The Decorator Pattern

The **Decorator Pattern** attaches additional responsibilities to an object dynamically. Decorators provide a flexible alternative to subclassing for extending functionality.

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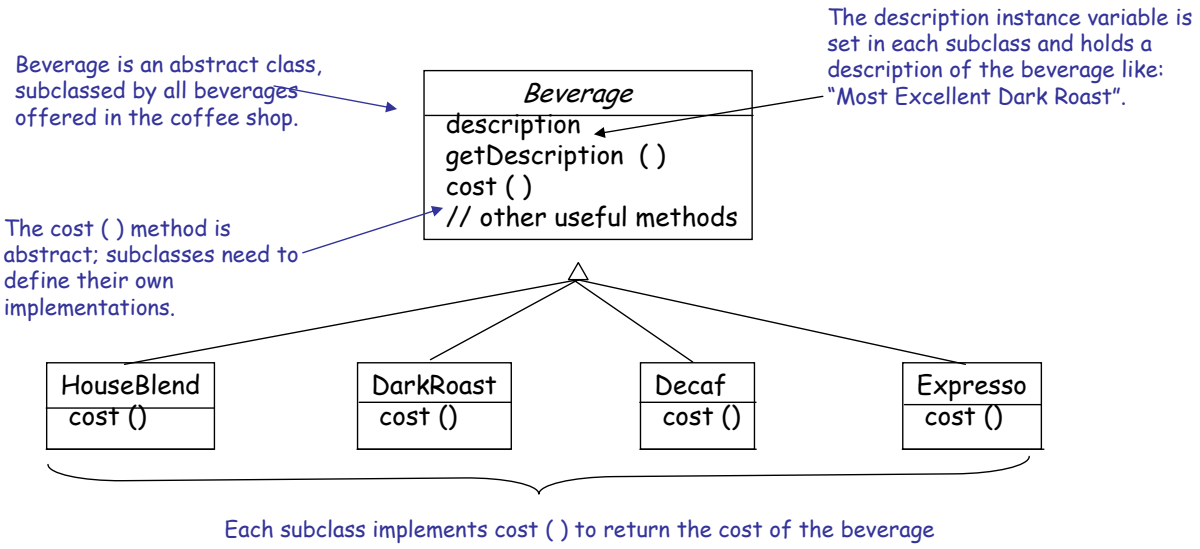
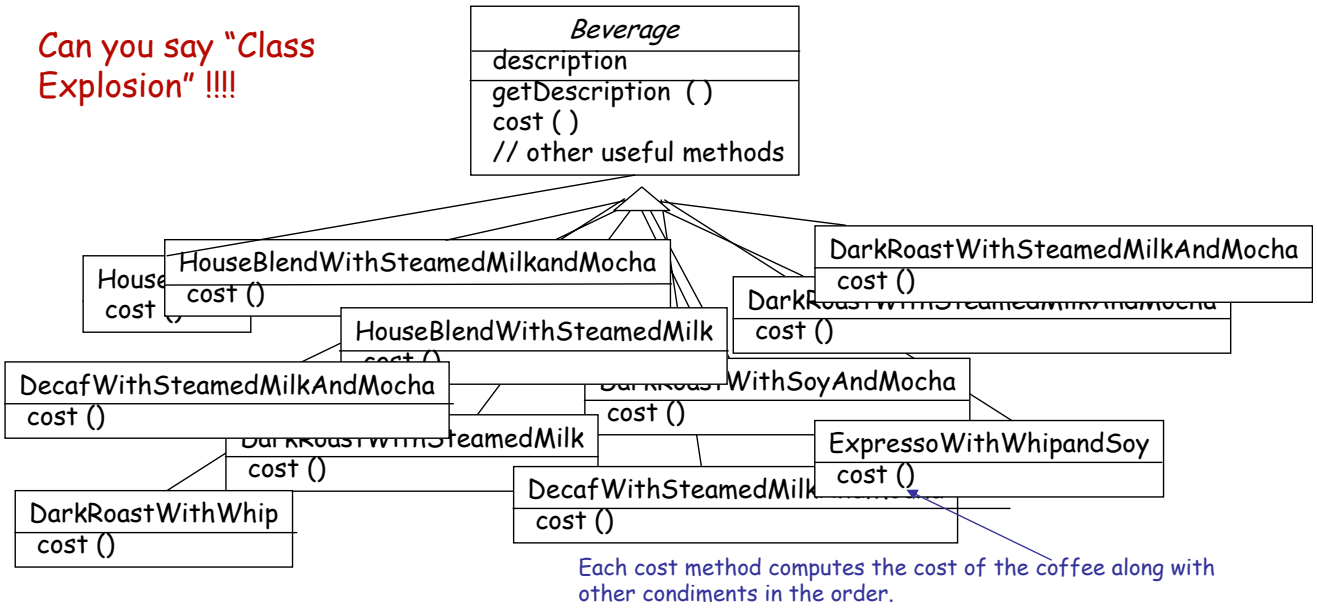
Welcome to Starbuzz Coffee!

Because Starbuzz Coffee have grown so quickly, they are scrambling to update their ordering system to match their beverage offerings….



Adding on….

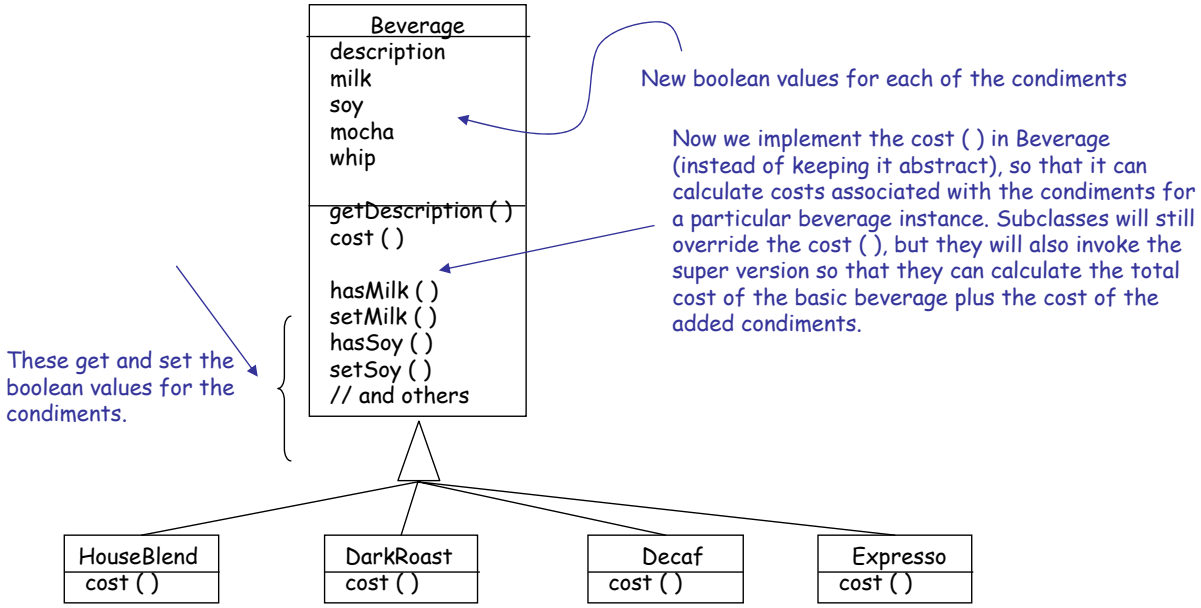
In addition to your coffee you can also ask for several condiments like steamed milk, soy, mocha etc. Starbuzz charges a bit for each of these so they really need to get them built into the order system. First attempt…..



Alternatives to the Design?

It is pretty obvious that Starbuzz has created a maintenance nightmare for themselves: what happens when the price of milk goes up? or when they add a new caramel topping?

Can't we just use instance variables and inheritance in the superclass to keep track of the condiments?



Alternatives to the Design?

What requirements or other factors might change that will impact this design?

1) Price changes for condiments will force us to alter the existing code.

2) New condiments will force us to add new methods and alter the cost method in the superclass.

3) We may have new beverages. For some of these beverages the condiments may not be appropriate.

4) What if a customer wants a double mocha?

Meet the Decorator Pattern

We start with a beverage and "*decorate*" it with the condiments at runtime. If a customer wants a *Dark Roast with Mocha and Whip* we do the following:

1. Take a `DarkRoast` object
2. Decorate it with a `Mocha` object
3. Decorate it with a `Whip` object
4. Call the `cost` ( ) method and rely on delegation to add on the condiment costs.

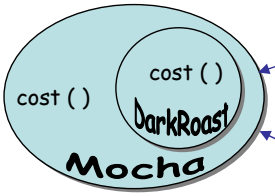
How do you "*decorate*" and how does delegation come into this?

Constructing a drink order with Decorators

1. Start with the DarkRoast object

DarkRoast inherits from Beverage and has a cost ( ) method that computes the cost of the drink.

2. Customer wants Mocha, so we create a Mocha object and wrap it around the DarkRoast.

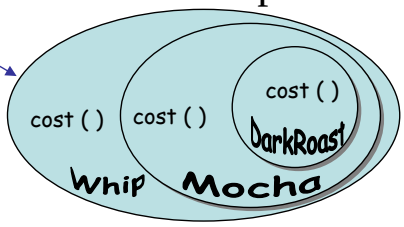


The Mocha object is a "decorator". Its type mirrors the object it is decorating, in this case, a Beverage. ("mirror" means it is the same type.

So Mocha has a cost ( ) method too, and through polymorphism we can treat any Beverage object wrapped in Mocha as a Beverage too. (Mocha is a subtype of Beverage)

3. The customer also wants Whip, so we create a Whip decorator and wrap Mocha with it.

Whip is a decorator, so it also mirrors DarkRoast's type and includes a cost ( ) method.



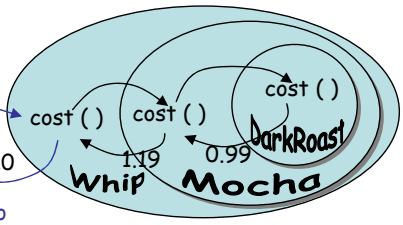
So DarkRoast wrapped in Mocha and Whip is still a Beverage and we can do anything with it that we can do with a DarkRoast, including call its cost ( ) method.

4. Now its time to compute the cost for the customer. Do this by calling **cost**( ) on the outermost decorator, **Whip**, and **Whip** is going to delegate computing cost to the objects it decorates. Once it gets a cost, it will add on the cost of the **Whip**.

(2) Whip calls cost ( ) on Mocha

(1) First we call cost ( ) on the outermost decorator, Whip.

(3) Mocha calls cost ( ) on DarkRoast



(4) DarkRoast returns its cost, 99 cents

(6) Whip adds its total, 10 cents, to the result from Mocha, and returns the final result -- $1.29.

(5) Mocha adds its cost, 20 cents, to the result and returns the new total $1.19

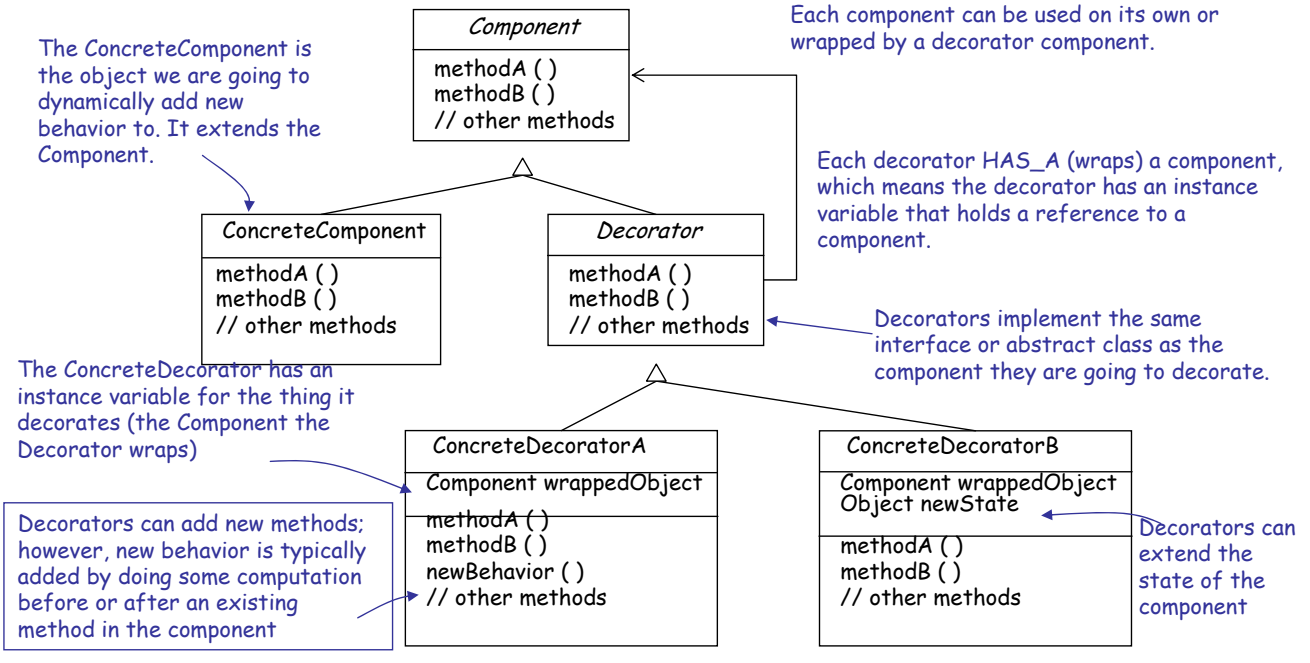
So what do we know so far?

- Decorators have the same *supertype* as the objects that they decorate.
- You can use one or more decorators to wrap an object.
- Given that the decorator has the same *supertype* as the object it decorates, we can pass around a decorated object in place of the original object.
- The decorator adds its own behavior either before and/or after delegating to the object its decorates to do the job.
- Objects can be decorated at any time, so we can decorate objects at runtime with as many decorators as we like.

Key point!

Decorator Pattern

The **Decorator Pattern** attaches additional responsibilities to an object dynamically. Decorators provide a flexible alternative to subclassing for extending functionality.



Decorator Pattern: Participants

- **Component**

  Define the interface for objects that can have responsibilities added to them dynamically.

- **ConcreteComponent**

  Defines an object to which additional responsibilities can be attached.

- **Decorator**

  Maintains a reference to a Component object and defines an interface that conforms to Component's interface.

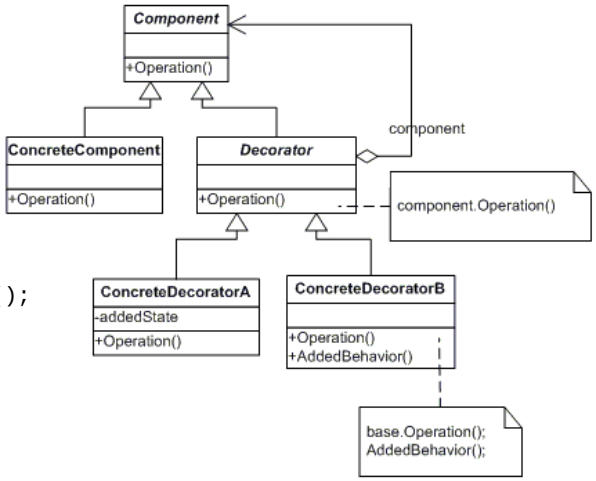
- **ConcreteDecorator**

  Adds responsibilities to the component.

Decorator Pattern: Structural Code

```
public class DecoratorTest {
        public static void main(String[] args) {
                System.out.println("Decorator : Test");

                Component decorated1 = new ConcreteDecoratorA();
                decorated1.action();

                Component decorated2 = new ConcreteDecoratorB();
                decorated2.action();

                }

}
```

```
public class Decorator implements Component {
        Component component = new ConcreteComponent();
        public void action() {
                component.action();
                }
}
```



```
public class ConcreteDecoratorA extends Decorator {
        String addedVariable;
        public void action() {
                super.action();
                System.out.println("ConcreteDecoratorA.action()
                called.");
                addedVariable = "extra";
                System.out.println("ConcreteDecoratorA.addedVariable="
                + addedVariable);
                }
}
```

```
public class ConcreteDecoratorB extends Decorator {
        public void action() {
                super.action();
                System.out.println("ConcreteDecoratorB.action()
                called.");
                addedBehavior ();
                }
        private void addedBehavior() {
                System.out.println("ConcreteDecoratorB.addedBehavior ()
                called.");
                }
}
```

```
 public class ConcreteComponent implements Component {
         public void action() {
                 System.out.println("ConcreteComponent.action()
                 called.");
                 }
 }
```

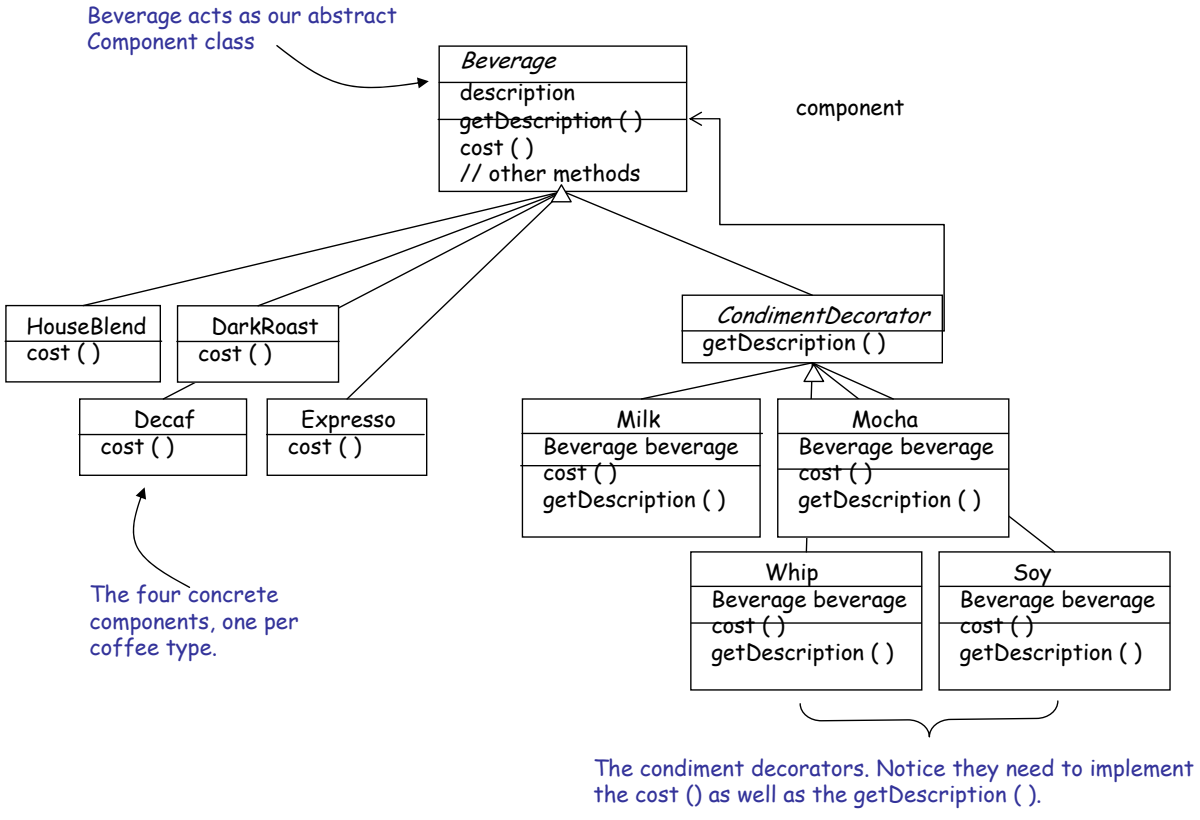
```
 public interface Component {
         public void action();
 }
```

Summary

- The Decorator Pattern is based on the open-closed principle!
  - We should allow behavior to be extended without the need to modify existing code.

- The Decorator Pattern
  - Provides an alternative to subclassing for extending behavior.
  - Involves a set of decorator classes that are used to wrap concrete components
  - Decorator classes mirror the types of the components they decorate.
  - Decorators change the behavior of their components by adding new functionality before and/or after method calls to the component.
  - You can wrap a component with any number of decorators.
  - Decorators are typically transparent to the client of the component -- unless the client is relying on the component's concrete type.
  - Decorators can result in many small objects in our design, and overuse can be complex!

Decorate the Beverages!



Some Code

```
public abstract class Beverage {
   String description = "Unknown Beverage";
   public String getDescription ( ) {
         return description;
    }
    public abstract double cost ( );
}

public abstract class CondimentDecorator extends Beverage {
     public abstract String getDescription ( );
}
```

Beverage is an abstract class with two methods getDescription ( ) and cost ( ). getDescription ( )is already implemented, but we need to implement cost ( ) in the subclasses.

First, we need to be interchangeable with Beverage, so we extend the Beverage class.

We are also going to require that the condiment decorators reimplement the getDescription ( ) method. We will see why in a sec…

Coding Beverages

```
public class Expresso extends Beverage {
     public Expresso ( ) {
          description = "Expresso";
     }
     public double cost  ( ) {
          return 1.99;
     }
}

public class HouseBlend extends Beverage {
      public HouseBlend ( ) {
           description = "HouseBlend";
      }
      public double cost ( ) {
           return .89;
      }
 }
```

Coding Condiments

```
public class Mocha extends CondimentDecorator {
    Beverage beverage;
    public Mocha(Beverage beverage) {
        this.beverage = beverage;
    }
    public String getDescription ( ) {
        return beverage.getDescription( ) + ", Mocha";
    }
    public double cost ( ) {
        return .20 + beverage.cost ( );
    }
}
```

We want our description to say not only Dark Roast -- but to also include the item decorating each beverage for instance: Dark Roast, Mocha. So we first delegate to the object we are decorating to get its description, then append ", Mocha" to that description.

Similarly, to compute the cost of the beverage with Mocha, we first delegate to the object that is being decorated, so that we can compute its cost and then add in the cost of the Mocha.

Ordering Coffee

```
public class StarbuzzCoffee {
    public static void main (String args[]) {
        Beverage beverage = new Espresso ( );
        System.out.println ( beverage.getDescription ( ) + " $ " + beverage.cost ( ));

        Beverage beverage2 = new DarkRoast ( );
        beverage2 = new Mocha(beverage2);
        beverage2 = new Mocha(beverage2);
        beverage2 = new Whip (beverage2);
        System.out.println( beverage.getDescription ( ) + "$ " + beverage2.cost ( ));
    }
}
```