Lecture 20

Inheritance and Polymorphism

Inheritance

- OOP let's you define new classes from existing classes.

- Very helpful for reusing code and we're always trying to reuse our code!

Inheritance

- We use a class to model stuff of the same type.
- Sometimes, different classes have common properties and behaviors that are general, and can be shared by other classes.
- You can define a specialized class that *inherits* from the general class
- This is for *"is-a"* relationships

Inheritance

- The more generic class is the superclass
- the more specific is the subclass
- a subclass is not a *subset* of a class. It usually has more information than the superclass
- private data fields and methods are *only accessible inside the class*. That means they can't be accessed from a subclass. Subclasses only inherit *accessible* data fields and methods

Inheritance

- When you create a subclass, you use the keyword *extends* in the class definition and which class you're extending from.

Inheritance

- Animal example!

Inheritance

```
public class Animal {

    private String name;
    private String sound;
    private double height;
    private double weight;

    Animal(){}

    Animal(String name, String sound, double height, double weight){
        this.name = name;
        this.sound = sound;
        this.height = height;
        this.weight = weight;
    }

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

    public void setSound(String sound){
        this.sound = sound;
    }
    public String getSound(){
        return sound;
    }


}
```

Inheritance

```
public class Bird extends Animal {
     private boolean flies;
     private double beakLength;

     Bird(){
     }

     Bird(boolean flies, double beakLength){
          this.flies = flies;
          this.beakLength = beakLength;
     }

     Bird(boolean flies, double beakLength, String name, String sound){
          this.flies = flies;
          this.beakLength = beakLength;
          //this.name = name;
          //this.sound = sound;
          setName(name);
          setSound(sound);
     }

     public void setFlies(boolean flies){
          this.flies = flies;
     }
     public boolean doesItFly(){
          return flies;
     }

     public void setBeakLength(double beakLength){
          this.beakLength = beakLength;
     }
     public double getBeakLength(){
          return beakLength;
     }
}
```

Inheritance

```
public class Fish extends Animal{
    private boolean livesInOcean;

    Fish(){
    }

    Fish(boolean livesInOcean){
        this.livesInOcean = livesInOcean;
    }
    Fish(boolean livesInOcean, String name, String sound){
        this.livesInOcean = livesInOcean;
        setName(name);
        setSound(sound);
    }

    public void setLivesInOcean(boolean livesInOcean){
        this.livesInOcean = livesInOcean;
    }
    public boolean getLivesInOcean(){
        return livesInOcean;
    }


}
```

Inheritance

```
public class TestAnimal {

    public static void main(String[] args) {

        Fish myFish = new Fish(true, "Wanda", "Glub Glub");
        Bird myBird = new Bird(true, 3.0);

        System.out.println("My fish is named " + myFish.getName());
        System.out.println("My fish says " + myFish.getSound());
//      System.out.println("My fish weighs " + myFish.get...); Don't have this yet!

        System.out.println();
        if (myBird.doesItFly()){
            System.out.println("My bird flies");
        } else {
            System.out.println("My bird does not fly");
        }

        System.out.println("My bird says " + myBird.getSound());
    }

}
```

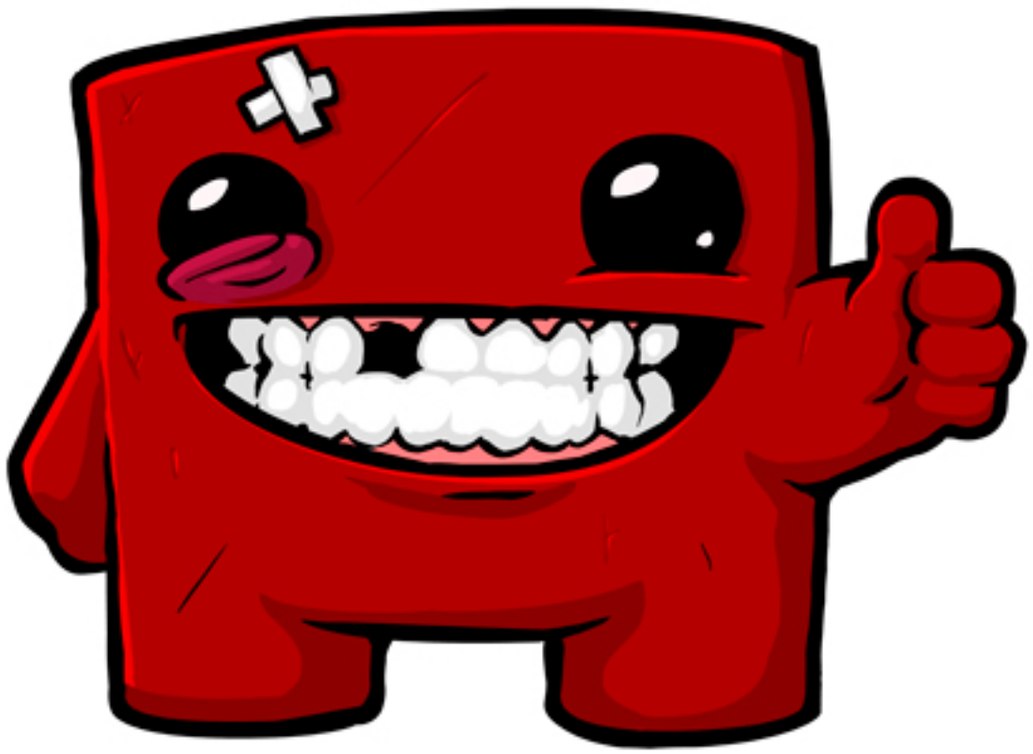
Inheritance

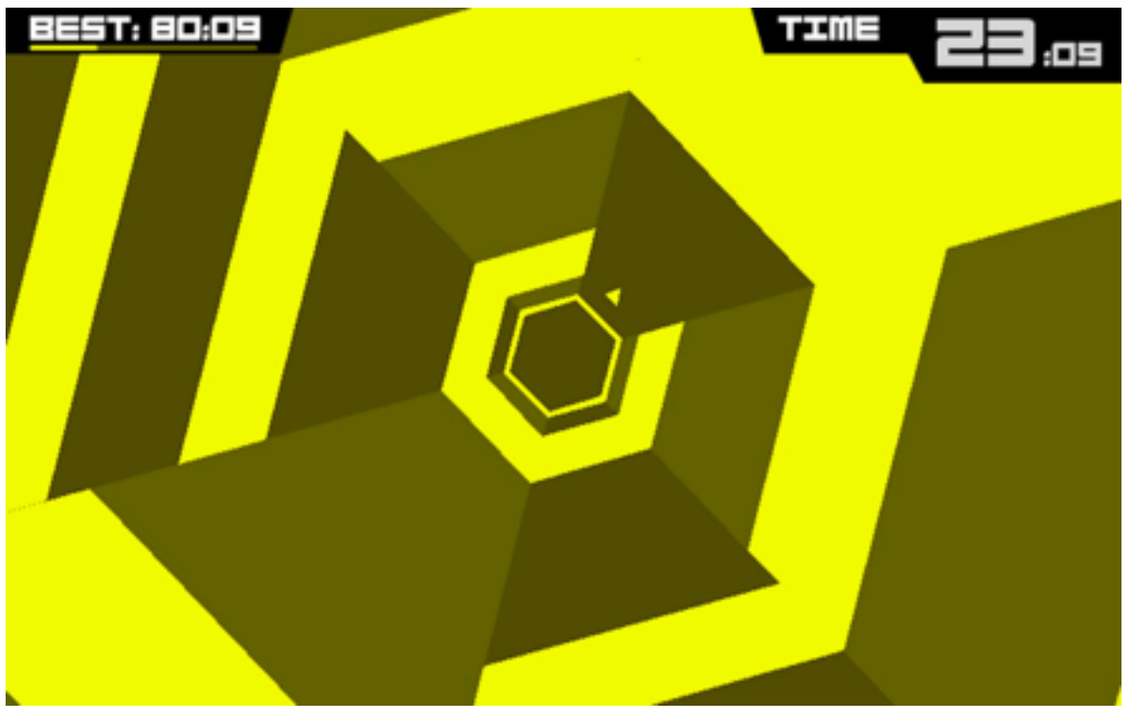
- Not every "is-a" relationship should use inheritance. Example: a square is a rectangle, but having width and height as separate data fields isn't necessary.

- Also, don't use inheritance if the objects don't have an "is-a" relationship. Example: a Butterfly class shouldn't extend from a Bird class, even if the data is very similar

Practice: Inheritance

- Create a subclass Bug that extends the Animal class and has the following properties:
  - a private variable legCount for how many legs it has
  - a constructor where you can pass in a name and leg count
  - a getter and setter for the legCount variable




BEST: 80:09
TIME 23:09

Super!

- The constructors of a superclass are not inherited by the subclass

- To call constructors or methods of a superclass, you can access the class using *`super`*. (very similar to the *`this`* keyword

super

```
Fish(boolean livesInOcean, String name, String sound, double height, double weight){
        super(name,sound,height,weight);
        this.livesInOcean = livesInOcean;

    }
```

Super!

- The *super()* call **must** be the first line of subclass constructor, and it is executed before the current constructor does anything else.

- If you don't put on in your subclass, the compiler puts one in for you behind the scenes.

```
public ClassName() {
  // some statements
}
```

Equivalent

```
public ClassName() {
  super();
  // some statements
}
```

```
public ClassName(double d) {
  // some statements
}
```

Equivalent

```
public ClassName(double d) {
  super();
  // some statements
}
```

Inheritance

- Note: if a class will be extended, make sure you have a no-arg constructor! Otherwise, you may run into an error

```
1  public class Apple extends Fruit {
2  }
3
4  class Fruit {
5    public Fruit(String name) {
6      System.out.println("Fruit's constructor is invoked");
7    }
8  }
```

Overriding Methods

- Sometimes, a subclass's methods should perform a bit differently than the superclass

- To do this, we can use *method overriding*

- Method overriding is when you have a method in a subclass that has the same signature as in the superclass. If you call it from a subclass, the subclass method will be executed.

- In order to call the superclass' method, you use super.methodName()

Overriding Methods

- Private methods cannot be overridden because they aren't accessible to the subclasses

- Static methods can be inherited, but not overridden. If a static method is named the same, the superclass method is hidden but can be accessed by using SuperClassName.StaticMethodName()

Overriding vs Overloading

```java
public class Test {
  public static void main(String[] args) {
    A a = new A();
    a.p(10);
    a.p(10.0);
  }
}

class B {
  public void p(double i) {
    System.out.println(i * 2);
  }
}

class A extends B {
  // This method overrides the method in B
  public void p(double i) {
    System.out.println(i);
  }
}
```

(a)

```java
public class Test {
  public static void main(String[] args) {
    A a = new A();
    a.p(10);
    a.p(10.0);
  }
}

class B {
  public void p(double i) {
    System.out.println(i * 2);
  }
}

class A extends B {
  // This method overloads the method in B
  public void p(int i) {
    System.out.println(i);
  }
}
```

(b)

Overriding vs Overloading

- Note: You can use @Override annotation to make sure you don't make a mistake!

```
1  public class CircleFromSimpleGeometricObject
2      extends SimpleGeometricObject {
3    // Other methods are omitted
4
5    @Override
6    public String toString() {
7      return super.toString() + "\nradius is " + radius;
8    }
9  }
```

Inheritance

- What happens if you don’t specify a superclass?

Object class

- Every class is java is descended from java.lang.object
- There is an implicit subclassing
- toString() method

Overriding Methods

- Let's add a toString() overriding method to our animals