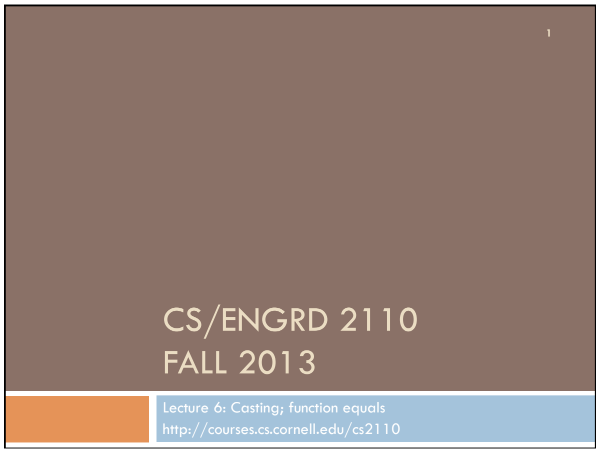

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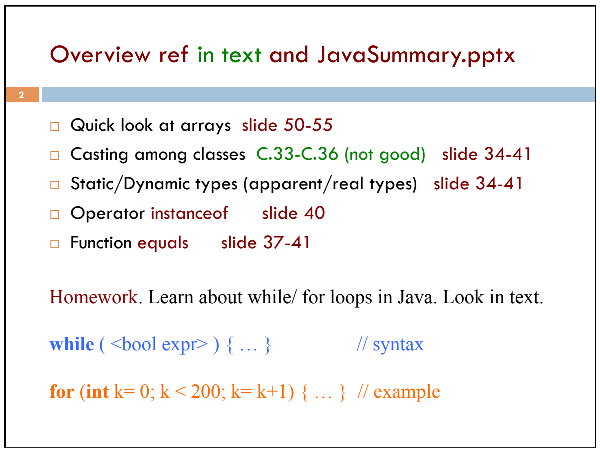
CS/ENGRD 2110
FALL 2013

Lecture 6: Casting; function equals
http://courses.cs.cornell.edu/cs2110



Overview ref in text and JavaSummary.pptx

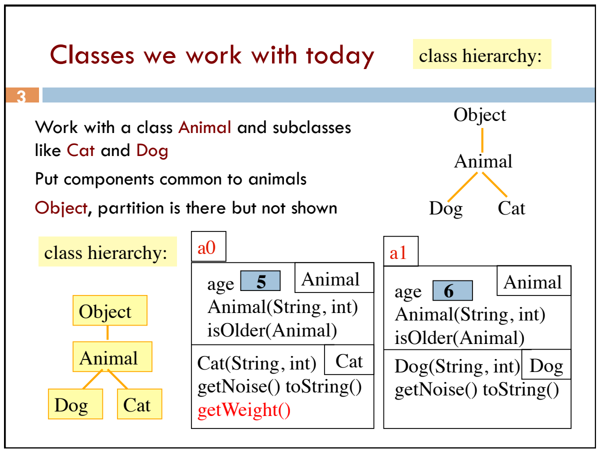
2

- Quick look at arrays slide 50-55
- Casting among classes C.33-C.36 (not good) slide 34-41
- Static/Dynamic types (apparent/real types) slide 34-41
- Operator instanceof slide 40
- Function equals slide 37-41

Homework. Learn about while/ for loops in Java. Look in text.

```
while ( <bool expr> ) { … }                  // syntax

for (int k= 0; k < 200; k= k+1) { … }  // example
```



Classes we work with today

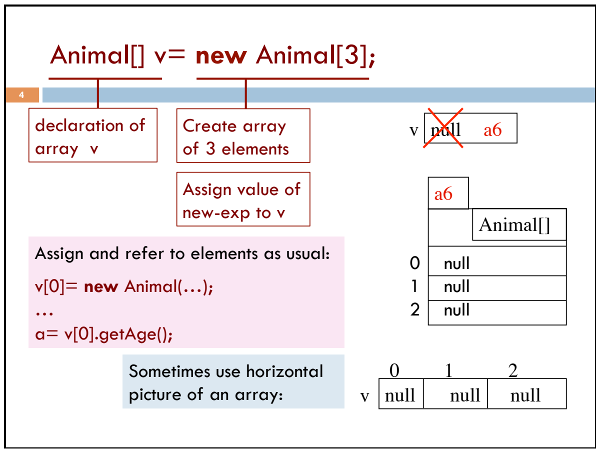
3

class hierarchy:

Work with a class Animal and subclasses like Cat and Dog

Put components common to animals

Object, partition is there but not shown



Animal[] v= new Animal[3];

4

declaration of array v

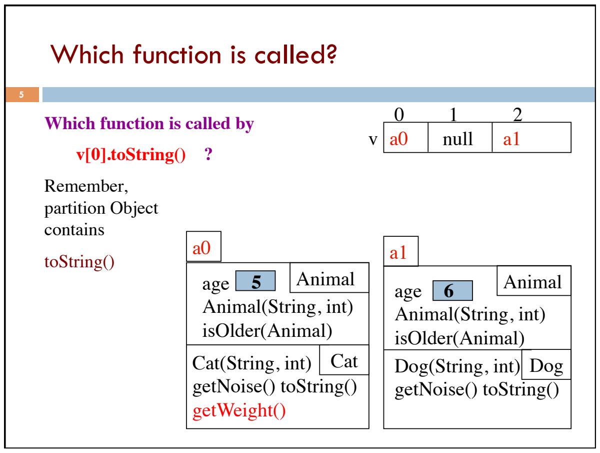
Create array of 3 elements

Assign value of new-exp to v

Assign and refer to elements as usual:

```
v[0]= new Animal(…);
…
a= v[0].getAge();
```

Sometimes use horizontal picture of an array:



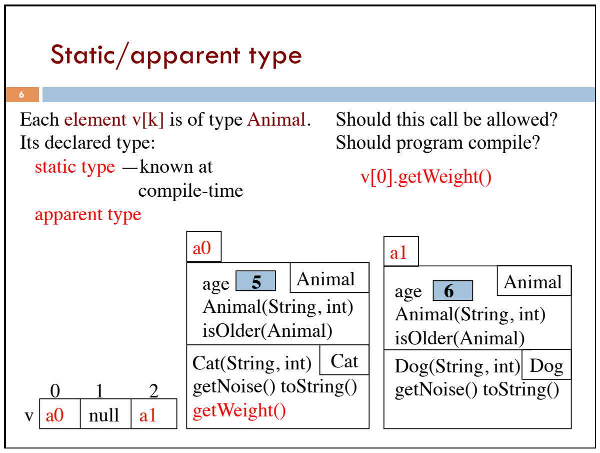
Which function is called?

5

Which function is called by

v[0].toString() ?

Remember, partition Object contains toString()



Static/apparent type

6

Each element v[k] is of type Animal.
Its declared type:
static type —known at compile-time
apparent type

Should this call be allowed?
Should program compile?

v[0].getWeight()

View of object from static type

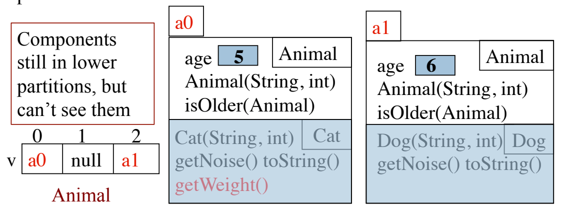
Each element v[k] is of (static) type Animal.

From v[k], see only what is in partition Animal and partitions above it.

getWeight() not in class Animal or Object. Calls are illegal, program does not compile:

v[0].getWeight() v[k].getWeight()

Components still in lower partitions, but can't see them



Casting up class hierarchy

You know about casts like

(int) (5.0 / 7.5)

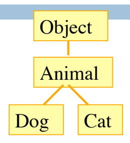
(double) 6

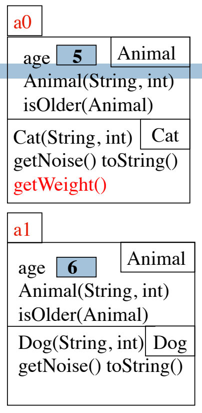
double d= 5;   // automatic cast

We now discuss casts up and down the class hierarchy.

Animal h= **new** Cat("N", 5);

Cat c= (Cat) h;





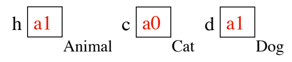
Implicit upward cast

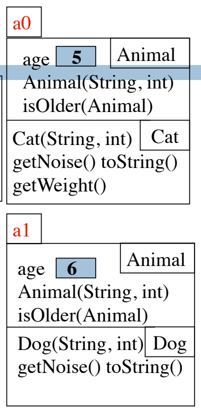
```
public class Animal {
    /** = "this Animal is older than h" */
    public boolean isOlder(Animal h) {
      return age > h.age;
    }
```

Call c.isOlder(d)

h is created. a1 is cast up to class Animal and stored in h

Upward casts done automatically when needed





Explicit casts: unary prefix operators

You may cast an object to the name of any partition that occurs within it —and to nothing else.

a0 maybe cast to Object, Animal, Cat.

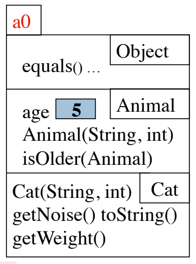
An attempt to cast it to anything else causes an exception

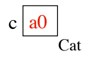
(Cat) c

(Object) c

(Animal) (Animal) (Cat) (Object) c

These casts don't take any time. The object does not change. It's a change of perception





Static/dynamic types

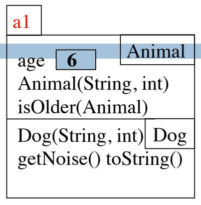
```
public class Animal {
    /** = "this is older than h" */
    public boolean isOlder(Animal h) {
      return age > h.age;
    }
```

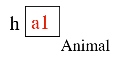
Static or apparent type of h is Animal. Syntactic property

Determines at compile-time what components can be used: those available in Animal

Dynamic or real type of h is Dog. Semantic/runtime property

If a method call is legal, dynamic type determines which one is called (overriding one)





Components used from h

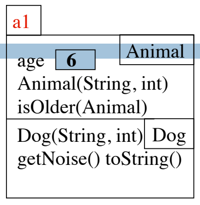
```
public class Animal {
    /** = "this is older than h" */
    public boolean isOlder(Animal h) {
      return age > h.age;
    }
```

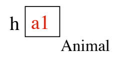
h.toString() OK —it's in class Object partition

h.isOlder(…) OK —it's in Animal partition

h.getWeight() ILLEGAL —not in Animal partition or Object partition

By overriding rule, calls toString() in Cat partition

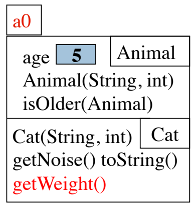


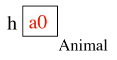


Explicit downward cast

13

```
public class Animal {
  // If Animal is a Cat, return its weight;
     otherwise, return 0.
  public int checkWeight(Animal h) {
   if ( !                              )
       return 0;
   // { h is a Cat }
   Cat c= (Cat) h ;  // downward cast
   return c.getWeight();
}
```





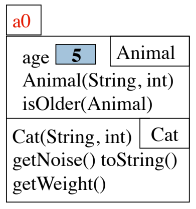
(Dog) h leads to runtime error.

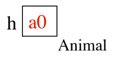
Don't try to cast an object to something that it is not!

Operator instanceof, explicit downward cast

14

```
public class Animal {
  // If Animal is a cat, return its weight;
     otherwise, return 0.
  public int checkWeight(Animal h) {
   if ( ! (h instanceof Cat) )
       return 0;
   // { h is a Cat }
   Cat c= (Cat) h ;  // downward cast
   return c.getWeight();
}
```





<object> **instanceof** <class>

true iff object is an instance of the class — if object has a partition for class

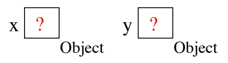
Function equals

15

```
public class Object {
    /** Return true iff this object is the same as ob */
    public boolean equals(Object b) {
        return this == b;
    }
}
```

x.equals(y) is same as
x == y
except when x is null!

This gives a null-pointer exception:
null.equals(y)



Overriding function equals

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Override function equals in a class to give meaning to:

"these two (possibly different) objects of the class have the same values in some of their fields"

For those who are mathematically inclined, like any equality function, equals should be reflexive, symmetric, and transitive.

Reflexive: b.equals(b)

Symmetric: b.equals(c) = c.equals(b)

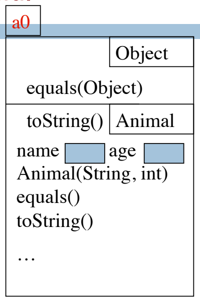
Transitive: if b.equals(c) and c.equals(d), then b.equals(d)

Function equals in class Animal

17

```
public class Animal {
  /** = "h is an Animal with the same
       values in its fields as this Animal" */
  public boolean equals (Object h) {

      if (!(h instanceof Animal))
          return false;
      Animal ob= (Animal) h;
      return name.equals(ob.name)  &&
                age == ob.age;
}
```



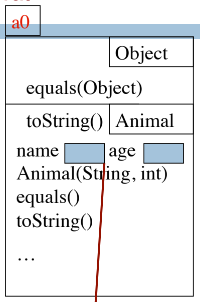
1. Because of h is an Animal in spec, need the test h instanceof Animal

Function equals in class Animal

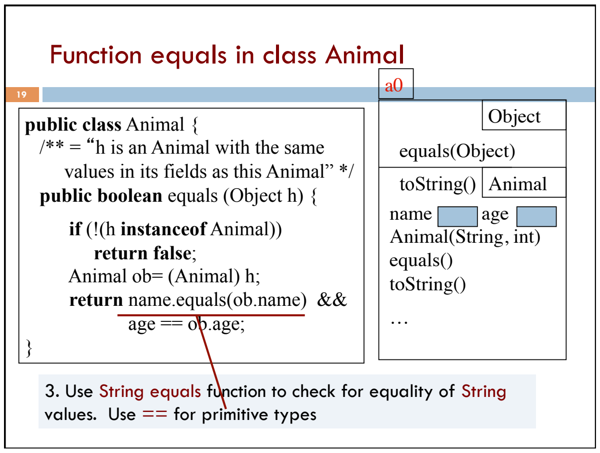
18

```
public class Animal {
  /** = "h is an Animal with the same
       values in its fields as this Animal" */
  public boolean equals (Object h) {

      if (!(h instanceof Animal))
          return false;
      Animal ob= (Animal) h;
      return name.equals(ob.name)  &&
                age == ob.age;
}
```



2. In order to be able to reference fields in partition Animal, need to cast h to Animal

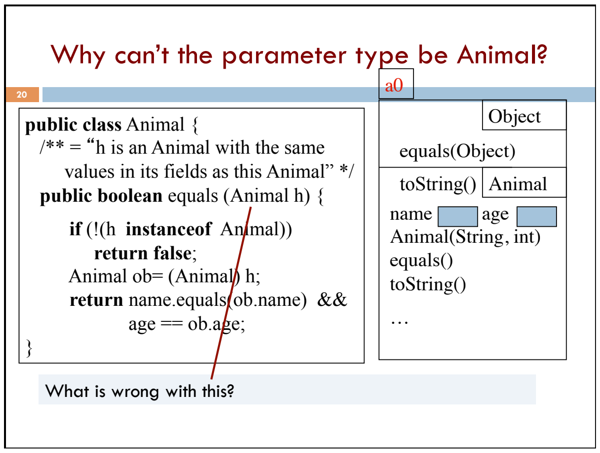


Function equals in class Animal

```
public class Animal {
  /** = "h is an Animal with the same
      values in its fields as this Animal" */
  public boolean equals (Object h) {
      if (!(h instanceof Animal))
          return false;
      Animal ob= (Animal) h;
      return name.equals(ob.name)  &&
              age == ob.age;
}
```

a0
Object
equals(Object)
toString()
Animal
name
age
Animal(String, int)
equals()
toString()
…

3. Use String equals function to check for equality of String values. Use == for primitive types

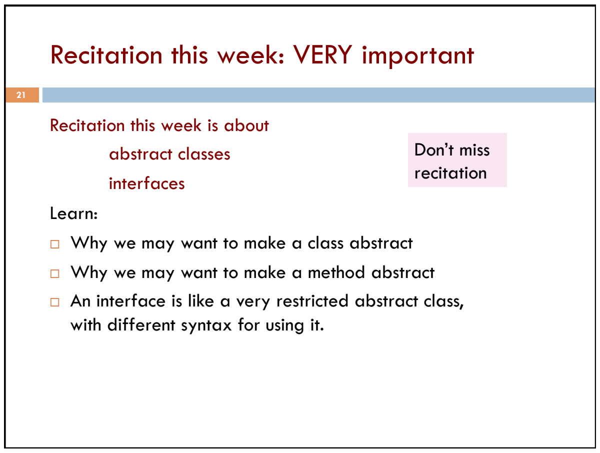


Why can't the parameter type be Animal?

```
public class Animal {
  /** = "h is an Animal with the same
      values in its fields as this Animal" */
  public boolean equals (Animal h) {
      if (!(h  instanceof  Animal))
          return false;
      Animal ob= (Animal) h;
      return name.equals(ob.name)  &&
              age == ob.age;
}
```

a0
Object
equals(Object)
toString()
Animal
name
age
Animal(String, int)
equals()
toString()
…

What is wrong with this?



Recitation this week: VERY important

Recitation this week is about

abstract classes

interfaces

Don't miss recitation

Learn:

- Why we may want to make a class abstract
- Why we may want to make a method abstract
- An interface is like a very restricted abstract class, with different syntax for using it.