

CS/ENGRD 2110

SPRING 2015

Lecture 6: Consequence of type, casting; function equals
<http://courses.cs.cornell.edu/cs2110>

Announcements

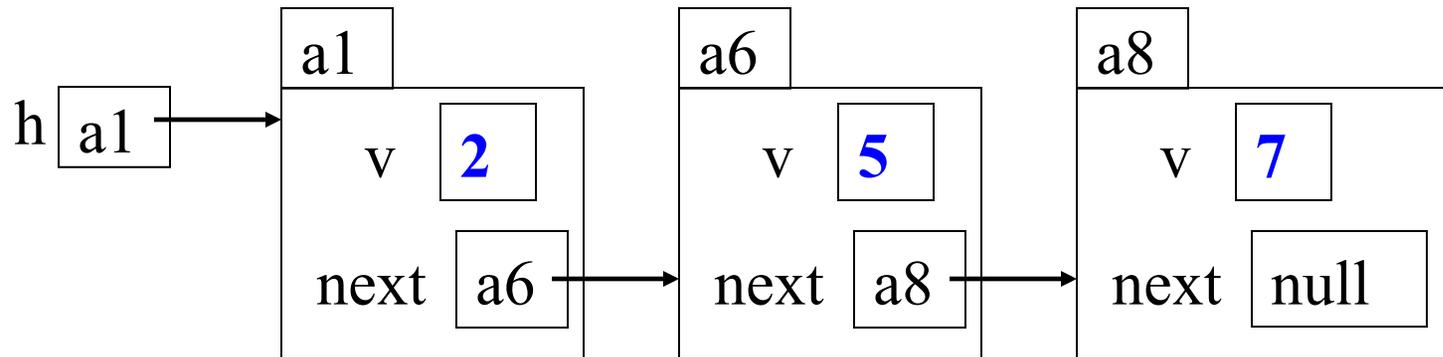
2

- **A1 feedback available.** 30 still to be graded. Hopefully today. If yours is not graded yet, we appreciate your patience.
Average 93.1 Median 95
- You can ask for a regrade of A1 on the CMS. State what you think we graded unfairly or incorrectly.
- **Your file A2.java must be in the default package.** Do NOT put a package statement at the top of it.
- **A3 now available on CMS and Piazza.** Refer often to the Piazza FAQ Note for A3
- **Please read the assignment FAQ Notes on the Piazza before asking a question.** It might already be answered.
- **Read Note @282 on study habits! Take its message to heart.**

Assignment A3: Doubly linked Lists

3

Idea: maintain a list (2, 5, 7) like this:

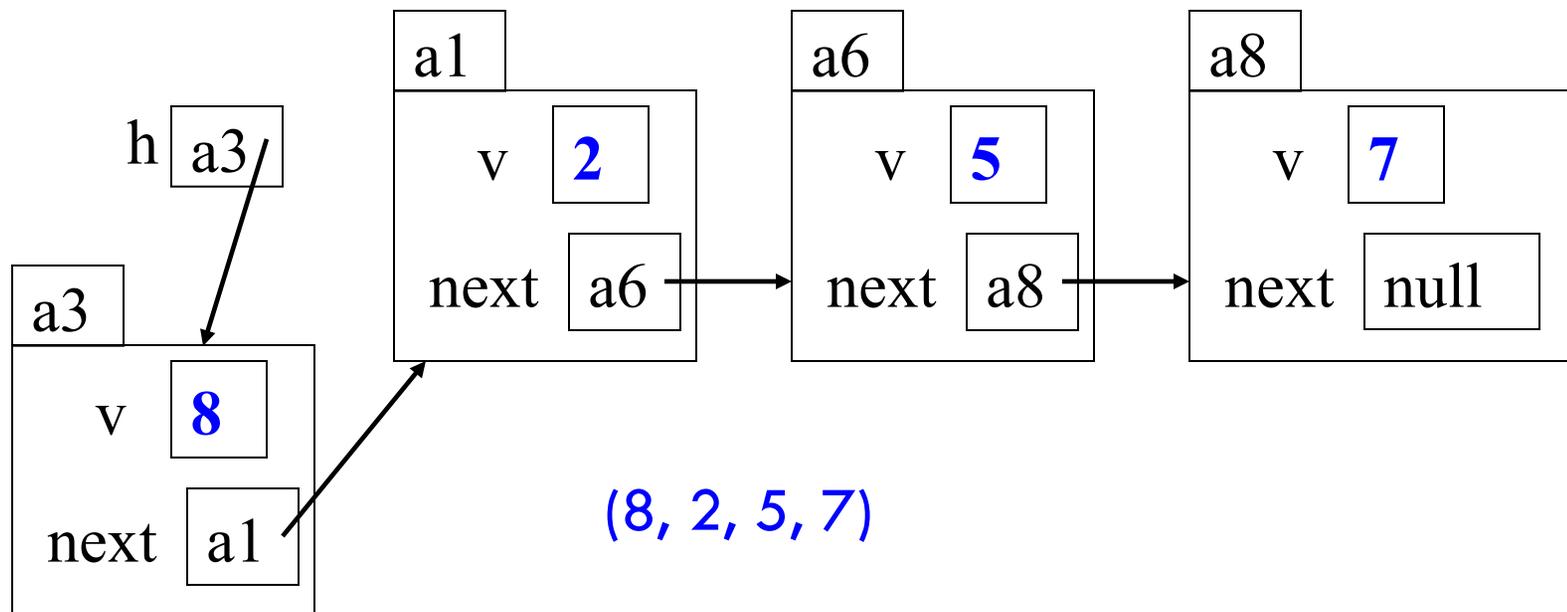
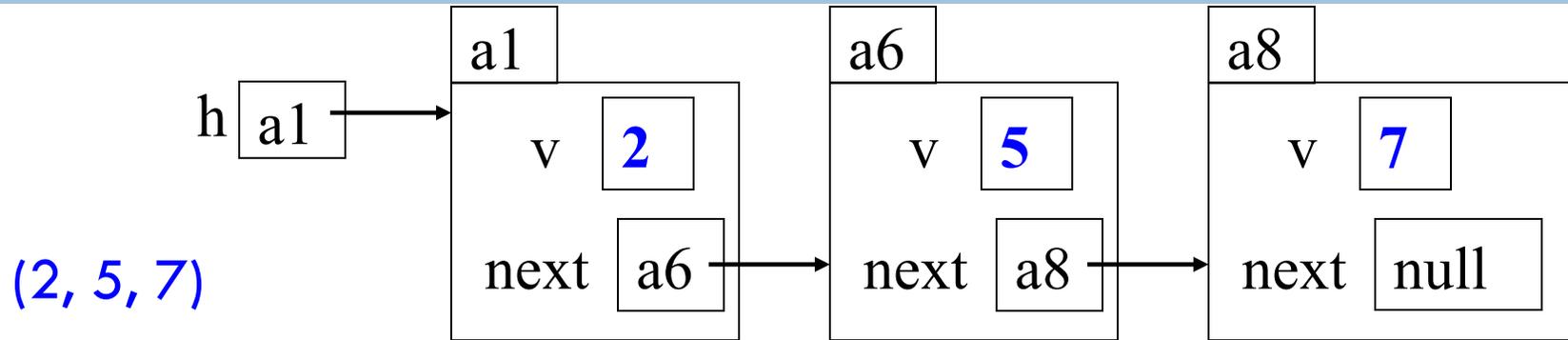


This is a singly linked list

To save space we write names like a6 instead of N@35abcd00

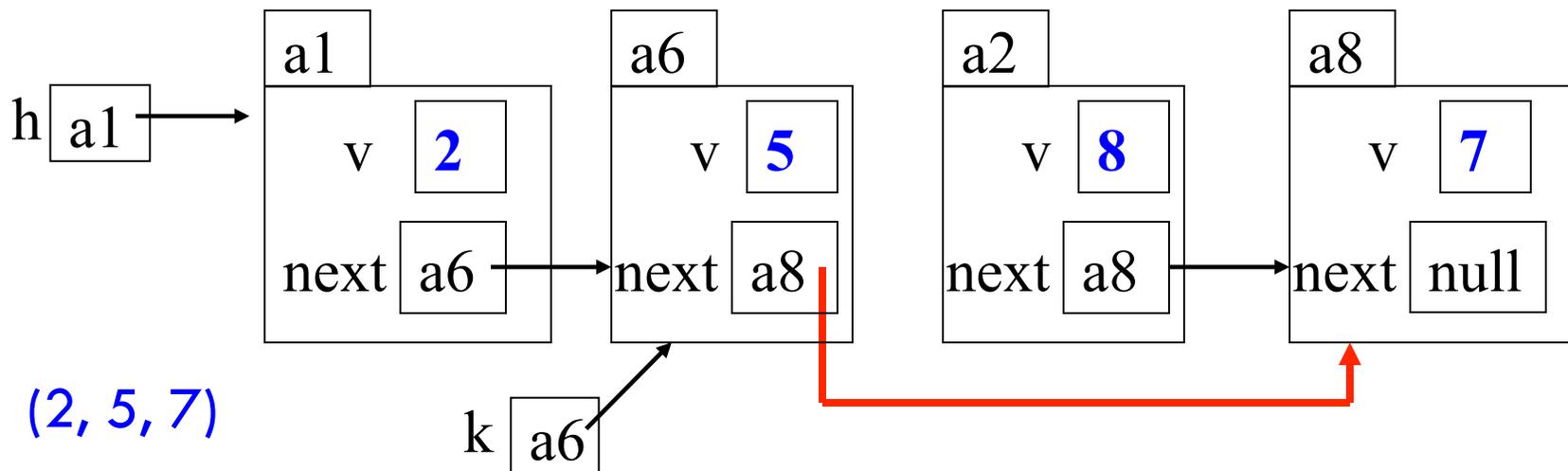
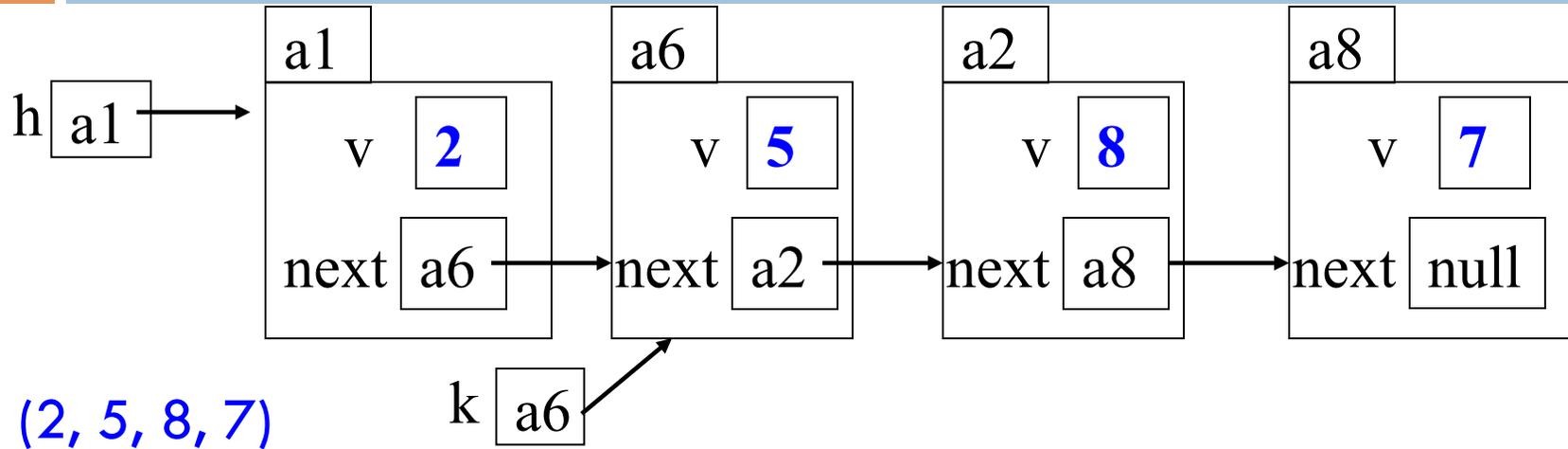
Easy to insert a node in the beginning!

4



Easy to remove a node if you have its predecessor!

5



Assignment A3: Use an **inner class**

6

```
public class LinkedList {  
    private int x;  
    public void m(int y) { ... }  
  
    private class CI {  
  
    }  
}
```

Inside-out rule: Objects of CI can reference components of the object of C in which they live.

In addition: methods of C can reference private components of CI

Assignment A3: Generics

7

```
public class LinkedList {  
  
}
```

Values of linked list are probably of class Object

```
public class LinkedList<E> {  
  
}
```

You can specify what type of values

```
new LinkedList<Integer>(...)  
new LinkedList<String>(...)  
new LinkedList<JFrame>(...)
```

Overview ref in text and JavaSummary.pptx

8

- Quick look at arrays **slide 50-55**
- Casting among classes **C.33-C.36 (not good)** **slide 34-41**
- Consequences of the class type **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

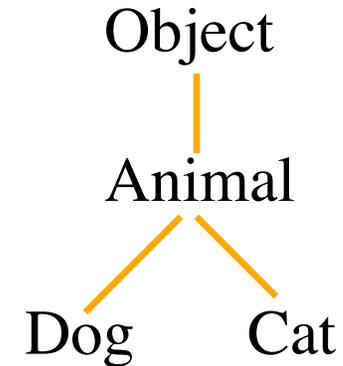
class hierarchy:

9

Work with a class **Animal** and subclasses like **Cat** and **Dog**

Put components common to animals in **Animal**

Object partition is there but not shown



a0

age 5	Animal
Animal(String, int) isOlder(Animal)	
Cat(String, int)	Cat
getNoise() toString() getWeight()	

a1

age 6	Animal
Animal(String, int) isOlder(Animal)	
Dog(String, int)	Dog
getNoise() toString()	

Animal[] v = new Animal[3];

10

declaration of array v

Create array of 3 elements

Assign value of new-exp to v

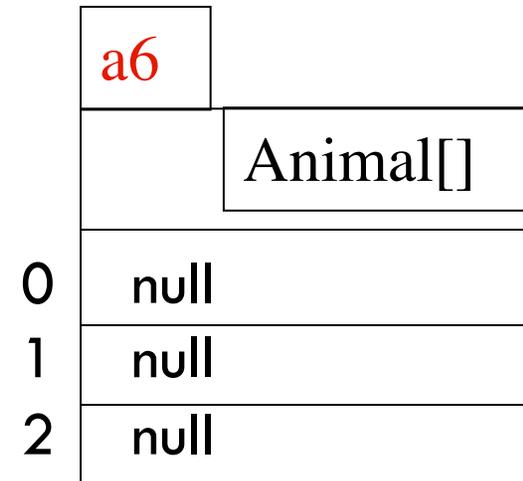


Assign and refer to elements as usual:

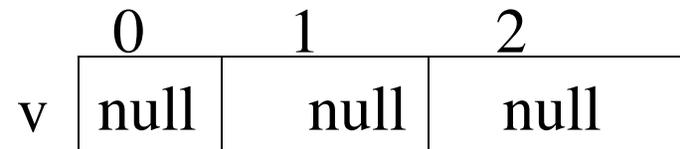
```
v[0] = new Animal(...);
```

...

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



Sometimes use horizontal picture of an array:



Which function is called?

11

Which function is called by
`v[0].toString()` ?

Remember, partition Object
contains `toString()`

	0	1	2
v	a0	null	a1

Bottom-up or
overriding rule
says function
`toString` in `Cat`
partition

a0	
age 5	Animal
Animal(String, int) isOlder(Animal)	
Cat(String, int)	Cat
getNoise() toString() getWeight()	

a1	
age 6	Animal
Animal(String, int) isOlder(Animal)	
Dog(String, int)	Dog
getNoise() toString()	

Consequences of a class type

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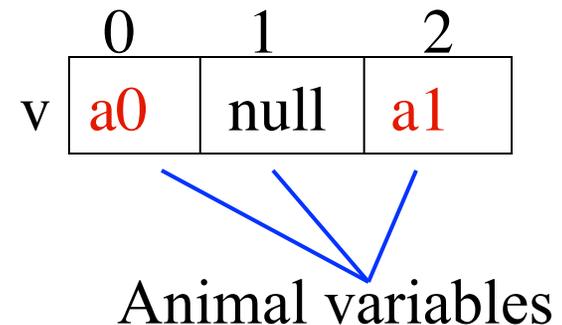
`Animal[] v;`

declaration of `v`. Also means that each variable `v[k]` is of type `Animal`

The type of `v` is `Animal[]`

The type of each `v[k]` is `Animal`

The type is part of the syntax/grammar of the language. Known at compile time.

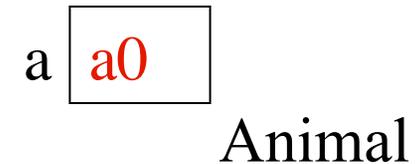
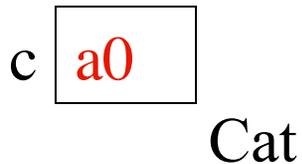


As we see on next slide, the type of a class variable like `v[k]` determines what methods can be called

From an Animal variable, can use only methods available in class Animal

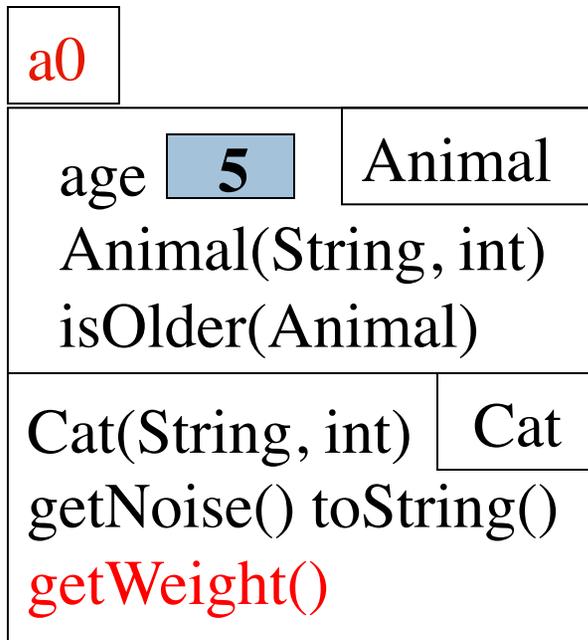
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The same object a0, from the viewpoint of a Cat variable and an Animal variable

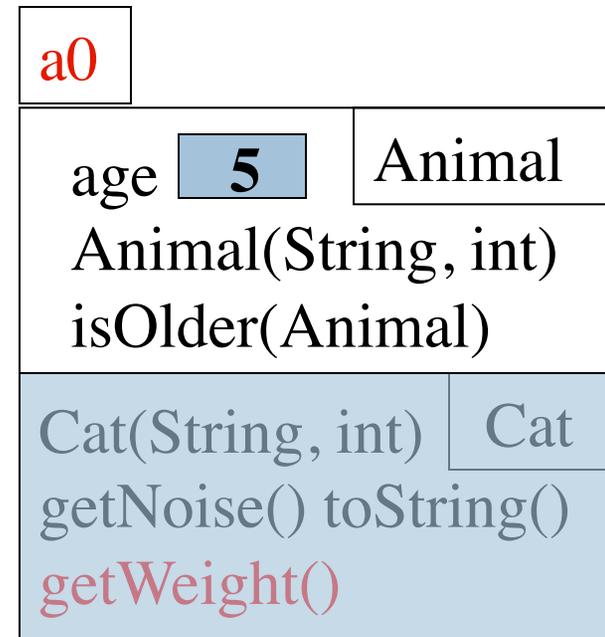


c.getWeight() is legal

a.getWeight() is illegal



because
getWeight
is not
available
in class
Animal



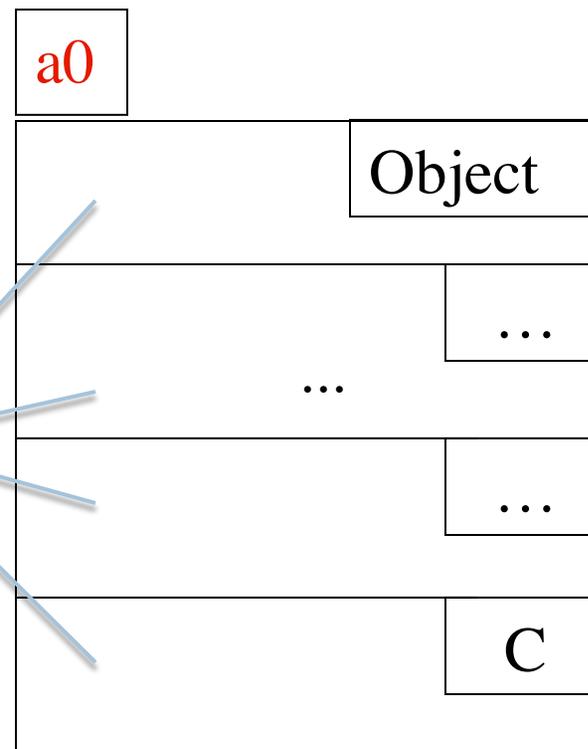
Rule for determining legality of method call

14

c a0
C

Rule: $c.m(\dots)$ is legal and the program will compile ONLY if method m is declared in C or one of its superclasses

$m(\dots)$ must be declared in one of these classes



Another example

15

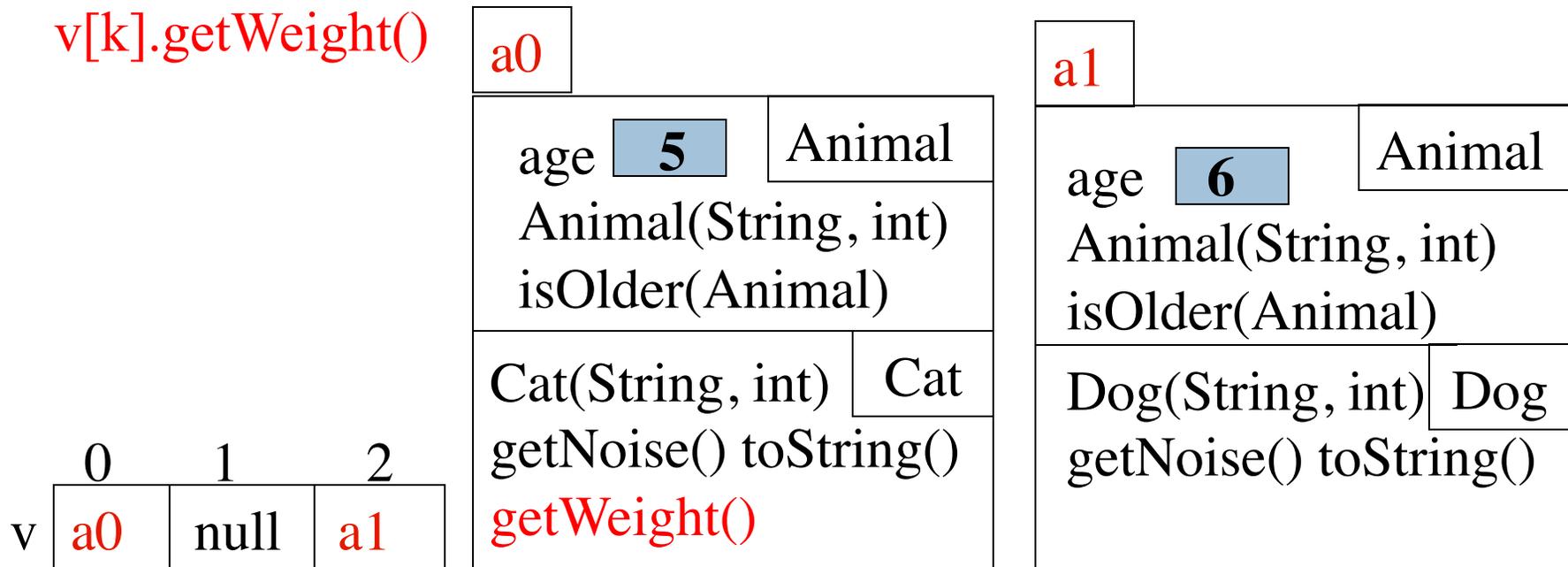
Type of v[0]: Animal

Should this call be allowed?
Should program compile?

Should this call be allowed?
Should program compile?

v[0].getWeight()

v[k].getWeight()



View of object based on the type

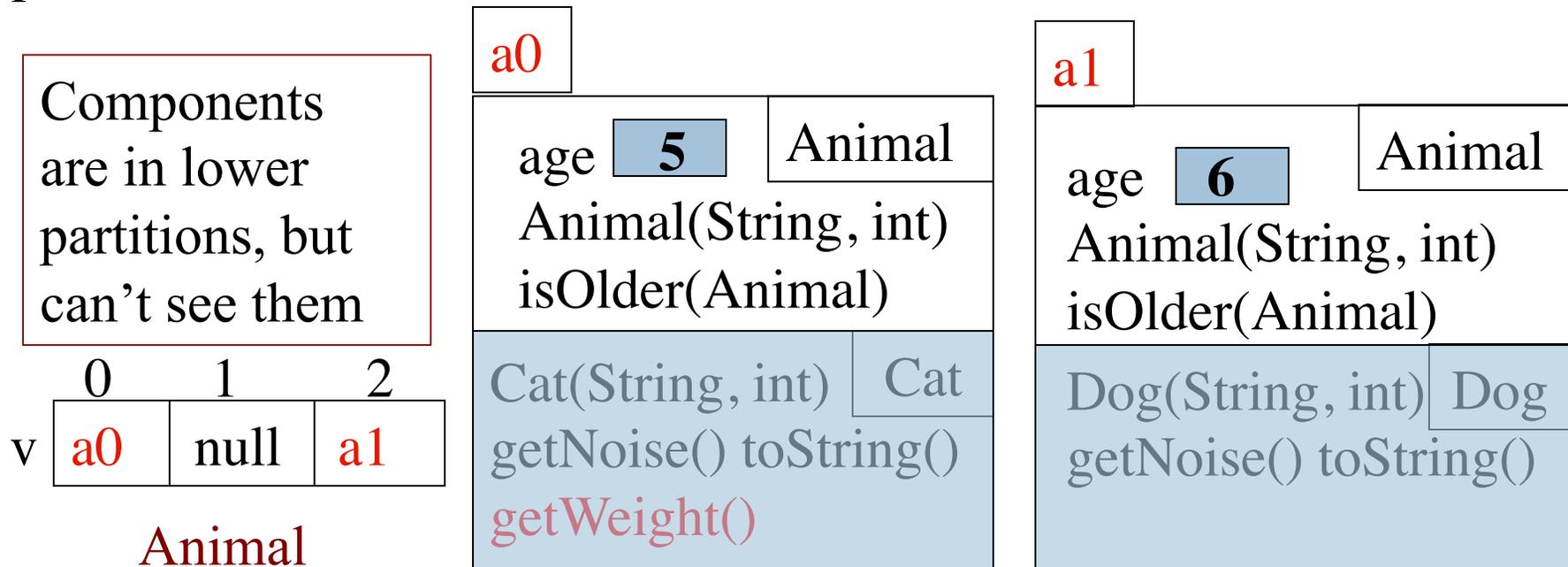
16

Each element $v[k]$ is of 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()`



Casting up class hierarchy

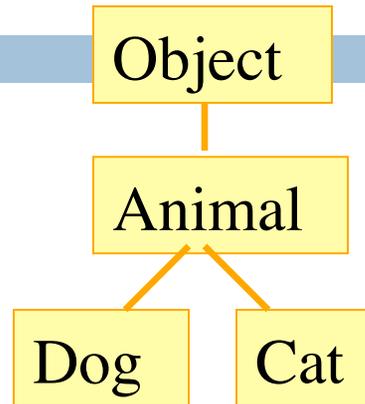
17

You know about casts like

(int) (5.0 / 7.5)

(double) 6

double d= 5; // automatic cast



Discuss casts up/down class hierarchy.

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

Cat c= (Cat) h;

A class cast doesn't change the object. It just changes the perspective –how it is viewed!

a0

age	5	Animal
Animal(String, int) isOlder(Animal)		
Cat(String, int)	Cat	
getNoise() toString() getWeight()		

a1

age	6	Animal
Animal(String, int) isOlder(Animal)		
Dog(String, int)	Dog	
getNoise() toString()		

Explicit casts: unary prefix operators

18

Rule: an object can be cast 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

<code>a0</code>	
<code>equals() ...</code>	<code>Object</code>
<code>age</code> <code>5</code>	<code>Animal</code>
<code>Animal(String, int)</code> <code>isOlder(Animal)</code>	
<code>Cat(String, int)</code> <code>getNoise() toString()</code> <code>getWeight()</code>	<code>Cat</code>

`c` `a0`
Cat

Implicit upward cast

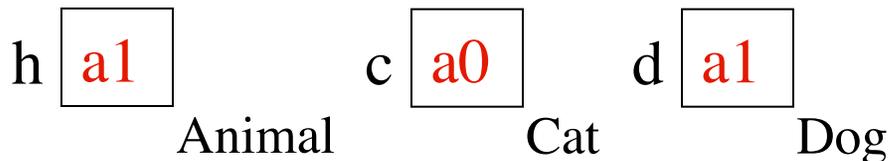
19

```
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



`a0`

age	<code>5</code>	Animal
Animal(String, int)		
isOlder(Animal)		

Cat(String, int)	Cat
getNoise() toString()	
getWeight()	

`a1`

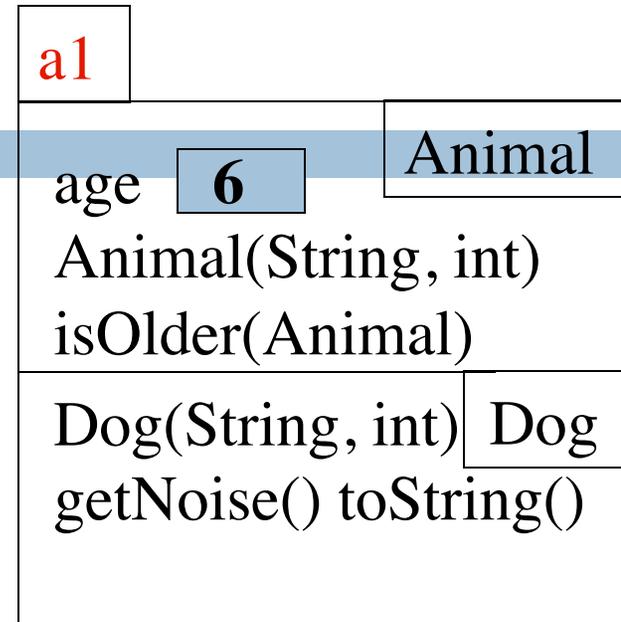
age	<code>6</code>	Animal
Animal(String, int)		
isOlder(Animal)		

Dog(String, int)	Dog
getNoise() toString()	

Example

20

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



Type of **h** is **Animal**. Syntactic property.

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

If a method call is legal, the overriding rule determines which method is called

h

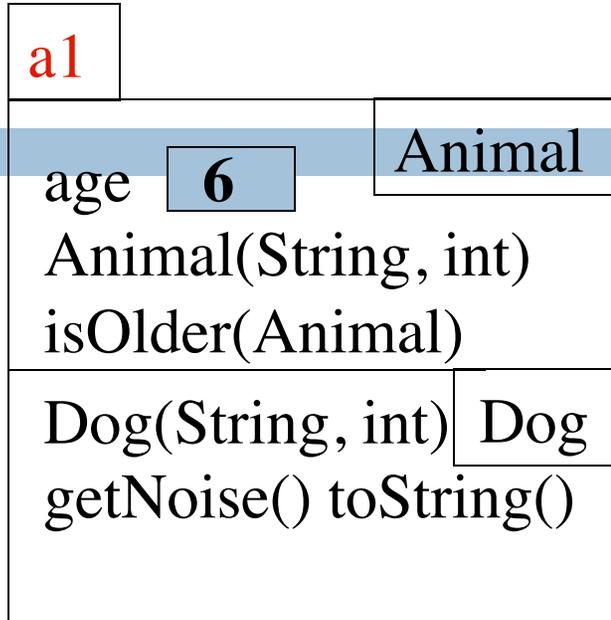
a1

Animal

Components used from h

21

```
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

h

al

Animal

Explicit downward cast

22

```
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();  
    }  
}
```

h a0
Animal

a0

age 5	Animal
Animal(String, int) isOlder(Animal)	

Cat(String, int)	Cat
getNoise() toString() 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

23

```
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();  
    }  
}
```

h a0
Animal

a0

age 5	Animal
Animal(String, int) isOlder(Animal)	

Cat(String, int)	Cat
getNoise() toString() getWeight()	

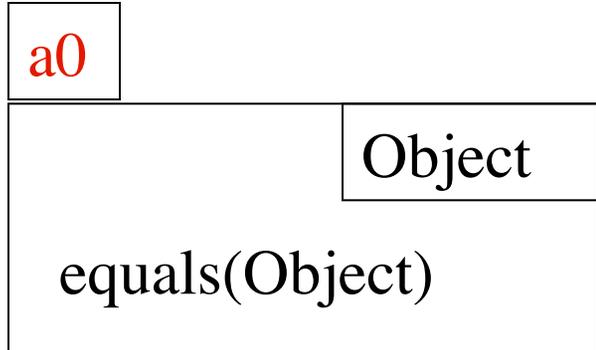
<object> instanceof <class>

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

Function equals

24

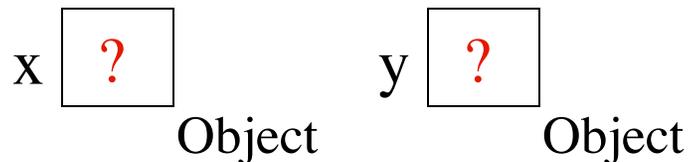
```
public class Object {  
    /** Return true iff this object is  
     * the same as ob */  
    public boolean equals(Object b) {  
        return this == b;  
    }  
}
```



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

This gives a null-pointer
exception:

$null.equals(y)$



Overriding function equals

25

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

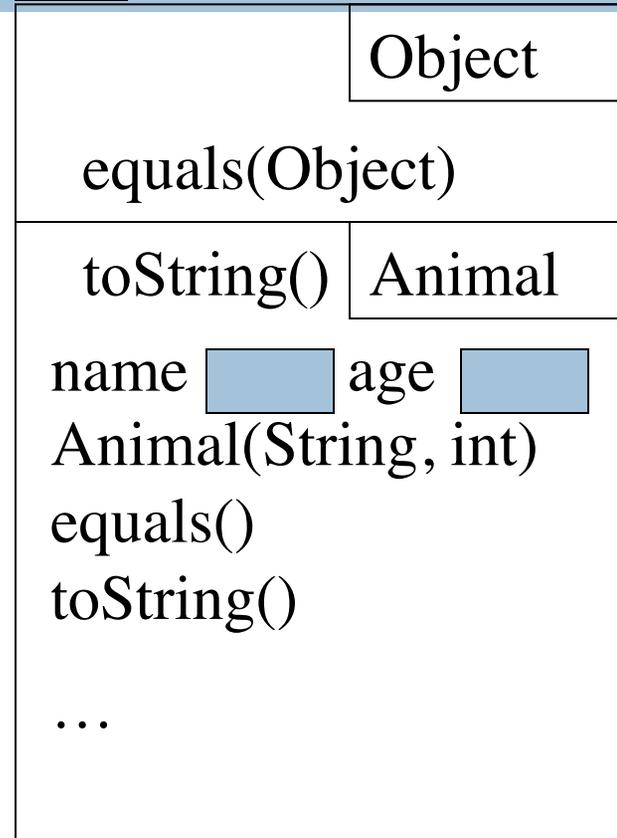
Transitive: if $b.equals(c)$ and $c.equals(d)$, then $b.equals(d)$

Function equals in class Animal

26

a0

```
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;  
    }  
}
```



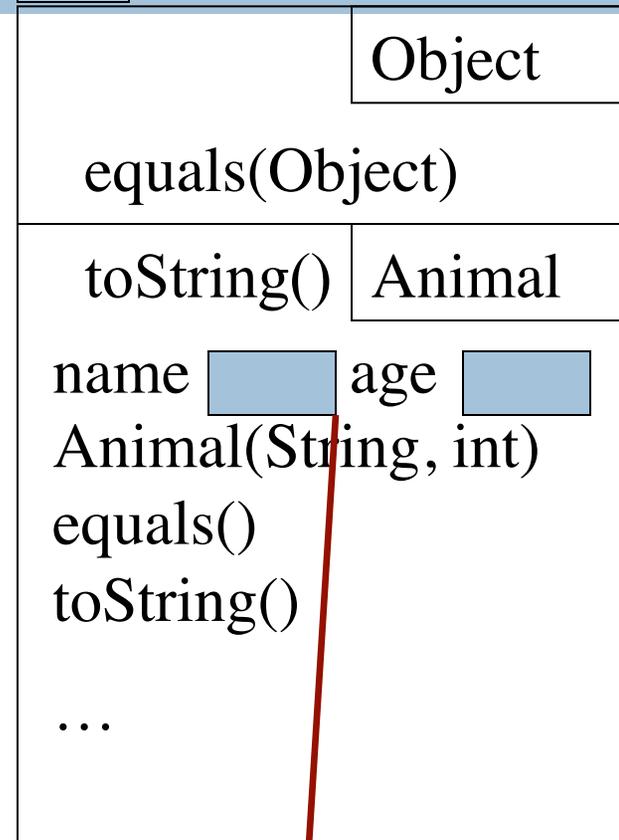
1. Because of **h is an Animal** in spec,
need the test **h instanceof Animal**

Function equals in class Animal

27

```
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



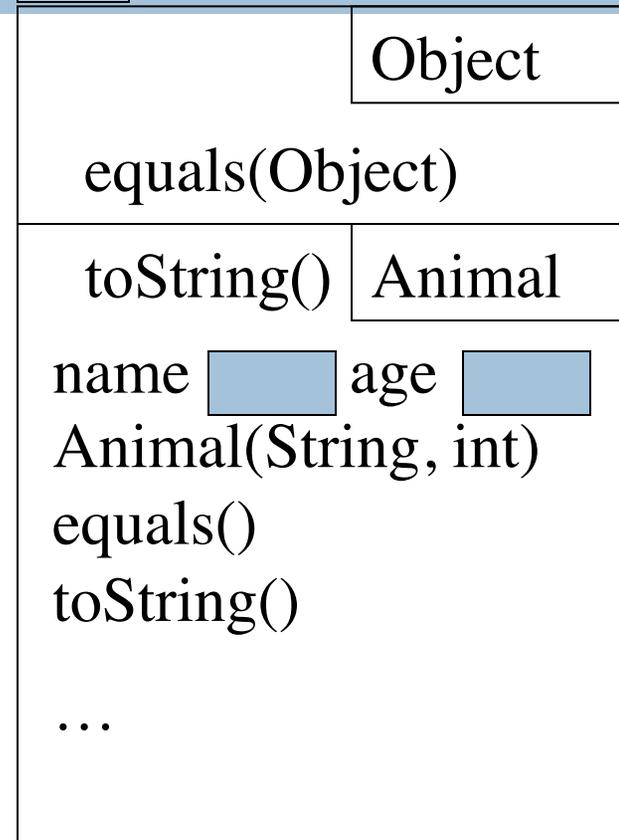
2. In order to be able to reference fields in partition **Animal**,
need to cast h to **Animal**

Function equals in class Animal

28

```
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



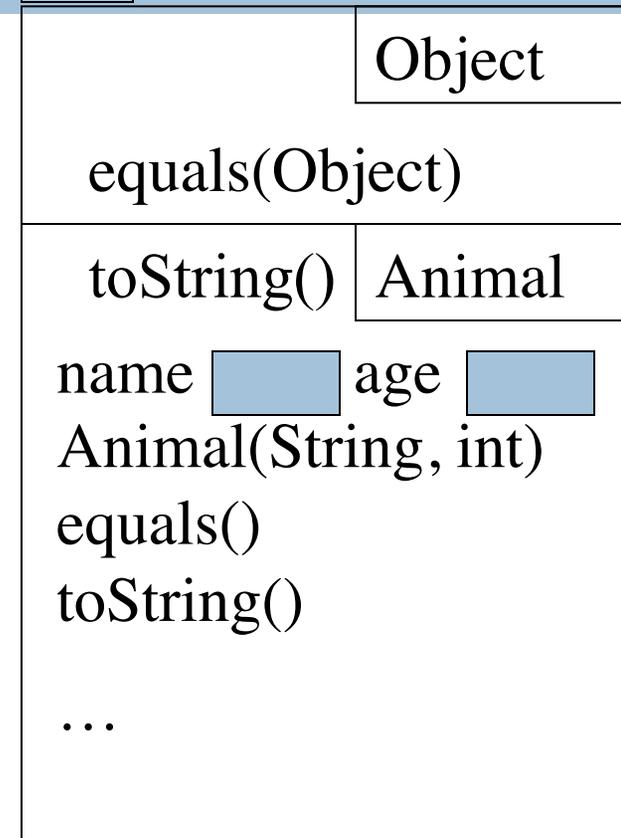
3. Use **String equals** function to check for equality of **String** values. Use **==** for primitive types

Why can't the parameter type be Animal?

29

```
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



What is wrong with this?