Announcements for This Lecture

Readings

- Sections 4.2, 4.3

- **Prelim, March 8th 7:30-9:30**
  - Material up to next Tuesday
  - Sample prelims from past years on course web page
- **Conflict with Prelim time?**
  - Submit to Prelim 1 Conflict assignment on CMS
  - Do not submit if no conflict

Announcements

- Assignment 1 Resubmissions
  - Still working on resubmits
  - 165 out of 195 have a 10
  - Others extended to Feb. 28
- Assignment 2 (last time)
  - Have not graded them yet
  - Solution posted in CMS
- Assignment 3 is now posted
  - Due next Tuesday to CMS
  - Even if still working on A1

Subclasses: Private is Private!

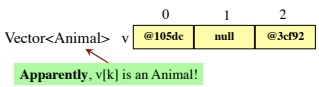
```
public class Animal {
  private String name;
  private int age;

  public Animal(String n, int a) {
    name = n;
    age = a;
  } … }
```

```
public class Cat extends Animal {
  public Cat(String n, int a) {
    name = n;
    age = a;
  } … }
```

```
public class Cat extends Animal {
  public Cat(String n, int a) {
    super(n,a);
  } …
}
```

- Private = only in class
  - Excludes subclasses too!
- How access fields?
  - getters and setters
  - Use super() to initialize

Apparent Type of an Expression



Apparently, v[k] is an Animal!

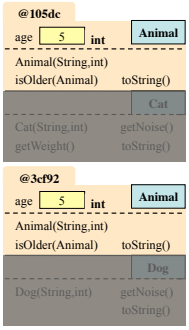
The call

v.get(k).getWeight()

is illegal (will not compile).

The apparent type of v[k] is Animal

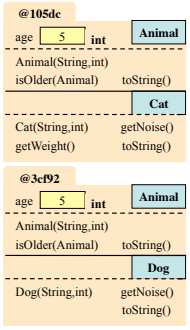
- Does not declare getWeight()
- Does not inherit getWeight()



Casting Up and Down the Class Hierarchy

- Review of casting
  - (int) (5.0 / 7.5)
  - (double) 6
  - double d= 5; // automatic cast
- Can also cast class types:
  - Animal h = new Cat("N", 5);
  - Cat c = (Cat) h;

The Class Hierarchy
(→ means "extends" or "is a kind of")

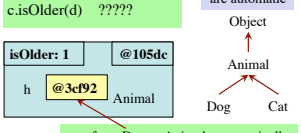


Implicit Casting in the Class Hierarchy

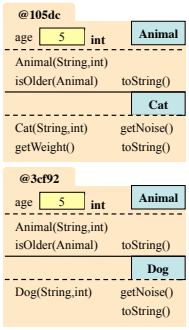
```
public class Animal {
  /** = "this is older than h" */
  public boolean isOlder(Animal h)
    { return this.age > h.age; }
}
```

```
Cat c = new Cat("C", 5);
Dog d = new Dog("D", 6);
c.isOlder(d)   ?????
```

Casts **up** the hierarchy are automatic



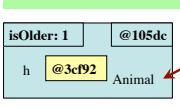
cast from Dog to Animal, automatically



Real vs. Apparent Type

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

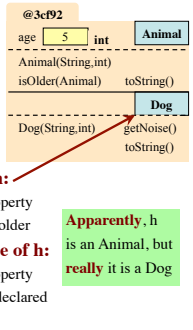
```
Cat c = new Cat("C", 5);
Dog d = new Dog("D", 6);
c.isOlder(d)   ?????
```



Real type of h:
- Semantic Property
- Type of the folder

Apparent type of h:
- Syntactic Property
- Type that is declared

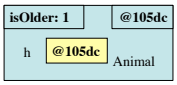
Apparently, h is an Animal, but **really** it is a Dog

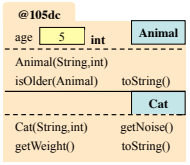


What Can Variable h reference?

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

```
Cat c = new Cat("C", 5);
Dog d = new Dog("D", 6);
d.isOlder(c)   ?????
```



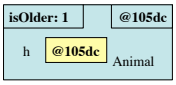


- **Apparent type** determines what methods calls are legal
- Cannot call h.getWeight();
  - This gives a syntax error
  - Even though real type is Cat

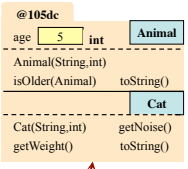
How Do We Resolve h.toString()?

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

```
Cat c = new Cat("C", 5);
Dog d = new Dog("D", 6);
d.isOlder(c)   ?????
```

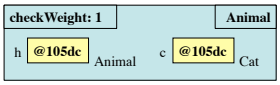


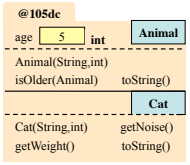
Determined by the real type of h



Casting Down the Class Hierarchy

```
public class Animal {
 /** If Animal is a cat, return weight; else return 0 */
 public static double checkWeight(Animal h) {
   if ( !(h instanceof Cat) ) {
     return 0.0;
   }
   // h is a Cat
   Cat c = (Cat)h;    // Downward cast
   return c.getWeight();
}}
```





(Dog) h would lead to a **runtime error.**

You can't cast an object to something that it is not!

Types of Errors in Java

Syntactic Errors

- Can check at compile time
- Bad use of "grammar"
- **Examples:**
  - Lack of semicolon
  - Unknown method or variable
  - Use of method not in the apparent type of variable

Runtime errors

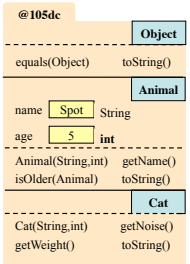
- Can only check at run time
- Generally have to do with contents (not type) of variable
- **Examples:**
  - Variable unexpectedly null
  - Bad downward casts
  - Method call that violates the parameter preconditions

How to Override equals(Object)

```
public class Animal {
  /** Yields: "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;
  }
}
```

May want to define equals() in Cat and Dog.

A cat is not equal to a dog, even if they have the same name and age!



Overriding Versus Overloading

```
public class Animal { …
  public boolean equals(Object h) {
    if (!(h instanceof Animal)) {
      return false; }
    Animal ob= (Animal)h;
    return name.equals(ob.name) &&
           age == ob.age;
  }}
```

```
public class Cat { …
  public boolean equals(Cat h) {
    return getName().equals(h.getName())
           && getAge() == h.getAge();
           && weight == h.weight;
}}
```

```
Cat c   = new Cat("C",  5);
Dog d = new Dog("C", 5);
c.equals(c)   ?????
```

- Method calls match on
  - Name of the method
  - Types of the parameters
- If no match:
  - Upcasts the arguments
  - Searches again for match