Exercises on Design Patterns II

Even more basics

STRATEGY DESIGN PATTERN, ABSTRACT FACTORY DESIGN PATTERN, BUILDER DESIGN PATTERN, FACADE DESIGN PATTERN, BRIDGE DESIGN PATTERN, and COMPOSITE DESIGN PATTERN

You should use Java 8 (or Scala) to answer the following exercises.
The source code examples can be found on the repository under the `exercise-dp-two` folder.

1. (a) Briefly describe the Strategy Design Pattern?

   (b) When is it appropriate to use the STRATEGY DESIGN PATTERN?

2. Create a text formatter for a text editor. A text editor can have different text formatters to format text. We can create different text formatters and then pass the required one to the text editor, so that the editor will able to format the text as required.

   The text editor will hold a reference to a common interface for the text formatter and the editorÃć's job will be to pass the text to the formatter to format the text. You are required to implement this outline using the STRATEGY DESIGN PATTERN which will make the code flexible and maintainable.

   Below is the `TextFormatter` interface which is implemented by all the concrete formatters.

```
package strategy;

public interface TextFormatter {
    void format(String text);
}
```

   The above interface contains only one method, `format`, used to format the text.

   Some sample test code might look like:

```
package strategy;

public class TestStrategyPattern {
    public static void main(String[] args) {
        TextFormatter formatter = new CapTextFormatter();
        TextEditor editor = new TextEditor(formatter);
        editor.publishText("Testing text in caps formatter");
        formatter = new LowerTextFormatter();
        editor = new TextEditor(formatter);
        editor.publishText("Testing text in lower formatter");
    }
}
```

The above code will result to the following output:

```
[CapTextFormatter]: TESTING TEXT IN CAPS FORMATTER
[LowerTextFormatter]: testing text in lower formatter
```

3. When is it appropriate to use the ABSTRACT FACTORY design pattern?

4. A product company, BIGFISH, has changed the way they take orders from their clients. The company uses an application to take orders from them. They receive orders, errors in orders, feedback for the previous order, and responses to the order, in an XML format.

   Now the clients donÃć't want to follow the companyÃć's specific XML rules. The clients want to use their own XML rules to communicate with BIGFISH. This means that for every client, the company should have client specific XML parsers. For example, for the NYC client there should be four specific types of XML parsers, i.e., `NYCErrorXMLParser`, `NYCFeedbackXML`, `NYCOrderXMLParser`, `NYCResponseXMLParser`, and four different parsers for the London client.

   The company has asked you to change the application according to the new requirements. To develop the parser for the original application they used a FACTORY METHOD design pattern in which the exact object to use is decided by the subclasses according to the type of parser. Now, to implement the new requirements, you are required to use a factory of factories, i.e., an ABSTRACT FACTORY.

   Note: You will need parsers according to client specific XMLs, so you will create different factories for different clients which will provide the client specific XML to parse. You will achieve this by creating an ABSTRACT FACTORY and then implement the factory to provide a client specific XML factory. Then you will use that factory to get the desired client specific XML parser object.

   To implement the pattern you first need to create an interface that will be implemented by all the concrete factories:

```
package abstractfactory;

public interface AbstractParserFactory {

    public XMLParser getParserInstance(String parserType);
}
```

   The above interface is implemented by the client specific concrete factories which will provide the XML parser object to the client object. The `getParserInstance` method takes the `parserType` as an argument which is used to get the message specific (error parser, order parser etc) parser object.

   The following is a test class for the resulting code:

```
package abstractfactory;

public class TestAbstractFactoryPattern {

    public static void main(String[] args) {

        AbstractParserFactory parserFactory = ParserFactoryProducer.getFactory("NYCFactory");
        XMLParser parser = parserFactory.getParserInstance("NYCORDER");
        String msg = "";
        msg = parser.parse();
```

```
        System.out.println(msg);

        System.out.println("***********************************");

        parserFactory = ParserFactoryProducer.getFactory("LondonFactory");
        parser = parserFactory.getParserInstance("LondonFEEDBACK");
        msg = parser.parse();
        System.out.println(msg);
    }

}
```

The above code will result to the following output:

```
NYC Parsing order XML...
NYC Order XML Message
***********************************
London Parsing feedback XML...
London Feedback XML Message
```

5. > "In general, the details of object construction, such as instantiating and initialising the components that comprise the object, are kept within the object, often as part of its constructor."

   Comment on this statement with reference to *modularity* and *construction bloat*.

6. As an example of the BUILDER PATTERN, consider a Car company which displays its different cars to its customers using a graphical model. The company has a graphical tool which displays the car on the screen. The requirements of the tool are that it is provided with a car object display. The car object should contain the carÃć's specifications. The graphical tool uses these specifications to display the car.

   The company has classified its cars into different groups, e.g., Sedan, or Sports Car. There is only one car object, and our job is to create the car object according to the classification. For example, for a sedan car, a car object according to the sedan specification should be built or, if a sports car is required, then a car object according to the sports car specification should be built.

   Currently, the Company wants only these two types of cars, but it may require other types of cars also in the future. You are required to create two different builders, one of each classification, i.e., for sedan and sports cars. The two builders will help in building the car object according to its specification.

   Below is the `Car` class which contains some of the important components of the car that are required to construct the complete car object.

```
package builder;

public class Car {

    private String bodyStyle;
    private String power;
    private String engine;
    private String breaks;
    private String seats;
    private String windows;
    private String fuelType;
    private String carType;

    public Car(String carType) {
        this.carType = carType;
```

```
    }

    public String getBodyStyle() {
        return bodyStyle;
    }

    public void setBodyStyle(String bodyStyle) {
        this.bodyStyle = bodyStyle;
    }

    public String getPower() {
        return power;
    }

    public void setPower(String power) {
        this.power = power;
    }

    public String getEngine() {
        return engine;
    }

    public void setEngine(String engine) {
        this.engine = engine;
    }

    public String getBreaks() {
        return breaks;
    }

    public void setBreaks(String breaks) {
        this.breaks = breaks;
    }

    public String getSeats() {
        return seats;
    }

    public void setSeats(String seats) {
        this.seats = seats;
    }

    public String getWindows() {
        return windows;
    }

    public void setWindows(String windows) {
        this.windows = windows;
    }

    public String getFuelType() {
        return fuelType;
    }

    public void setFuelType(String fuelType) {
        this.fuelType = fuelType;
    }

    @Override
    public String toString() {
        StringBuilder sb = new StringBuilder();
        sb.append("--------------" + carType + "--------------------- \n");
        sb.append(" Body: ");
        sb.append(bodyStyle);
        sb.append("\n Power: ");
        sb.append(power);
        sb.append("\n Engine: ");
        sb.append(engine);
        sb.append("\n Breaks: ");
        sb.append(breaks);
        sb.append("\n Seats: ");
        sb.append(seats);
        sb.append("\n Windows: ");
```

```
        sb.append(windows);
        sb.append("\n Fuel Type: ");
        sb.append(fuelType);

        return sb.toString();
    }
}
```

You should be able to test your implementation using the following `TestBuilderPattern` class:

```
package builder;

public class TestBuilderPattern {

    public static void main(String[] args) {
        CarBuilder carBuilder = new SedanCarBuilder();
        CarDirector director = new CarDirector(carBuilder);
        director.build();
        Car car = carBuilder.getCar();
        System.out.println(car);

        carBuilder = new SportsCarBuilder();
        director = new CarDirector(carBuilder);
        director.build();
        car = carBuilder.getCar();
        System.out.println(car);
    }

}
```

The above code will result to the following output:

```
--------------SEDAN---------------------
 Body: External dimensions: overall length (inches): 202.9,
   overall width (inches): 76.2, overall height (inches): 60.7,
   wheelbase (inches): 112.9, front track (inches): 65.3,
   rear track (inches): 65.5 and curb to curb turning circle (feet): 39.5
 Power: 285 hp @ 6,500 rpm; 253 ft lb of torque @ 4,000 rpm
 Engine: 3.5L Duramax V 6 DOHC
 Breaks: Four-wheel disc brakes: two ventilated. Electronic brake distribution
 Seats: Front seat centre armrest.Rear seat centre armrest.Split-folding rear seats
 Windows: Laminated side windows.Fixed rear window with defroster
 Fuel Type: Diesel 19 MPG city, 29 MPG highway, 23 MPG combined and 437 mi. range
--------------SPORTS---------------------
 Body: External dimensions: overall length (inches): 192.3,
   overall width (inches): 75.5, overall height (inches): 54.2,
   wheelbase (inches): 112.3, front track (inches): 63.7,
   rear track (inches): 64.1 and curb to curb turning circle (feet): 37.7
 Power: 323 hp @ 6,800 rpm; 278 ft lb of torque @ 4,800 rpm
 Engine: 3.6L V 6 DOHC and variable valve timing
 Breaks: Four-wheel disc brakes: two ventilated. Electronic brake distribution.
   Stability control
 Seats: Driver sports front seat with one power adjustments manual height,
   front passenger seat sports front seat with one power adjustments
 Windows: Front windows with one-touch on two windows
 Fuel Type: Petrol 17 MPG city, 28 MPG highway, 20 MPG combined and 380 mi. range
```

7. (a) What is the Facade Pattern?
   (b) When, and why, would you use the Facade Pattern?

8. BetterBisc is product based company and it has launched a product in the market, named *Schedule Server*. It is a kind of server in itself, and it is used to manage jobs. The jobs could be any kind of jobs like sending a list of emails, sms, reading or

writing files from a destination, or just simply transferring files from a source to the destination.

The product is used by the developers to manage such types of job and enables them to concentrate on their business goal. The server executes each job at their specified time and also manages any underling issues like concurrency, security, etc. As a developer, one just needs to code the relevant business requirements and a good amount of API calls is provided to schedule a job according to their needs.

Everything was going fine, until the clients started complaining about starting and stopping the the server. Although the server is working well, the initialisation and the shut down processes are very complex and they want an easy way to do that. The server has exposed a complex interface to the clients which looks a bit *busy* to them.

We need to provide an easy way to start and stop the server.

A complex interface to the client is already considered as a fault in the design of the current system. Fortunately or unfortunately, we cannot start the design and the coding from scratch. We need a way to resolve this problem and make the interface easy to access.

The problem faced by the clients in using the schedule server is the complexity brought by the server in order to start and stop its services. The client wants a simple way to do it. The following is the code that clients required to write to start and stop the server.

```
ScheduleServer scheduleServer = new ScheduleServer();
```

To start the server, the client needs to create an object of the `ScheduleServer` class and then needs to call the following methods (in sequence) to start and initialise the server.

```
scheduleServer.startBooting();
scheduleServer.readSystemConfigFile();
scheduleServer.init();
scheduleServer.initializeContext();
scheduleServer.initializeListeners();
scheduleServer.createSystemObjects();
System.out.println("Start working......");
System.out.println("After work done.........");
```

To stop the server, the client needs to call the following methods in sequence:

```
scheduleServer.releaseProcesses();
scheduleServer.destory();
scheduleServer.destroySystemObjects();
scheduleServer.destoryListeners();
scheduleServer.destoryContext();
scheduleServer.shutdown();
```

To resolve this, you will create a *facade class* which will *wrap* a server object. This class will provide simple interfaces (methods) for the client. These interfaces internally will call the methods on the server object.

```
package facadepattern;

public interface ScheduleServer {
```

```
    void startBooting();

    void readSystemConfigFile();

    void init();

    void initializeContext();

    void initializeListeners();

    void createSystemObjects();

    void releaseProcesses();

    void destory();

    void destroySystemObjects();

    void destoryListeners();

    void destoryContext();

    void shutdown();
}
```

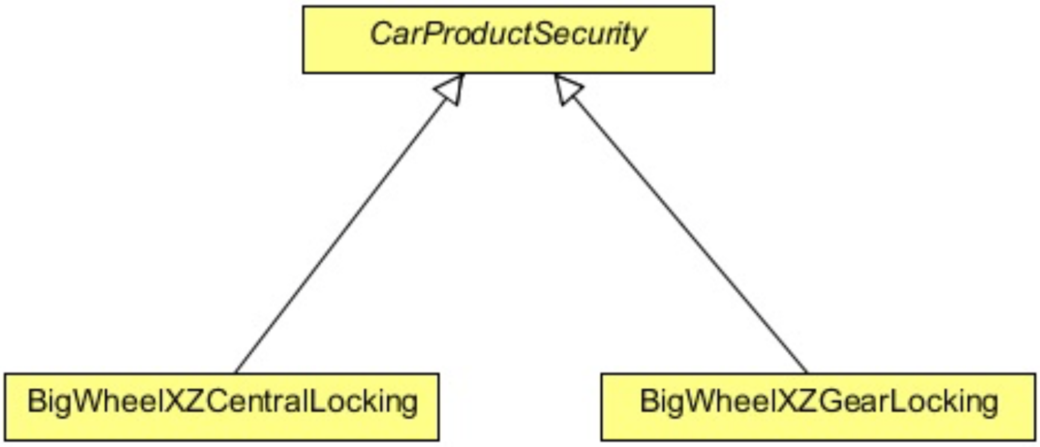
9. When should one make use of the BRIDGE DESIGN PATTERN?

10. DODGY SECURITY SYSTEMS is a security and electronic company which produces and assembles products for cars. It delivers any car electronic or security system you want, from air bags to GPS tracking system, reverse parking system, etc. The company uses a well defined object oriented approach to keep track of their products using software which is developed and maintained only by them. They receive a vehicle, produce the system for it, and then assemble it and install it into the vehicle.

    Recently, they received new orders from BIGWHEEL (a car company) to produce central locking and gear lock systems for their new car model. To maintain this, they are creating a new software system. They started by creating a new abstract class `CarProductSecurity`, in which they kept some car specific methods and some of the features which they thought are common to all security products. Then they extended the class and created two different sub classes:

    - `BigWheelCentralLocking`, and
    - `BigWheelGearLocking`.

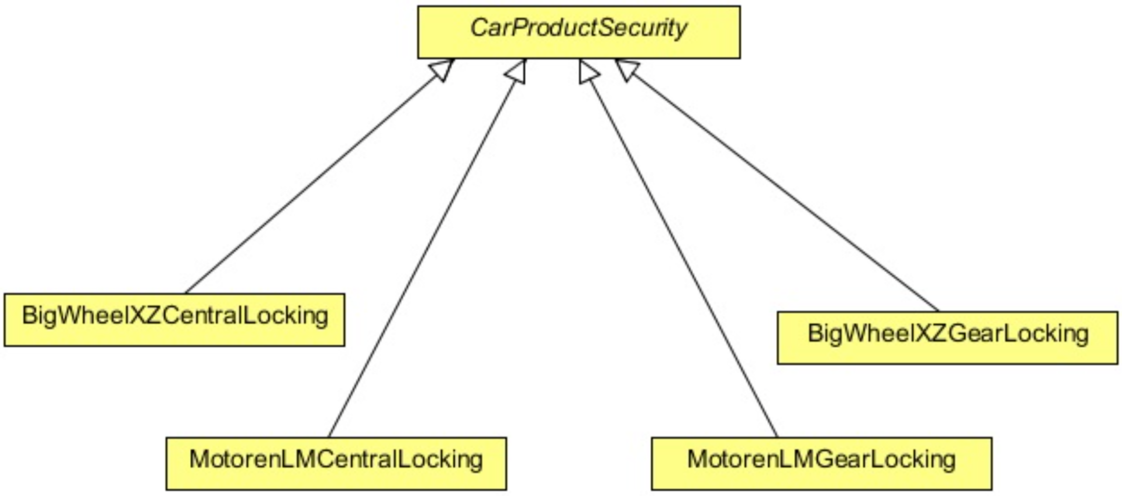
    The class diagram is as follows:



After a while, another car company Motoren asked them to produce a new system of central locking and gear lock for their new model. Since, the same security system cannot be used in both models of different cars, Dodgy Security Systems has produced a new system for them, and also has created two new classes

- `MotorenCentralLocking`, and
- `MotorenGearLocking`

which also extend the `CarProductSecurity` class. Now the new class diagram looks like this:



what happens if another car company demands another new system for central locking and gear lock? One would need to create another two new classes for it. This design will create one class per system, or worse, if a reverse parking system is produced for each of these two car companies, two more new classes will be created for each of them.

Provide a solution to this problem using an implementation of the Bridge Design Pattern. We provide an appropriate test method:

```
package bridge;
```

```
public class TestBridgePattern {
    public static void main(String[] args) {
        Product product = new CentralLocking("Central Locking System");
        Product product2 = new GearLocking("Gear Locking System");
        Car car = new BigWheel(product, "BigWheel xz model");
        car.produceProduct();
        car.assemble();
        car.printDetails();
        System.out.println();
        car = new BigWheel(product2, "BigWheel xz model");
        car.produceProduct();
        car.assemble();
        car.printDetails();
        car = new Motoren(product, "Motoren lm model");
        car.produceProduct();
        car.assemble();
        car.printDetails();
        System.out.println();
        car = new Motoren(product2, "Motoren lm model");
        car.produceProduct();
        car.assemble();
        car.printDetails();
    }
}
```

which will produce the following output:

```
Producing Central Locking System
Modifying product Central Locking System according to BigWheel xz model
Assembling Central Locking System for BigWheel xz model
Car: BigWheel xz model, Product:Central Locking System

Producing Gear Locking System
Modifying product Gear Locking System according to BigWheel xz model
Assembling Gear Locking System for BigWheel xz model
Car: BigWheel xz model, Product:Gear Locking System

Producing Central Locking System
Modifying product Central Locking System according to Motoren lm model
Assembling Central Locking System for Motoren lm model
Car: Motoren lm model, Product:Central Locking System

Producing Gear Locking System
Modifying product Gear Locking System according to Motoren lm model
Assembling Gear Locking System for Motoren lm model
Car: Motoren lm model, Product:Gear Locking System
```

11. (a) What is the Composite Pattern?
    (b) Under what conditions would you use a Composite Design Pattern?
    (c) What are the four participants of the Composite Design Pattern?

12. HTML is hierarchical in nature, its starts from an `<html>` tag which is the parent or the root tag, and it contains other tags which can be a parent or a child tag. The Composite Pattern in Java can be implemented using the component class as an abstract class or an interface. In this question, you will use an abstract class which contains all the important methods used in a composite class and a leaf class.

```
package composite;

import java.util.List;

public abstract class HtmlTag {
    public abstract String getTagName();

    public abstract void setStartTag(String tag);
```

```
    public abstract void setEndTag(String tag);

    public void setTagBody(String tagBody) {
        throw new UnsupportedOperationException("Current operation is not support - for this object");
    }

    public void addChildTag(HtmlTag htmlTag) {
        throw new UnsupportedOperationException("Current operation is not support - for this object");
    }

    public void removeChildTag(HtmlTag htmlTag) {
        throw new UnsupportedOperationException("Current operation is not support - for this object");
    }

    public List<HtmlTag> getChildren() {
        throw new UnsupportedOperationException("Current operation is not support - for this object");
    }

    public abstract void generateHtml();
}
```

Given the above class complete two subclasses of the class:

HtmlParentElement — handles the *child* nodes, and

HtmlElement — handles the *leaf* nodes.

The following class should be used to test out your classes.

```
package composite;

public class TestCompositePattern {
    public static void main(String[] args) {
        HtmlTag parentTag = new HtmlParentElement("<html>");
        parentTag.setStartTag("<html>");
        parentTag.setEndTag("</html>");
        HtmlTag p1 = new HtmlParentElement("<body>");
        p1.setStartTag("<body>");
        p1.setEndTag("</body>");
        parentTag.addChildTag(p1);
        HtmlTag child1 = new HtmlElement("<P>");
        child1.setStartTag("<P>");
        child1.setEndTag("</P>");
        child1.setTagBody("Testing html tag library");
        p1.addChildTag(child1);
        child1 = new HtmlElement("<P>");
        child1.setStartTag("<P>");
        child1.setEndTag("</P>");
        child1.setTagBody("Paragraph 2");
        p1.addChildTag(child1);
        parentTag.generateHtml();
    }
}
```

The above code will result to the following output:

```
<html>
<body>
<P>Testing html tag library</P>
<P>Paragraph 2</P>
</body>
</html>
```