CS18000: Problem Solving and Object-Oriented Programming

Polymorphism

Video 1
Polymorphism and Abstract Classes

Polymorphism

Abstract Classes

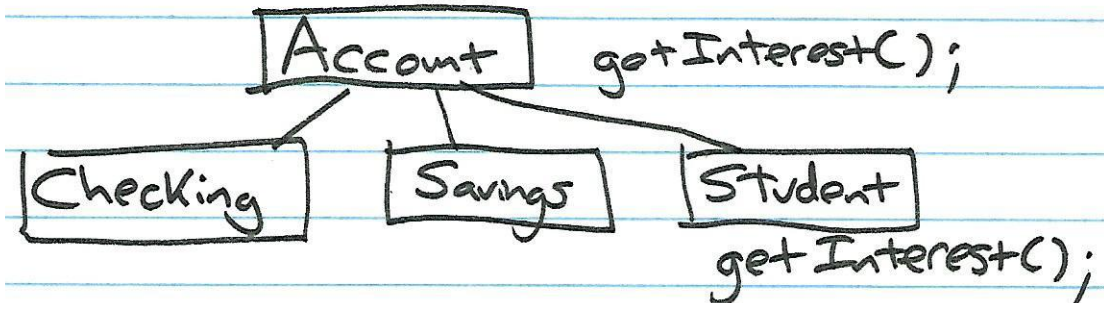
Polymorphism

Dynamic Binding

Polymorphism

- “Many forms”
- Animals can take on many forms … yet exhibit similar behaviors.
- Java allows a superclass variable to contain a reference to a subclass object
- The compiler chooses the subclass implementation of any overridden methods
- `account.withdraw(amount);` could be savings acct, checking acct, money market acct, ….

Polymorphism



```
Account account = new Student (…);

account.withdraw(50.00);

interest = account.getInterest();
```

Code Reuse

- Suppose you’re modeling animals
  - Dog
  - Cat
  - Fish
  - Horse
  - …
- Lots of redundancy, so you create a superclass
  - Animal
  - All other subclasses extend Animal
  - Q: But what does “new Animal()” mean?
  - A: Nothing--don’t want to create a “generic” animal

Abstract Classes

- The Java solution for Animal: an abstract class
- Declaring a class abstract means that it cannot be instantiated
- Some methods may be unimplemented (just like an interface)
- But an abstract class may also include some implemented methods for default behavior

Animal

```
public abstract class Animal {
    abstract void speak();

    public static void main(String[] args) {
        Animal[] animals = new Animal[2];

        animals[0] = new Cat();
        animals[1] = new Dog();

        for (int i = 0; i < animals.length; i++)
            animals[i].speak();
    }
}
```

Cat and Dog

```
public class Cat extends Animal {
    void speak() {
        System.out.printf("Meow\n");
    }
}

public class Dog extends Animal {
    void speak() {
        System.out.printf(“Bark\n");
    }
}
```

Video 2
Dynamic Binding and Abstract Methods

Dynamic Binding

- Methods are selected at runtime based on the class of the object referenced, not the class of the variable that holds the object reference
- Example

```
Animal[] animals = new Animal[100];
animals[i].speak();
```

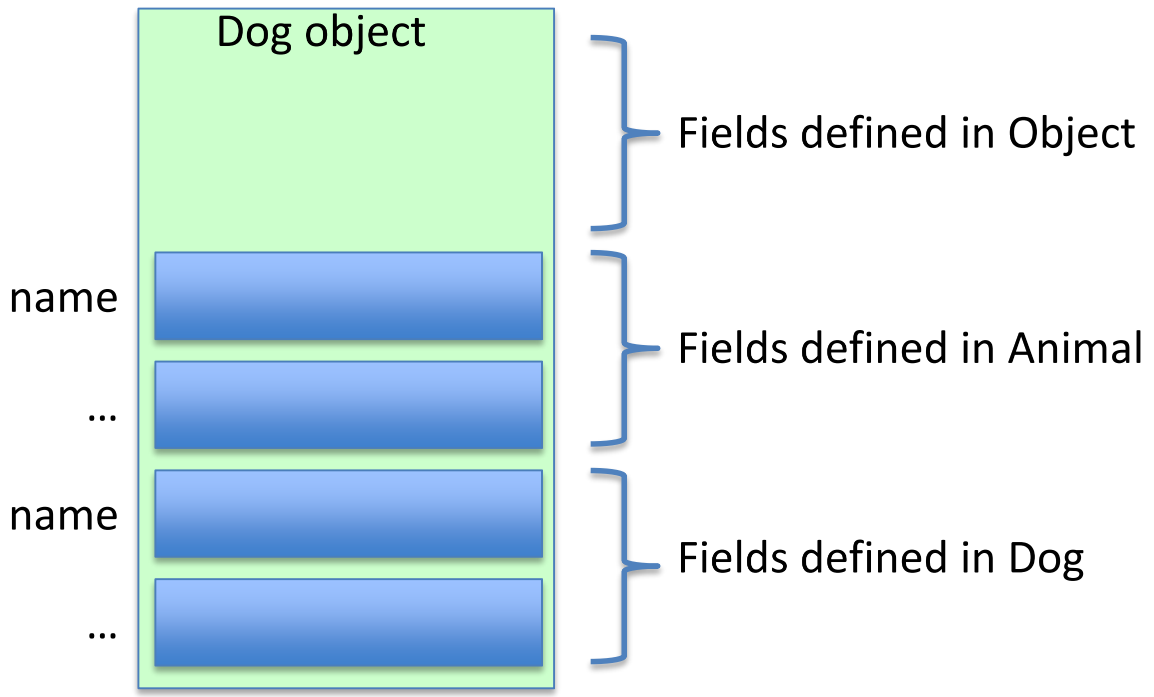
- If `animals[i]` is a Dog, calls the speak() method in Dog, even though the variable is of type Animal

Why polymorphism?

- Allows generic treatment of objects
- An array of Animals
  - Some are Dogs
  - Some are Cats
  - Some are new animal classes defined after the superclass code is written
- Programmer must be disciplined: the overridden methods should implement “consistent” or “expected” behavior
- Example: In Java, all GUI widgets are a subclass of Component; allows uniform treatment by GUI code

Reminder: Subclass Object

Contains its fields as well as all the fields defined in its superclasses…



Revised: Dog

```
public class Dog extends Animal {
    private String name;

    public Dog(String name) {
        super(name);
        this.name = super.getName() + " Barker";
    }

     public String getName() {
          return name;
     }

    void speak() {
        System.out.printf("Bark\n");
    }
}
```

Revised: Animal

```
public abstract class Animal {
    private String name;

    public Animal(String name) {
        this.name = name;
    }
    public String getName() {
            return name;
      }

    abstract void speak();

    public static void main(String[] args) {
        Animal[] animals = new Animal[2];
        animals[0] = new Cat("Garfield");
        animals[1] = new Dog("Snoopy");

        for (int i = 0; i < animals.length; i++)
            animals[i].speak();

        Dog d = new Dog("Marmaduke");
        System.out.println(d.getName());
        Animal a = d;
        System.out.println(a.getName());
    }
}
```

Abstract Methods

- Methods may be declared abstract
  - Provide only the header (no body)
  - Class must then be declared abstract
- Methods in an interface are implicitly declared abstract
- When subclassing an abstract class
  - Generally provide method bodies for abstract methods
  - If abstract methods remain, then subclass is still abstract and must be declared so

Example: Abstract Methods

```
abstract public class AbstractParent {
    abstract void doOne();
    abstract void doTwo();
}
abstract class AbstractChild extends AbstractParent {
    void doOne() {
        System.out.println("in AbstractChild");
    }
}
class ConcreteGrandChild extends AbstractChild {
    void doTwo() {
        System.out.println("in ConcreteGrandChild");
    }
}
 public static void main(String[] args) {
        ConcreteGrandChild cc = new ConcreteGrandChild();
        cc.doOne();
        cc.doTwo();
    }
```