SOLID

EXERCISES

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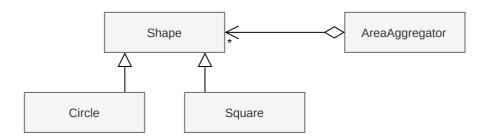
#exercises #java #solid #oop

SOLID

- 1. SINGLE RESPONSIBILITY (SRP)
 - Create a Java/Gradle project, using IntelliJ, called area-calculator.
 - Create an **AreaAggregator** class with the following code:

```
public class AreaAggregator {
  private List<Shape> shapes = new ArrayList<>();
  public void addShape(Shape shape) {
    shapes.add(shape);
  }
  public double sum() {
    double sum = 0;
    for (Shape shape: shapes) {
      if(shape.getClass().equals(Circle.class)) {
        sum += Math.PI * Math.pow(((Circle) shape).getRadius(), 2);
      } else if (shape.getClass().equals(Square.class)) {
        sum += Math.pow(((Square) shape).getSide(), 2);
      }
    return sum;
  }
  public String output() {
      return "Sum of areas: " + sum();
  }
}
```

- Create new classes for Shape, Circle and Squares. A Circle has a radius, a Square
 has a side and both extend a Shape (shapes do nothing for now).
- Create a new Application class with a main() method, where you instantiate the AreaAggregator class, calculate the total area of two or three shapes of different types and dimensions, and print it.



IDENTIFYING THE ISSUE

We have now a very basic but working program. Let's now **add** two more **features**:

- Add a new shape: Ellipse. An Ellipse has a x-radius and a y-radius and the
 AreaAggregator should also know how to calculate its area (π * x-radius * y-radius).
- Add a new way to output an area. For example: outputXML() that prints the area in
 XML, for example:

<area>25</area>

- Use these new functionalities in your Application class to see if they are working.
- Realize that you changed the AreaAggregator class for two different reasons (new shape and new output format) and that it is a violation of the SRP (Single Responsibility Principle):

"Each software module should have one and only one reason to change."

FIXING THE ISSUE

- Start by deleting the **outputXML()** method.
- Split the AreaAggregator into two different classes: AreaAggregator (that calculates areas) and AreaStringOutputter (that receives a AreaAggregator in its

constructor, and has a method called **output()** that uses the aggregator to calculate an area and output the result).

- Now add an AreaXMLOutputter class, and notice that you didn't have to change the AreaAggregator class.
- Use these new classes in your **Application** class. It should look something like this:

```
//...
AreaStringOutputter stringOutputter = new
AreaStringOutputter(aggregator);
AreaXMLOutputter xmlOutputter = new AreaXMLOutputter(aggregator);
System.out.println(stringOutputter.output());
System.out.println(xmlOutputter.output());
```



2. OPEN/CLOSED (OCP)

Add a new shape: Rectangle. A Rectangle has a width and height.

IDENTIFYING THE ISSUE

- Notice that you still had to change the **AreaAggregator** class to add the new shape.
- Realize that this violates the OCP (Open/Close Principle):

"A module should be open for extension but closed for modification."

FIXING THE ISSUE

Move the area calculation to the **Shape** class and implementations by creating a **getArea()** method in all of them. The **getArea()** method in the **Shape** class and the Shape class itself should now be **abstract**, like this:

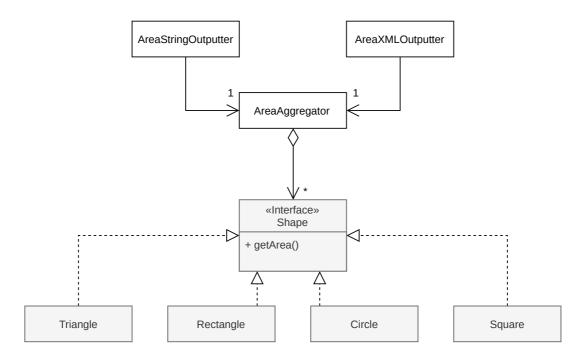
```
public abstract class Shape {
  public abstract double getArea();
}
```

A **better** solution would be to have **Shape** as an **interface** and all subclasses **implementing** this **interface** instead of **extending** a **class**:

```
public interface Shape {
  double getArea();
}
```

Lets do it **this way**, and then:

- Simplify the **AreaAggregator** class using these new methods (**polymorphism FTW**).
- Add a **Triangle** class. A **Triangle** has a **base size** and **height** (area = height * base / 2).
- Notice that you **did not** have to **change** any other classes.
- Use the **Triangle** class in your **Application** class.



3. LISKOV SUBSTITUTION (LSP)

- Add a new shape: **Line**.
- A **Line** has a **length** and throws a **NoAreaException** if asked for an area.

IDENTIFYING THE ISSUE

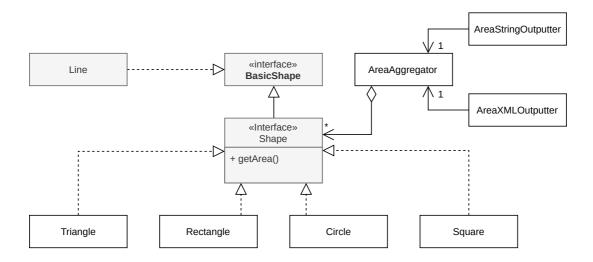
Realize that this violates the LSP (**Liskov Substitution Principle**) as you cannot trust **Shape**s to have an area. You would have to catch this exception inside the **AreaAgreggator** class:

"Subclasses should be substitutable for their base classes."

You can see this is a problem by trying to use a **Line** in your **Application** class.

FIXING THE ISSUE

- Create a new interface called BasicShape and make Shape extend it. Make Line implement this interface instead of Shape.
- Notice that now, you don't have to worry about a shape throwing a
 NoAreaException inside the AreaAggregator, as there is no risk that a Line will be found when iterating through all the Shapes. This happens because you can't even add a Line to the AreaAggregator.



4. INTERFACE SEGREGATION (ISP)

Add a **draw()** method to the **Shape** interface and implement it in each **Shape**. For now this method can just **print** the **name** of the **class** (e.g **Rectangle**, **Circle**, ...).

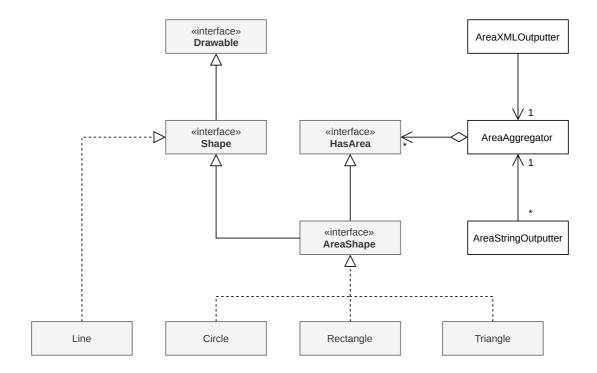
IDENTIFYING THE ISSUE

Realize that your **AreaAggregator** class now depends on **something** that knows how to **draw** itself without really needing to, violating the ISP (**Interface Segregation Principle**):

Many client specific interfaces are better than one general purpose interface.

FIXING THE ISSUE

- Separate the **drawing** aspect of a shape into a **Drawable** interface.
- Now that we are at it, we can also separate an HasArea interface and organize our classes like this:



- Realize that now, adding a new class that also has an area (like a Shape) but isn't a shape is very easy. And these HasArea classes could be easily used with the AreaAggregator class.
- Add a new House class that implements the HasArea interface (but is not a Shape)
 and use it with the AreaAggregator class in the Application.

5. DEPENDENCY INVERSION (DIP)

 Create a new class called City that is capable of receiving and saving a List of Houses. • This class should also have a **sum()** method that calculates the sum of all house areas in the city.

IDENTIFYING THE ISSUE

- Try, and fail, to use the **City** class together with the **AreaAgreggator** class.
- This does not work:

```
List<House> houses = new ArrayList<>();
houses.add(new House(50));
houses.add(new House(150));

City city = new City(houses);

AreaStringOutputter cityStringOutputter = new
AreaStringOutputter(city);
AreaXMLOutputter cityXmlOutputter = new AreaXMLOutputter(city);
```

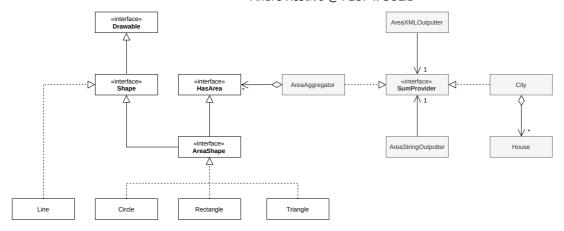
Having **AreaStringOutputter** depend on **AreaAggregator** makes it a not very reusable solution – e.g., it can't be used to output a sum of areas provided by alternative implementations.

This happens because we are violating the DIP (**Dependency Inversion Principle**):

"High-level modules should not depend on low-level modules. Both should depend on abstractions."

FIXING THE ISSUE

- Change AreaStringOutputter and AreaXMLOutputter to depend on an
 SumProvider interface instead of depending directly on the AreaAggregator class.
- The City and AreaAggregator classes should implement this interface.
- This will allow alternative implementations to be used with the **outputter** classes.



In the end, your main() method in the Application class should look something like this:

```
public static void main(String[] args) {
  AreaAggregator aggregator = new AreaAggregator();
  aggregator.addShape(new Square(10));
  aggregator.addShape(new Circle(5));
  aggregator.addShape(new Circle(2));
  aggregator.addShape(new Ellipse(2, 3));
  aggregator.addShape(new Rectangle(10, 5));
  aggregator.addShape(new Triangle(10, 2));
  aggregator.addShape(new House(100));
  AreaStringOutputter stringOutputter = new
AreaStringOutputter(aggregator);
  AreaXMLOutputter xmlOutputter = new AreaXMLOutputter(aggregator);
  System.out.println(stringOutputter.output());
  System.out.println(xmlOutputter.output());
  List<House> houses = new ArrayList<>();
  houses.add(new House(50));
  houses.add(new House(150));
  City city = new City(houses);
  AreaStringOutputter cityStringOutputter = new
AreaStringOutputter(city);
  AreaXMLOutputter cityXmlOutputter = new AreaXMLOutputter(city);
  System.out.println(cityStringOutputter.output());
  System.out.println(cityXmlOutputter.output());
}
```

And print:

Sum of areas: 369.9557428756428
<area>369.9557428756428</area>

Sum of areas: 200.0 <area>200.0</area>

6. TIME FOR HEROES

Open your the **Hero** code you created in a previous class and analyse it looking for possible OOP principles violations.

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