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Section	19
Assignment No.	03
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Answer to Question 1: (Please scroll down to page 8 for question 2)

(Compiled in VS Code), in sequence in this report: TestGeometricObject, GeometricObject.java, Triangle.java

Rectangle.java, Circle.java not added here since no changes were made.

TestGeometricObject.java

```java
public class TestGeometricObject {

    /** Main method */

    public static void main(String[] args) {

      //create the geometric objects needed

      GeometricObject geoObject1 = new Circle(5);

      GeometricObject geoObject2 = new Rectangle(5, 3);

      GeometricObject geoObject3 = new Triangle(5, 3, 4);


      System.out.println("Do the three objects have the same area? " +
equalArea(geoObject1, geoObject2, geoObject3));


      // Display circle

      showGeometricObject(geoObject1);


      // Display rectangle

      showGeometricObject(geoObject2);


      //Display triangle

      showGeometricObject(geoObject3);

    }


    /** A method for comparing the areas of three geometric objects */
    public static boolean equalArea(GeometricObject o1, GeometricObject
o2, GeometricObject o3) {

      return o1.getArea() == o2.getArea() && o1.getArea() == o3.getArea();
//returns true if equal

    }


    //show geometric object by accessing their area, perimeter

    public static void showGeometricObject(GeometricObject object) {

      System.out.println();

      System.out.println("The area is " + object.getArea());

      System.out.println("The perimeter is " + object.getPerimeter());

    }

  }
```

GeometricObject.java

```
public abstract class GeometricObject {

    private String color = "white";

    private boolean filled;

    private java.util.Date dateCreated;


    /** Construct a default geometric object */

    protected GeometricObject() {

      dateCreated = new java.util.Date();

    }


    /** Construct a geometric object with color and filled value */

    protected GeometricObject(String color, boolean filled) {
```

```java
    dateCreated = new java.util.Date();
    this.color = color;
    this.filled = filled;
  }

  /** Return color */
  public String getColor() {
    return color;
  }

  /** Set a new color */
  public void setColor(String color) {
    this.color = color;
  }

  /** Return filled. Since filled is boolean,
   *  the get method is named isFilled */
  public boolean isFilled() {
    return filled;
  }

  /** Set a new filled */
  public void setFilled(boolean filled) {
    this.filled = filled;
  }

  /** Get dateCreated */
```

```
    public java.util.Date getDateCreated() {

      return dateCreated;

    }


    /** Return a string representation of this object */

    public String toString() {

      return "created on " + dateCreated + "\ncolor: " + color +

        " and filled: " + filled;

    }


    /** Abstract method getArea */

    public abstract double getArea();


    /** Abstract method getPerimeter */

    public abstract double getPerimeter();

  }
```

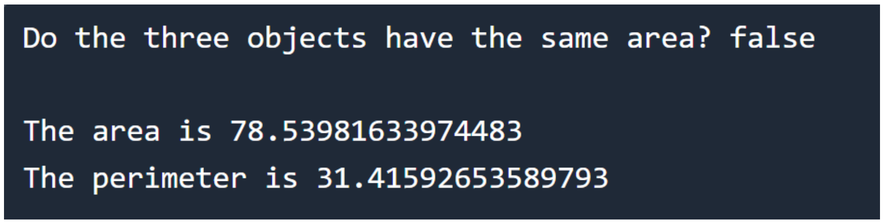
Triangle.java

```
public class Triangle extends GeometricObject {

    private double s1 = 1.0;

    private double s2 = 1.0;

    private double s3 = 1.0;


    public Triangle() {

    }
```

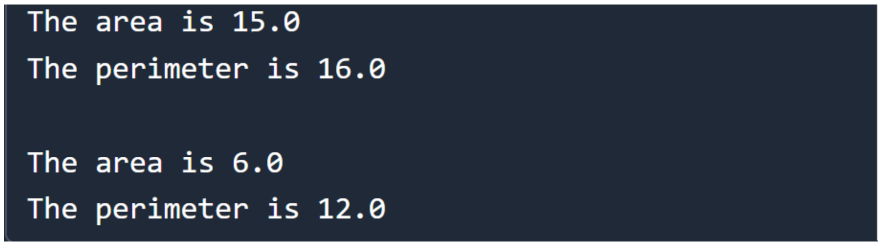
```
public Triangle(double s1, double s2, double s3) {
    this.s1 = s1;
    this.s2 = s2;
    this.s3 = s3;
}

    /** Return sides */
public double getS1() {
    return s1;
}

public double getS2() {
    return s2;
}

public double getS3() {
    return s3;
}

public void setS1(double s1) {
    this.s1 = s1;
}

public void setS2(double s2) {
    this.s2 = s2;
}
```

```java
    public void setS3(double s3) {
        this.s3 = s3;
    }
    //calculate perimeter

    public double getPerimeter() {
        return s1 + s2 + s3;
    }

    //calculate area
    public double getArea() {
        double x = getPerimeter() / 2;
        return Math.sqrt(x * ((x - s1) * (x - s2) * (x - s3)));
    }

}
```

Output after compiling TestGeometricObject.java (as it has main method)



```
Do the three objects have the same area? false

The area is 78.53981633974483
The perimeter is 31.41592653589793
```



```
The area is 15.0
The perimeter is 16.0

The area is 6.0
The perimeter is 12.0
```

Answer to Question 2

The four characteristics of OOP are: 1. Encapsulation, 2. Abstraction, 3. Inheritance, 4. Polymorphism.

1. **Encapsulation** in code: In Java, we can create a fully encapsulated class by making all the data members of the class private. Now we can use setter and getter methods to set and get the data in it. There were numerous examples of encapsulation used in all of the 5 classes. For example, in Triangle class, we saw the sides being declared as private variables early on, then used setter and getter to get the data.

   Declaring the private variables

```
  private double s1 = 1.0;

  private double s2 = 1.0;

  private double s3 = 1.0;
```

   Sample getter setters for a side

```
  public double getS1() {

    return s1;}

  public void setS1(double s1) {

      this.s1 = s1;

  }
```

2. **Abstraction** in code: In Java, Abstraction is a process of hiding the implementation details and showing only functionality to the user, abstraction can be done for classes and methods both. In GeometricObject.java, the class was created as abstract then two abstract methods were defined with the implementations hidden.

```
  /** Abstract method getArea */

  public abstract double getArea();



  /** Abstract method getPerimeter */

  public abstract double getPerimeter();
```

3. **Inheritance** in code: In Java, inheritance is a mechanism in which one object acquires all the properties and behaviors of a parent object. There were numerous examples of inheritance all throughout the code, Triangle, Rectangle, Circle all of the three classes inherited all of the available attributes and methods from GeometricObject

```
public class Triangle extends GeometricObject {
```

4. **Polymorphism** in code: in Java, Polymorphism is an idea by which we can perform a single action in different ways. All of the Triangle, Circle, Rectangle classes had getArea(), getPerimeter() methods with the same return type and same method name. Then later they were compared in main program to check whether the area is not equal for all three or not, calling methods with same name but with different functionality from separate classes.

   Triangle getArea():

```
  public double getArea() {

    double x = getPerimeter() / 2;

    return Math.sqrt(x * ((x - s1) * (x - s2) * (x - s3)));

  }
```

   Circle getArea():

```
  public double getArea() {

    return radius * radius * Math.PI;

  }
```

Rectangle getArea():

```
    public double getArea() {

      return width * height;

    }
```

Comparison in main, for three different objects calling three separate methods with same name but different formulae from three different classes

```
    /** A method for comparing the areas of three geometric objects
*/

    public static boolean equalArea(GeometricObject o1,
GeometricObject o2, GeometricObject o3) {

      return o1.getArea() == o2.getArea() && o1.getArea() ==
o3.getArea();       //returns true if equal

    }
```

The End