
```
Dog    myDog   =   new Poodle();

Poodle   myPoodle   =   (Poodle)   myDog;

         myPoodle.show();

        ((Poodle)  myDog).show();
```

✓ myDog references a Poodle

✓ object is indeed a Poodle

✓ Poodle's have a show method

✓ We have given the compiler a heads up to expect myDog to reference a Poodle, and indeed the referenced object is a Poodle.

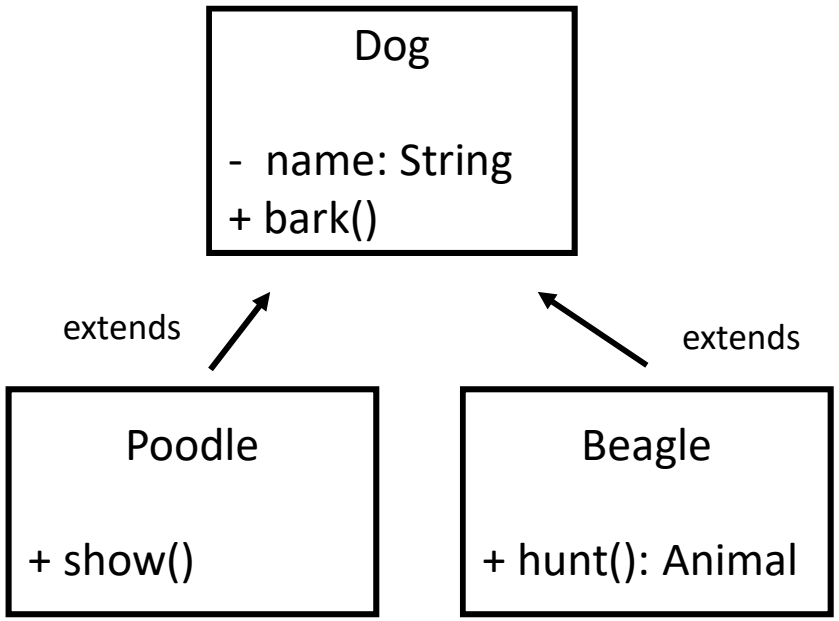


No Runtime errors either

```
Dog    myDog   =  new Beagle();

Poodle   myPoodle  =  (Poodle)  myDog;

          myPoodle.show();

          ((Poodle)  myDog).show();
```

Run-time error!

myDog references a Beagle



instanceof

Sometimes we want to test at runtime whether an object is an instance of a specified class.

The `instanceof` operator can be used for this.

It returns `true` or `false`.

```
Dog  d = new Dog();
System.out.println( d instanceof Dog);      // true

Beagle b = new Beagle();
System.out.println( b instanceof Dog);      // true

d = new Poodle();   //  allowed

System.out.println( d instanceof Dog );     // true

System.out.println( d instanceof String);   // false
```

`instanceof` and downcasting

We can use `instanceof` to make sure that downcasting will not cause a run time error.

```
class  Test {

       static void dogMethod(Dog dog) {

           if  (dog instanceof Beagle) {
              Beagle b = (Beagle) dog;
              b.hunt();
         }

         //  :

     }
}
```

instanceof and equals()

We sometimes use `instanceof` when overriding `equals()` :

```
public class Shape {

   public boolean equals( Object obj ) {

     if(obj instanceof Shape) {

         return this.getArea == ((Shape) obj).getArea();

     else return false;
     }
}
```

FYI, the compiler does require that you have the modifier `public` and return type `boolean` since you are overriding the Object.equals(Object o) method. So the compiler does care about the signature.

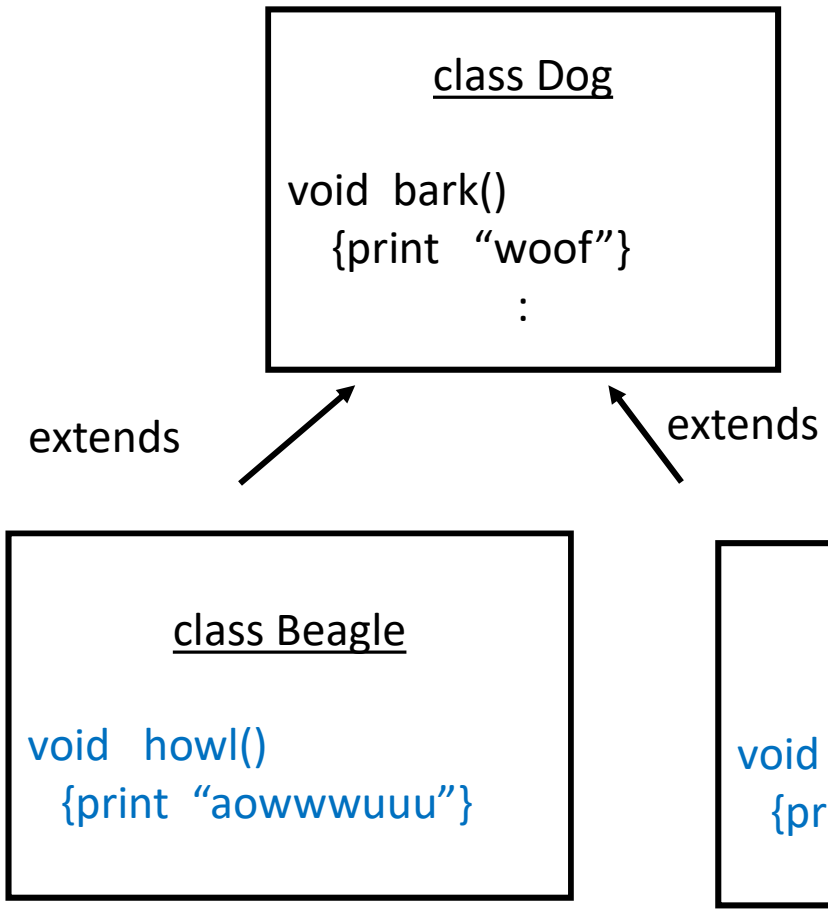
Avoiding `instanceof`

It is tempting to use `instanceof` whenever you are unsure what the type of the object will be (at runtime), and you don't want a runtime error.

But often it is unnecessary.

Let's look at an example. We'll say more next lecture.

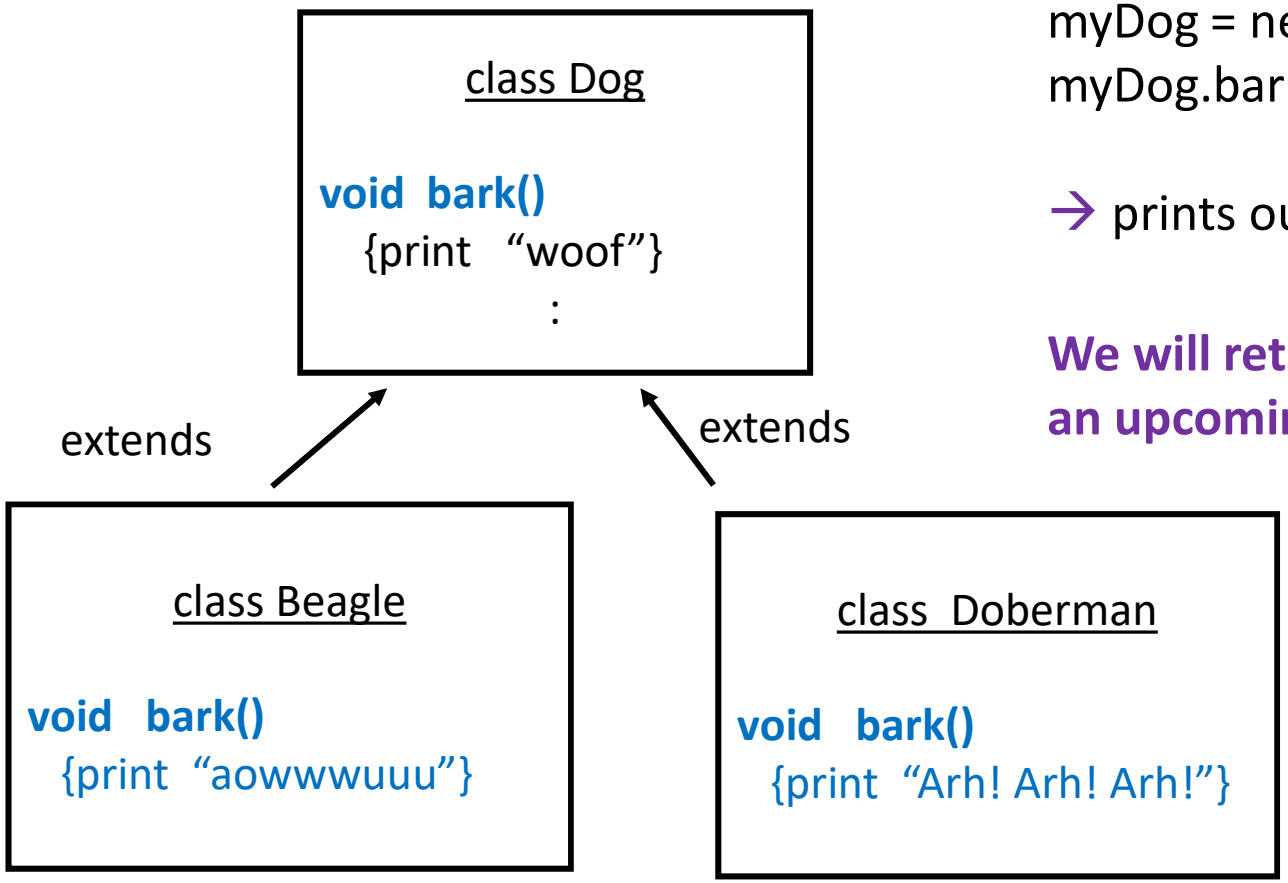
Unnecessary use of `instanceof`...




```
Dog  dog;
     :
if  (dog instanceof Doberman)
     ((Doberman) dog).threaten();
else if (dog instanceof Beagle)
     ((Beagle) dog).howl ();
```

Instead... override

(example from last lecture)




```
Dog  myDog = new Beagle();
     myDog.bark();
```

→ prints out "aowwwuuu"

```
myDog = new Doberman();
myDog.bark();
```

→ prints out "Arh! Arh! Arh!"

We will return to this example in an upcoming lecture.

ASIDE: Object.getClass()

class Object

+ equals(Object) : boolean
# clone( ) : Object
+ hashCode( ) : int
+ toString( ) : String
+ getClass( ) : Class
:

An alternative way to compare objects is to use the Object class'es getClass() method.

For example,

dog1.getClass() == dog2.getClass()

How this works is an advanced topic and beyond the scope of the course. In particular, we won't talk about the Class class.

Coming up…

Lectures

Wed. Feb. 9

Inheritance 3:

(interfaces, abstract classes,

polymorphism)

Fri. Feb. 11

Inheritance 4 :

examples of interfaces:

comparable, iterable)

Assessments

Assignment 1

- due on Friday, Feb. 11

Quiz 2 also on Friday, Feb. 11