



Hyperion Development

Task: Object Oriented Design and Design Patterns

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Introduction

Welcome to the Object Oriented Design and Design Patterns Task!

This task will attempt to provide a brief overview of what design patterns are in the realm of software development. We will also take a closer look at a few specific design patterns.



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What are Design Patterns?

Simply put, a design pattern is a general repeatable solution to commonly occurring problems faced by software developers during software design. They represent the best practices used by experienced object-oriented software developers and are obtained by trial and error by numerous software developers over a substantial period of time. A design pattern is not a finished design that can be transformed directly into code. It is rather a description or template of how to solve a problem that can be used in many different situations.

The Hillside Group (<http://hillside.net>), which is dedicated to maintaining information about patterns, describes design patterns as follows:

Patterns and Pattern Languages are ways to describe best practices, good designs, and capture experience in a way that it is possible for others to reuse this experience.

Design patterns have made a huge impact on object-oriented software design. Not only are they tested solutions to common problems, but they also have become a vocabulary for talking about a design. You can therefore, explain your design by describing the patterns that you have used.

Benefits of using Design Patterns

- Using them can speed up development process by providing tested, proven development paradigms.
- Reusing design patterns can help prevent subtle issues that may only become visible later in the implementation which can cause major problems.
- It improves code readability for coders and architects familiar with the patterns.
- Design patterns provide general solutions, documented in a format that does not require specifics tied to a particular problem.
- They allow developers to communicate using well-known, well understood names for software interactions.
- Design patterns are constantly improved over time, making them more robust than ad-hoc designs.

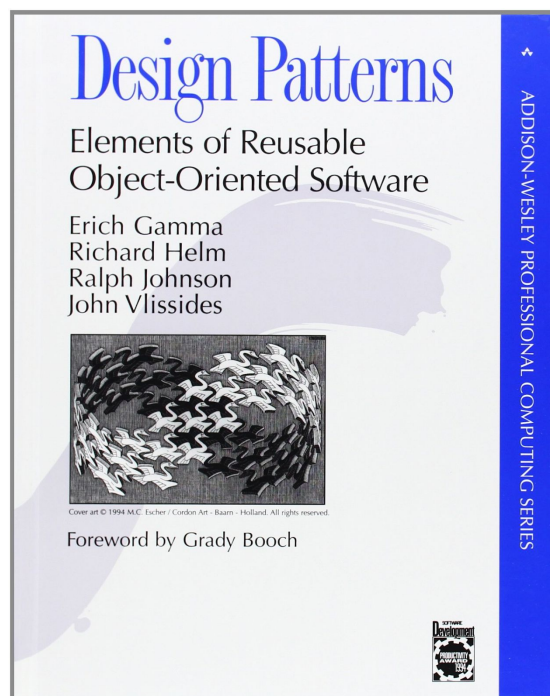
- They are language neutral and so can be applied to any object-orientated programming language.

The Gang of Four

The best known design patterns were described in a book entitled: Design Patterns - Elements of Reusable Object-Oriented Software. This book initiated the concept of Design Pattern in Software development. It was written by four authors, Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, who collectively became known as the "Gang of Four" (GOP).

According to the Gang of Four, design patterns are primarily based on the following principles of object orientated design:

- "Program to an 'interface', not an 'implementation'." (Gang of Four 1995:18)
- Composition over inheritance: "Favor 'object composition' over 'class inheritance'." (Gang of Four 1995:20)



The cover of Design Patterns - Elements of Reusable Object-Oriented Software

Types of Design Patterns

According to the book Design Patterns - Elements of Reusable Object-Oriented Software, design patterns can be classified into three categories:

1. Creational
2. Structural
3. Behavioural

Creational Design Patterns

Creational design patterns provide a way to create objects while hiding the creation logic, instead of instantiating objects directly using the new operator. This gives programs more flexibility in deciding which objects need to be created for a given use case.

Structural Design Patterns

Structural design patterns are all about class and object composition. Interfaces are composed using the concept of inheritance. The concept of inheritance is also used to define ways to compose objects to obtain new functionalities.

Behavioural Design Patterns

Behavioural design patterns are concerned with communication between objects.

We will now take a closer look at a few popular design patterns.

Factory Pattern

One of the most popular and widely used design patterns in Java is the Factory pattern. The Factory Pattern is a creational pattern as it provides one of the best ways to create an object. As the name implies, it is a class that acts as a factory of object instances.

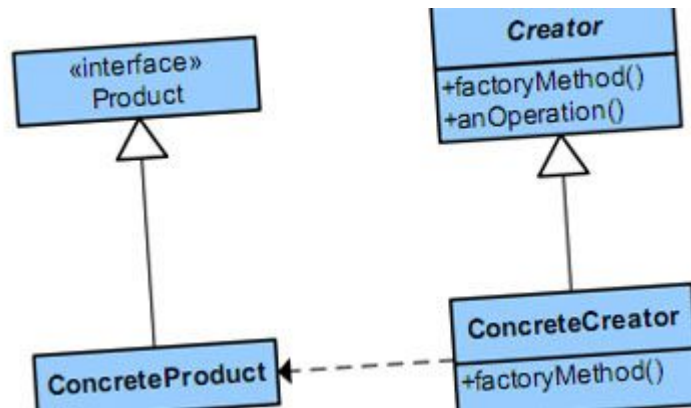
The main goal of the Factory Pattern is to encapsulate the creational procedure that may span different classes into one single function. The factory method will be able to return the correct object if it is provided with the correct context.

Factory Method

Type: Creational

What it is:

Define an interface for creating an object, but let subclasses decide which class to instantiate. Lets a class defer instantiation to subclasses.



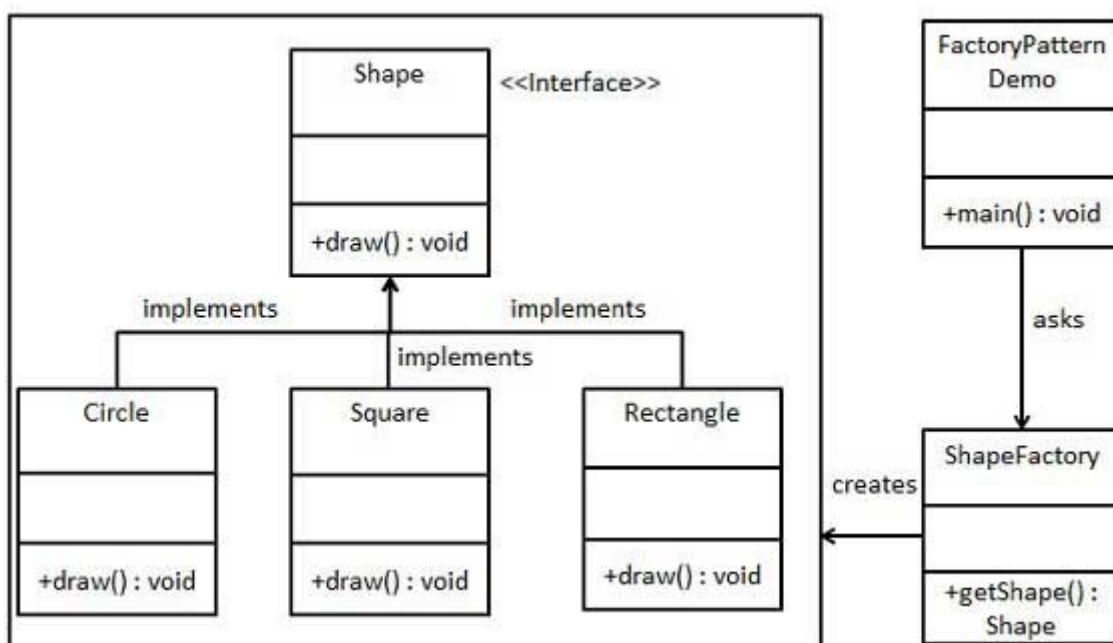
The Factory Method (www.code.tutsplus.com)

When to Use the Factory Pattern

If you have multiple different variations of a single entity, the factory pattern can be useful. For example, let's say that you have a Shape class. This class has different variations, such as Circle, Square and Rectangle. You need to be able to create different shapes depending on your needs. This is where you can use a factory to create the Shapes for you!

Implementation of the Factory Pattern

We are firstly going to create a Shape interface and concrete classes that implement the Shape interface. We then are going to define the factory class ShapeFactory. Our demo class FactoryPatternDemo will use this factory class to get a Shape object.



1. We firstly create an interface.

Shape.java

```
public interface Shape {  
    void draw();  
}
```

2. We then create concrete classes to implement the interface.

Rectangle.java

```
public class Rectangle implements Shape {  
  
    @Override  
    public void draw() {  
        System.out.println("Inside Rectangle::draw() method.");  
    }  
}
```

Square.java

```
public class Square implements Shape {  
  
    @Override  
    public void draw() {  
        System.out.println("Inside Square::draw() method.");  
    }  
}
```

Circle.java

```
public class Circle implements Shape {  
  
    @Override  
    public void draw() {  
        System.out.println("Inside Circle::draw() method.");  
    }  
}
```

3. We now create a Factory class to generate object of concrete class based on given information.

ShapeFactory.java

```

public class ShapeFactory {

    //use getShape method to get object of type shape
    public Shape getShape(String shapeType){
        if(shapeType == null){
            return null;
        }
        if(shapeType.equalsIgnoreCase("CIRCLE")){
            return new Circle();

        } else if(shapeType.equalsIgnoreCase("RECTANGLE")){
            return new Rectangle();

        } else if(shapeType.equalsIgnoreCase("SQUARE")){
            return new Square();
        }

        return null;
    }
}

```

4. The Factory class is then used to get object of concrete class by passing some information. In this case we pass the type of shape.

FactoryPatternDemo.java

```

public class FactoryPatternDemo {

    public static void main(String[] args) {
        ShapeFactory shapeFactory = new ShapeFactory();

        //get an object of Circle and call its draw method.
        Shape shape1 = shapeFactory.getShape("CIRCLE");

        //call draw method of Circle
        shape1.draw();

        //get an object of Rectangle and call its draw method.
        Shape shape2 = shapeFactory.getShape("RECTANGLE");

        //call draw method of Rectangle
        shape2.draw();

        //get an object of Square and call its draw method.
        Shape shape3 = shapeFactory.getShape("SQUARE");

        //call draw method of circle
    }
}

```



```
        shape3.draw();  
    }  
}
```

5. The output should be the following:

```
Inside Circle::draw() method.  
Inside Rectangle::draw() method.  
Inside Square::draw() method.
```

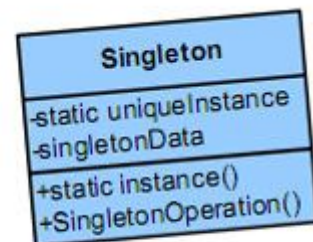
Singleton Pattern

One of the simplest patterns in Java is the Singleton pattern. This creational design pattern involves a single class which is responsible for creating a single object and making sure that only that single object gets created. This class provides a way to access this single object which can be accessed directly without need to instantiate the object of the class.

Singleton

Type: Creational

What it is:
Ensure a class only has one instance and provide a global point of access to it.



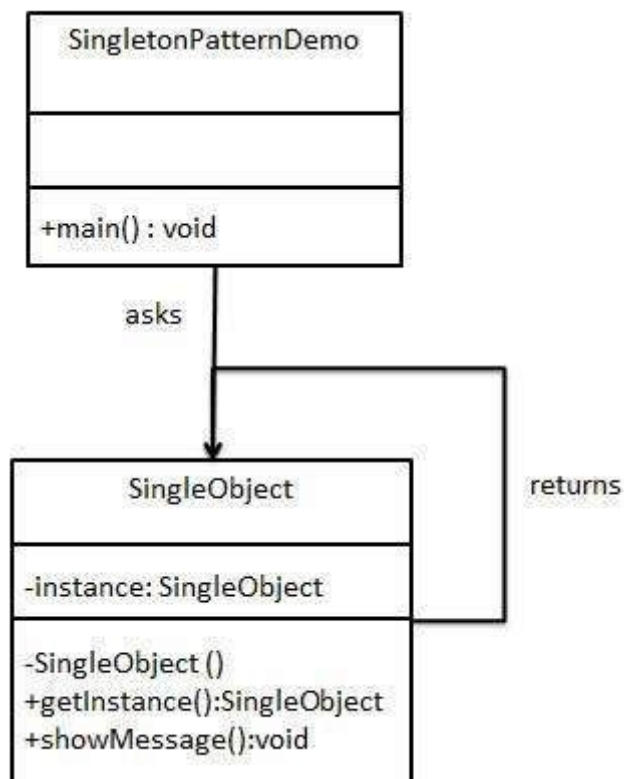
The Singleton Pattern (www.code.tutsplus.com)

When to Use the Singleton Pattern

You can use the singleton pattern to avoid having to pass an instance via constructor or argument, if you need to pass a specific instance from one class to another.

Implementation of the Singleton Pattern

We will now create a `SingleObject` class which has its constructor as private and a static instance of itself. This class has a static method to get its static instance. The demo class `SingletonPatternDemo`, will use `SingleObject` class to get a `SingleObject` object.



1. We firstly create a Singleton class.

`SingleObject.java`

```
public class SingleObject {

    //create an object of SingleObject
    private static SingleObject instance = new SingleObject();

    //make the constructor private so that this class cannot be
    //instantiated
    private SingleObject(){}

    //Get the only object available
    public static SingleObject getInstance(){
        return instance;
    }
}
```

```
public void showMessage(){  
    System.out.println("Hello World!");  
}  
}
```

2. Now, get the single object from the Singleton class

SingletonPatternDemo.java

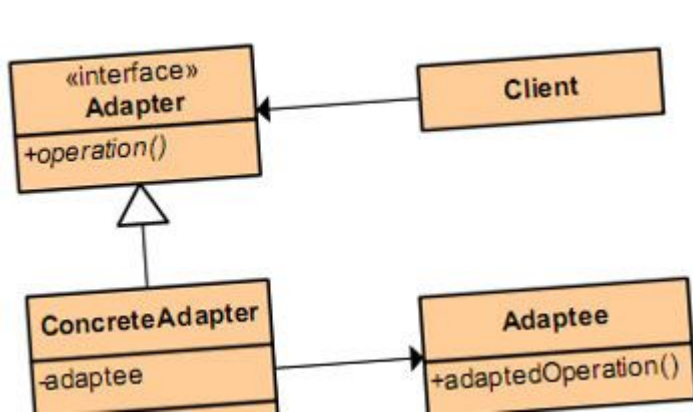
```
public class SingletonPatternDemo {  
    public static void main(String[] args) {  
  
        //illegal construct  
        //Compile Time Error: The constructor SingleObject() is not visible  
        //SingleObject object = new SingleObject();  
  
        //Get the only object available  
        SingleObject object = SingleObject.getInstance();  
  
        //show the message  
        object.showMessage();  
    }  
}
```

3. The output should be as follows:

```
Hello World!
```

Adapter Pattern

The Adapter pattern is a structural pattern that works as a bridge between two incompatible interfaces. It involves a single class which is responsible for joining functionalities of independent or incompatible interfaces.



Adapter

Type: Structural

What it is:

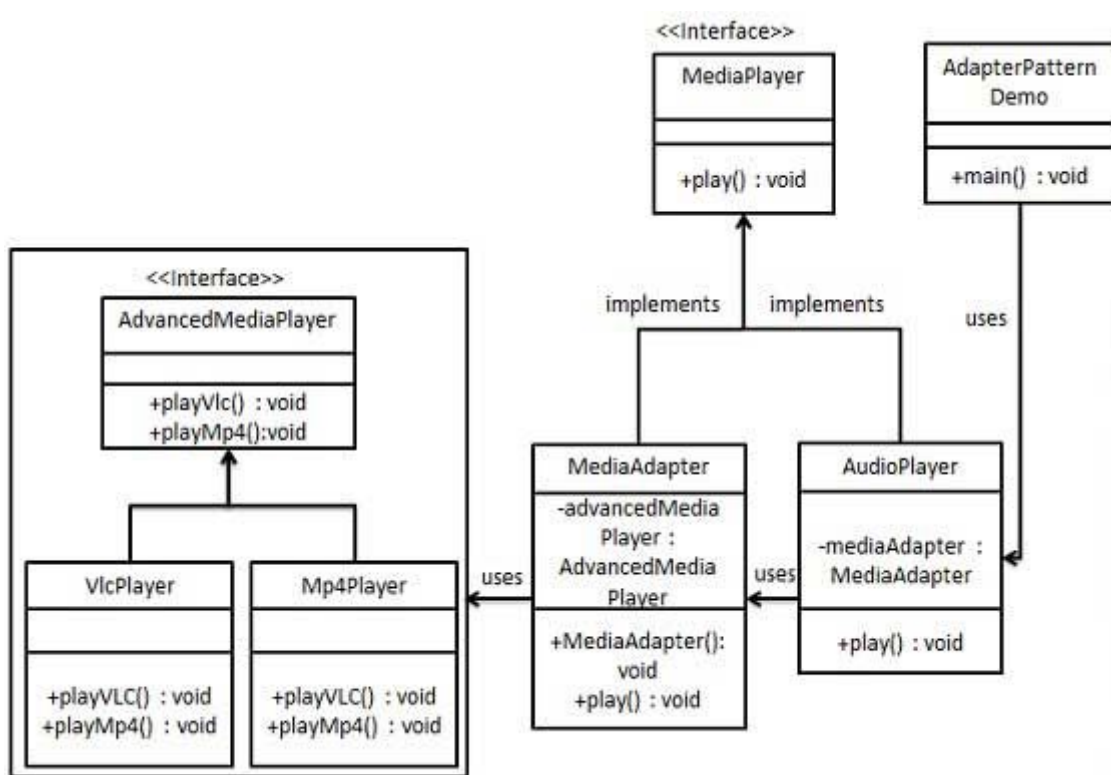
Convert the interface of a class into another interface clients expect. Lets classes work together that couldn't otherwise because of incompatible interfaces.

The Adapter Pattern (www.code.tutsplus.com)

The adapter class is also known as a wrapper because it lets you "wrap" actions into a class and reuse these actions in the correct situations.

Implementation of the Adapter Pattern

We will now demonstrate how the Adapter pattern is used in the following example where an audio player device can play mp3 files only and wants to use an advanced audio player capable of playing vlc and mp4 files.



We have a concrete class named `AudioPlayer` that implements the `MediaPlayer` interface. `AudioPlayer` can play mp3 format audio files by default. We also have concrete classes that implement the `AdvancedMediaPlayer` interface. These classes can play vlc and mp4 format files.

We would like `AudioPlayer` to play these other formats as well. In order to do this, we have created an adapter class `MediaAdapter` which implements the `MediaPlayer` interface and uses `AdvancedMediaPlayer` objects to play the required format.

`AudioPlayer` uses the adapter class `MediaAdapter` and passes it the desired audio type without knowing the actual class which can play the desired format. The demo class, `AdapterPatternDemo`, will use `AudioPlayer` class to play various formats.

1. Firstly, create the `MediaPlayer` and `AdvancedMediaPlayer` interfaces.

`MediaPlayer.java`

```
public interface MediaPlayer {  
    public void play(String audioType, String fileName);  
}
```

`AdvancedMediaPlayer.java`

```
public interface AdvancedMediaPlayer {  
    public void playVlc(String fileName);  
    public void playMp4(String fileName);  
}
```

2. Next, create the concrete classes that implement that `AdvancedMediaPlayer` interface.

`VlcPlayer.java`

```
public class VlcPlayer implements AdvancedMediaPlayer{  
    @Override  
    public void playVlc(String fileName) {  
        System.out.println("Playing vlc file. Name: "+ fileName);  
    }  
  
    @Override  
    public void playMp4(String fileName) {  
  
    }  
}
```

Mp4Player.java

```
public class Mp4Player implements AdvancedMediaPlayer{

    @Override
    public void playVlc(String fileName) {

    }

    @Override
    public void playMp4(String fileName) {
        System.out.println("Playing mp4 file. Name: "+ fileName);
    }
}
```

3. The class MediaAdapter that implements the MediaPlayer interface is then created.

MediaAdapter.java

```
public class MediaAdapter implements MediaPlayer {

    AdvancedMediaPlayer advancedMusicPlayer;

    public MediaAdapter(String audioType){

        if(audioType.equalsIgnoreCase("vlc") ){
            advancedMusicPlayer = new VlcPlayer();
        }else if (audioType.equalsIgnoreCase("mp4")){
            advancedMusicPlayer = new Mp4Player();
        }
    }

    @Override
    public void play(String audioType, String fileName) {

        if(audioType.equalsIgnoreCase("vlc")){
            advancedMusicPlayer.playVlc(fileName);
        }
        else if(audioType.equalsIgnoreCase("mp4")){
            advancedMusicPlayer.playMp4(fileName);
        }
    }
}
```

4. Then, the concrete class AudioPlayer that implements the MediaPlayer interface is created.

AudioPlayer.java

```
public class AudioPlayer implements MediaPlayer {
    MediaAdapter mediaAdapter;

    @Override
    public void play(String audioType, String fileName) {

        //inbuilt support to play mp3 music files
        if(audioType.equalsIgnoreCase("mp3")){
            System.out.println("Playing mp3 file. Name: " + fileName);
        }

        //mediaAdapter is providing support to play other file formats
        else if(audioType.equalsIgnoreCase("vlc") ||
audioType.equalsIgnoreCase("mp4")){
            mediaAdapter = new MediaAdapter(audioType);
            mediaAdapter.play(audioType, fileName);
        }

        else{
            System.out.println("Invalid media. " + audioType + " format not
supported");
        }
    }
}
```

5. finally , the AudioPlayer is used to play different types of audio formats.

```
public class AdapterPatternDemo {
    public static void main(String[] args) {
        AudioPlayer audioPlayer = new AudioPlayer();

        audioPlayer.play("mp3", "beyond the horizon.mp3");
        audioPlayer.play("mp4", "alone.mp4");
        audioPlayer.play("vlc", "far far away.vlc");
        audioPlayer.play("avi", "mind me.avi");
    }
}
```

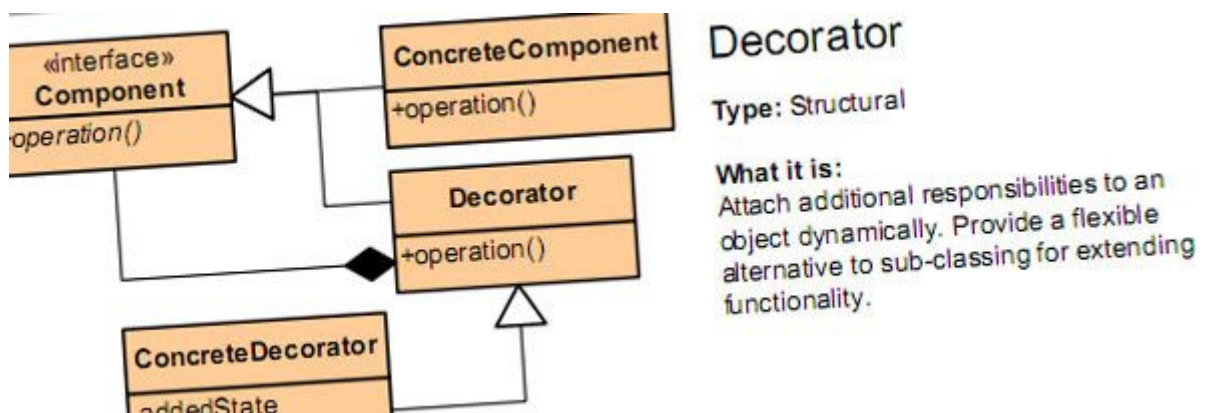
6. The output should be as follows:

```
Playing mp3 file. Name: beyond the horizon.mp3
Playing mp4 file. Name: alone.mp4
```

```
Playing vlc file. Name: far far away.vlc  
Invalid media. avi format not supported
```

Decorator Pattern

The Decorator Pattern is a structural design pattern that allows you to add new functionality to an existing object without altering its structure. It creates a decorator class which wraps the original class and provides additional functionality keeping class methods signature intact.



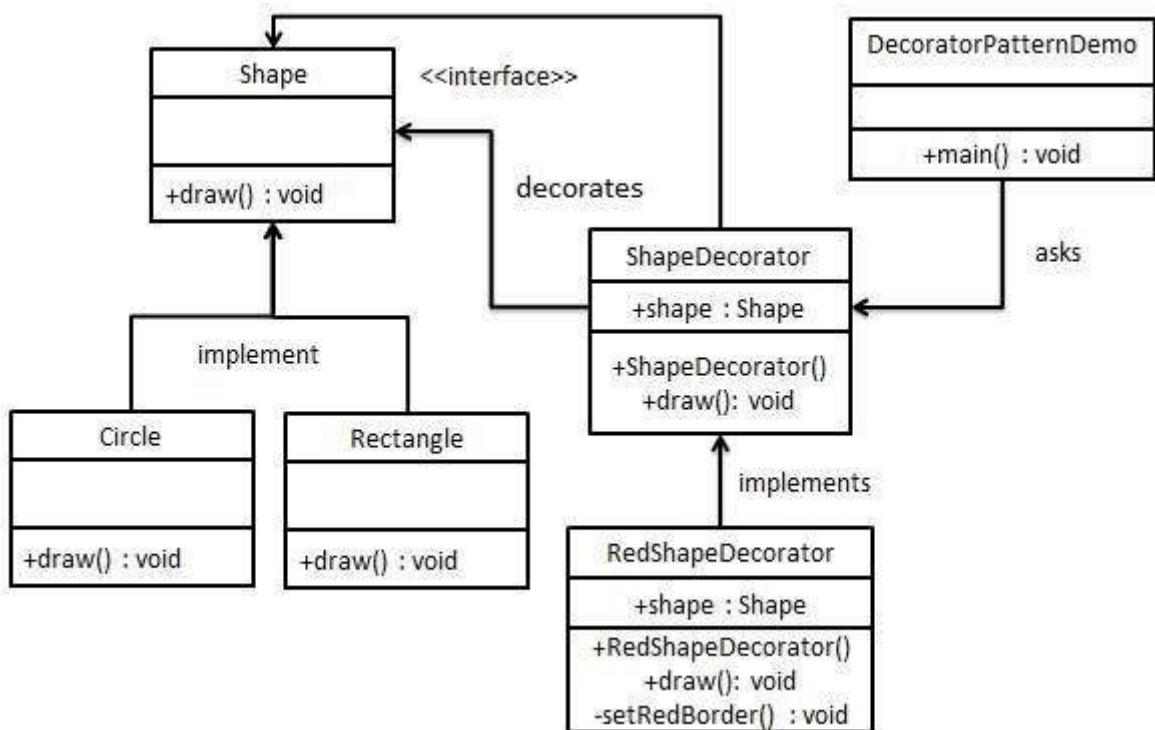
The Decorator Pattern (www.code.tutsplus.com)

When to Use the Decorator Pattern

The best place to use the decorator pattern is when you have an entity which needs to have new behavior only if the situation requires it.

Implementation of the Decorator Pattern

We will now demonstrate how the Decorator pattern is used in the following example where a shape will be decorated with some colour without altering shape class.



1. Firstly create a Shape interface.

Shape.java

```

public interface Shape {
    void draw();
}
  
```

2. Then , create concrete classes which implement the Shape interface.

Rectangle.java

```

public class Rectangle implements Shape {

    @Override
    public void draw() {
        System.out.println("Shape: Rectangle");
    }
}
  
```

Circle.java

```

public class Circle implements Shape {

    @Override
    public void draw() {
        System.out.println("Shape: Circle");
    }
}

```

3. Then, create an abstract decorator class called ShapeDecorator which implements the Shape interface and has Shape object as its instance variable.

ShapeDecorator.java

```

public abstract class ShapeDecorator implements Shape {
    protected Shape decoratedShape;

    public ShapeDecorator(Shape decoratedShape){
        this.decoratedShape = decoratedShape;
    }

    public void draw(){
        decoratedShape.draw();
    }
}

```

4. Now create RedShapeDecorator which is concrete class implementing ShapeDecorator.

RedShapeDecorator.java

```

public class RedShapeDecorator extends ShapeDecorator {

    public RedShapeDecorator(Shape decoratedShape) {
        super(decoratedShape);
    }

    @Override
    public void draw() {
        decoratedShape.draw();
        setRedBorder(decoratedShape);
    }

    private void setRedBorder(Shape decoratedShape){
        System.out.println("Border Color: Red");
    }
}

```

5. Lastly, use the RedShapeDecorator class to decorate Shape objects.

DecoratorPatternDemo.java

```
public class DecoratorPatternDemo {  
    public static void main(String[] args) {  
  
        Shape circle = new Circle();  
  
        Shape redCircle = new RedShapeDecorator(new Circle());  
  
        Shape redRectangle = new RedShapeDecorator(new Rectangle());  
        System.out.println("Circle with normal border");  
        circle.draw();  
  
        System.out.println("\nCircle of red border");  
        redCircle.draw();  
  
        System.out.println("\nRectangle of red border");  
        redRectangle.draw();  
    }  
}
```

6. The output should be as follows:

```
Circle with normal border  
Shape: Circle  
  
Circle of red border  
Shape: Circle  
Border Color: Red  
  
Rectangle of red border  
Shape: Rectangle  
Border Color: Red
```

Strategy Pattern

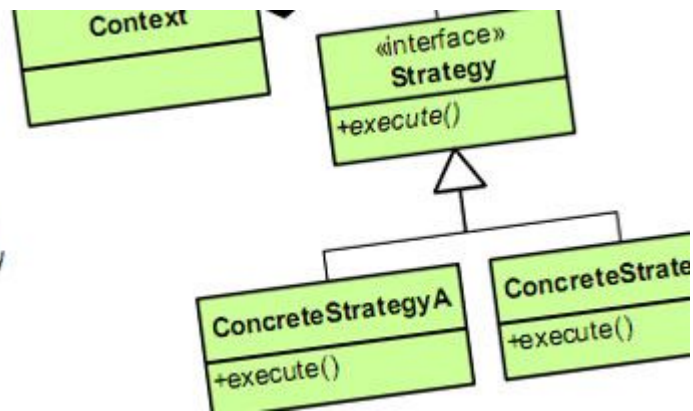
The Strategy pattern is a behavioural design pattern in which a class behavior or its algorithm can be changed at runtime. With this pattern we create objects which represent various strategies and a context object whose behavior varies as per its strategy object. The strategy object changes the executing algorithm of the context object.

Strategy

Type: Behavioral

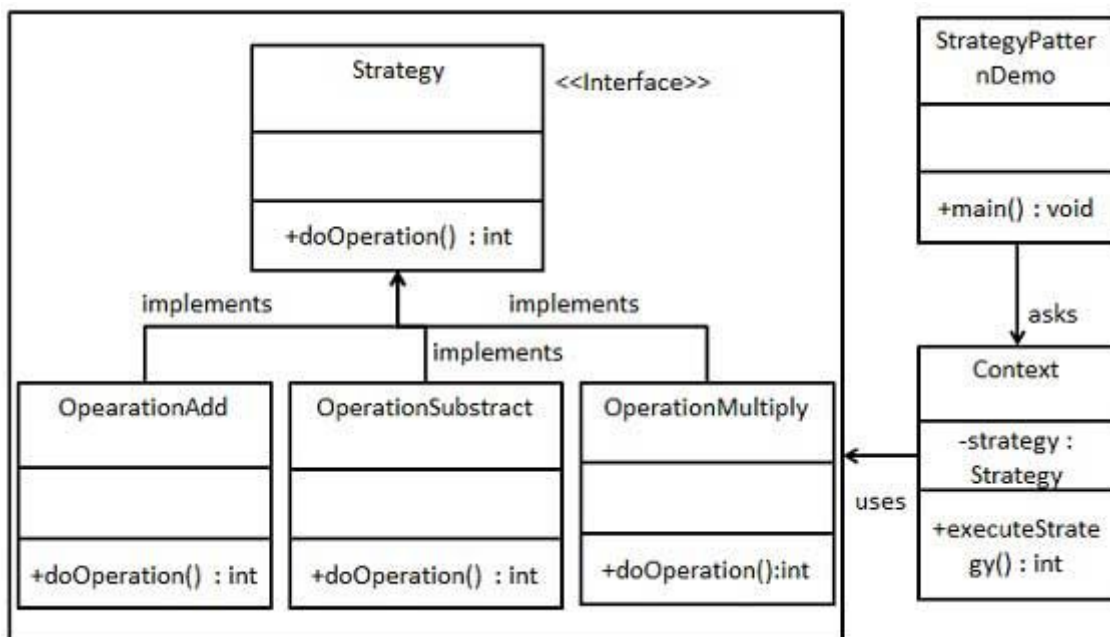
What it is:

Define a family of algorithms, encapsulate each one, and make them interchangeable. Lets the algorithm vary independently from clients that use it.



The Strategy Pattern (www.code.tutsplus.com)

Implementation of the Strategy Pattern



To demonstrate how the Strategy pattern is implemented, we are going to create a Strategy interface which defines an action and concrete strategy classes which implement this interface. We then create a Context class which uses a Strategy and finally a demo class called, StrategyPatternDemo, which will use Context and strategy objects to demonstrate change in Context behaviour based on strategy it deploys or uses.

1. Firstly create an interface.

Strategy.java

```
public interface Strategy {  
    public int doOperation(int num1, int num2);  
}
```

2. Then, create concrete classes which implement the interface.

OperationAdd.java

```
public class OperationAdd implements Strategy{  
    @Override  
    public int doOperation(int num1, int num2) {  
        return num1 + num2;  
    }  
}
```

OperationSubtract.java

```
public class OperationSubtract implements Strategy{  
    @Override  
    public int doOperation(int num1, int num2) {  
        return num1 - num2;  
    }  
}
```

OperationMultiply.java

```
public class OperationMultiply implements Strategy{  
    @Override  
    public int doOperation(int num1, int num2) {  
        return num1 * num2;  
    }  
}
```

3. Now create the Context class.

Context.java

```
public class Context {  
    private Strategy strategy;  
  
    public Context(Strategy strategy){  
        this.strategy = strategy;  
    }  
  
    public int executeStrategy(int num1, int num2){  
        return strategy.doOperation(num1, num2);  
    }  
}
```

```
}  
}
```

4. Finally create a demo class that uses the Context class to see change in behaviour when it changes its Strategy.

StrategyPatternDemo.java

```
public class StrategyPatternDemo {  
    public static void main(String[] args) {  
        Context context = new Context(new OperationAdd());  
        System.out.println("10 + 5 = " + context.executeStrategy(10, 5));  
  
        context = new Context(new OperationSubtract());  
        System.out.println("10 - 5 = " + context.executeStrategy(10, 5));  
  
        context = new Context(new OperationMultiply());  
        System.out.println("10 * 5 = " + context.executeStrategy(10, 5));  
    }  
}
```

5. The output should be as follows:

```
10 + 5 = 15  
10 - 5 = 5  
10 * 5 = 50
```

Compulsory Task

Follow these steps:

- Download the SingletonExercise.java file.
- Change the Deck class into a Singleton class.
- Change the main method to get the Deck instance rather than creating a new object.
- The program should print all 52 cards in random order.



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