

2.1 Exercise: The Circle and Cylinder Classes

In this exercise, a subclass called **Cylinder** is derived from the superclass **Circle** as shown in the class diagram (where an arrow pointing up from the subclass to its superclass). Study how the subclass **Cylinder** invokes the superclass' constructors (via `super()` and `super(radius)`) and inherits the variables and methods from the superclass **Circle**.

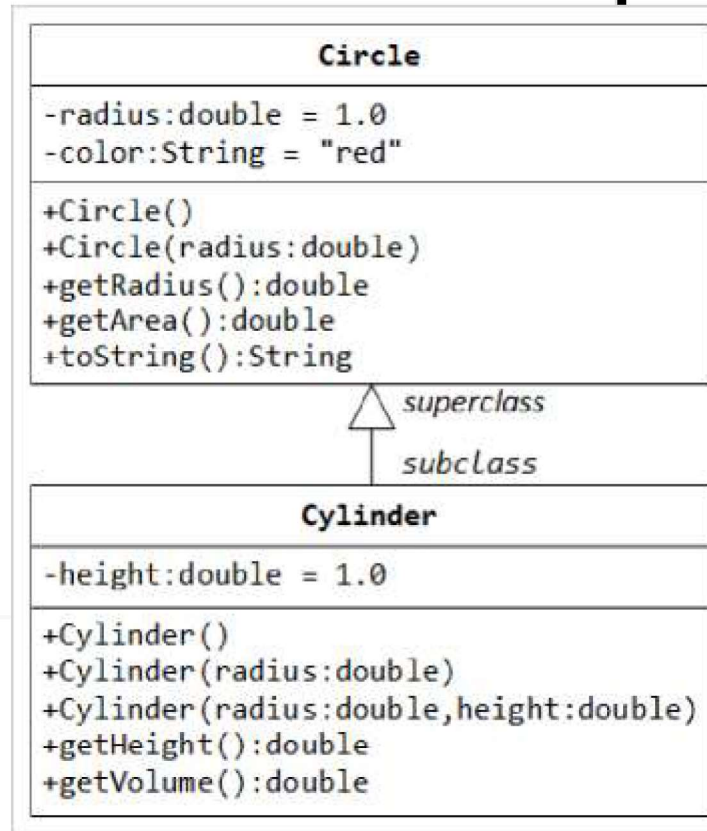
You can reuse the **Circle** class that you have created in the previous exercise. Make sure that you keep "**Circle.class**" in the same directory.

```
public class Cylinder extends Circle { //save as
    "Cylinder.java" private double height;
                                // private variable

    // Constructor with default color,
    // radius and height public Cylinder() {
        super(); // call superclass no-arg
        constructor Circle() height = 1.0;
    }
    // Constructor with default radius, color but
    // given height public Cylinder(double height) {
        super(); // call superclass no-arg
        constructor Circle() this.height = height;
    }
    // Constructor with default color, but given radius, height
    public Cylinder(double radius, double height) {
        super(radius); // call superclass constructor Circle(r)
        this.height = height;
    }

    // A public method for retrieving the height
    public double getHeight() {
        return height;
    }

    // A public method for computing the volume of cylinder
    // use superclass method getArea() to get the base area
    public double getVolume() {
        return getArea()*height;
    }
}
```



Write a test program `TestCylinder` to test the `Cylinder` class created, as follow:

```
public class TestCylinder { // save as "TestCylinder.java"
    public static void main (String[] args) {
        // Declare and allocate a new instance of cylinder
        // with default color, radius, and height
        Cylinder c1 = new Cylinder();
        System.out.println("Cylinder:"
            + " radius=" + c1.getRadius()
            + " height=" + c1.getHeight()
            + " base area=" + c1.getArea()
            + " volume=" + c1.getVolume());

        // Declare and allocate a new instance of cylinder
        // specifying height, with default color and radius
        Cylinder c2 = new Cylinder(10.0);
        System.out.println("Cylinder:"
            + " radius=" + c2.getRadius()
            + " height=" + c2.getHeight()
            + " base area=" + c2.getArea()
            + " volume=" + c2.getVolume());

        // Declare and allocate a new instance of cylinder
        // specifying radius and height, with default color
        Cylinder c3 = new Cylinder(2.0, 10.0);
        System.out.println("Cylinder:"
            + " radius=" + c3.getRadius()
            + " height=" + c3.getHeight()
            + " base area=" + c3.getArea()
            + " volume=" + c3.getVolume());
    }
}
```

Method Overriding and "Super": The subclass `Cylinder` inherits `getArea()` method from its superclass `Circle`. Try overriding the `getArea()` method in the subclass `Cylinder` to compute the surface area $\langle = 2\pi \times \text{radius} \times \text{height} + 2 \times \text{base-area} \rangle$ of the cylinder instead of base area. That is, if `getArea()` is called by a `Circle` instance, it returns the area. If `getArea()` is called by a `Cylinder` instance, it returns the surface area of the cylinder.

If you override the `getArea()` in the subclass `Cylinder`, the `getVolume()` no longer works. This is because the `getVolume()` uses the overridden `getArea()` method found in the same class. `Java` runtime will search the superclass only if it cannot locate the method in this class. Fix the `getVolume()`.

Hints: After overriding the `getArea()` in subclass `Cylinder`, you can choose to invoke the `getArea()` of the superclass `Circle` by calling `super.getArea()`.

TRY:

Provide a `toString()` method to the `Cylinder` class, which overrides the `toString()` inherited from the superclass `Circle`, e.g.,

```
@Override
public String toString() { // in Cylinder class
    return "Cylinder: subclass of " + super.toString() // use Circle's toString()
        + " height=" + height;
}
```

Try out the **toString()** method in **TestCylinder**.

Note: **@Override** is known as annotation \llcorner introduced in JDK 1.5 \gg , which asks compiler to check whether there is such a method in the superclass to be overridden. This helps greatly if you misspell the name of the **toString()**. If **@Override** is not used and **toString()** is misspelled as **Tostring()**, it will be treated as a new method in the subclass, instead of overriding the superclass. If **@Override** is used, the compiler will signal an error. **@Override** annotation is optional, but certainly nice to have.