CS/ENGRD 2110
SPRING 2017

Lecture 6: Consequence of type, casting; function equals

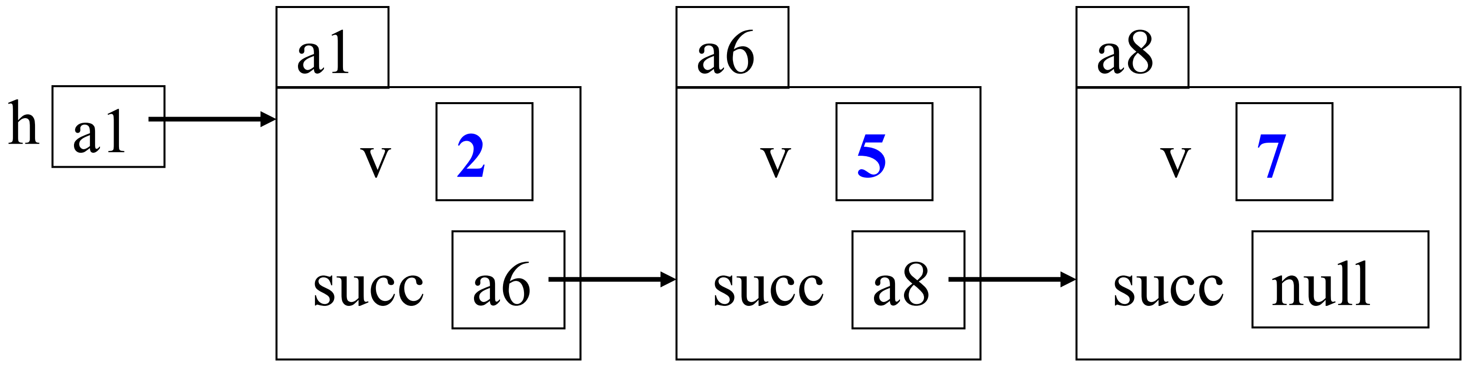
http://courses.cs.cornell.edu/cs2110

Announcements

- A3 will available on Piazza tomorrow. Refer often to the Piazza FAQ Note for A3
- Please read the assignment A1 FAQ Notes on the Piazza before asking a question. It might already be answered.

Assignment A3: Doubly linked Lists

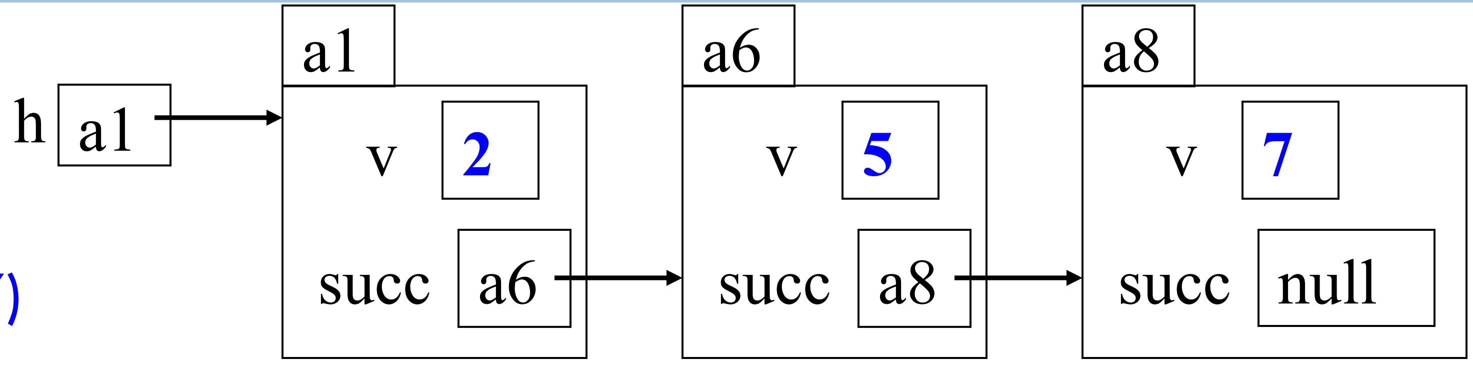
Idea: maintain a list (**2**, **5**, **7**) like this:



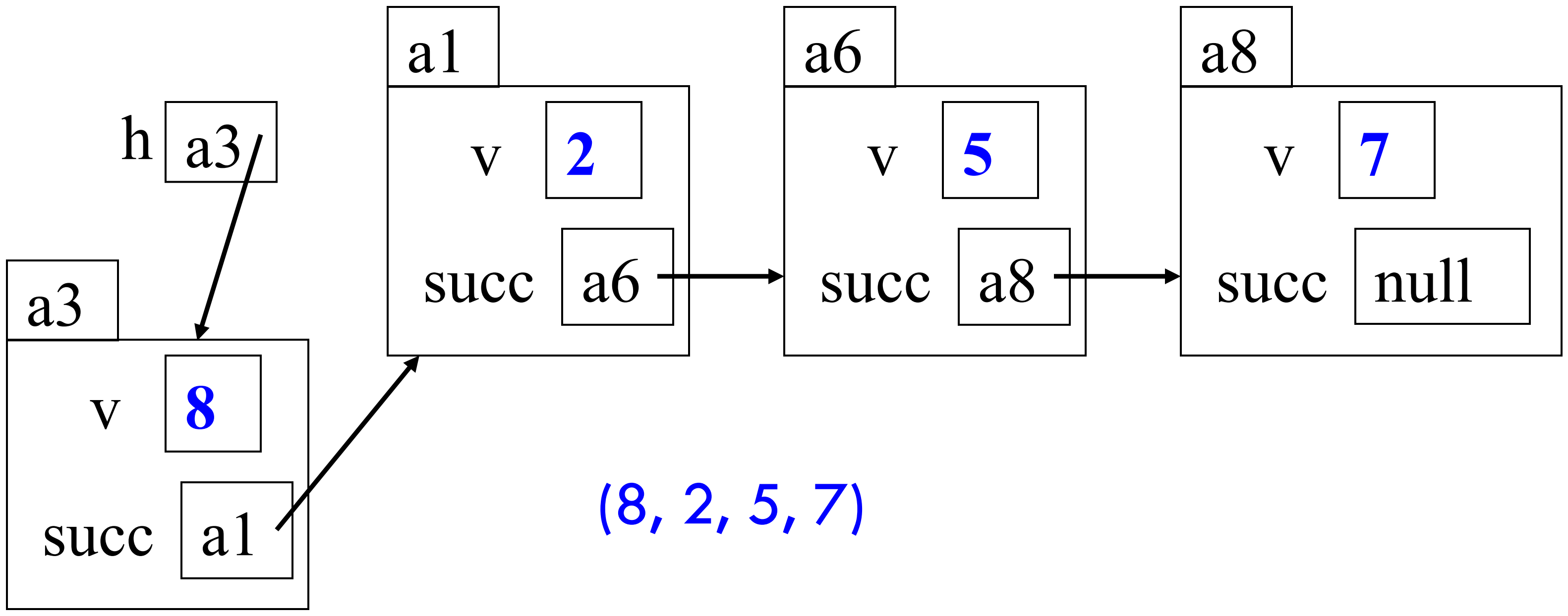
This is a singly linked list

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

How to insert a node at the beginning

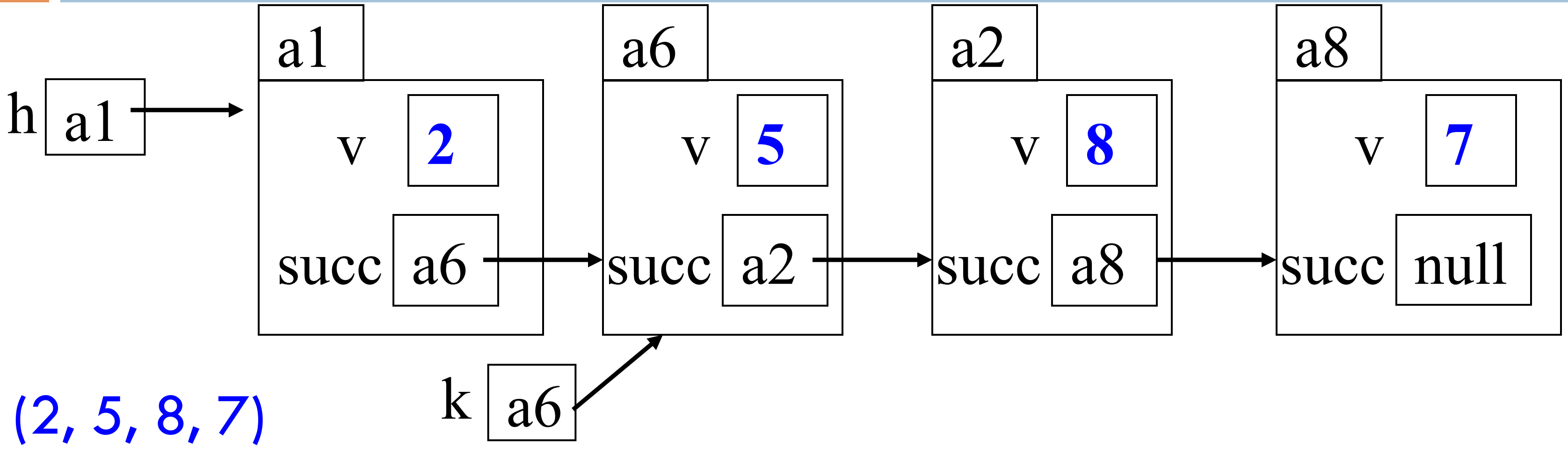


(2, 5, 7)

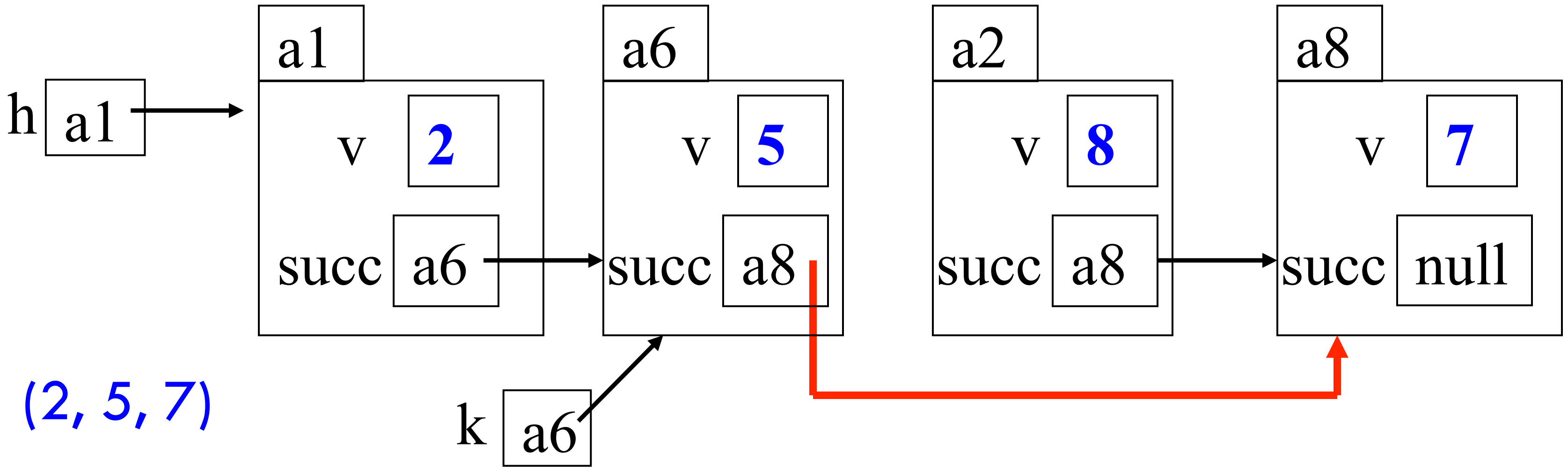


(8, 2, 5, 7)

How to remove successor of a node in the middle



(2, 5, 8, 7)



(2, 5, 7)

Assignment A3: Use an inner class

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

```
public class C {
    private int x;
    public void m(int y) {   …  ob= new Cin(…);   ob.b= 5;    }

   private class Cin {
       private int b;
       public void mm() { …   x= b; …     }
   }
}
```

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

Assignment A3: Generics

```
public class LinkedList {
    void add(Object elem) {…}
    Object get(int index) {…}
}
```

Values of linked list are probably of class Object

```
public class LinkedList<E> {
    void add(E elem) {…}
    E get(int index) {…}
}
```

You can specify what type of values

```
ns = new LinkedList<Integer>();
ns.add("Hello"); // error
ns.add(5);
String s = ns.get(0); // error
int n = ns.get(0);
```

```
ss = new LinkedList<String>();
ss.add("Hello");
ss.add(5); // error
String s = ss.get(0);
int n = ss.get(0); // error
```

Overview ref in text and JavaSummary.pptx

- 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
```

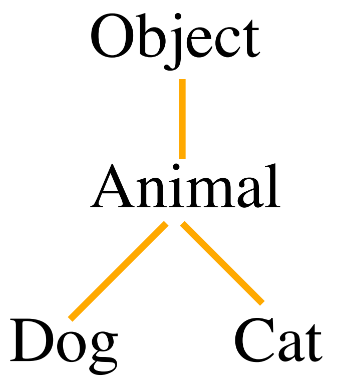
Classes we work with today

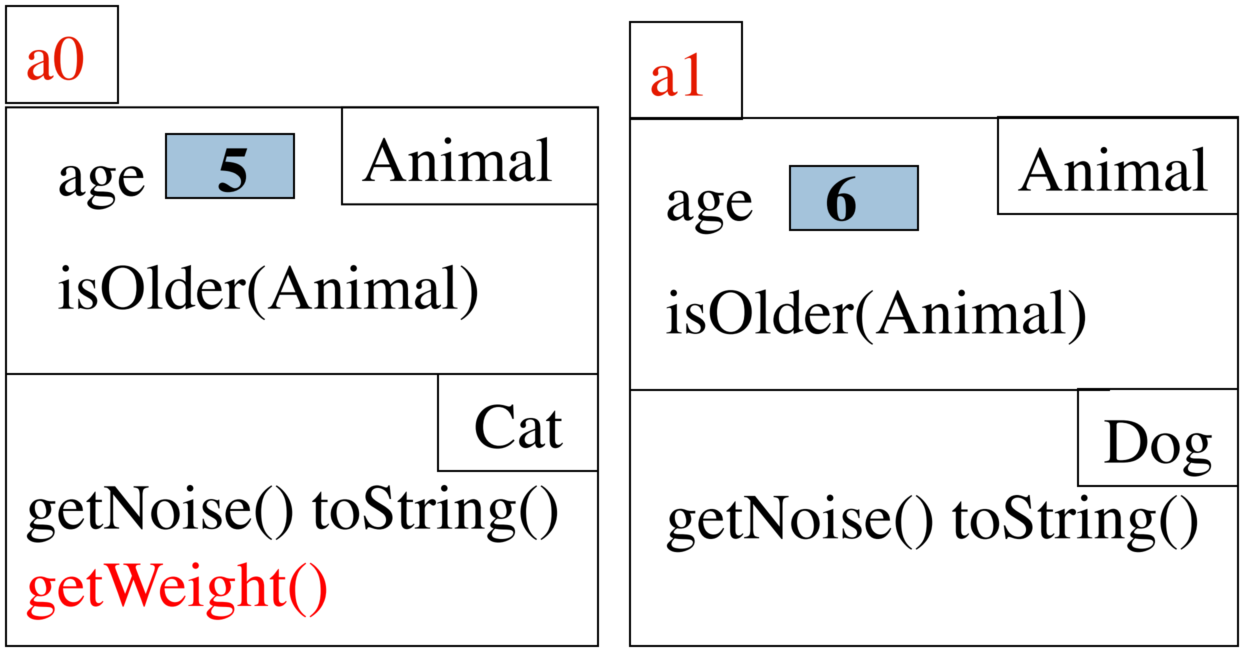
class hierarchy:

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



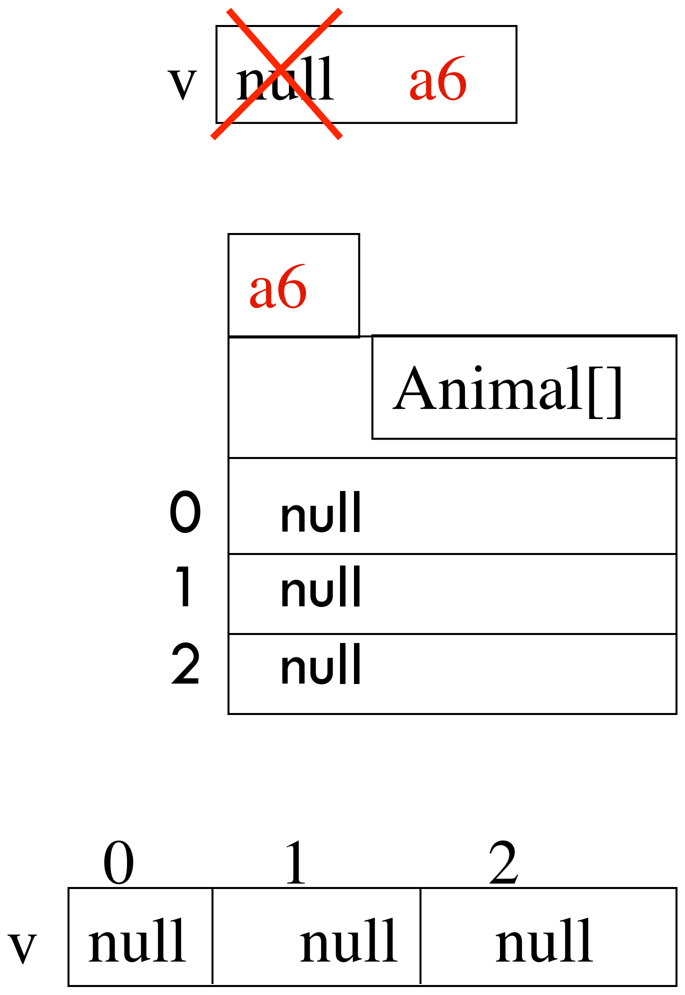


Animal[] v= **new** Animal[3];

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:

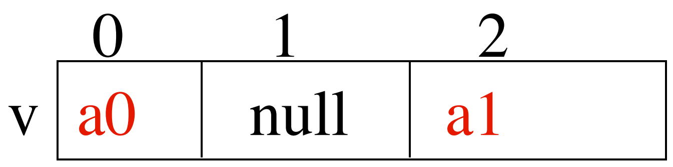
Which function is called?

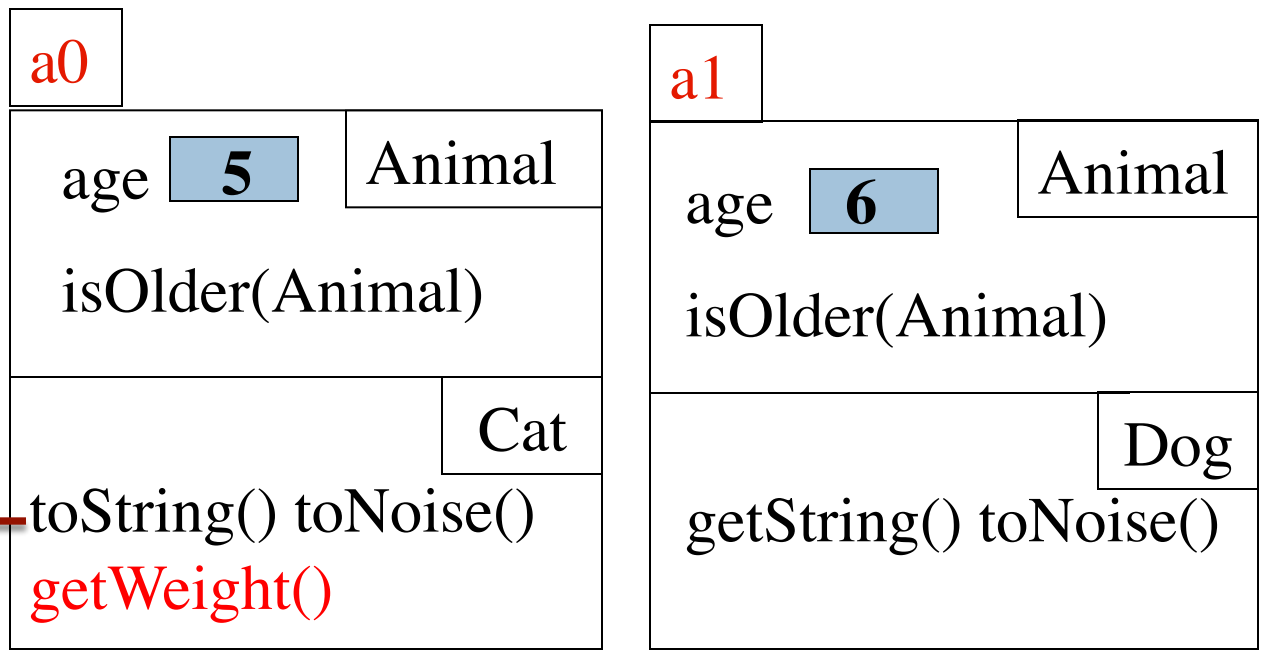
Which function is called by

v[0].toString() ?

Remember, partition Object contains toString()

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

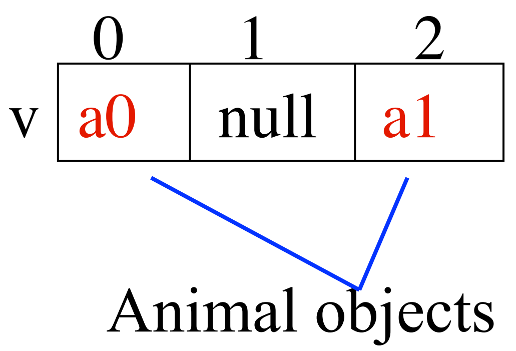




Consequences of a class type

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

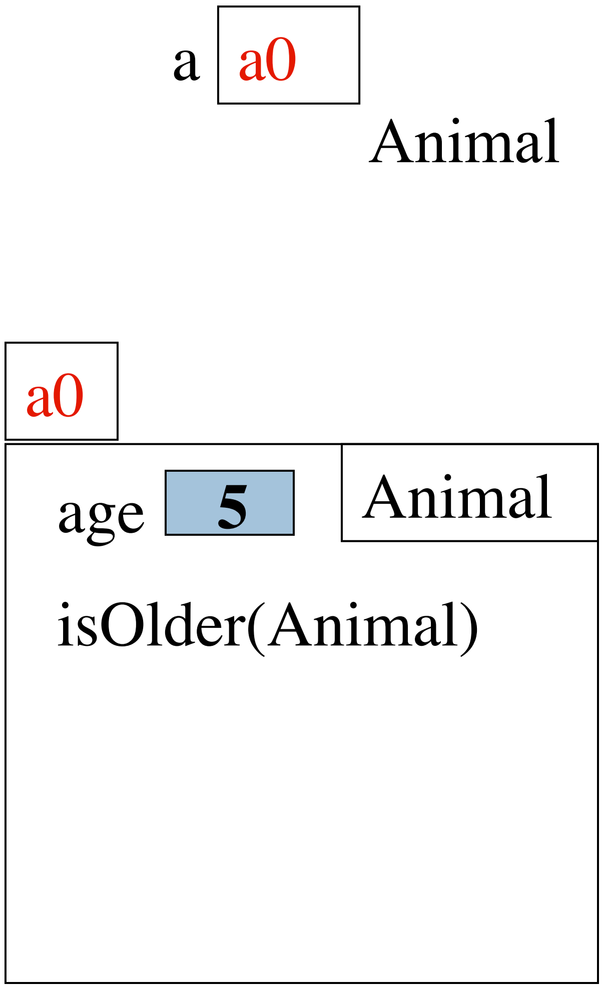
From an Animal variable, can use only methods available in class Animal

a.getWeight() is obviously illegal.
The class won't compile.

When checking legality of a call like

    a.getWeight(…)

since the type of a is Animal, function getWeight must be declared in Animal or one of its superclasses.



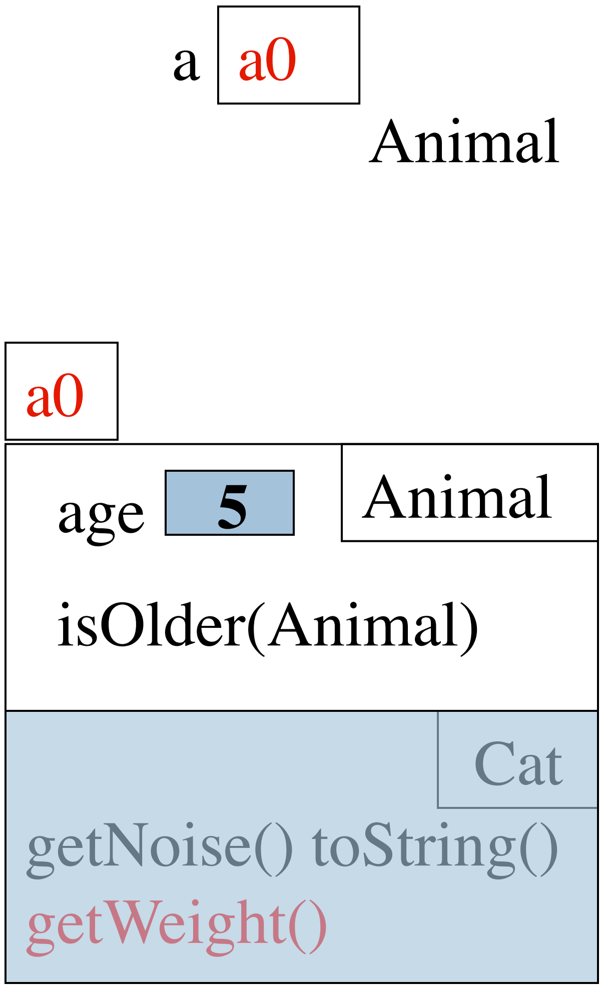
From an Animal variable, can use only methods available in class Animal

Suppose a0 contains an object of a subclass Cat of Animal. By the rule below, a.getWeight(…) is still illegal. Remember, the test for legality is done at compile time, not while the program is running. …

When checking legality of a call like

a.getWeight(…)

since the type of a is Animal, function getWeight must be declared in Animal or one of its superclasses.



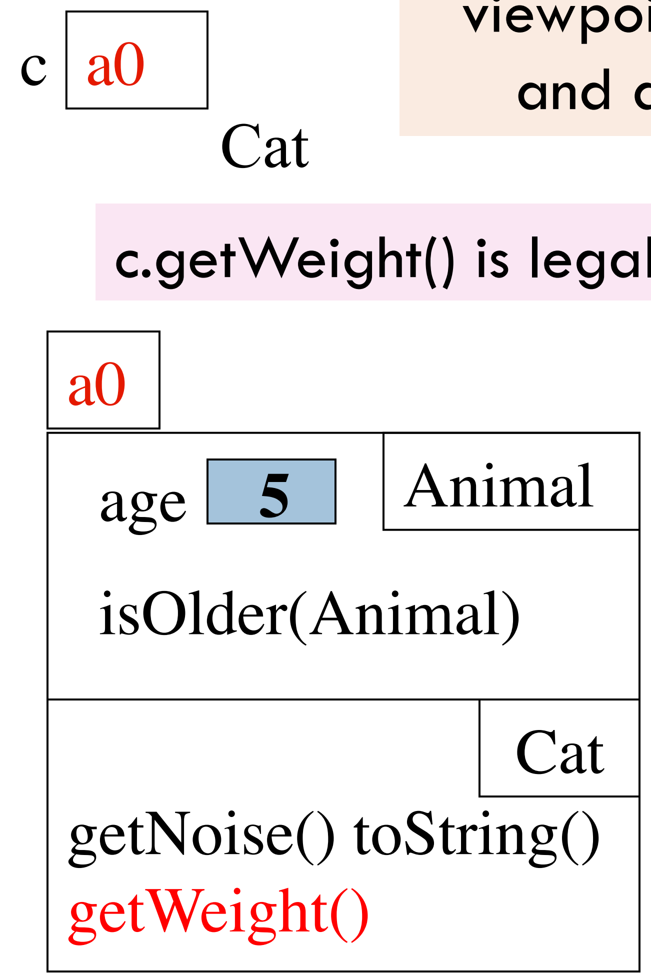
From an Animal variable, can use only methods available in class Animal

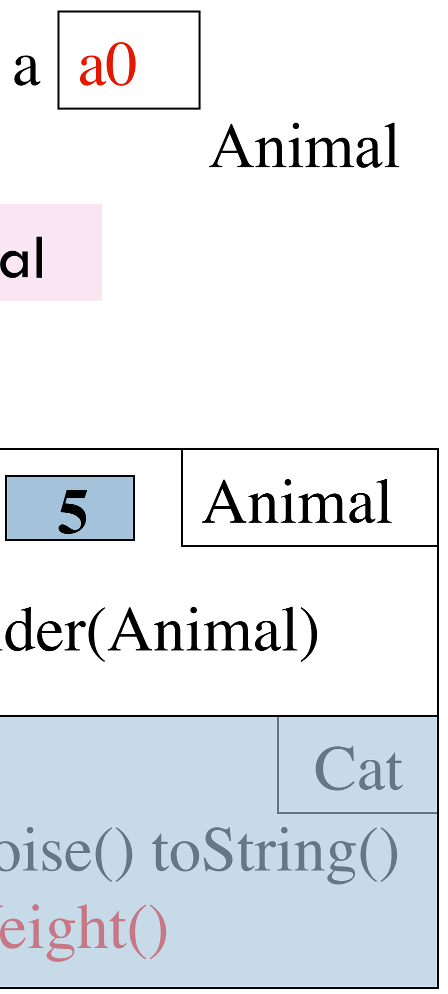
The same object a0, from the viewpoint of a Cat variable and an Animal variable

c.getWeight() is legal

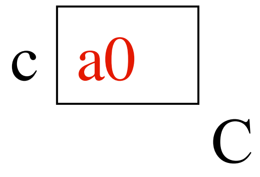
a.getWeight() is illegal

because getWeight is not available in class Animal

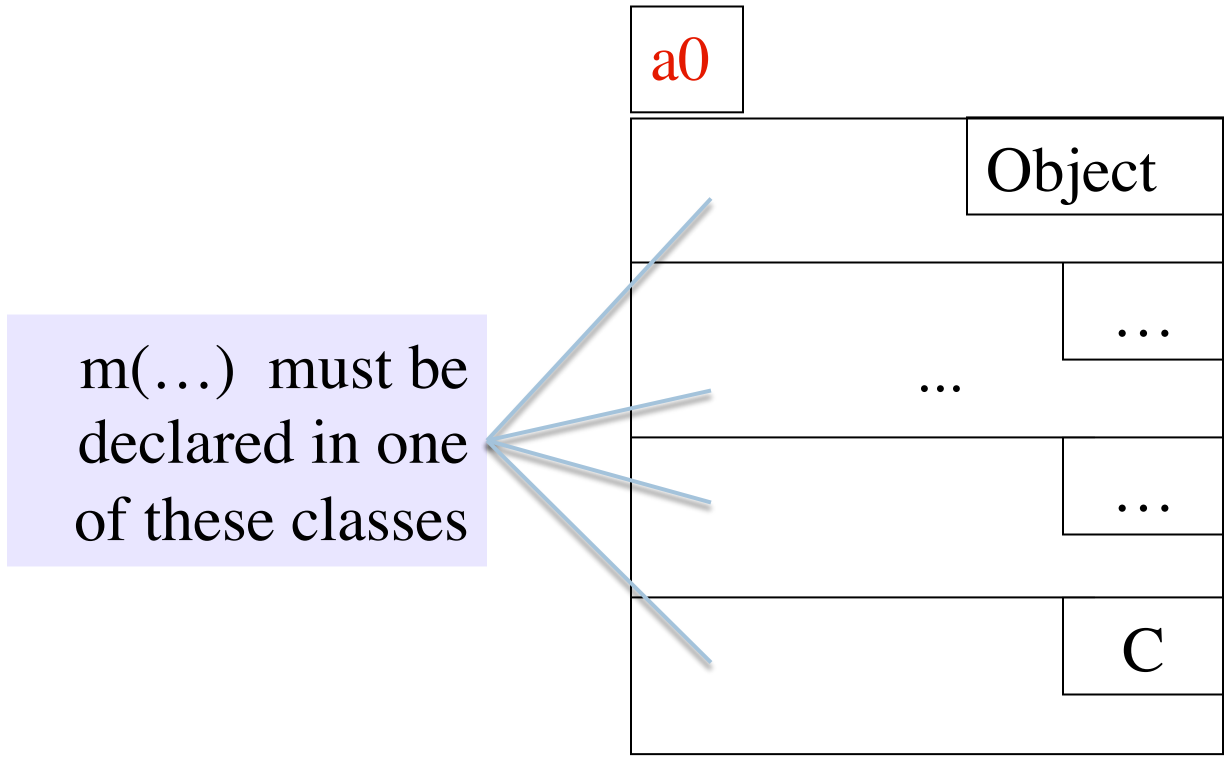




Rule for determining legality of method call



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



Another example

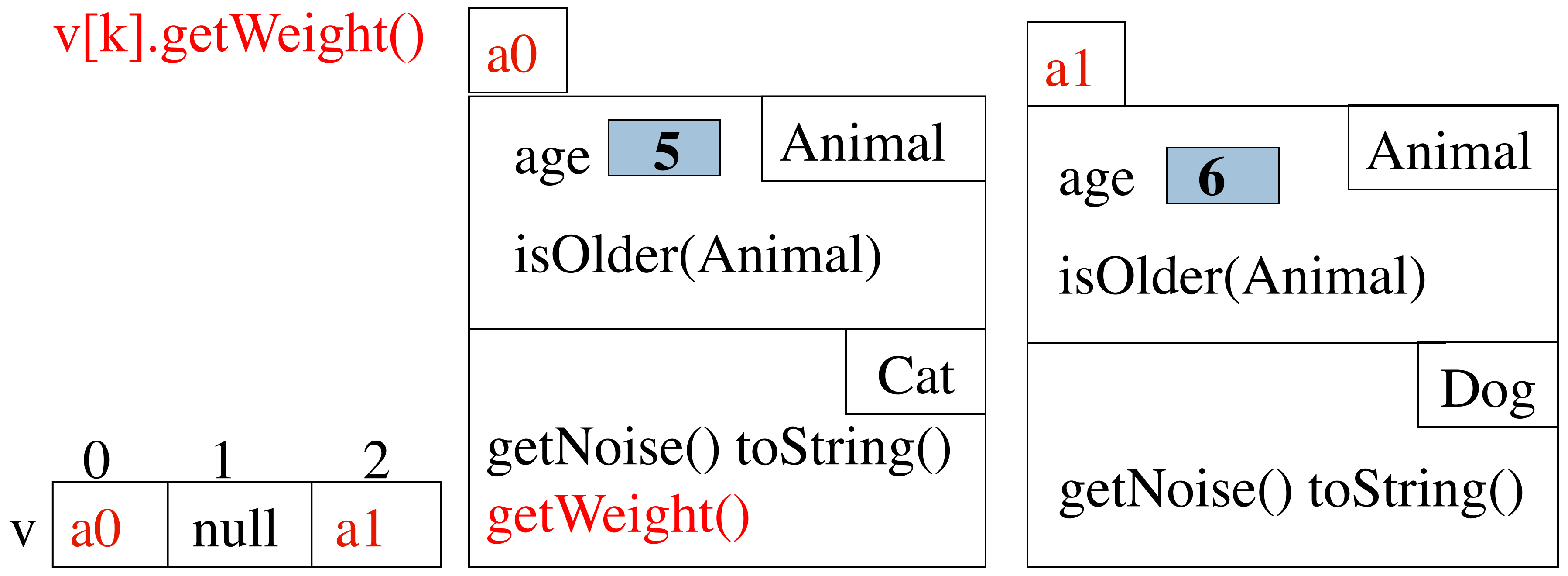
Type of v[0]: Animal

Should this call be allowed?
Should program compile?

v[k].getWeight()

Should this call be allowed?
Should program compile?

v[0].getWeight()



View of object based on the type

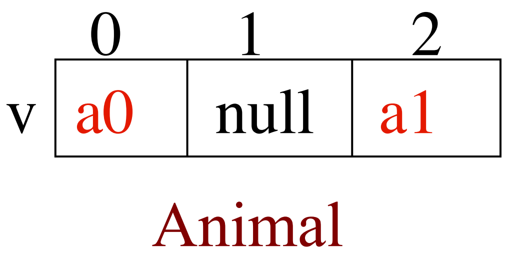
Each element v[k] is of type Animal.

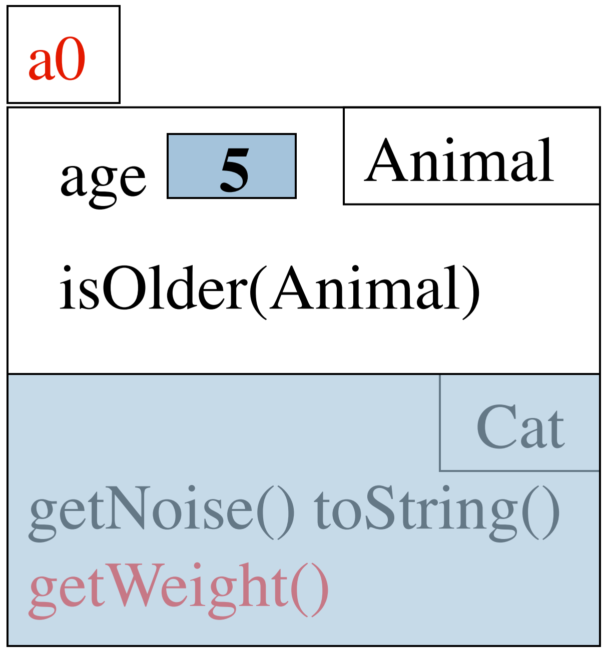
From v[k], see only what is in partition Animal and partitions above it.

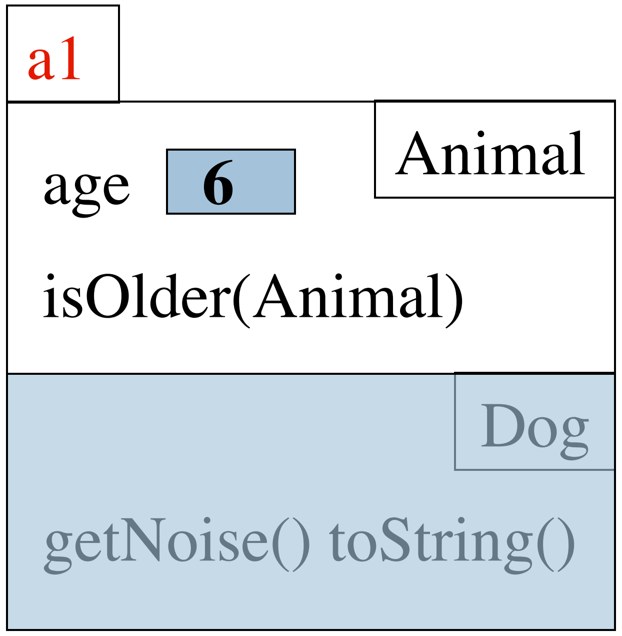
getWeight() not in class Animal or Object. Calls are illegal, program does not compile:

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

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







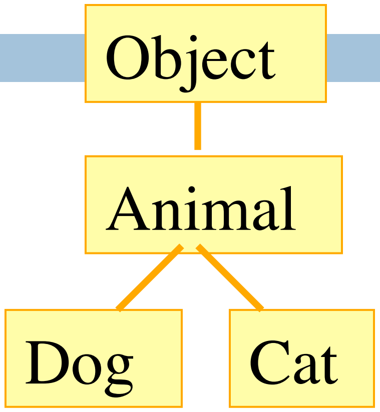
Casting objects

You know about casts like

(int) (5.0 / 7.5)

(double) 6

double d= 5;   // automatic cast

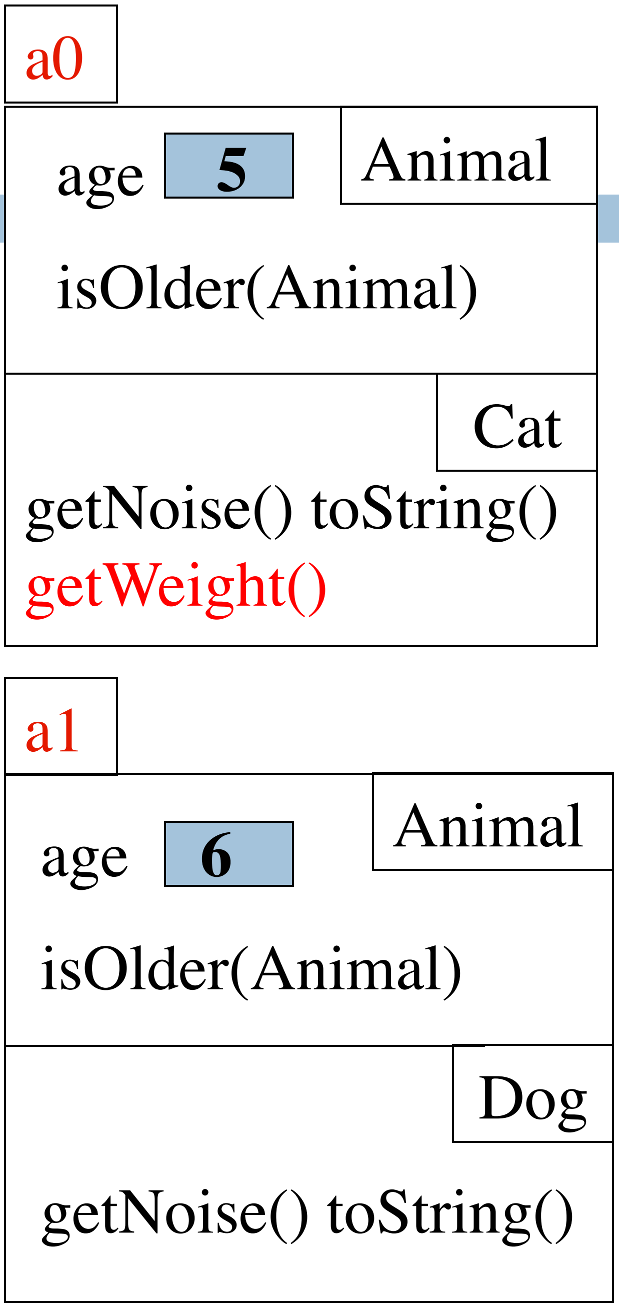


Discuss casts up/down class hierarchy.

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

Cat c= (Cat) h;

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



Explicit casts: unary prefix operators

Rule: an object can be cast to the name of any partition that occurs within it — and to nothing else.

a0 can be cast to Object, Animal, Cat.

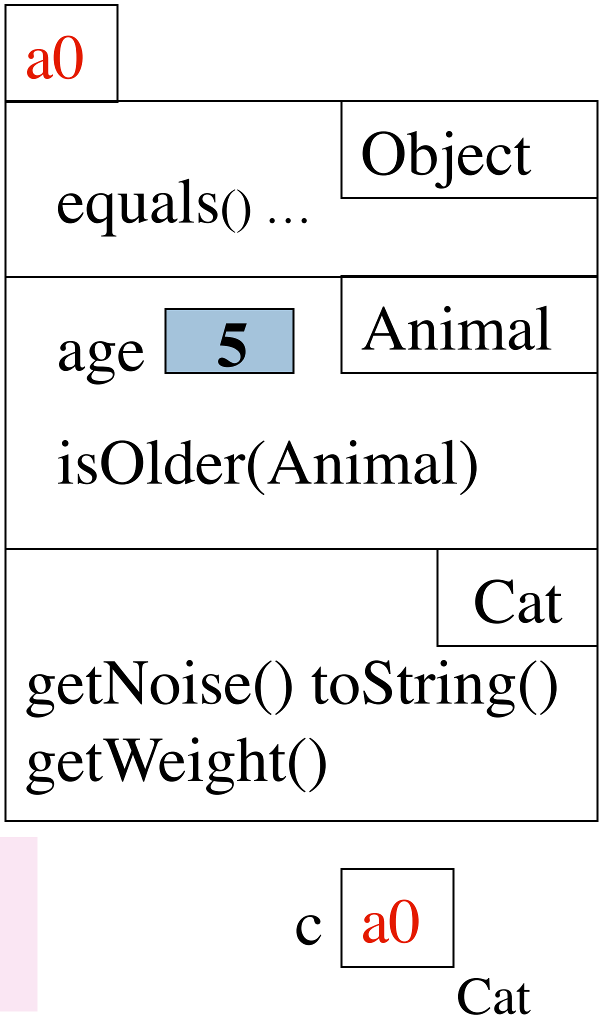
An attempt to cast it to anything else causes an exception

(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



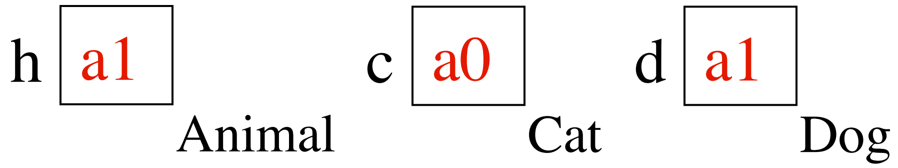
Implicit upward cast

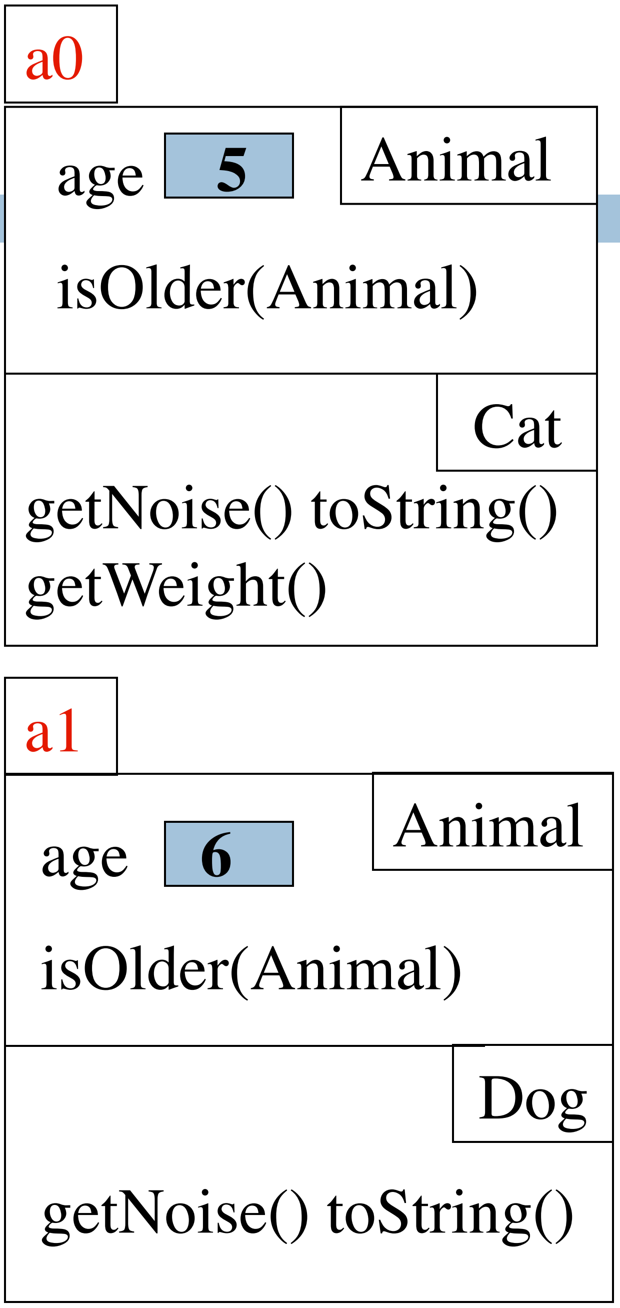
```
public class Animal {
   /** = "this Animal is older than h" */
   public boolean isOlder(Animal h) {
      return age > h.age;
   }
```

Call c.isOlder(d)

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

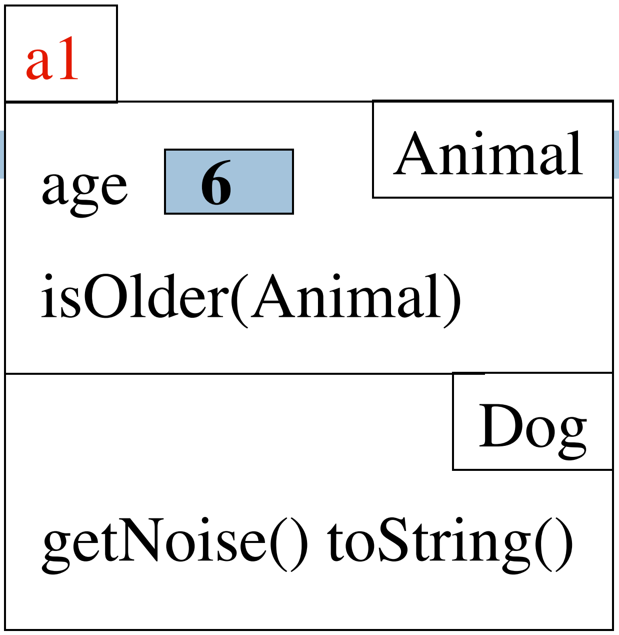
Upward casts done automatically when needed





Example

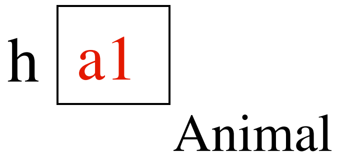
```
public class Animal {
   /** = "this is older than h" */
   public boolean isOlder(Animal h) {
      return age > h.age;
   }
```



Type of h is Animal. Syntactic property.

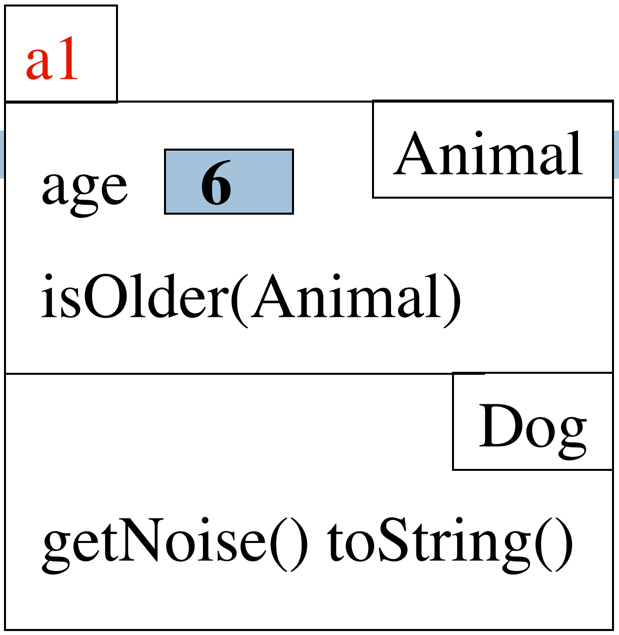
Determines at compile-time what components can be used: those available in Animal

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



Components used from h

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

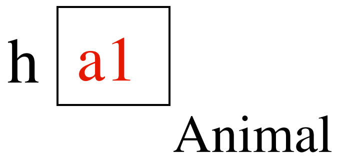


h.toString() OK —it's in class Object partition

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

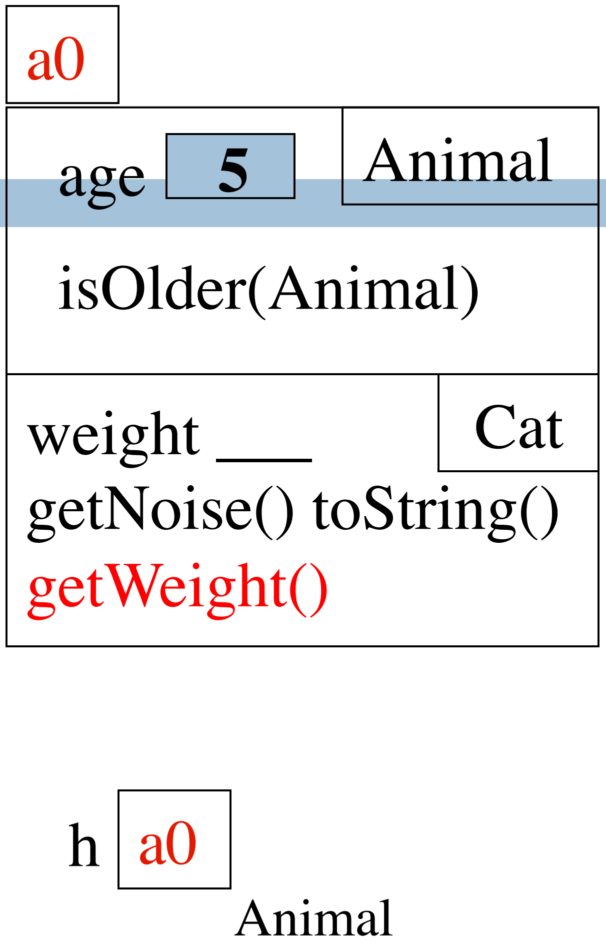
h.getWeight() ILLEGAL —not in Animal partition or Object partition

By overriding rule, calls toString() in Dog partition



Explicit downward cast

```
public class Cat extends Animal {
   private float weight;
   /** return true iff ob is a Cat and its
     * fields have same values as this */
   public boolean equals(Object ob) {
               ?
     // { h is a Cat }
     if ( ! super.equals(ob) ) return false;
     Cat c= (Cat) ob ;  // downward cast
     return weight == c.getWeight();
}
```

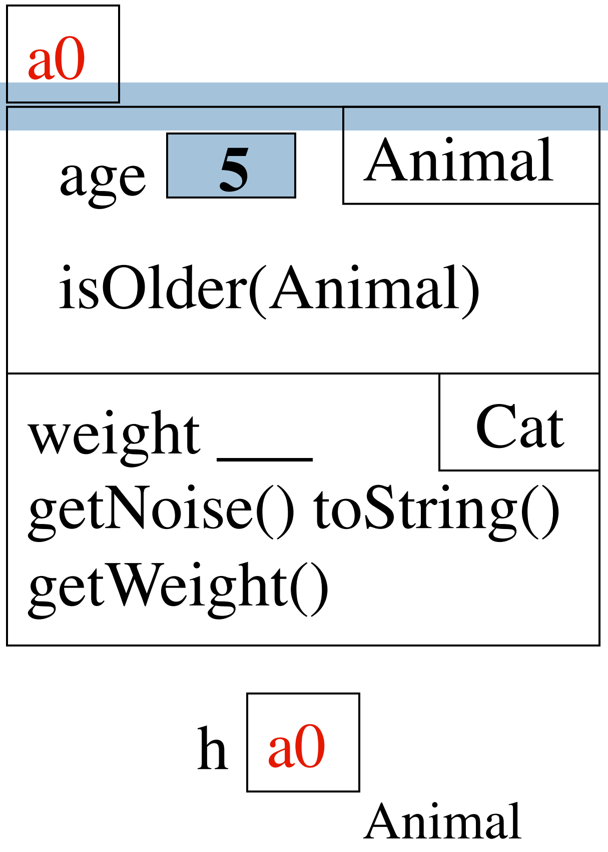


(Dog) ob leads to runtime error.

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

Operator instanceof, explicit down cast

```
public class Cat extends Animal {
   private float weight;
  /** return true iff ob is a Cat and its
     * fields have same values as this */
   public boolean equals(Object ob) {
     if ( ! (ob instanceof Cat) ) return false;
     // { h is a Cat }
     if ( ! super.equals(ob) ) return false;
     Cat c= (Cat) ob ;  // downward cast
     return weight == c.getWeight();
}
```



<object> **instanceof** <class-name>

true iff <object> has a partition for <class-name>

Opinions about casting

- Use of instanceof and downcasts can indicate bad design

DON'T:

```
if (x instanceof C1)
    do thing with (C1) x
else if (x instanceof C2)
    do thing with (C2) x
else if (x instanceof C3)
    do thing with (C3) x
```

DO:

```
x.do()
```

(dothing overridden in C1, C2, C3)

- But how do I implement equals() ?

  That requires casting