Some slides contain lots of animation; you must be in class to fully understand them.

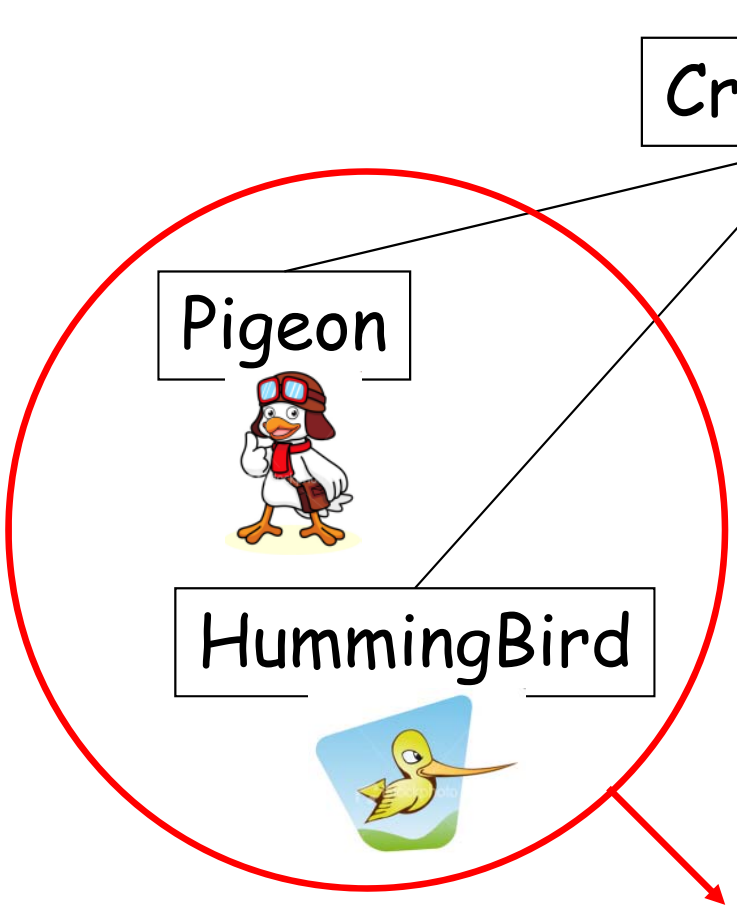
Interfaces

Topics:

- Interfaces & a little more on Abstract Classes
- Multiple Inheritance

Chapter 8 – “Big Java” book
Chapter 8 – “Head First Java” book
Chapter 10 – “Introduction to Java Programming” book
Chapter 4 – “Java in a Nutshell” book

More creatures (*before* `abstract`)



Remember?

Creature
String name; String tailType; Color color; int speed;
run(); swim();

but if we put in a generic fly method in Creature so would Rabbits and Turtles!!

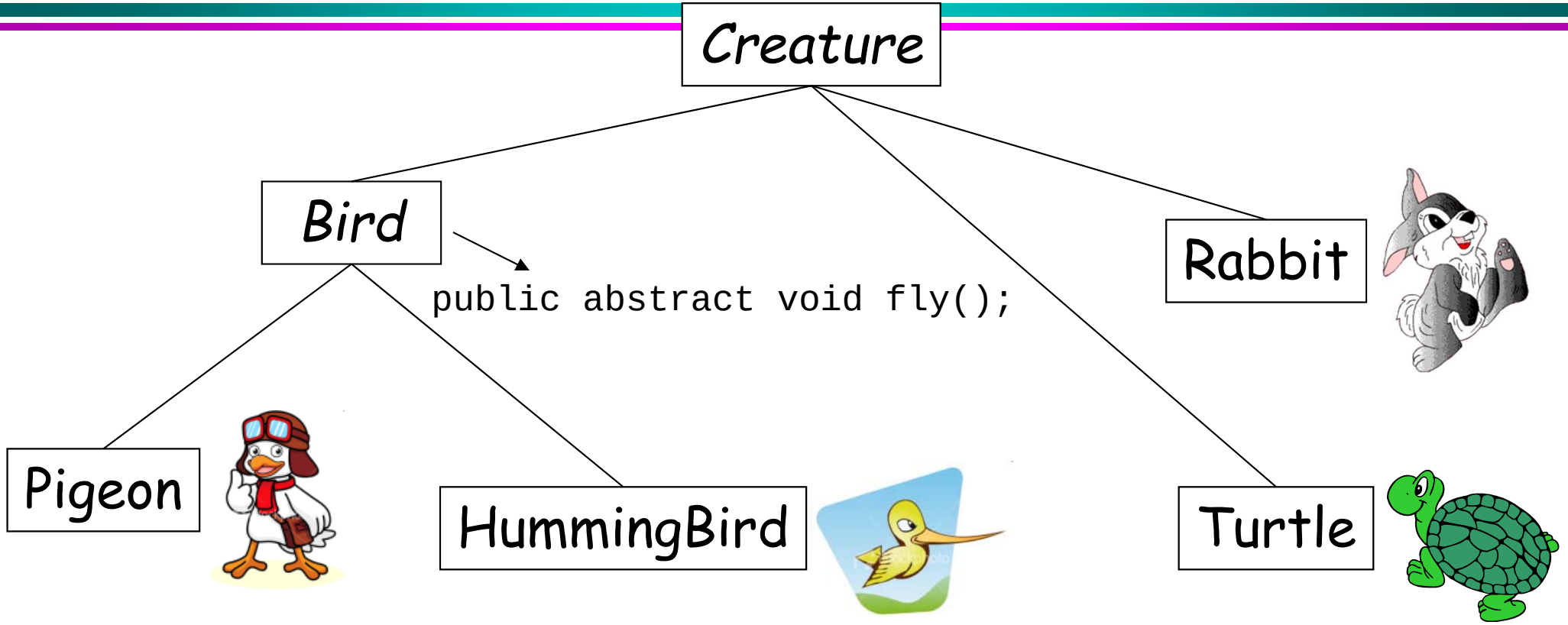
More creatures: analysis …

Instead of providing generic methods in `Creature`, we could make the `fly()` method abstract.

The classes that need to *fly* implement the `fly()` method.

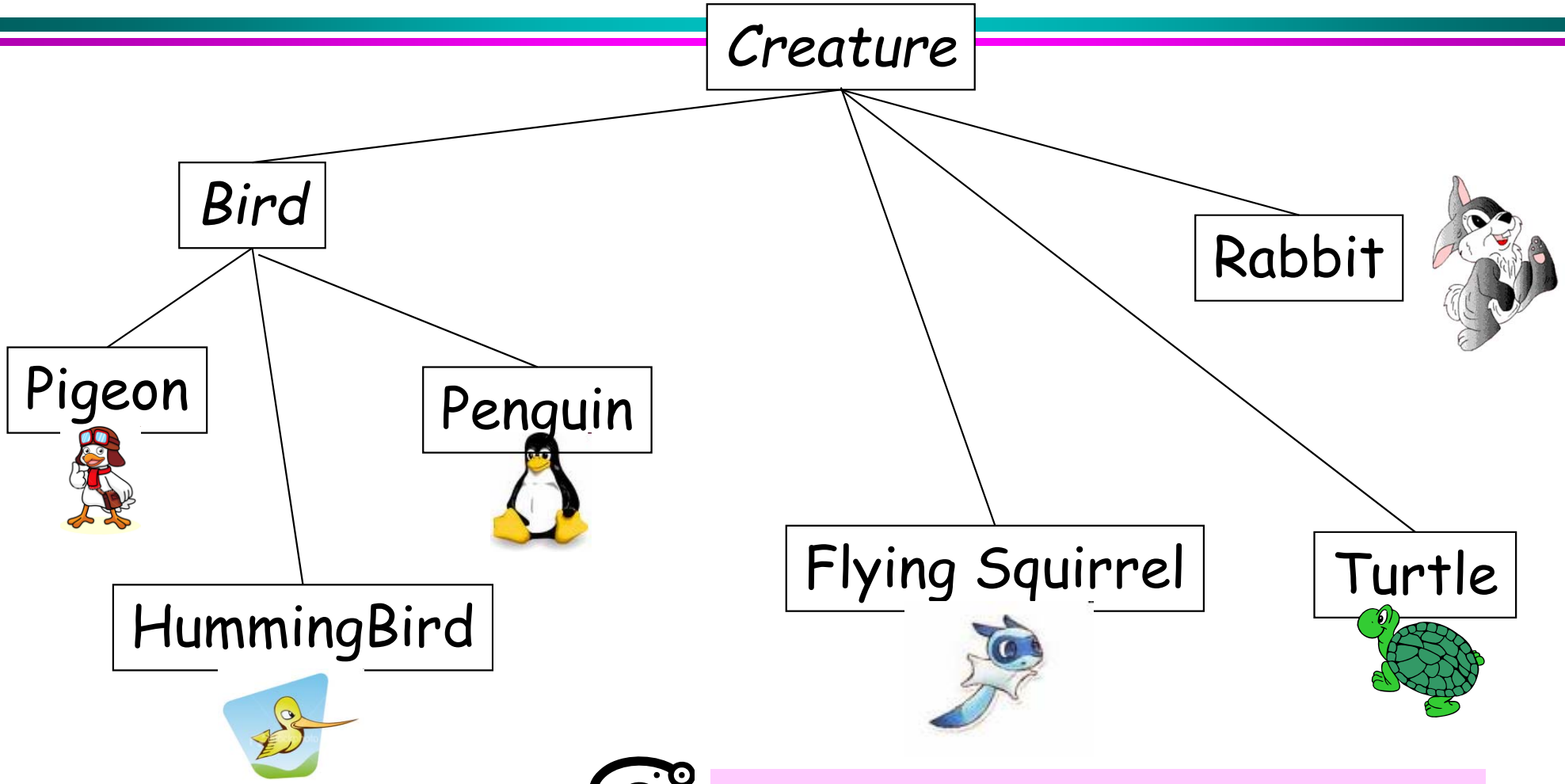
All subclasses of the then abstract class `Creature` must provide a `fly()` method.
Even those that do not *fly*!

Creating multiple `abstract` parents



Now Birds can *fly*, but Rabbits and Turtles remain grounded!

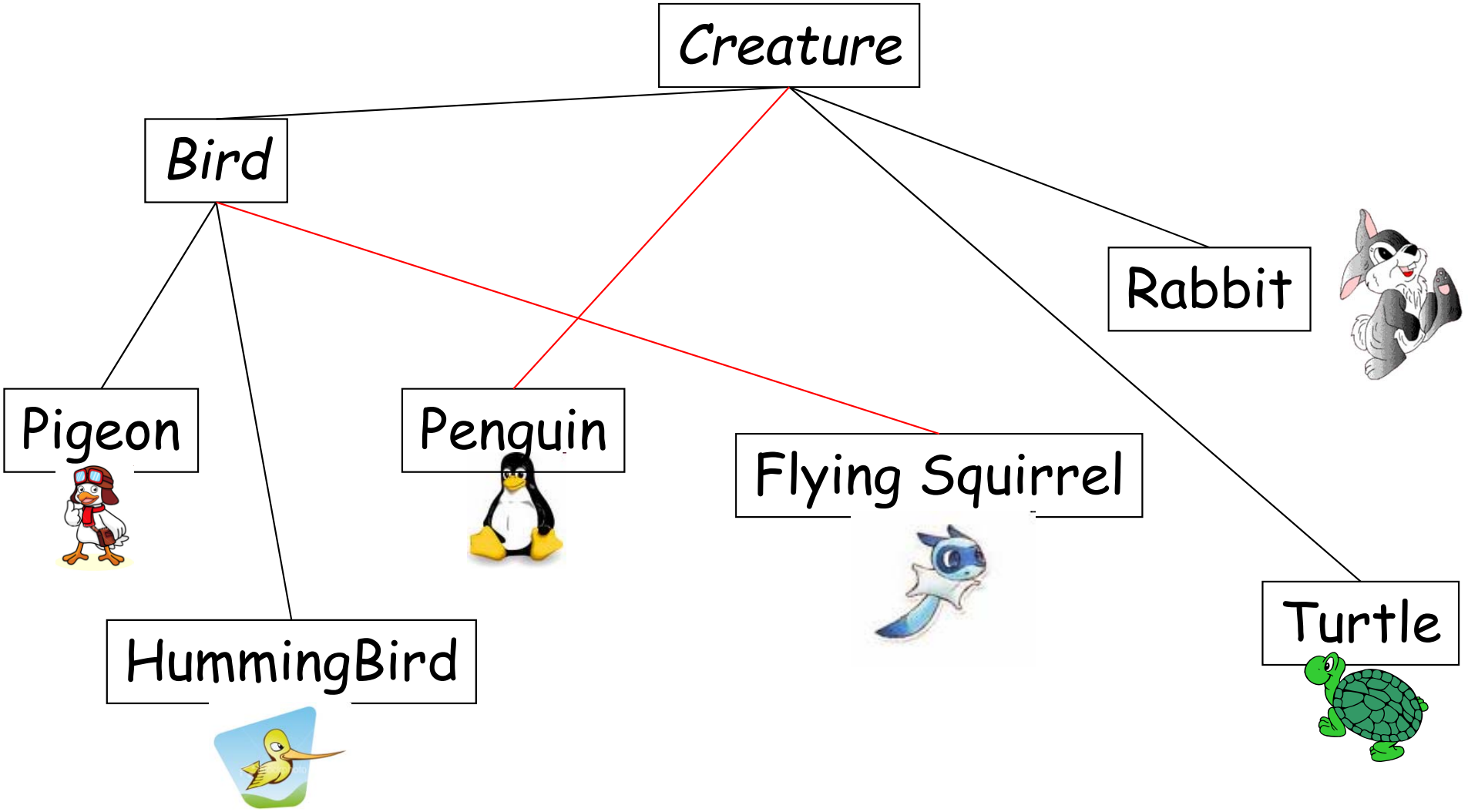
Let us add more Creatures (1/3)



Do Penguins fly?
And how about flying mammals?

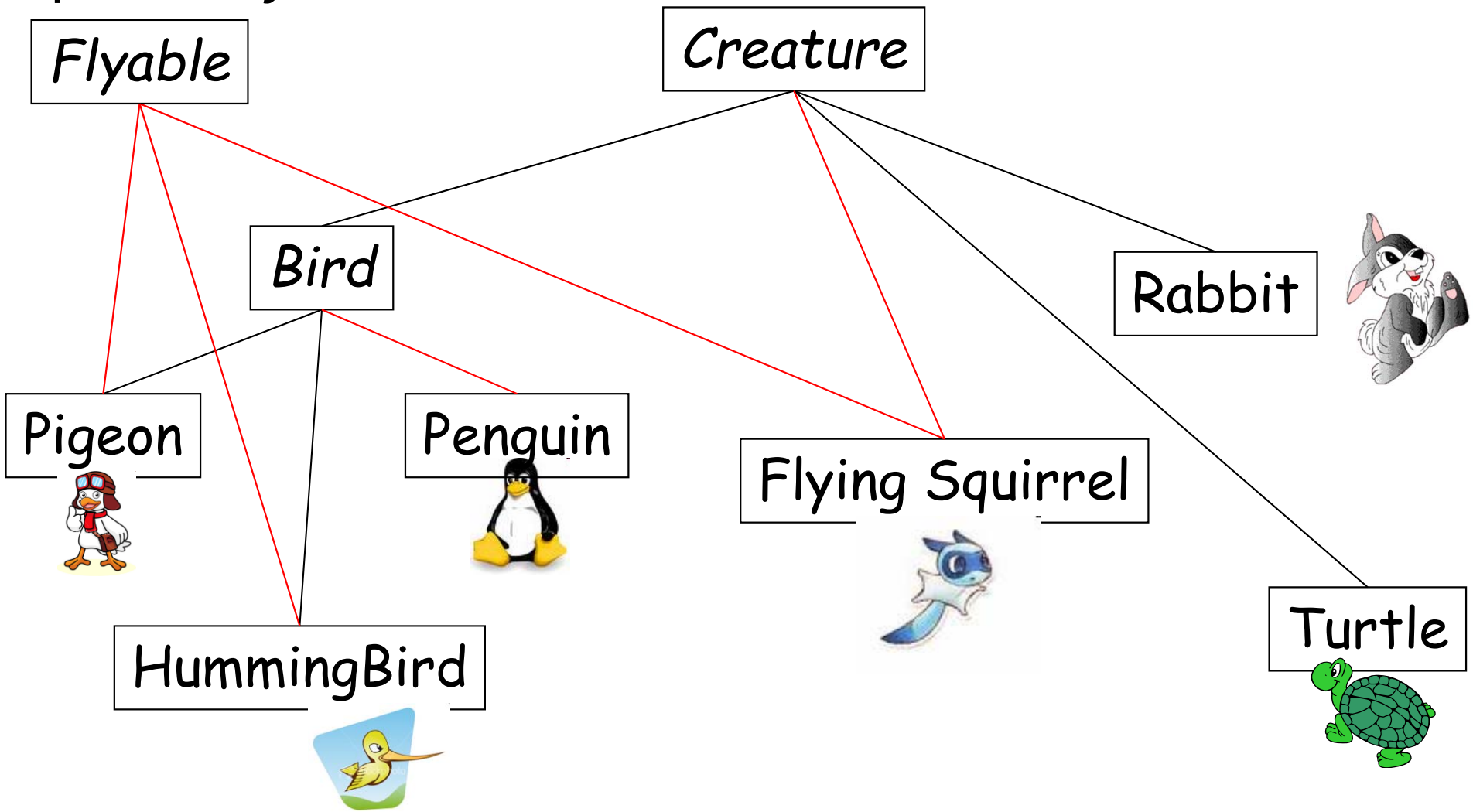
Let us add more Creatures (2/3)

- How can we make a *penguin not fly* and a *flying squirrel fly*?



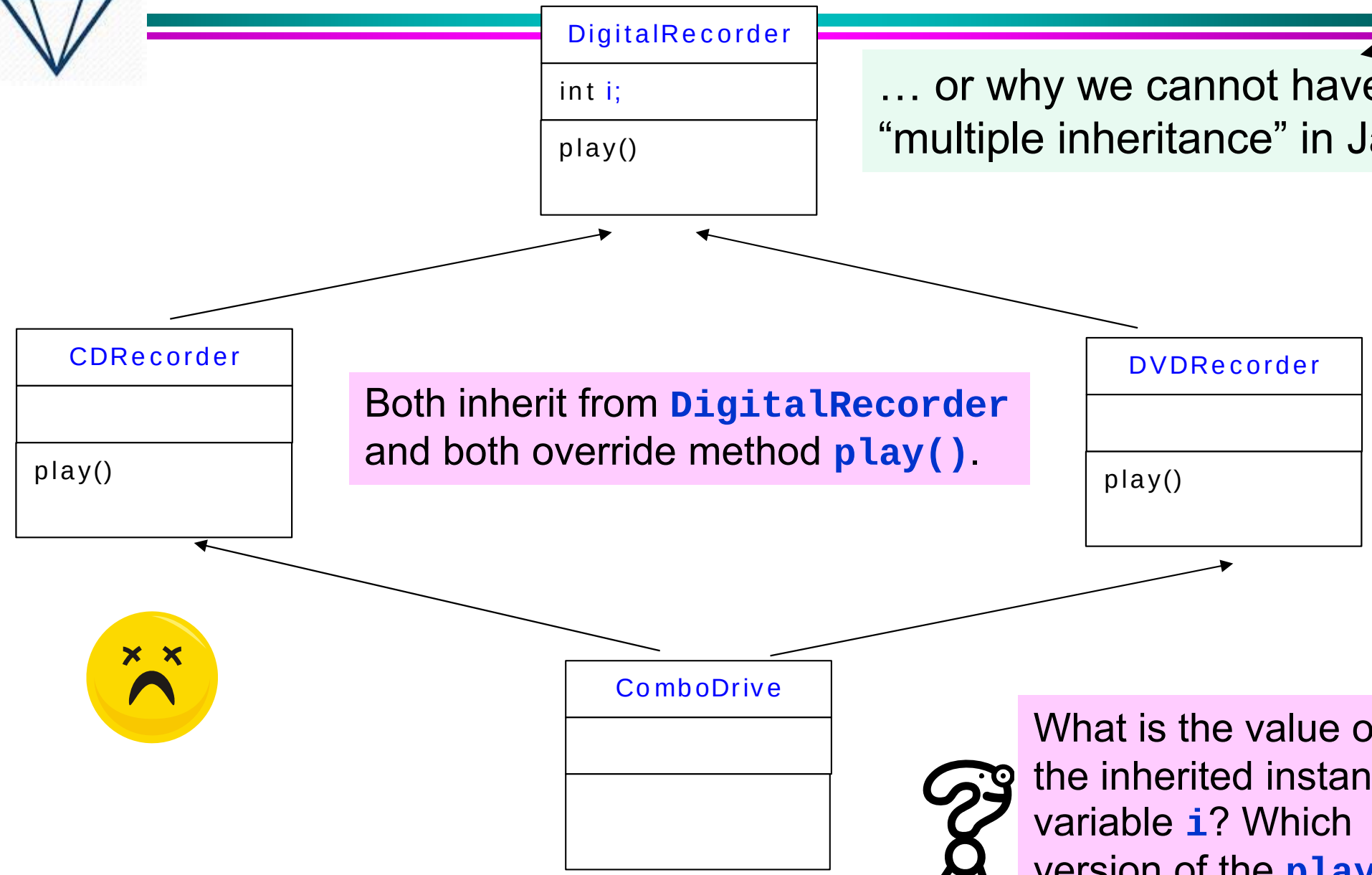
Let us add more Creatures (3/3)

- Why not have two parents? Then only creatures that *fly* have the parent *Flyable* ...



“Deadly Diamond Problem” …

… or why we cannot have “multiple inheritance” in Java



Both inherit from **`DigitalRecorder`** and both override method **`play()`**.

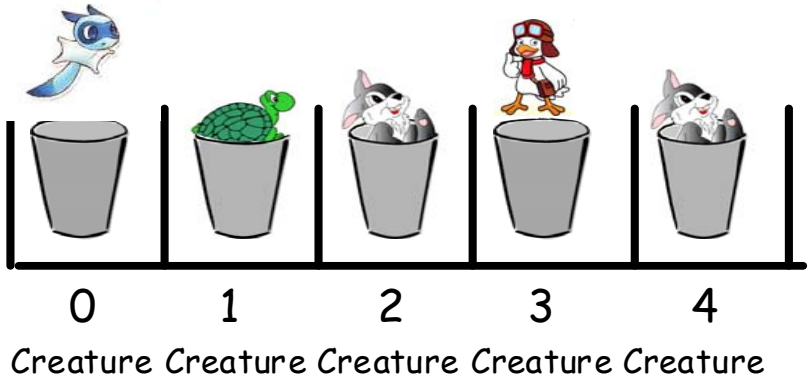
What is the value of the inherited instance variable **`i`**? Which version of the **`play()`** method is inherited?

Interfaces

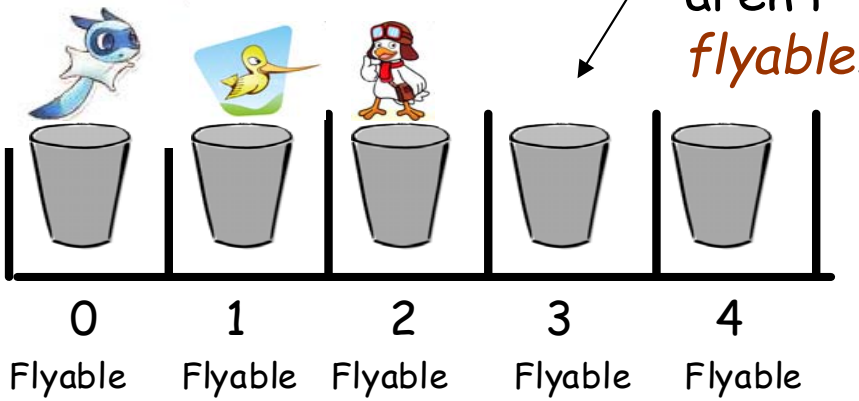
- An interface is like a **100%** abstract class.

An interface allows polymorphic capabilities without the problems of multiple inheritance.

Note: you can't put *turtle* in here – they aren't *flyable*!!



or



- Since an interface has **NO** implemented methods, multiple inheritance is not a problem, as no class inherits a "finished" method.

From Java SE8, **interfaces** can have both `default` and `static` methods – outside the scope of this course.

interface Flyable

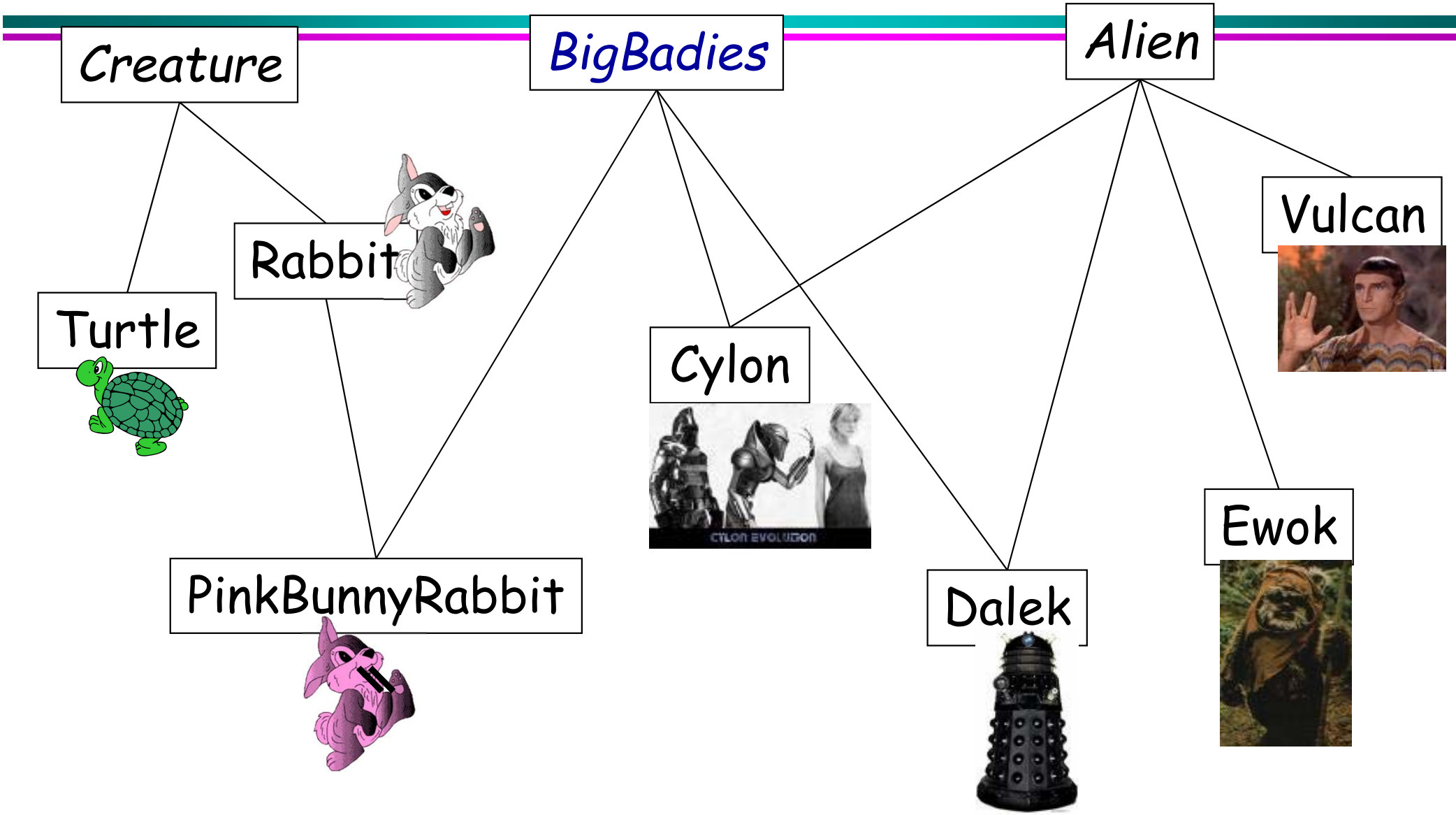
```
public interface Flyable {
   public abstract void fly();  // OR public void fly();
     // Even if you don't declare the method abstract or
     // public, it is!!!
}
```

```
public class FlyingSquirrel extends Creature
                                implements Flyable {
   public void fly() {
     // some code
   }
   public void run(int duration) {
     // some code
   }
}
```

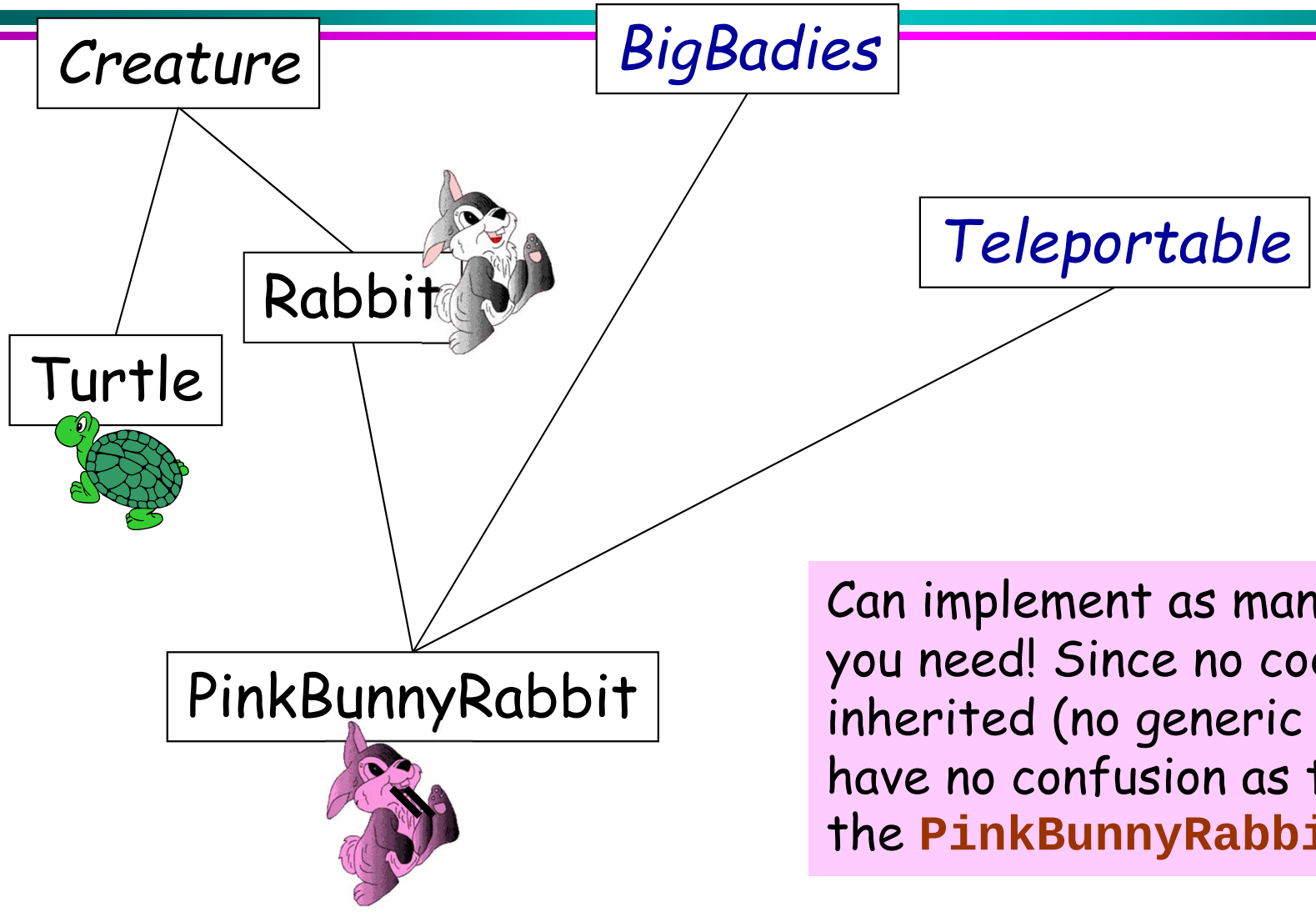
must provide implementation, as you "said" you are Flyable

must provide implementation, as you "said" you are a Creature

Interfaces can be used across *different inheritance trees*



Multiple interfaces



Can implement as many interfaces as you need! Since no code is actually inherited (no generic methods), you have no confusion as to which method the `PinkBunnyRabbit` has inherited!

extends and *implements*

- A class can only **`extend`** 1 class:
  - meaning 1 class can only have 1 parent;
  - a **`PinkBunnyRabbit`** can only have one direct parent – **`Rabbit`**.
- A class can **`implement`** as many interfaces as it likes!
  - A **`PinkBunnyRabbit`** can *be* (via interfaces) a **`BigBadies`** and **`Teleportable`**.

Interfaces

- At *design time*, we can write code that needn't worry about the *implementation* of any class that implements **`Flyable (or BigBadies or Teleportable)`**
  - We can treat the implementation as a black box, and rest safe in the knowledge that it must provide **`fly()`**.
- Interfaces are then like *certificates*, which say "I provide these services".
  - You *can't* make an instance of an interface so e.g.,

```
Flyable friend = new Flyable(); // ERROR!
```

Exercise 1

- Which of the following is a *correct interface*?

```
interface A {
  void print() {
    // some code
  }
}
```

```
abstract interface A {
  print();
}
```

```
abstract interface A extends I1, I2 {
  abstract void print() {
    // some code
  };
}
```

```
interface A {
  void print();
}
```

Notes on Abstract Classes & Interfaces

- Neither **abstract classes** and **interfaces** can have an instance made of them.
- If you don't provide *any* method implementation, then use an **interface** instead of an **abstract class**.
- A class can **implement** many interfaces, but **extends** only one superclass.
- Interfaces are how Java provides (a kind of) *multiple inheritance*.
- If even one method in a class is declared to be abstract, then the whole class must be declared abstract.
- Both abstract classes and interfaces *can* contain constants, which will be inherited by classes that *extend* or *implement* them, respectively.

Example (1/3): Abstract Class *versus* Interface

```
public interface Countable {
  int x = 20;
  int y = 30;       // declaring interface constants
  void counting(); // declaring an interface method
}

public class Example implements Countable {
  int x = 1;
  int y = 2;
  int sum = 0;
  public void counting() { // implements interface method
    sum = x + y;
    System.out.println("Sum is " + sum);
  }
}
```

Example (2/3): Abstract Class *versus* Interface

```
public class Example1 extends Example implements Countable {
  int sub = 0;
  public void counting() {
    // implements interface abstract method
    sub = Countable.y - super.x;
    System.out.println("Sub is " + sub);
  }
}

public class ResultOfCount {
  public static void main(String args[]) {
    Example x = new Example();
    x.counting();
    Example1 y = new Example1();
    y.counting();
  }
}
```

It is *not necessary to provide* an *implementation* for **`counting()`** at this level.

Example (3/3): Abstract Class *versus* Interface

- Analysis of program:
  - Output of the program:

```
Sum is 3
Sub is 29
```

  - The **`counting()`** method is implemented (overridden) by two classes that implement the **`Countable`** interface.
  - An interface may have many methods. If a class implements an interface, but only implements some of its methods, then this class becomes an abstract class; it cannot be instantiated.

… and things for you to try out!

Example: Abstract Classes & Interfaces Implementation

```
interface InterfaceExample {
  void method1();
  void method2();
}
class Example1 implements InterfaceExample {
  public void method1() {
    // implement 1st method
  }
}
class Example2 extends Example1 {
  public void method2() {
    // implement the 2nd method
  }
}
```

Example1 implements **method1()**, but not **method2()** so it cannot be instantiated.

Example2 implements **method2()** (and inherited **method1()** from **Example1**), so it can be instantiated.

Extending an Interface

- Like classes, *interfaces can be extended* as well.

```
interface Father {
   int age = 30;
   void wash();
}
interface Mother {
   long bank_account = 100000;
   void cook();
}
interface Child extends Father, Mother {
   void cry(boolean tear);
}
```

Child inherits from **Father** and **Mother** and has the following:

```
int age = 30; (!!)
long bank_account = 100000;
void wash();
void cook();
void cry(boolean tear);
```

This example tells us *how to pack several interfaces together*.

Name Conflicts

- What happens if **`Father`** interface and **`Mother`** interface contain *same named methods* and *variables* (constants)?
  - *Same named methods*:
    - If they have different parameters, then **`Child`** interface has both (this is same as *overloading*).
    - If they differ by only return type, then *error*.
    - If the two methods are identical, only keep one.
  - *Same named constants*: we keep both constants. To refer to them, *use parent interface name* as prefix.
    - **Example**:
      - If both **`Father`** and **`Mother`** contain an **`age`** variable, then **`Child`** interface contains both.
      - To refer to them, we use: **`Father.age`** or **`Mother.age`**.

… and things for you to try out!

Multiple Inheritance in Java

- Java's "multiple inheritance" is *at interface level* only!
  - If you've already got class A and class B, and you want to extend A and B together to generate class C, forget about it. You can't do that!
- Only interfaces can do multiple inheritance … at design level.

Exercise 2

- What will happen if each of the statements is inserted where indicated in the code?

```
public interface MyConstants {
   int r = 4;
   int s = 6;
   // INSERT CODE HERE
}
```

1. `final double circumference = 2*Math.PI*r;`
2. `int total = total + r + s;`
3. `int AREA = r*s;`
4. `public static MAIN = 15;`
5. `protected int CODE = 31337;`