SOLID

EXERCISES

home / exercises / solid

#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:

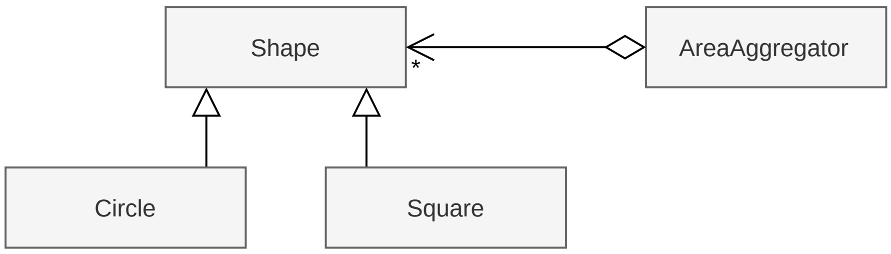
```
public class AreaAggregator {
  private List<Shape> shapes = new ArrayList<>();

  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 **Square**s. 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

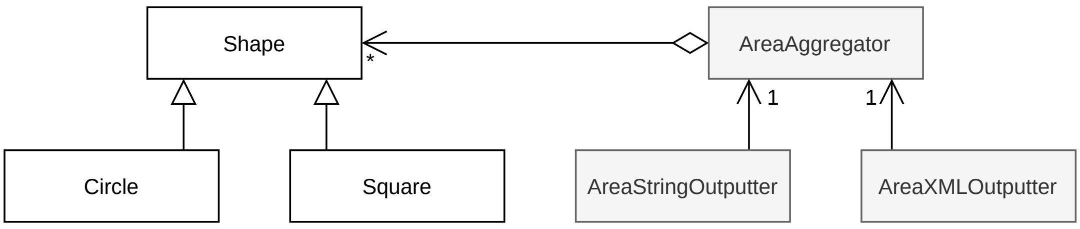
- Start by deleting the **outputXML()** method.
- Split the **AreaAggregator** into two different classes: **AreaAggregator** (that calculates areas) and **AreaStringOutputter** (that receives a **AreaAggregator** in its

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:

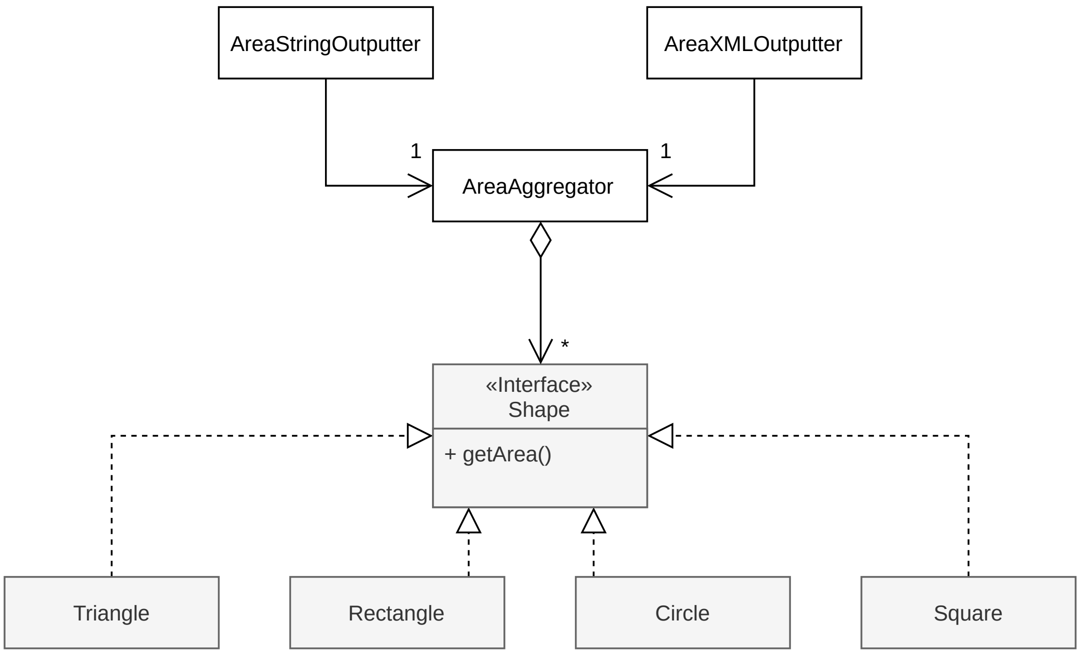
```java
public abstract class Shape {
  public abstract double getArea();
}
```

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

```java
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

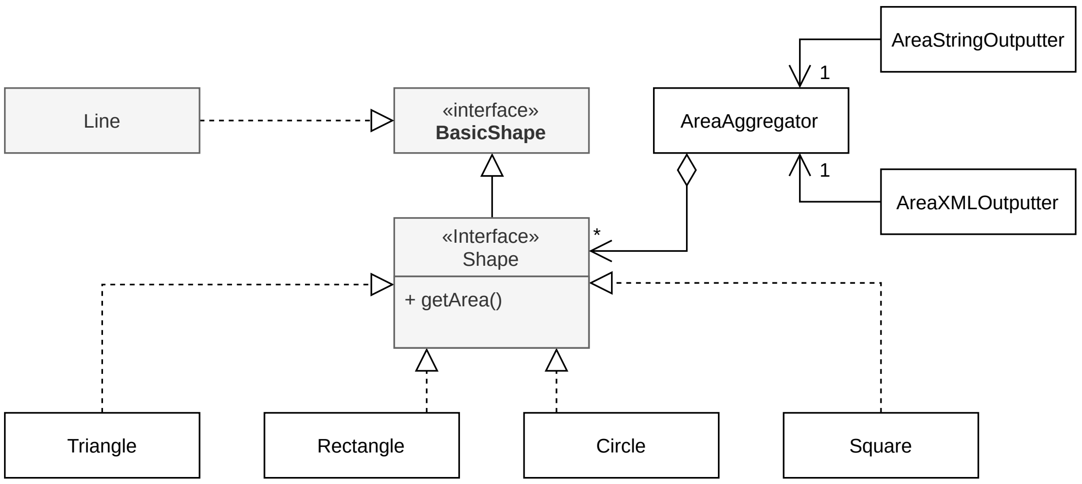
Realize that this violates the LSP (**Liskov Substitution Principle**) as you cannot trust **Shape**s to have an area. You would have to catch this exception inside the **AreaAgreggator** class:

> "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**, ...).

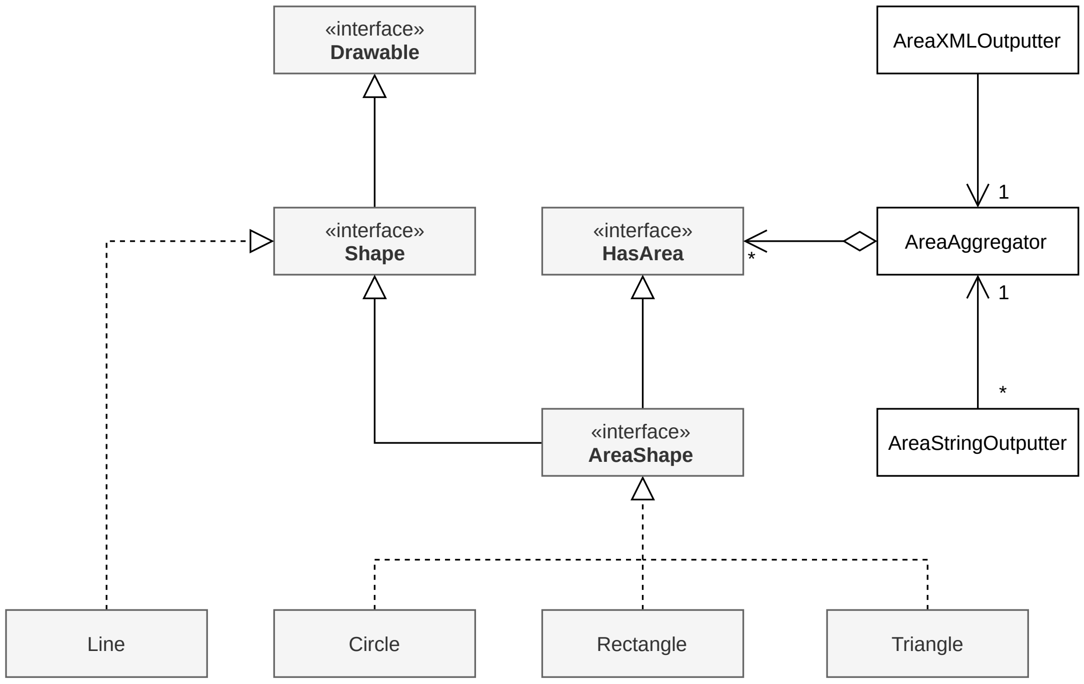
IDENTIFYING THE ISSUE

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 **House**s.

- 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);
```

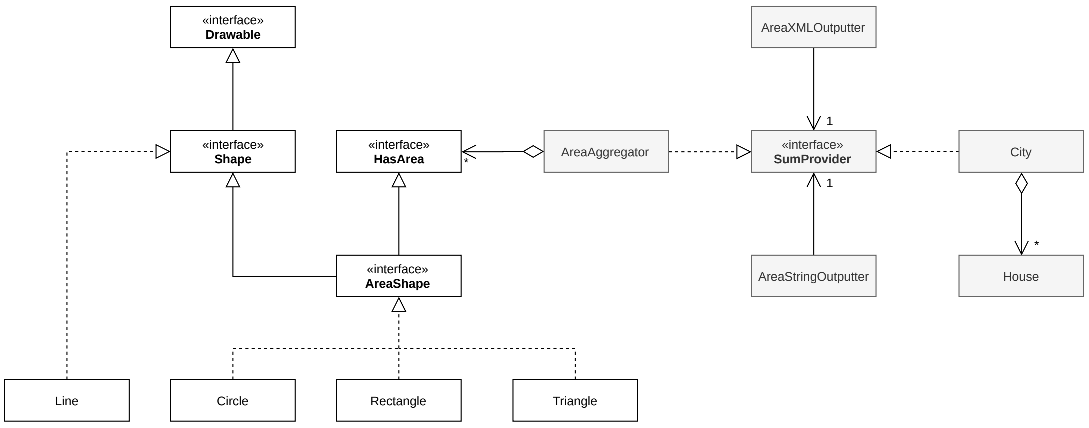
Having **AreaStringOutputter** depend on **AreaAggregator** makes it a not very reusable solution – e.g., it can't be used to output a sum of areas provided by alternative implementations.

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.