CT2106
Object Oriented Programming

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Lecture Topic

Polymorphism

For examples, see: https://www.javatpoint.com/runtime-polymorphism-in-java

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Animal Code

```
public abstract class Animal
{

    public abstract void move(int y);

}
```

```
public class Bird extends Animal
{
    @Override
    public void move(int y)
    {
        System.out.printf("I fly %d metres", y);
    }
}
```

```
public class Frog extends Animal
{
    @Override
    public void move(int y)
    {
        System.out.printf("I hop %d metres", y);
    }
}
```

```
public class Fish extends Animal
{
    @Override
    public void move(int y)
    {
        System.out.printf("I swim %d metres", y);
    }
}
```

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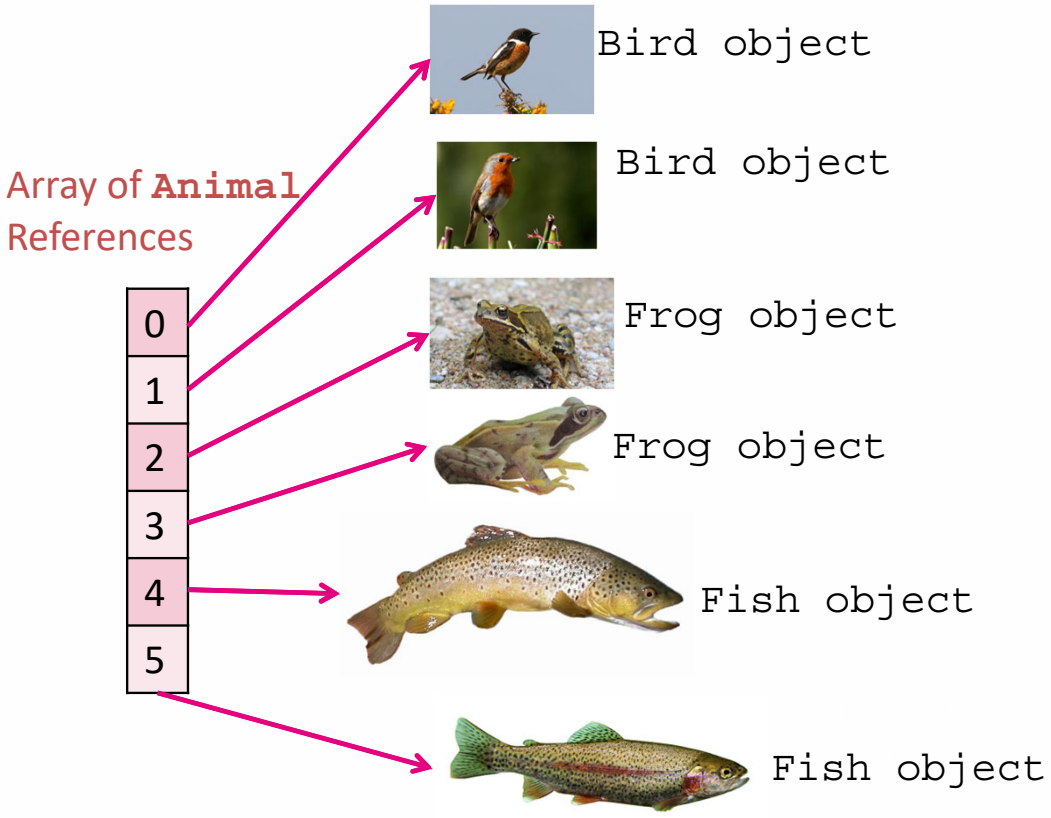
Write the code

Write the code to add a reference to a different animal in each array location

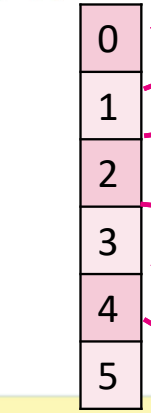
E.g. a bird in the first location
a bird in the second location
A Frog in the third location
And so on



```
public class AnimalTest
{

    public static void main(String[] args)
    {
        Animal[] animals = new Animal[6];
        animals[0] = new Bird();
        animals[1] = new Bird();
        animals[2] = new Frog();
        animals[3] = new Frog();
        animals[4] = new Frog();
        animals[4] = new Fish();
        animals[5] = new Fish();


    }
}
```




Bird object


Bird object


Frog object


Frog object


Fish object

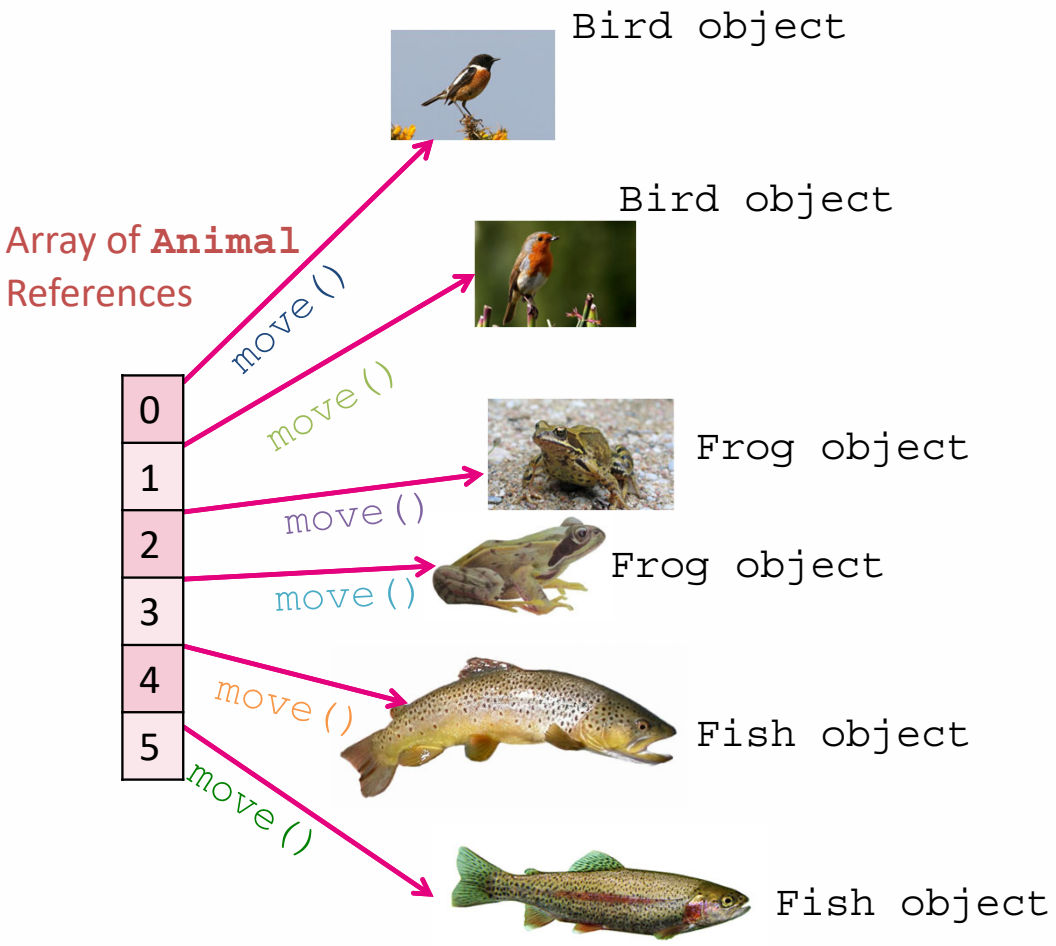

Fish object

Example

Now write the code
to call the move() method
from each
reference in the array
Use a *for* loop

```
for(Animal animal: animals){
    animal.move(5);
}
```

Run the code from the main
method



Example

- Note how you haven't explicitly called the move methods of Bird, Frog or Fish
- Just the move method of Animal (which is abstract)

```
for(Animal animal: animals){
    animal.move(5);
}
```

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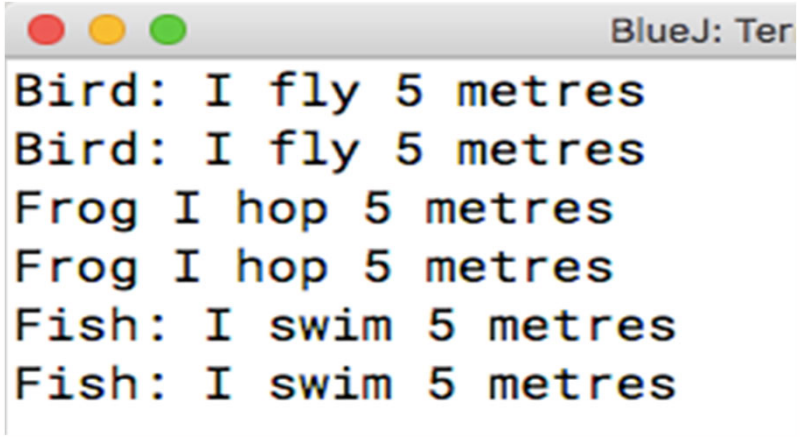
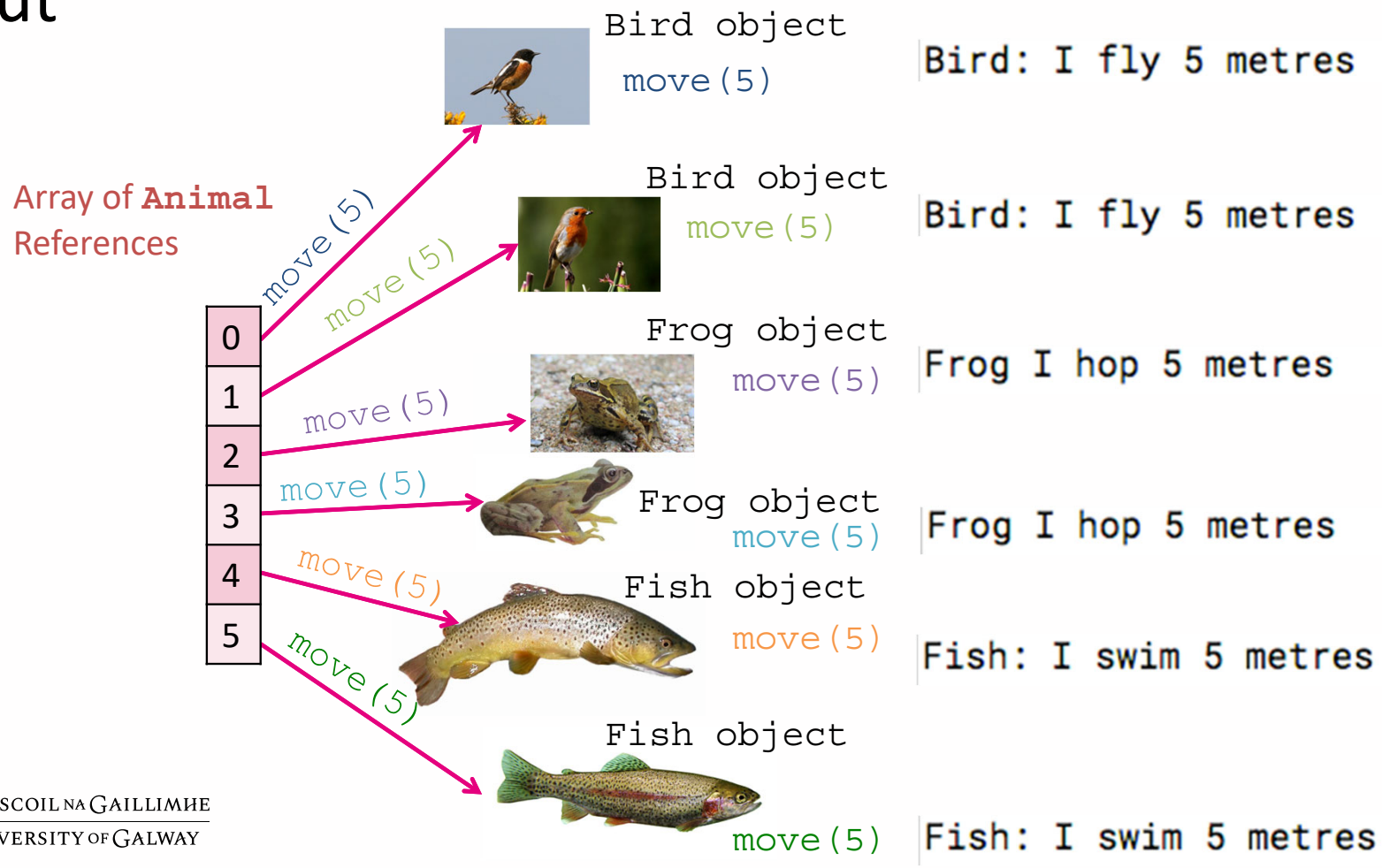
Output

Examine the output produced in the terminal

The specific *move* method of each of the referenced animal objects(Bird, Frog, Fish) has been called

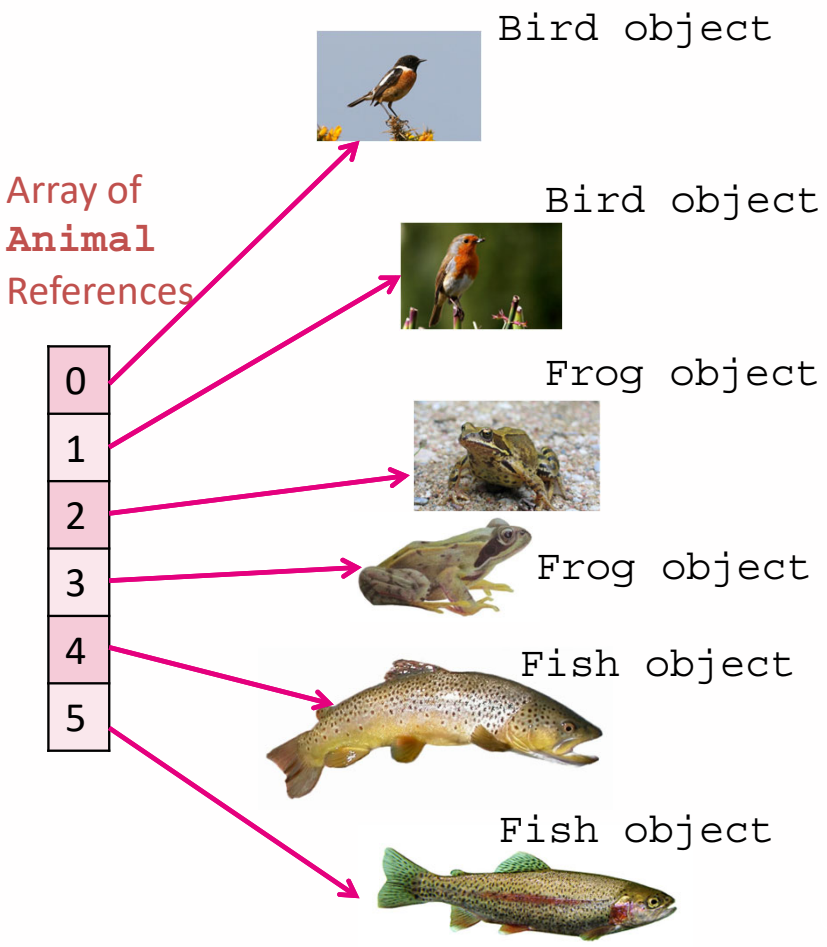


Output


Array of Animal References
0
1
2
3
4
5
move(5)
move(5)
move(5)
move(5)
move(5)
move(5)
Bird object
move(5)
Bird: I fly 5 metres
Bird object
move(5)
Bird: I fly 5 metres
Frog object
move(5)
Frog I hop 5 metres
Frog object
move(5)
Frog I hop 5 metres
Fish object
move(5)
Fish: I swim 5 metres
Fish object
move(5)
Fish: I swim 5 metres

Explanation

- Each element in the array contains a reference variable of type `Animal`
- Each reference points to a `Bird`, `Frog` or `Fish` object
- So when the `move()` method is called from the `Animal` references in the array it is the `move()` method of the respective `Bird`, `Frog`, `Fish` objects that is invoked



Dynamic Dispatch/Late binding

- This an example of what is called **dynamic dispatch** or **late binding**
- The decision as to which method to invoke is decided at program runtime, not compilation time
- If at run time, `animals[0]` points to a `Bird` object, then `animals[0].move()` invokes the `move()` method of the `Bird` object
- If `animals[0]` points to a `Fish` object, then `animals[0].move()` invokes the `move()` method of the `Fish` object

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Polymorphism

- We can add new `Animal` types with new `move()` behaviours to the array of `Animal` references
- As long as these are subclasses of `Animal`, their `move()` method will always be called

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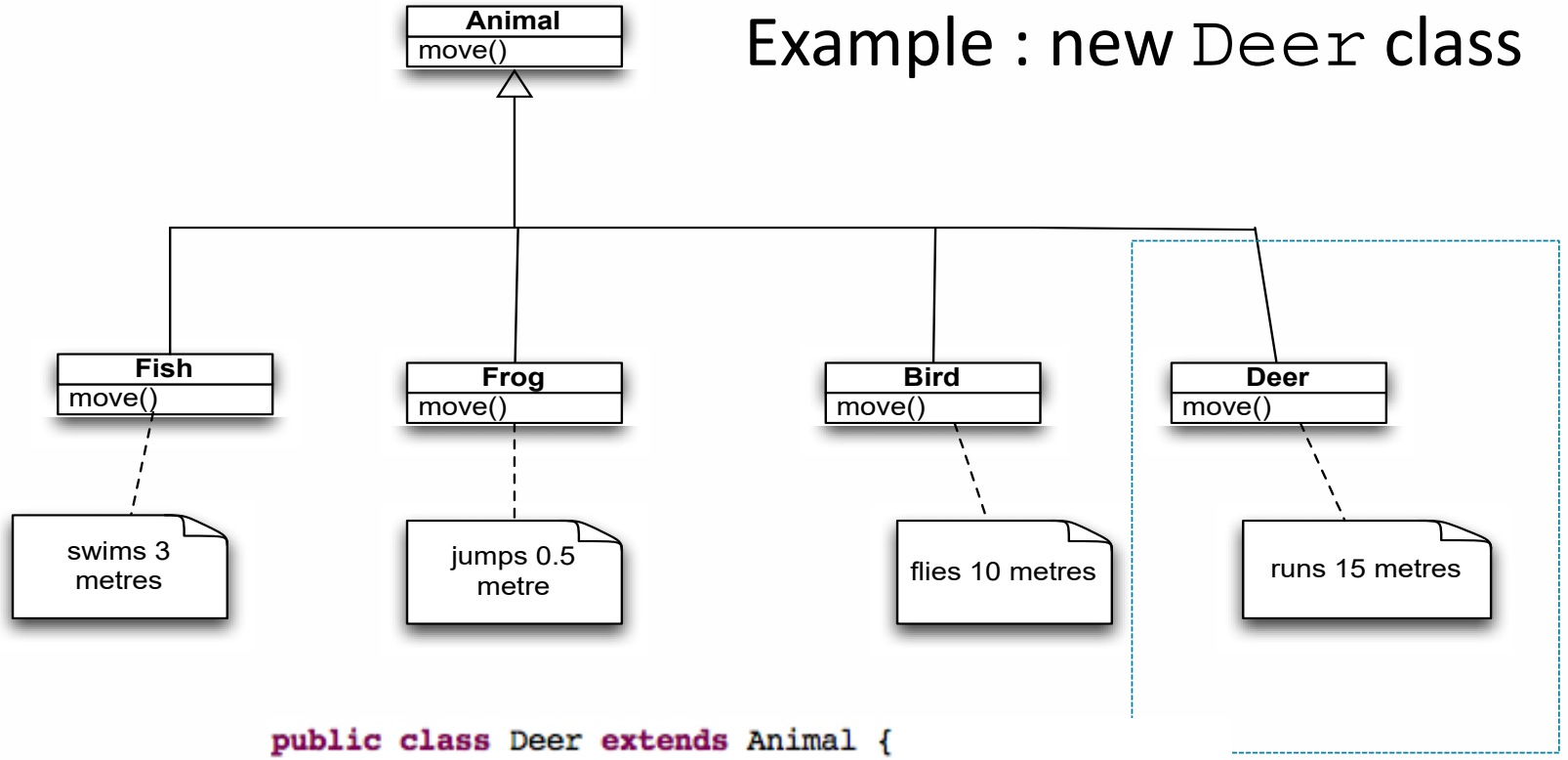
Example : new `Deer` class




```java
public class Deer extends Animal {

    @Override
    public void move(){
        // TODO  code for flying 10 metres
        System.out.println("Deer: I run 15 metres");
    }

}
```

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Create a deer object

- Place a reference to a Deer object in the array and run the program again.

```
Animal[] animals = new Animal[6];
animals[0] = new Bird();
animals[1] = new Bird();
animals[2] = new Frog();
animals[3] = new Frog();
animals[4] = new Frog();
animals[4] = new Fish();
animals[5] = new Fish();
animals[5] = new Deer(); // this replaces the previous value

for(Animal animal: animals){
    animal.move(5);
}
```

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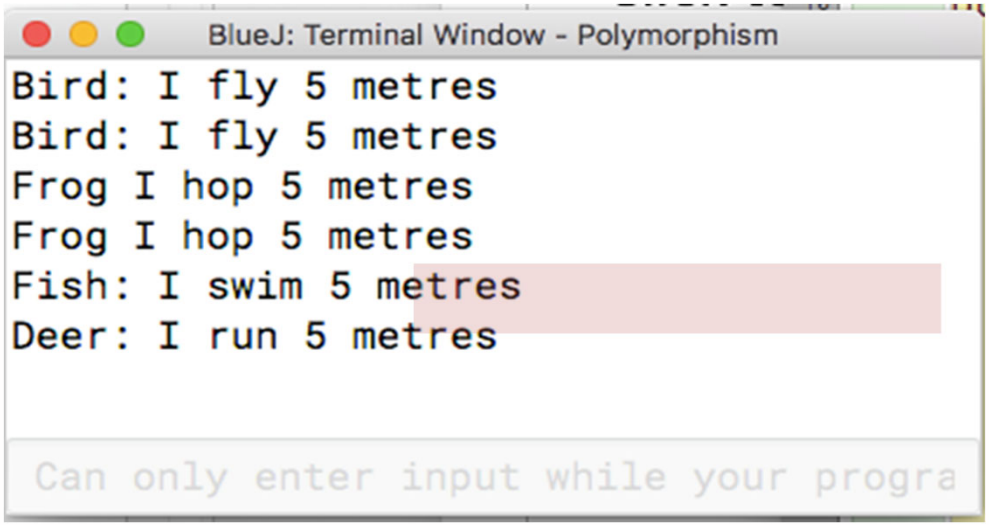
Output

- Key message we can change the behaviour of a program **without changing its code**
- E.g. this piece of code remains the same




```
for(Animal animal: animals){
    animal.move(5);
}
```

Implications

- With polymorphism, we can design and implement systems that are easily *extensible*
- New classes with new behaviours can be added with little or no modification to the general portions of the program

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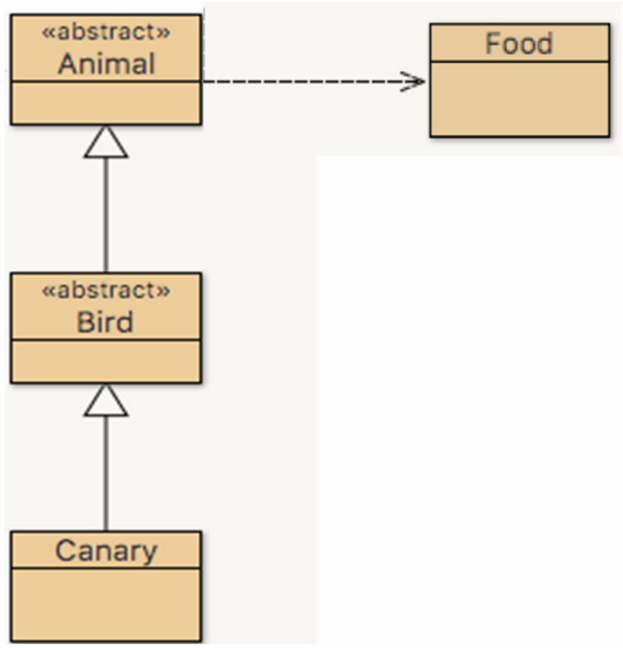
Let’s look at applying these ideas

Open the code we first looked at yesterday



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Instructions

Food:

Make Food an abstract class

Give it two abstract methods *getCalories* and *getFat* with a return type *int*

Animal: make *eat* method abstract

- Create an abstract subclass of Food called **Vegetable**
- Create a concrete subclass of Vegetable called **Seed**
- Seed has two fields *calories* and *fat*
- Canary must implement a concrete version of the *eat* method
- Canary's eat method checks if Food object is an *instanceof* Seed; if it is, the Canary calls Food's getCalories method and moves the distance returns. She also calls the sing method.

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Lecture wrap up

- We looked at polymorphism – the facility by which an object can be referenced by a variable of its Superclass
- This allows us to create code that is easily extensible
- We saw that we can create variables of abstract types (classes)

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