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Software Design Patterns: Best Practices for Software Developers

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Bridge Pattern

This lesson discusses how parallel class hierarchies or layers can be decoupled from one another using the bridge pattern.

We'll cover the following



- What is it ?
- Class Diagram
- Example
- Other Examples
- Caveats

What is it ?#

A physical bridge provides connectivity between two points. The bridge pattern describes how to pull apart two software layers fused together in a single class hierarchy and change them into parallel class hierarchies connected by a bridge.

The bridge pattern can be applied to scenarios where the class and what it does changes often. Think of it as two layers of abstraction. The class itself becomes one layer and what it does i.e. the implementation becomes another layer. This setup allows us to extend the two layers independently of each other. In Java, both the layers would be represented by two separate class hierarchies. The bridge sits between these two class hierarchies,



allowing the class abstraction to configure itself with the implementation abstraction.

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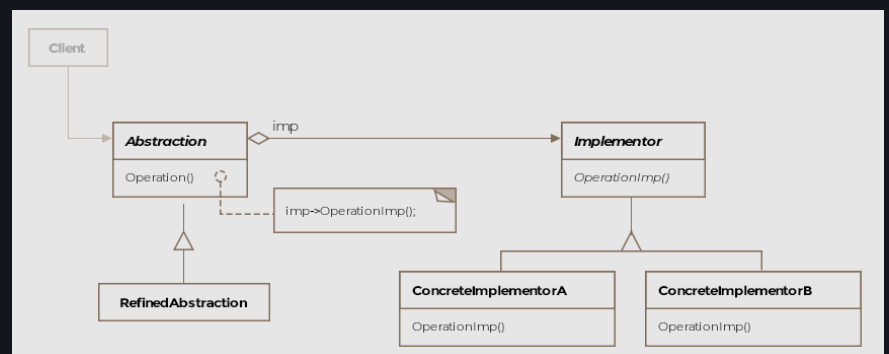


Formally, *the bridge pattern lets you vary the abstraction independently of the implementation, thus decoupling the two in the process*. However, the *abstraction* and the *implementation* in the definition don't mean Java's abstract class/interface and concrete classes respectively.

Class Diagram#

The class diagram consists of the following entities

- **Abstraction**
- **Refined Abstraction**
- **Implementor**
- **Concrete Implementor**



Class Diagram

Example#

Suppose you are writing software for Toyota Motors and need to represent the most sold car in the world - the [Toyota Corolla](#). We'll use an abstract class `Corolla` to represent the car. The

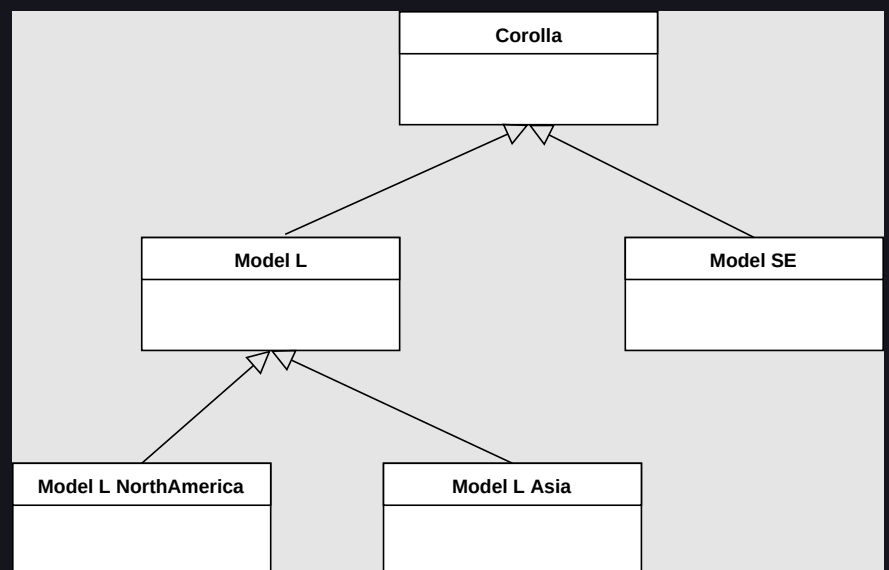




different models of the car. So far so good.

However, the same model could be built to different standards for different locales. For instance, the North American model may have different safety requirements than an Asian model. The same model could be left or right handed depending on which country it is being shipped to. Corolla has several models and the models have different names in different countries. In the US, the different models include L, LE, XLE etc. For our purposes we'll consider only one model L.

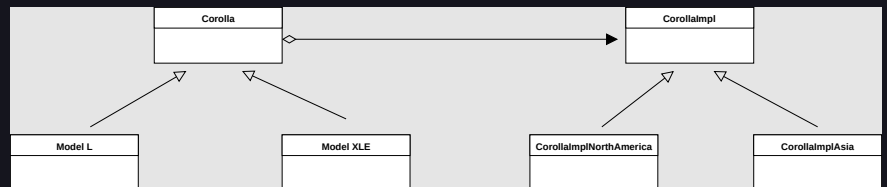
Let's see how the class hierarchy would look like.



Without the Bridge Pattern

We can divide the above class structure into two hierarchies. One that just represents the models of the car and another that represents the location-specific variations for each model of the car. After applying the pattern the class diagram would look like below:





So you can see there's one hierarchy of class the `Corolla` which would have subclasses for each of the models, however, the actual car produced by the factory may be different from another car of the same model that is destined for a different country. The *implementation* of the car would make up a separate class hierarchy `CorollaImpl` which will have implementation subclasses for each of the Corolla models and have information such as safety equipment installed, whether the car is left or right handed drive etc.

You would have guessed by now that the class `Corolla` (the abstraction) would hold a reference to an object of the class `CorollaImpl` (the implementation) and invoke method calls on the implementation object. We are using object composition to add location dependent behavior to each model of the car.

Let's examine the first class hierarchy that represents the car Corolla and acts as the abstraction.

```

public abstract class AbstractCorolla {

    protected AbstractCorollaImpl corollaImpl;

    public AbstractCorolla(AbstractCorolla
  
```



```

Impl corollaImpl) {
    this.corollaImpl = corollaImpl;
}

abstract void listSafetyEquipment();

abstract boolean isCarRightHanded();
}

```

The `AbstractCorolla` holds a reference to the *implementation* class `AbstractCorollaImpl` object. The abstract class `AbstractCorollaImpl` forms a parallel class hierarchy and is defined below.

```

public abstract class AbstractCorollaImpl {

    abstract void listSafetyEquipment();

    abstract boolean isCarRightHanded();
}

```

The class that represents the model L is shown below:

```

public class Corolla_L extends AbstractCorolla {

    public Corolla_L(AbstractCorollaImpl corollaImpl) {
        super(corollaImpl);
    }

    @Override
    void listSafetyEquipment() {
        corollaImpl.listSafetyEquipment();
    }

    @Override
    boolean isCarRightHanded() {

```

```

        return corollaImpl.isCarRightHanded();
    }
}

```

We'll have corresponding *implementation* classes for the L model. They are given below:

```

public class Corolla_L_Impl_AsiaPacific extends AbstractCorollaImpl {

    @Override
    void listSafetyEquipment() {
        System.out.println("Not so safe.");
    }

    @Override
    boolean isCarRightHanded() {
        return false;
    }
}

public class Corolla_L_Impl_NorthAmerica extends AbstractCorollaImpl {

    @Override
    void listSafetyEquipment() {
        System.out.println("High safety standards.");
    }

    @Override
    boolean isCarRightHanded() {
        return true;
    }
}

```

The client can use the classes like so:

```

public class Client {

    public void main() {

```

```

        AbstractCorolla myCorolla =
            Corolla_L(new Corolla_L_Impl_AsiaPacific());
        System.out.println(myCorolla.isCarR
            ightHanded());

        myCorolla.setCorollaImpl(new Corolla_L_Impl_NorthAmerica());
        System.out.println(myCorolla.isCarR
            ightHanded());
    }
}

```

Note how the client can switch out the implementation class object at runtime and make the model behave for an entirely different location. Using the bridge pattern we have avoided permanent binding of models and their intended locations of operation. The client can continue to work with the objects of the *abstraction layer* without noticing any changes to *implementation layer* classes. New safety rules or regulations would only affect the implementation layer classes.

Other Examples#

- Consider the development of a GUI toolkit. The toolkit will likely use system level api calls specific to the operating system. If you design a widget menu then you'll need to subclass the menu for both Windows and Linux. If you have several dozen widgets then each widget class will end up with subclasses for each operating system you intend to target. The code slowly becomes one giant





The bridge pattern suggest to create two class hierarchies. One captures the widget operations and another which encapsulates the system specific api details. Before the change we could have the following classes:

- `Menu` and its derived classes `MenuWindows` and `MenuLinux`

After applying the bridge pattern, the resulting classes would be


- `Menu`
- `AbstractMenuImpl` and its derived classes `MenuImplWindows` and `MenuImplLinux`

When a `Menu` object is instantiated we can compose it with either of the implementation classes to target different operating systems.

Caveats#

- The bridge pattern may be confused with the adapter pattern but one difference between the two is that the adapter pattern is usually applied after a system is designed whereas the bridge pattern is intentionally applied as part of the design process to decouple the two layers.




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Adapter Pattern

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Composite Pattern



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