[**https://www3.ntu.edu.sg/home/ehchua/programming/java/J3f\_OOPExercises.html**](https://www3.ntu.edu.sg/home/ehchua/programming/java/J3f_OOPExercises.html)

**Ex: Polymorphism**

Examine the following codes and draw the class diagram.

abstract public class **Animal** {

 abstract public void greeting();

}

public class **Cat extends Animal** {

 @Override

 public void greeting() {

 System.out.println("Meow!");

 }

}

public class **Dog extends Animal** {

 @Override

 public void greeting() {

 System.out.println("Woof!");

 }

 public void greeting(Dog another) {

 System.out.println("Woooooooooof!");

 }

}

public class **BigDog extends Dog** {

 @Override

 public void greeting() {

 System.out.println("Woow!");

 }

 @Override

 public void greeting(Dog another) {

 System.out.println("Woooooowwwww!");

 }

}

Explain the outputs (or error) for the following test program.

public class **TestAnimal** {

 public static void main(String[] args) {

 // Using the subclasses

 Cat cat1 = new Cat();

 cat1.greeting();

 Dog dog1 = new Dog();

 dog1.greeting();

 BigDog bigDog1 = new BigDog();

 bigDog1.greeting();

 // Using Polymorphism

 Animal animal1 = new Cat();

 animal1.greeting();

 Animal animal2 = new Dog();

 animal2.greeting();

 Animal animal3 = new BigDog();

 animal3.greeting();

 Animal animal4 = new Animal();

 // Downcast

 Dog dog2 = (Dog)animal2;

 BigDog bigDog2 = (BigDog)animal3;

 Dog dog3 = (Dog)animal3;

 Cat cat2 = (Cat)animal2;

 dog2.greeting(dog3);

 dog3.greeting(dog2);

 dog2.greeting(bigDog2);

 bigDog2.greeting(dog2);

 bigDog2.greeting(bigDog1);

 }

}



In this exercise, Shape shall be defined as an abstract class, which contains:

* Two protected instance variables color(String) and filled(boolean). The protected variables can be accessed by its subclasses and classes in the same package. They are denoted with a '#' sign in the class diagram.
* Getter and setter for all the instance variables, and toString().
* Two abstract methods getArea() and getPerimeter() (shown in italics in the class diagram).

The subclasses Circle and Rectangle shall *override* the abstract methods getArea() and getPerimeter() and provide the proper implementation. They also *override* the toString().

Write a test class to test these statements involving polymorphism and explain the outputs. Some statements may trigger compilation errors. Explain the errors, if any.

Shape s1 = new Circle(5.5, "RED", false); // Upcast Circle to Shape

System.out.println(s1); // which version?

System.out.println(s1.getArea()); // which version?

System.out.println(s1.getPerimeter()); // which version?

System.out.println(s1.getColor());

System.out.println(s1.isFilled());

System.out.println(s1.getRadius());

Circle c1 = (Circle)s1; // Downcast back to Circle

System.out.println(c1);

System.out.println(c1.getArea());

System.out.println(c1.getPerimeter());

System.out.println(c1.getColor());

System.out.println(c1.isFilled());

System.out.println(c1.getRadius());

Shape s2 = new Shape();

Shape s3 = new Rectangle(1.0, 2.0, "RED", false); // Upcast

System.out.println(s3);

System.out.println(s3.getArea());

System.out.println(s3.getPerimeter());

System.out.println(s3.getColor());

System.out.println(s3.getLength());

Rectangle r1 = (Rectangle)s3; // downcast

System.out.println(r1);

System.out.println(r1.getArea());

System.out.println(r1.getColor());

System.out.println(r1.getLength());

Shape s4 = new Square(6.6); // Upcast

System.out.println(s4);

System.out.println(s4.getArea());

System.out.println(s4.getColor());

System.out.println(s4.getSide());

// Take note that we downcast Shape s4 to Rectangle,

// which is a superclass of Square, instead of Square

Rectangle r2 = (Rectangle)s4;

System.out.println(r2);

System.out.println(r2.getArea());

System.out.println(r2.getColor());

System.out.println(r2.getSide());

System.out.println(r2.getLength());

// Downcast Rectangle r2 to Square

Square sq1 = (Square)r2;

System.out.println(sq1);

System.out.println(sq1.getArea());

System.out.println(sq1.getColor());

System.out.println(sq1.getSide());

System.out.println(sq1.getLength());

What is the usage of the abstract method and abstract class?