

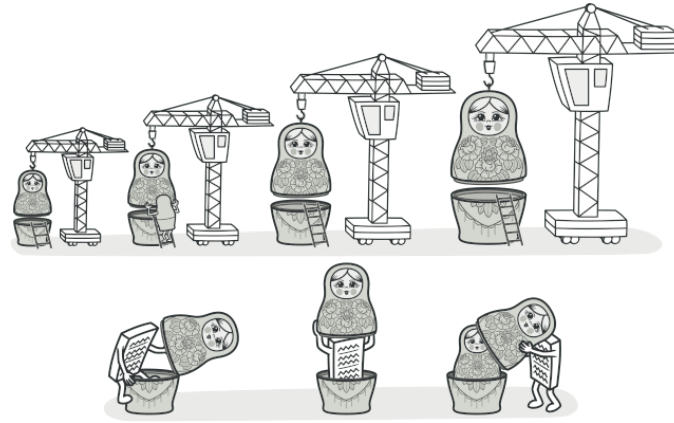
Decorator Pattern

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1 Intent

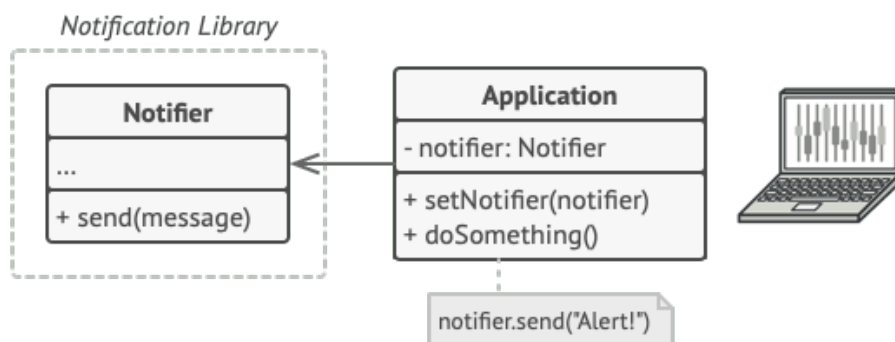
Decorator is a structural design pattern that lets you attach new behaviors to objects by placing these objects inside special wrapper objects that contain the behaviors.



2 Problem

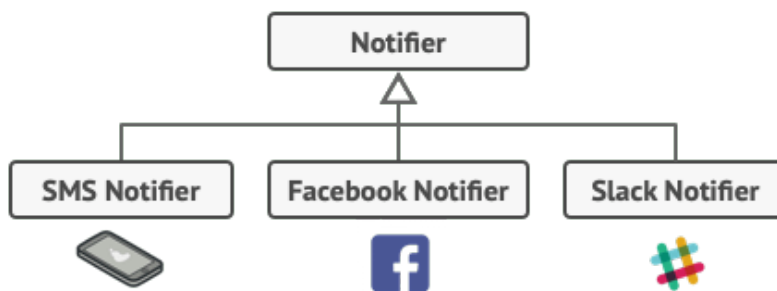
Imagine that you're working on a notification library which lets other programs notify their users about important events.

The initial version of the library was based on the [Notifier](#) class that had only a few fields, a constructor and a single *send* method. The method could accept a message argument from a client and send the message to a list of emails that were passed to the notifier via its constructor. A third-party app which acted as a client was supposed to create and configure the notifier object once, and then use it each time something important happened.



A program could use the notifier class to send notifications about important events to a predefined set of emails.

At some point, you realize that users of the library expect more than just email notifications. Many of them would like to receive an SMS about critical issues. Others would like to be notified on Facebook and, of course, the corporate users would love to get Slack notifications.

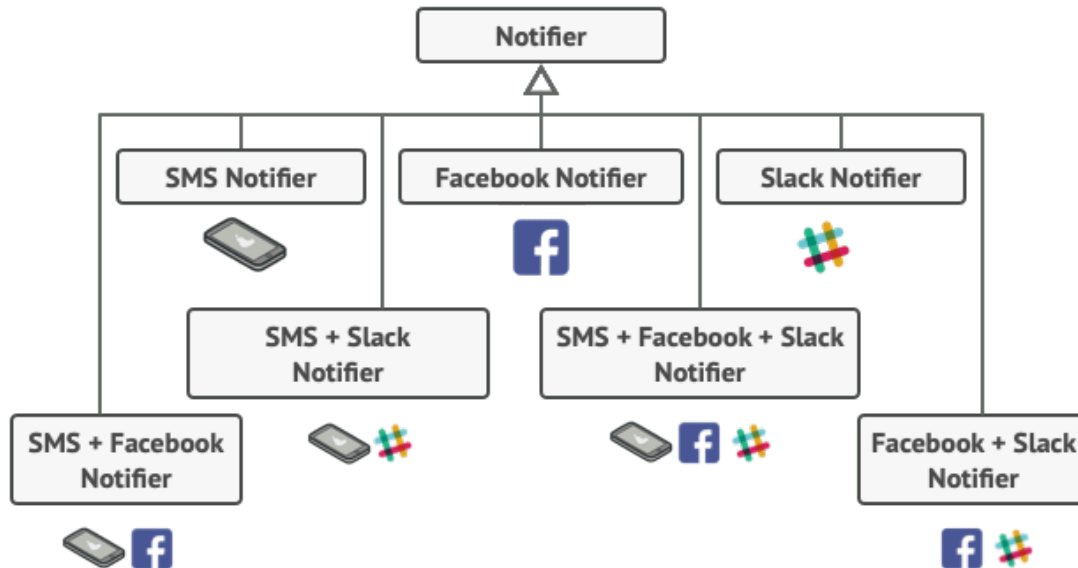


Each notification type is implemented as a notifier's subclass.

How hard can that be? You extended the Notifier class and put the additional notification methods into new subclasses. Now the client was supposed to instantiate the desired notification class and use it for all further notifications.

But then someone reasonably asked you, “Why can’t you use several notification types at once? If your house is on fire, you’d probably want to be informed through every channel.”

You tried to address that problem by creating special subclasses which combined several notification methods within one class. However, it quickly became apparent that this approach would bloat the code immensely, not only the library code but the client code as well.



Combinatorial explosion of subclasses.

You have to find some other way to structure notifications classes so that their number won't accidentally break some Guinness record.

3 Solution

Extending a class is the first thing that comes to mind when you need to alter an object's behavior. However, inheritance has several serious caveats that you need to be aware of.

- Inheritance is static. You can't alter the behavior of an existing object at runtime. You can only replace the whole object with another one that's created from a different subclass.
- Subclasses can have just one parent class. In most languages, inheritance doesn't let a class inherit behaviors of multiple classes at the same time.

One of the ways to overcome these caveats is by using **Aggregation** or **Composition** instead of **Inheritance**. Both of the alternatives work almost the same way: one object has a reference to another and delegates it some work, whereas with inheritance, the object itself is able to do that work, inheriting the behavior from its superclass.

With this new approach you can easily substitute the linked "helper" object with another, changing the behavior of the container at runtime. An object can use the behavior of various classes, having references to multiple objects and delegating them all kinds of work. Aggregation/composition is the key principle behind many design patterns, including Decorator. On that note, let's return to the pattern discussion.

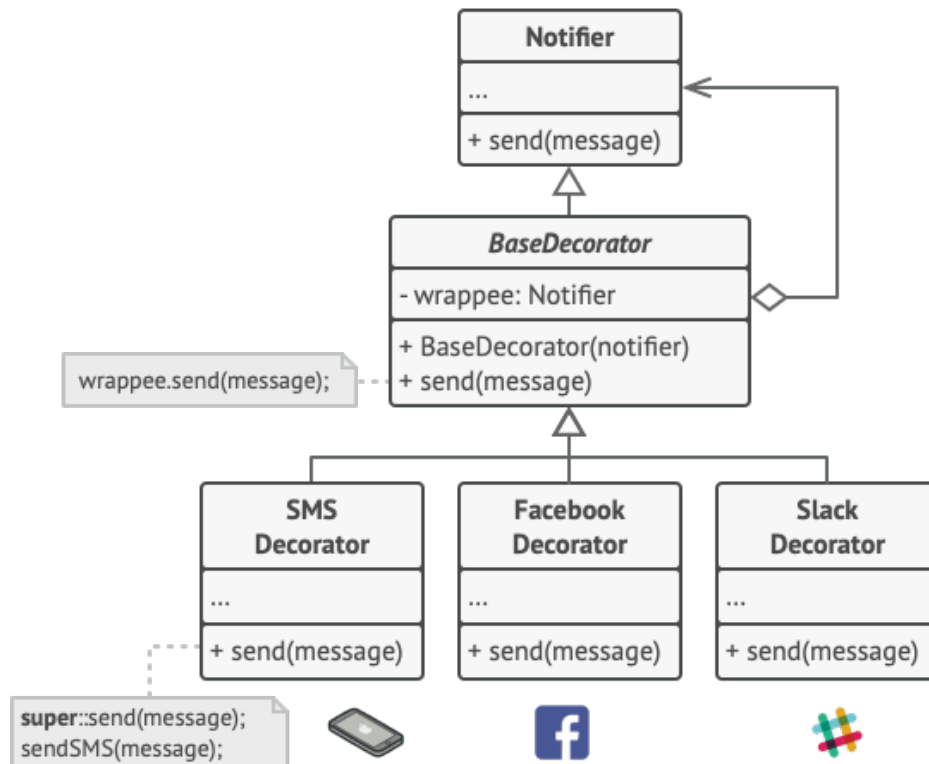


Inheritance vs. Aggregation.

"Wrapper" is the alternative nickname for the Decorator pattern that clearly expresses the main idea of the pattern. A **wrapper** is an object that can be linked with some target object. The wrapper contains the same set of methods as the target and delegates to it all requests it receives. However, the wrapper may alter the result by doing something either before or after it passes the request to the target.

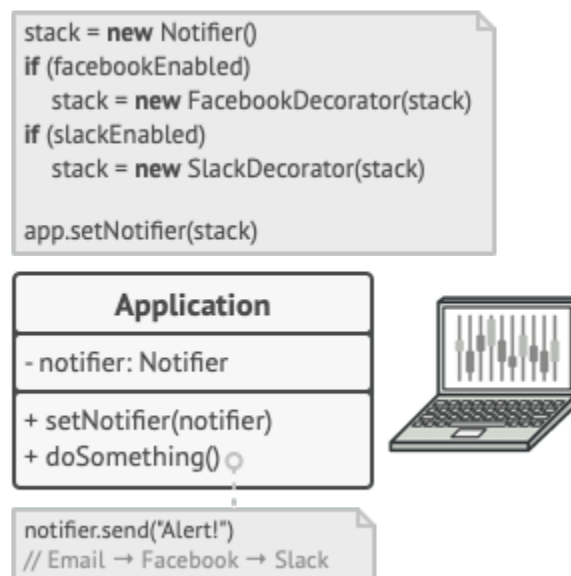
When does a simple wrapper become the real decorator? As I mentioned, the wrapper implements the same interface as the wrapped object. That's why from the client's perspective these objects are identical. Make the wrapper's reference field accept any object that follows that interface. This will let you cover an object in multiple wrappers, adding the combined behavior of all the wrappers to it.

In our notifications example, let's leave the simple email notification behavior inside the base **Notifier** class, but turn all other notification methods into decorators.



Various notification methods become decorators.

The client code would need to wrap a basic notifier object into a set of decorators that match the client's preferences. The resulting objects will be structured as a stack.

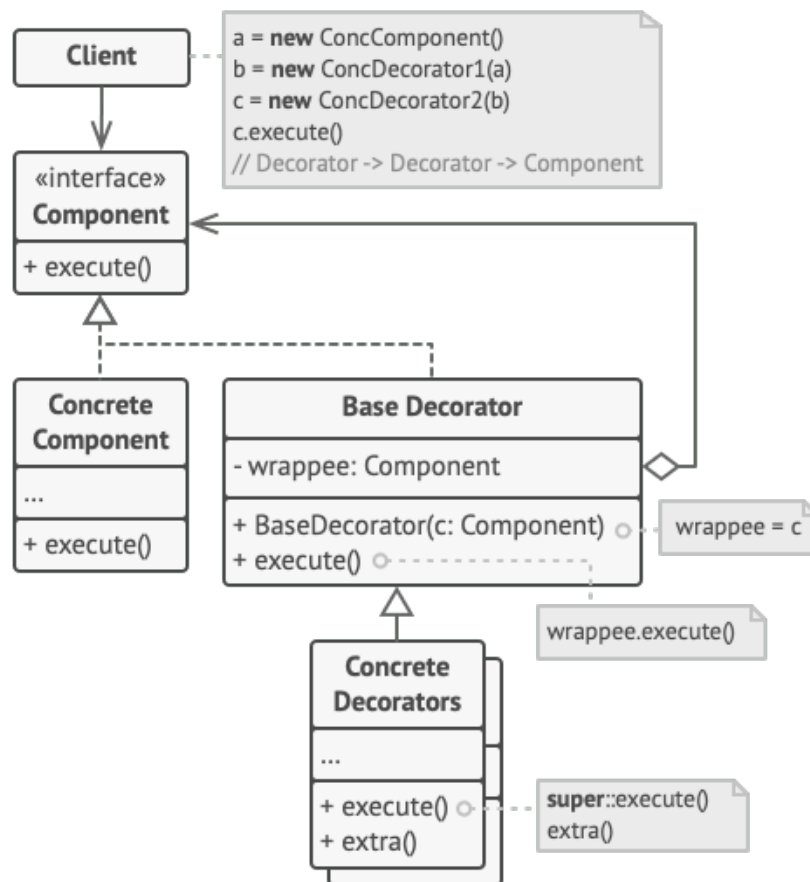


Apps might configure complex stacks of notification decorators.

The last decorator in the stack would be the object that the client actually works with. Since all decorators implement the same interface as the base notifier, the rest of the client code won't care whether it works with the "pure" notifier object or the decorated one.

We could apply the same approach to other behaviors such as formatting messages or composing the recipient list. The client can decorate the object with any custom decorators, as long as they follow the same interface as the others.

4 Structure



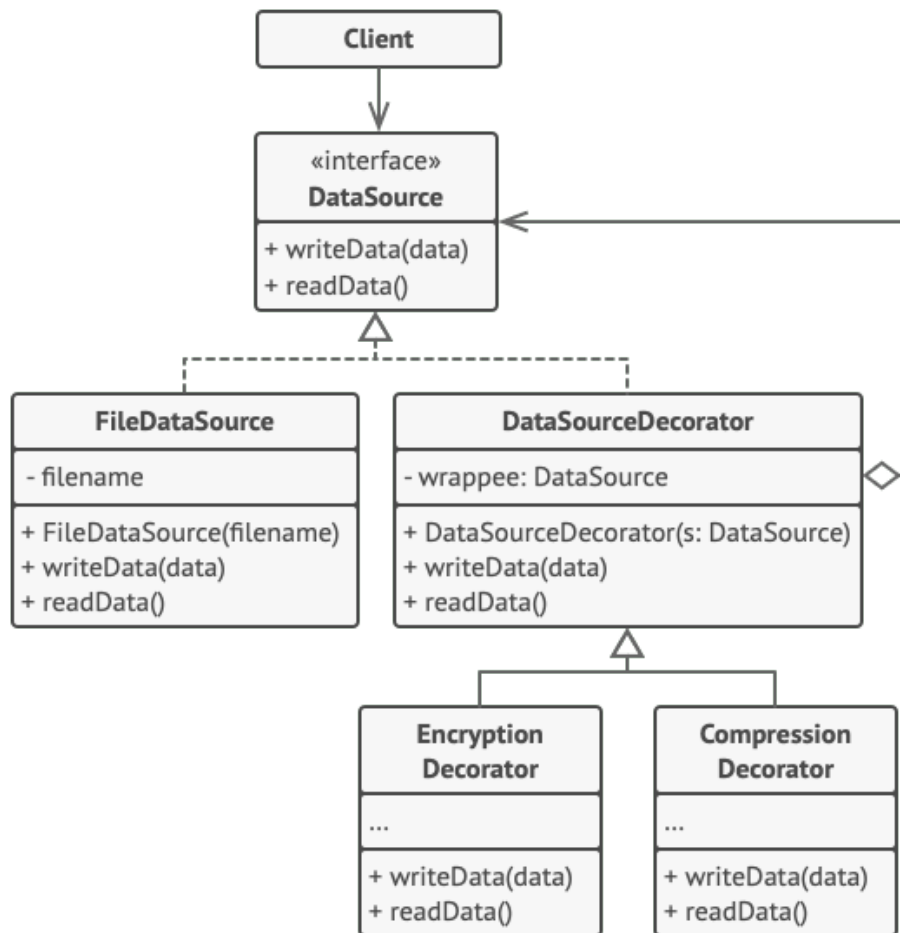
Structure of Decorator Pattern.

1. The **Component** declares the common interface for both wrappers and wrapped objects.
2. **Concrete Component** is a class of objects being wrapped. It defines the basic behavior, which can be altered by decorators.
3. The **Base Decorator** class has a field for referencing a wrapped object. The field's type should be declared as the component interface so it can contain both concrete components and decorators. The base decorator delegates all operations to the wrapped object.

4. **Concrete Decorators** define extra behaviors that can be added to components dynamically. Concrete decorators override methods of the base decorator and execute their behavior either before or after calling the parent method.

5 Pseudocode

In this example, the **Decorator** pattern lets you compress and encrypt sensitive data independently from the code that actually uses this data.



The encryption and compression decorators example.

The application wraps the data source object with a pair of decorators. Both wrappers change the way the data is written to and read from the disk:

- Just before the data is **written to disk**, the decorators encrypt and compress it. The original class writes the encrypted and protected data to the file without knowing about the change.
- Right after the data is **read from disk**, it goes through the same decorators, which decompress and decode it.

The decorators and the data source class implement the same interface, which makes them all interchangeable in the client code.



```

1 // The component interface defines operations that can be
  // altered by decorators.
3 interface DataSource is
    method writeData(data)
5    method readData():data

7 // Concrete components provide default implementations for the
  // operations. There might be several variations of these
9 // classes in a program.
  class FileDataSource implements DataSource is
11    constructor FileDataSource(filename) { ... }

13    method writeData(data) is
        // Write data to file.
15
    method readData():data is
17        // Read data from file.

19
21 // The base decorator class follows the same interface as the other
  // components. The primary purpose of this class is to define the
  // wrapping interface for all concrete decorators. The default
23 // implementation of the wrapping code might include a field for
  // storing a wrapped component and the means to initialize it.
25 class DataSourceDecorator implements DataSource is
    protected field wrappee: DataSource

27
    constructor DataSourceDecorator(source: DataSource) is
29        wrappee = source

31 // The base decorator simply delegates all work to the wrapped
  // component. Extra behaviors can be added in concrete decorators.
33 method writeData(data) is
        wrappee.writeData(data)
35
    // Concrete decorators may call the parent implementation of
    // the operation instead of calling the wrapped object directly.
    // This approach simplifies extension of decorator classes.
37
    method readData():data is
39        return wrappee.readData()
41

43 // Concrete decorators must call methods on the wrapped object, but may
  // add something of their own to the result. Decorators can execute the
45 // added behavior either before or after the call to a wrapped object.
  class EncryptionDecorator extends DataSourceDecorator is
47    method writeData(data) is
        // 1. Encrypt passed data.

```




```

49 // 2. Pass encrypted data to the wrappee's writeData
   // method.
51
   method readData():data is
53 // 1. Get data from the wrappee's readData method.
   // 2. Try to decrypt it if it's encrypted.
55 // 3. Return the result.
57
// You can wrap objects in several layers of decorators.
59 class CompressionDecorator extends DataSourceDecorator is
   method writeData(data) is
61 // 1. Compress passed data.
   // 2. Pass compressed data to the wrappee's writeData
63 // method.
65
   method readData():data is
   // 1. Get data from the wrappee's readData method.
67 // 2. Try to decompress it if it's compressed.
   // 3. Return the result.
69
71 // Option 1. A simple example of a decorator assembly.
   class Application is
73   method dumbUsageExample() is
       source = new FileDataSource("somefile.dat")
75       source.writeData(salaryRecords)
       // The target file has been written with plain data.
77
       source = new CompressionDecorator(source)
79       source.writeData(salaryRecords)
       // The target file has been written with compressed data.
81
       source = new EncryptionDecorator(source)
83       // The source variable now contains this:
       // Encryption > Compression > FileDataSource
85       source.writeData(salaryRecords)
       // The file has been written with compressed and
87       // encrypted data.
89
// Option 2. Client code that uses an external data source. SalaryManager
91 // objects neither know nor care about data storage specifics. They work
// with a pre-configured data source received from the app configurator.
93 class SalaryManager is
   field source: DataSource
95
   constructor SalaryManager(source: DataSource) { ... }
97
   method load() is
99   return source.readData()

```



```
001 method save() is
002     source.writeData(salaryRecords)
003     // ...Other useful methods...
004
005
006 // The app can assemble different stacks of decorators at
007 // runtime, depending on the configuration or environment.
008 class ApplicationConfigurator is
009     method configurationExample() is
010         source = new FileDataSource("salary.dat")
011         if (enabledEncryption)
012             source = new EncryptionDecorator(source)
013         if (enabledCompression)
014             source = new CompressionDecorator(source)
015
016         logger = new SalaryManager(source)
017         salary = logger.load()
018         // ...
```

6 Applicability

- Use the Decorator pattern when you need to be able to assign extra behaviors to objects at runtime without breaking the code that uses these objects.
- ▷ The Decorator lets you structure your business logic into layers, create a decorator for each layer and compose objects with various combinations of this logic at runtime. The client code can treat all these objects in the same way, since they all follow a common interface.
- Use the pattern when it's awkward or not possible to extend an object's behavior using inheritance.
- ▷ Many programming languages have the **final** keyword that can be used to prevent further extension of a class. For a final class, the only way to reuse the existing behavior would be to wrap the class with your own wrapper, using the Decorator pattern.

7 How to Implement

1. Make sure your business domain can be represented as a primary component with multiple optional layers over it.
2. Figure out what methods are common to both the primary component and the optional layers. Create a component interface and declare those methods there.
3. Create a concrete component class and define the base behavior in it.

4. Create a base decorator class. It should have a field for storing a reference to a wrapped object. The field should be declared with the component interface type to allow linking to concrete components as well as decorators. The base decorator must delegate all work to the wrapped object.
5. Make sure all classes implement the component interface.
6. Create concrete decorators by extending them from the base decorator. A concrete decorator must execute its behavior before or after the call to the parent method (which always delegates to the wrapped object).
7. The client code must be responsible for creating decorators and composing them in the way the client needs.

8 Pros and Cons

- + You can extend an object's behavior without making a new subclass.
- + You can add or remove responsibilities from an object at runtime.
- + You can combine several behaviors by wrapping an object into multiple decorators.
- + **Single Responsibility Principle**. You can divide a monolithic class that implements many possible variants of behavior into several smaller classes.
- It's hard to remove a specific wrapper from the wrappers stack.
- It's hard to implement a decorator in such a way that its behavior doesn't depend on the order in the decorators stack.
- The initial configuration code of layers might look pretty ugly.

9 Relations with Other Patterns

- **Adapter** changes the interface of an existing object, while **Decorator** enhances an object without changing its interface. In addition, Decorator supports recursive composition, which isn't possible when you use Adapter.
- **Adapter** provides a different interface to the wrapped object, **Proxy** provides it with the same interface, and **Decorator** provides it with an enhanced interface.
- **Chain of Responsibility** and **Decorator** have very similar class structures. Both patterns rely on recursive composition to pass the execution through a series of objects. However, there are several crucial differences.

The CoR handlers can execute arbitrary operations independently of each other. They can also stop passing the request further at any point. On the other hand, various **Decorators** can extend the object's behavior while keeping it consistent with the base interface. In addition, decorators aren't allowed to break the flow of the request.

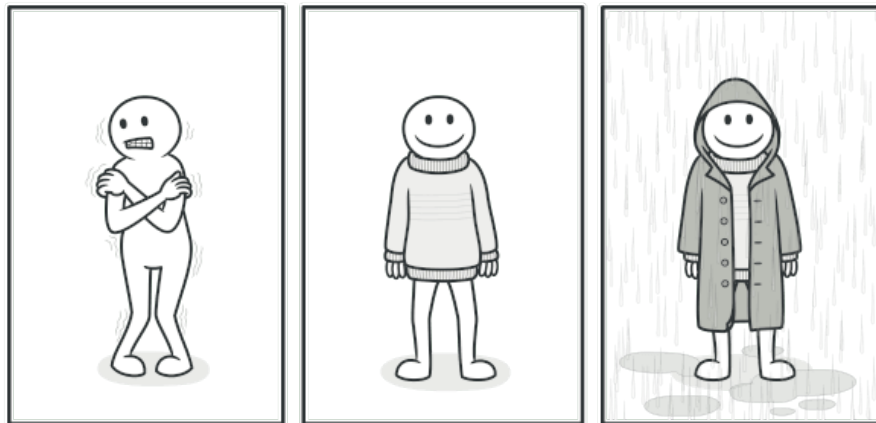
- **Composite** and **Decorator** have similar structure diagrams since both rely on recursive composition to organize an open-ended number of objects.

A **Decorator** is like a **Composite** but only has one child component. There's another significant difference: **Decorator** adds additional responsibilities to the wrapped object, while **Composite** just "sums up" its children's results.

However, the patterns can also cooperate: you can use **Decorator** to extend the behavior of a specific object in the Composite tree.

- Designs that make heavy use of **Composite** and **Decorator** can often benefit from using Prototype. Applying the pattern lets you clone complex structures instead of re-constructing them from scratch.
- **Decorator** lets you change the skin of an object, while **Strategy** lets you change the guts.
- **Decorator** and **Proxy** have similar structures, but very different intents. Both patterns are built on the composition principle, where one object is supposed to delegate some of the work to another. The difference is that a **Proxy** usually manages the life cycle of its service object on its own, whereas the composition of **Decorators** is always controlled by the client.

10 Real-World Analogy



You get a combined effect from wearing multiple pieces of clothing.

Wearing clothes is an example of using decorators. When you're cold, you wrap yourself in a sweater. If you're still cold with a sweater, you can wear a jacket on top. If it's raining, you can put on a raincoat. All of these garments "extend" your basic behavior but aren't part of you, and you can easily take off any piece of clothing whenever you don't need it.

11 Examples

1. Structure



```
package com.patterns.decorator;  
  
2 public abstract class AbstractComponent {  
4     public abstract void operation();  
}
```



```
1 package com.patterns.decorator;  
  
3 public class ConcreteComponent extends AbstractComponent {  
  
5     @Override  
    public void execute() {  
7         System.out.println("ConcreteComponent.execute()");  
    }  
9 }
```



```
1 package com.patterns.decorator;  
  
3 public abstract class BaseDecorator extends AbstractComponent {  
    private final AbstractComponent component;  
  
5     protected BaseDecorator(AbstractComponent component) {  
7         this.component = component;  
    }  
  
9     @Override  
11    public void execute() {  
        this.component.execute();  
13    }  
}
```



```
package com.patterns.decorator;  
  
2 public class ConcreteDecorator extends BaseDecorator {  
  
4     public ConcreteDecorator(AbstractComponent component) {  
6         super(component);  
    }  
}
```



```
8
@Override
10 public void execute() {
    super.execute();
12     System.out.println("[ADDITIONAL CODE BLOCK]");
    }
14 }
```



```
package com.patterns.decorator;

2
public class App {
4     public static void main(String[] args) {
        AbstractComponent component = new ConcreteComponent();
6         BaseDecorator decorator = new ConcreteDecorator(component);
        decorator.operation();
8     }
    }
}
```

2. Real world example



```
1 package com.patterns.decorator;

3 public abstract class Pizza {
    protected String description = "Basic Pizza";
5
    public String getDescription() {
7         return description;
    }
9
    public abstract double cost();
11 }
```



```
1 package com.patterns.decorator;

3 public class ThickerustPizza extends Pizza {
    public ThickerustPizza() {
5         description = "Thick crust pizza, with tomato sauce";
    }
7 }
```



```
public double cost() {  
9     return 7.99;  
    }  
11 }
```



```
1 package com.patterns.decorator;  
  
3 public class ThincrustPizza extends Pizza {  
    public ThincrustPizza() {  
5        description = "Thin crust pizza, with tomato sauce";  
    }  
  
7  
    public double cost() {  
9        return 7.99;  
    }  
11 }
```



```
1 package com.patterns.decorator;  
  
3 public abstract class ToppingDecorator extends Pizza {  
    protected Pizza pizza;  
5  
    public abstract String getDescription();  
7 }
```



```
1 package com.patterns.decorator;  
  
3 public class Cheese extends ToppingDecorator {  
    public Cheese(Pizza pizza) {  
5        this.pizza = pizza;  
    }  
  
7  
    public String getDescription() {  
9        return pizza.getDescription() + ", Cheese";  
    }  
11  
    public double cost() {  
13        return pizza.cost(); // cheese is free  
    }  
15 }
```



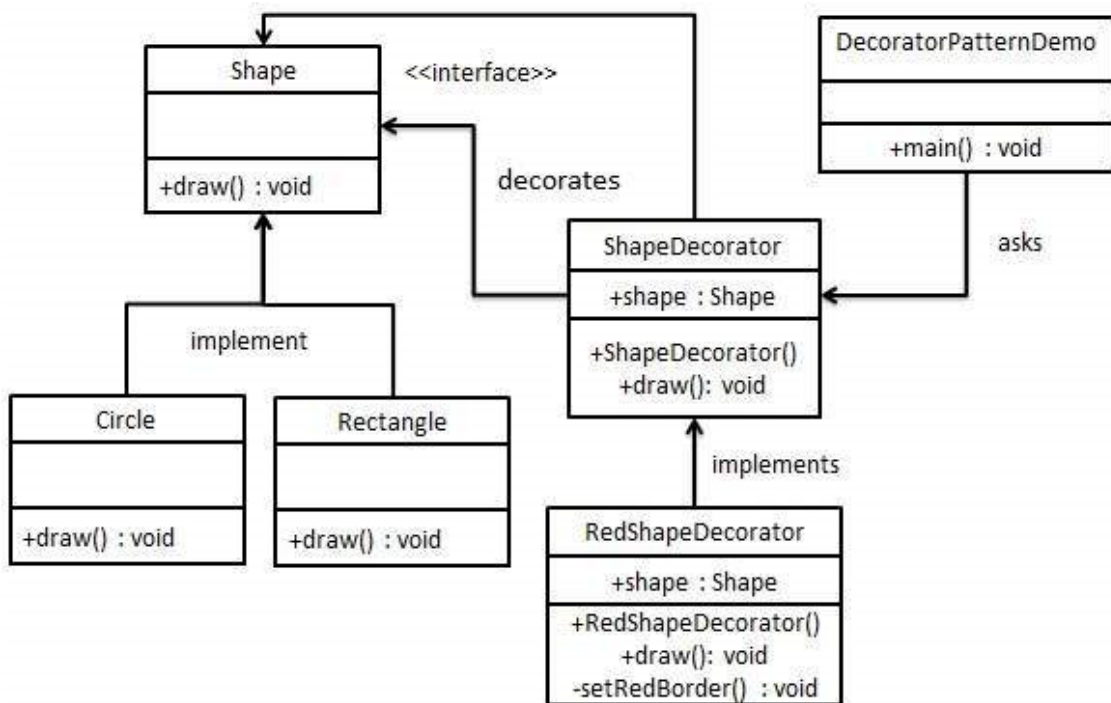
```
1 package com.patterns.decorator;  
  
3 public class Olives extends ToppingDecorator {  
    public Olives(Pizza pizza) {  
5         this.pizza = pizza;  
    }  
  
7  
    public String getDescription() {  
9         return pizza.getDescription() + ", Olives";  
    }  
  
11  
    public double cost() {  
13         return pizza.cost() + .30;  
    }  
15 }
```



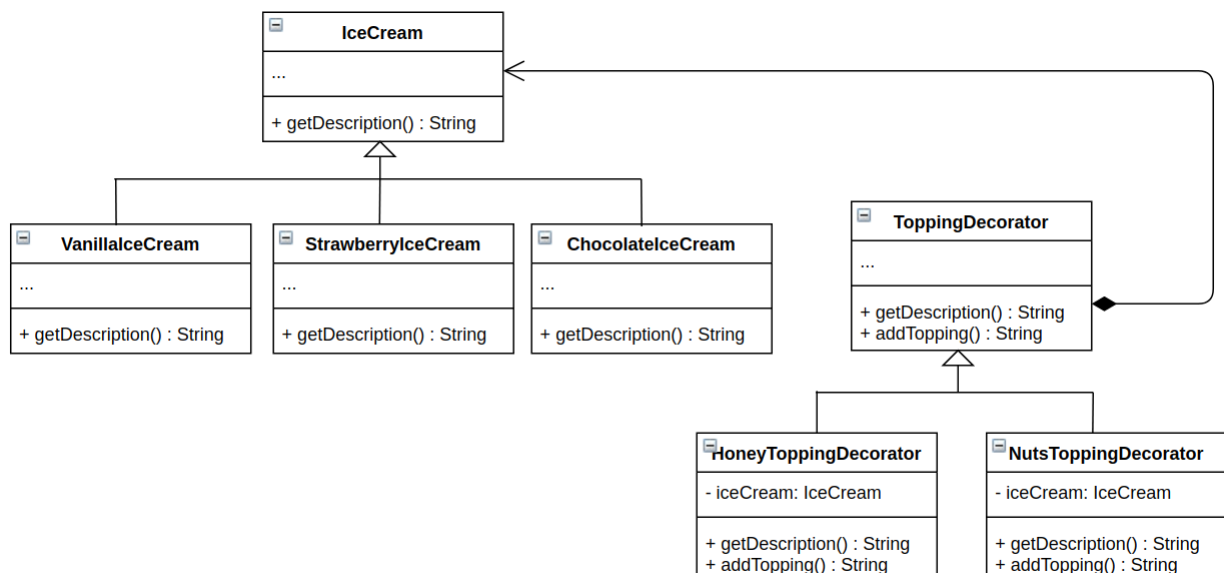
```
1 package com.patterns.decorator;  
  
3 public class PizzaStore {  
  
5     public static void main(String args[]) {  
        Pizza pizza = new ThincrustPizza();  
7        Pizza cheesePizza = new Cheese(pizza);  
        Pizza greekPizza = new Olives(cheesePizza);  
9  
        System.out.println(greekPizza.getDescription()  
11            + " $" + greekPizza.cost());  
13    }  
}
```


12 Exercises

- Write a program using Decorator Pattern according to the following uml diagram.



- Write a program using Decorator Pattern according to the following uml diagram.



- Write code to demonstrate the program from the pseudocode.