CS427a: Object-Oriented Programming

Design Patterns for Flexible and Reusable design

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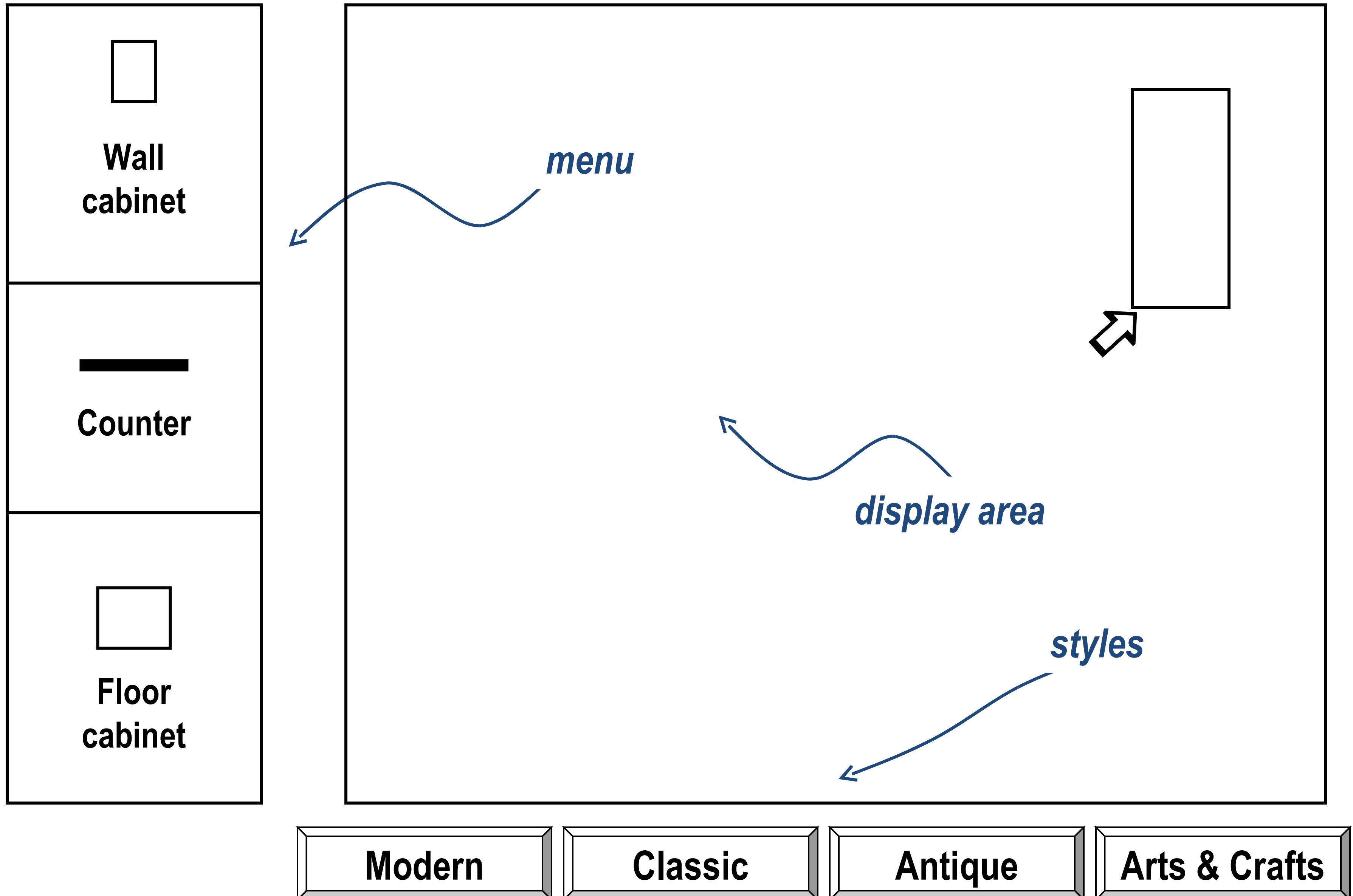
(from slides by Y. Richard Yang)

Lecture 21
November 18, 2010

Example: KitchenViewer Interface



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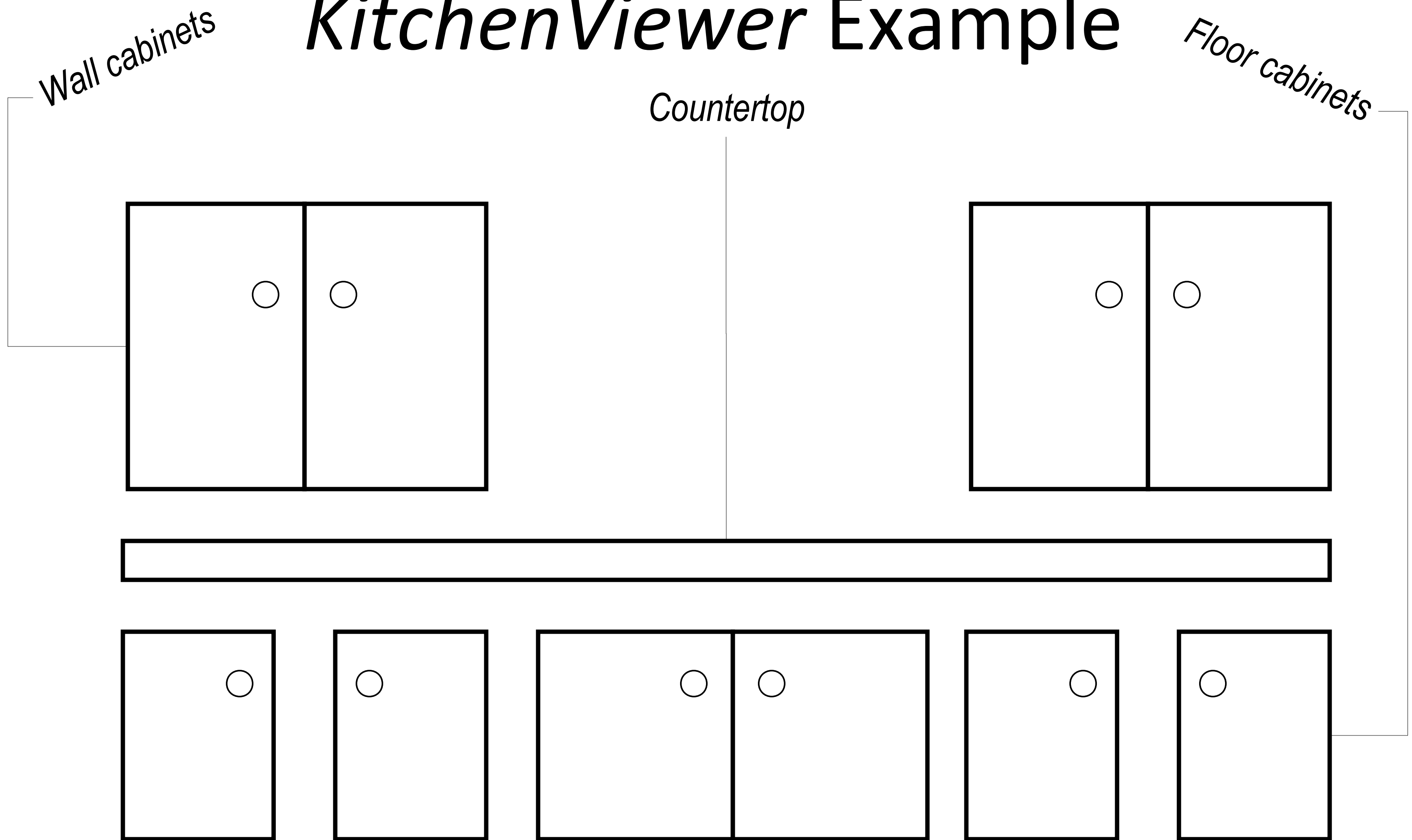
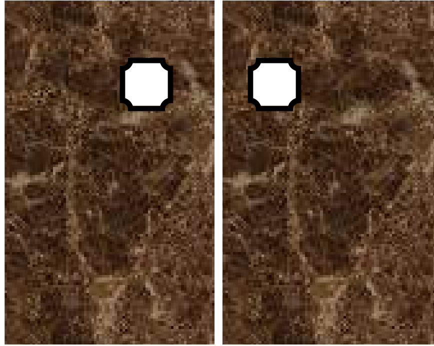
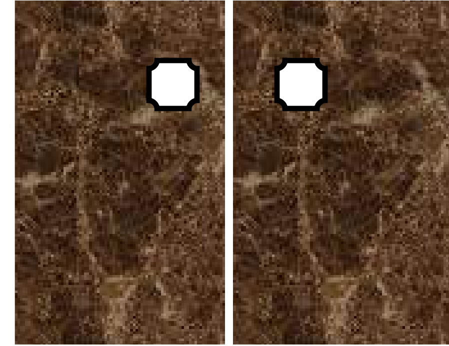
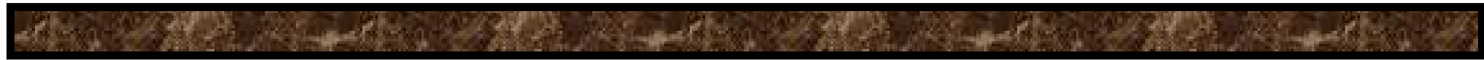
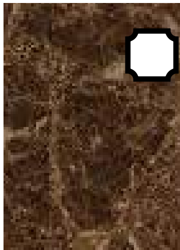
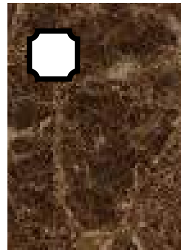
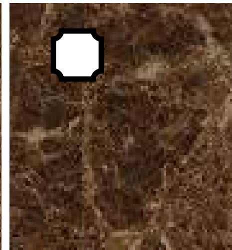
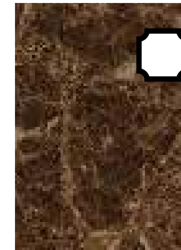


Modern | **Classic** | **Antique** | **Arts & Crafts**

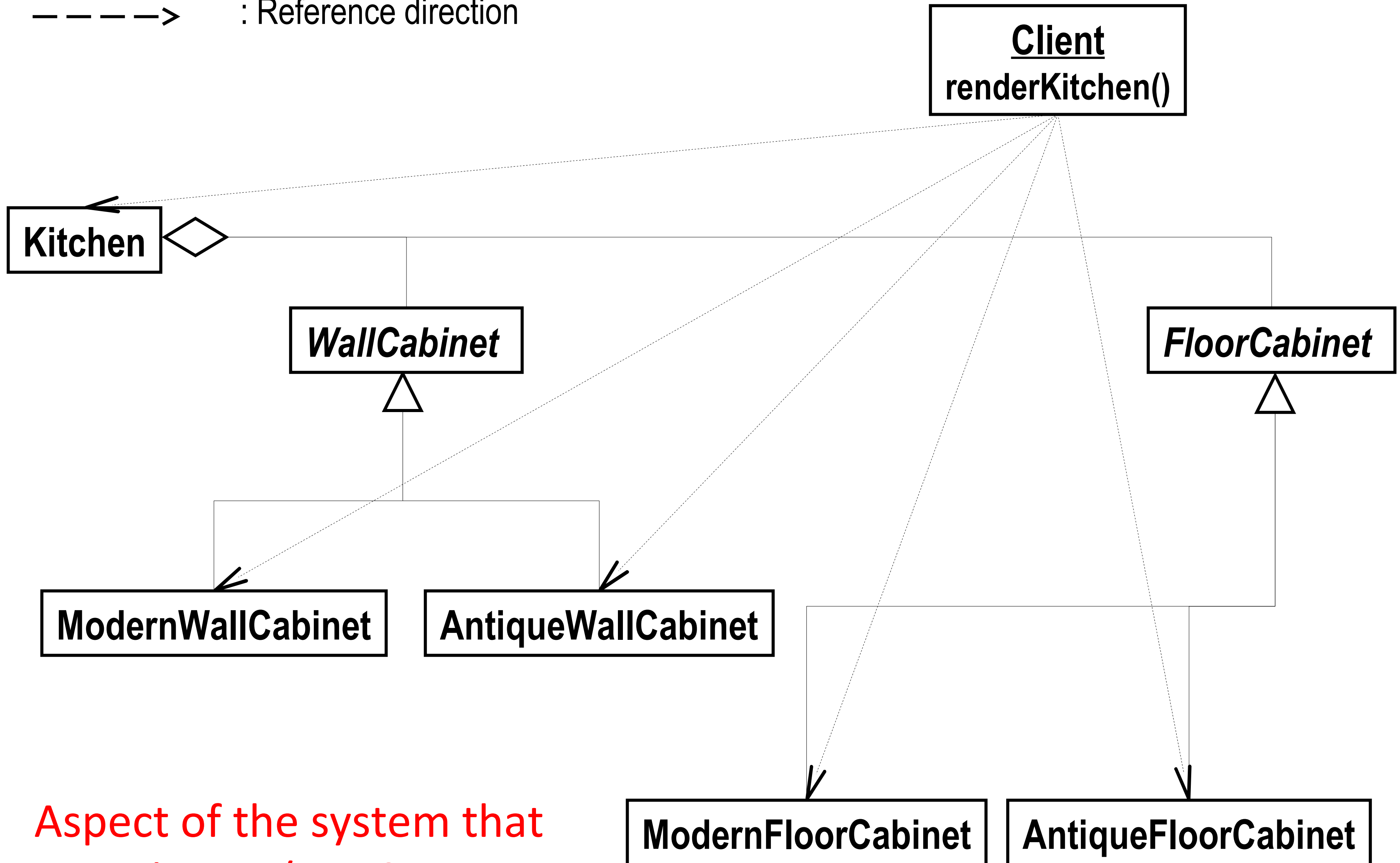
Selecting *Antique* Style

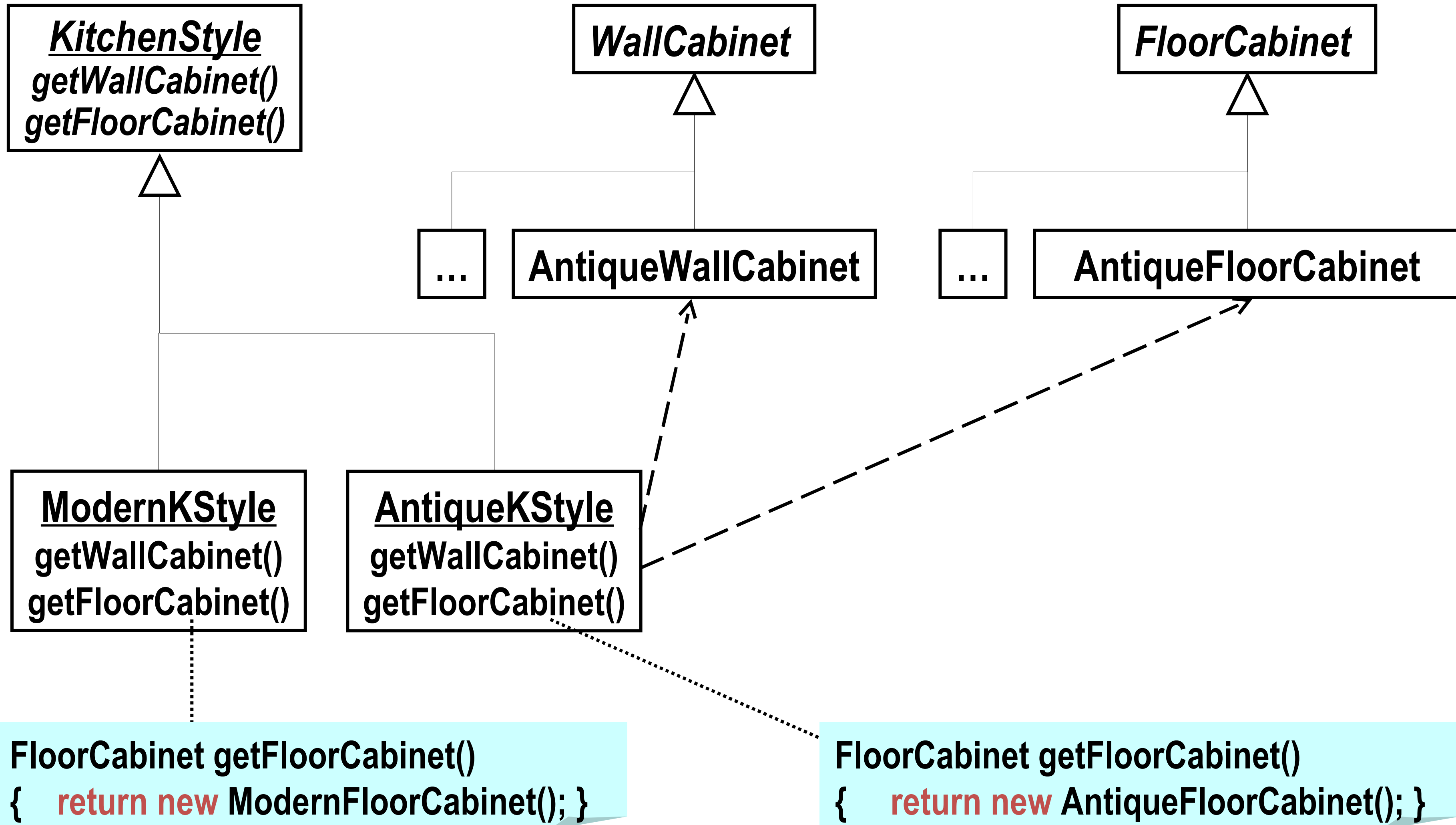



Modern | Classic | **Antique** | Arts & Crafts

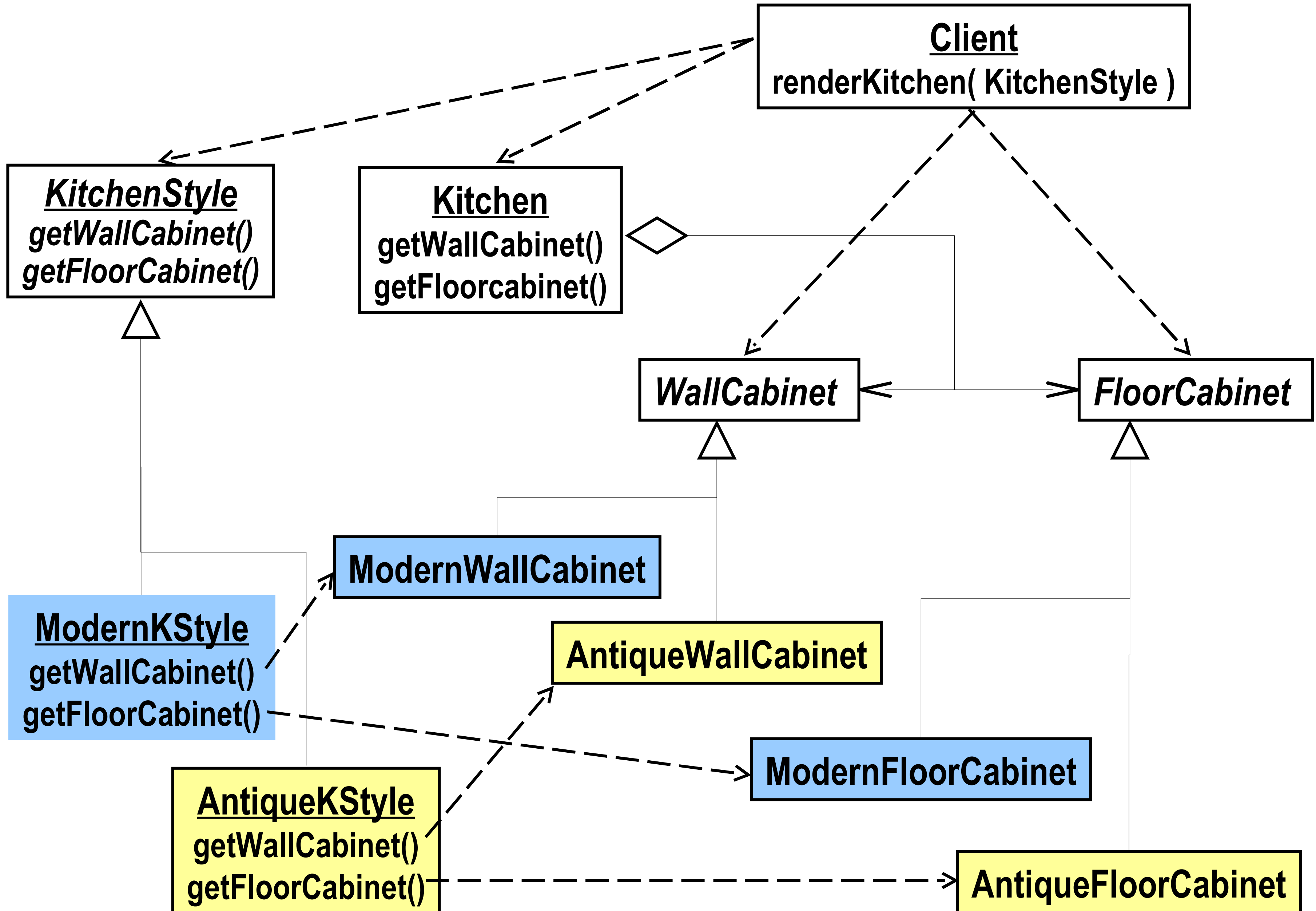
KitchenViewer Using Standard Inheritance

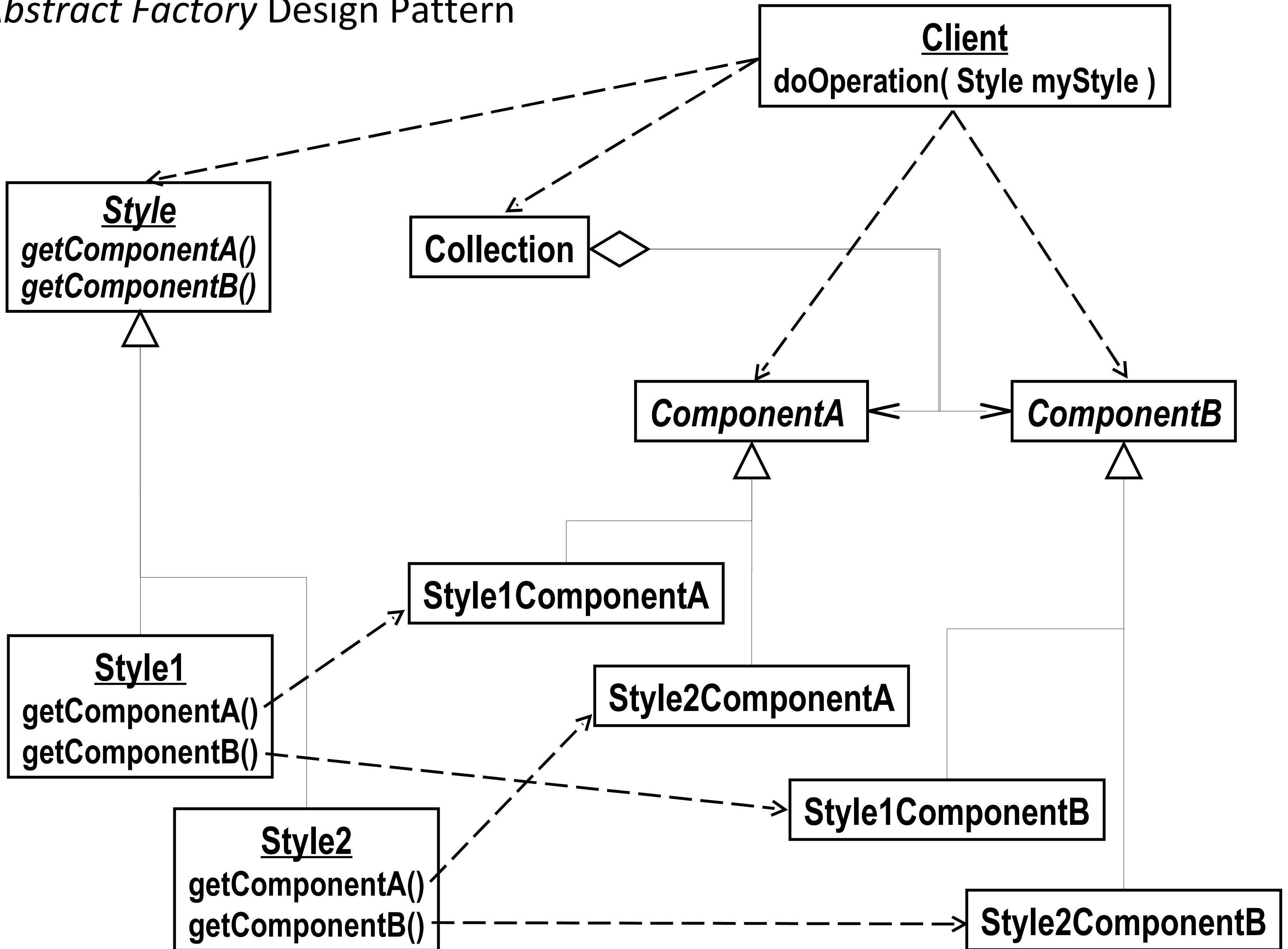


The Abstract Factory Idea

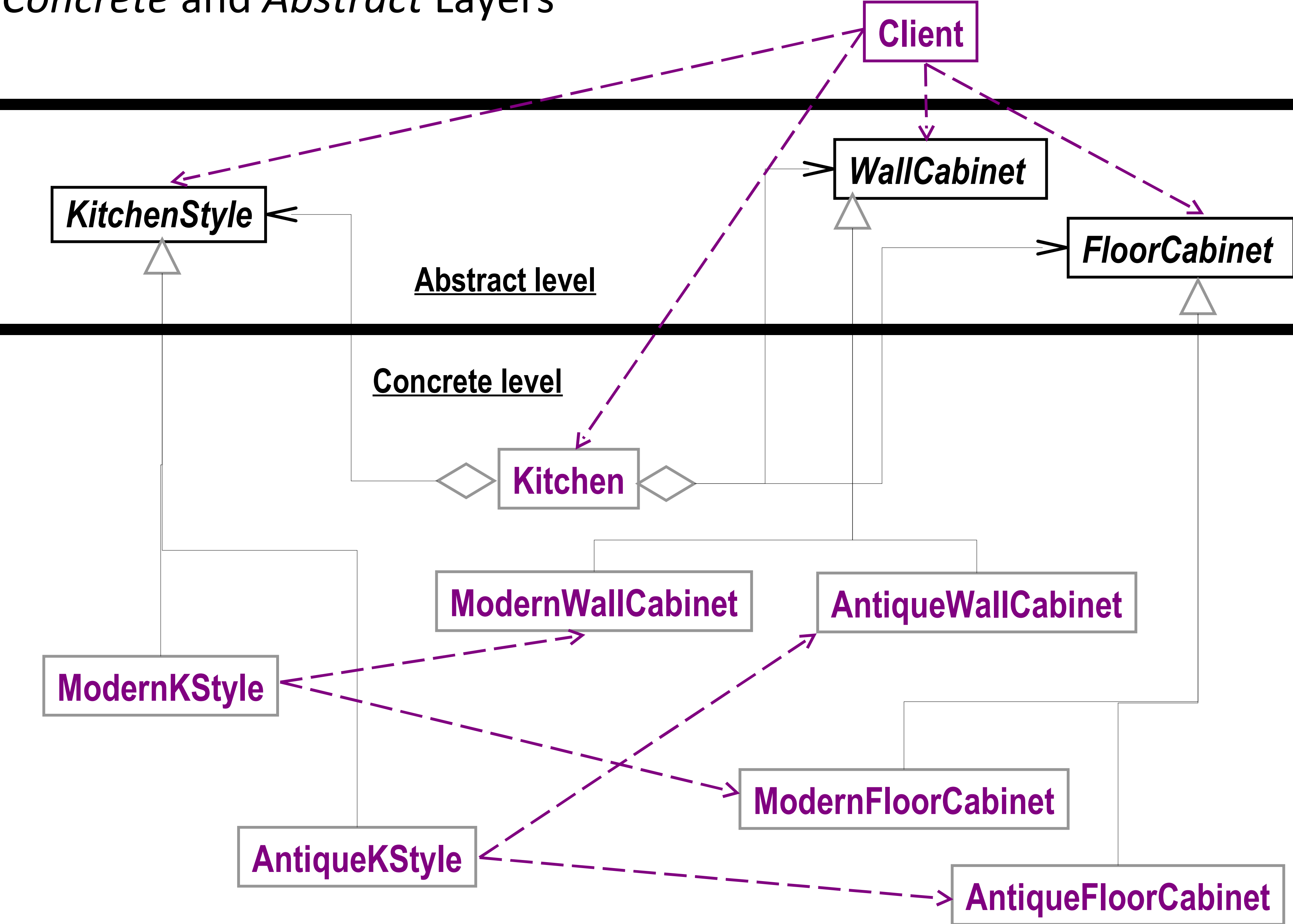


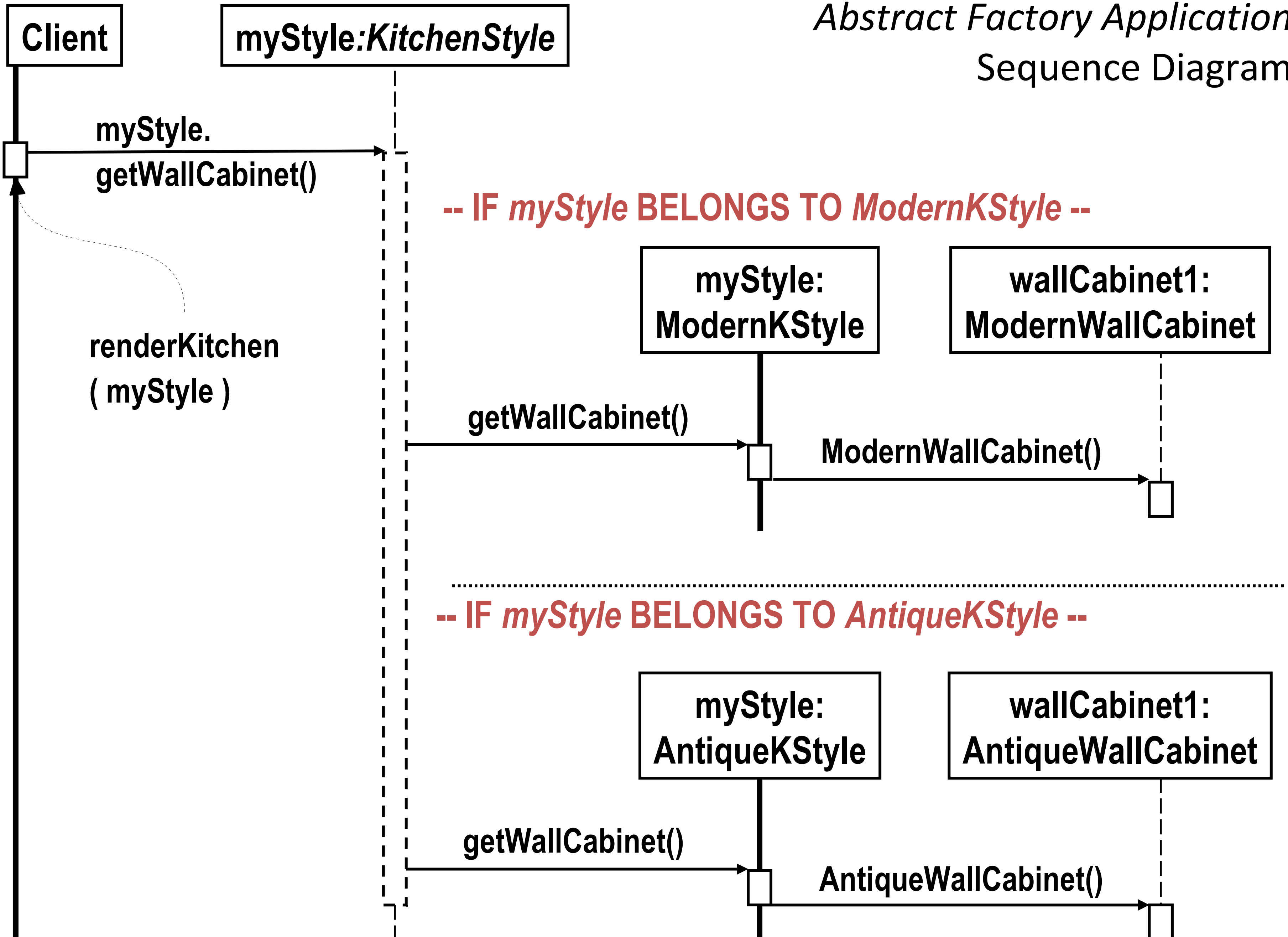
Abstract Factory Design Pattern Applied to *KitchenViewer*



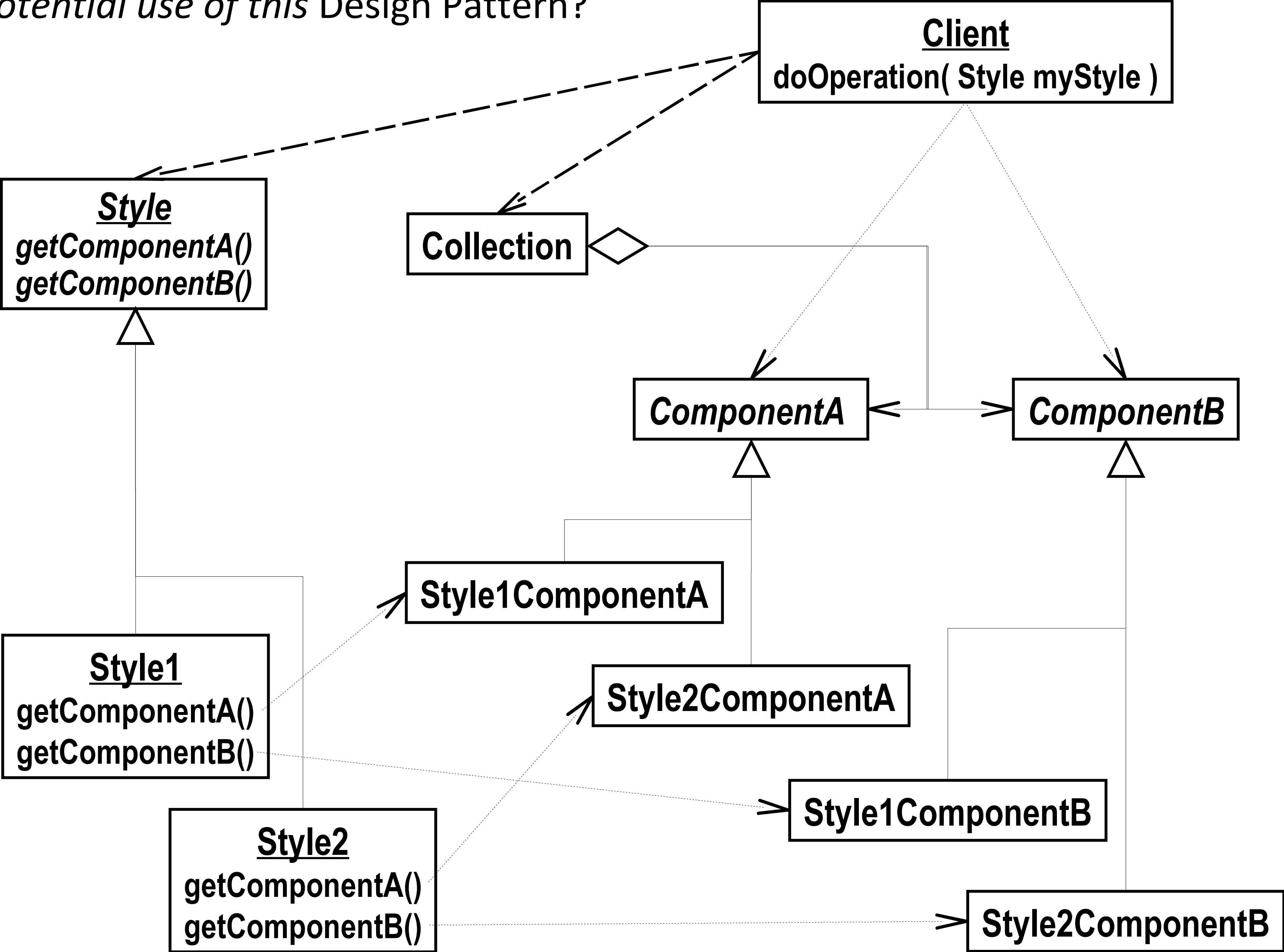

Abstract Factory Design Pattern
Client
doOperation(Style myStyle)
Style
getComponentA()
getComponentB()
Collection
ComponentA
ComponentB
Style1ComponentA
Style2ComponentA
Style1ComponentB
Style2ComponentB
Style1
getComponentA()
getComponentB()
Style2
getComponentA()
getComponentB()

Concrete and *Abstract* Layers



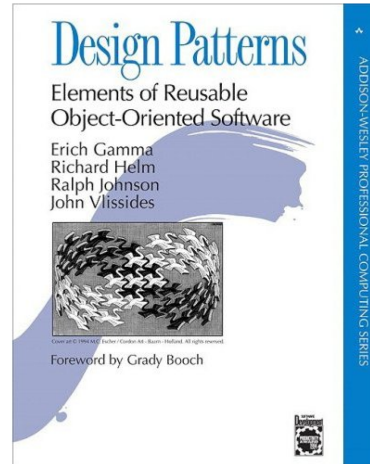

Abstract Factory Application
Sequence Diagram
Client
myStyle:KitchenStyle
myStyle.
getWallCabinet()
renderKitchen
(myStyle)
-- IF myStyle BELONGS TO ModernKStyle --
myStyle:
ModernKStyle
wallCabinet1:
ModernWallCabinet
getWallCabinet()
ModernWallCabinet()
-- IF myStyle BELONGS TO AntiqueKStyle --
myStyle:
AntiqueKStyle
wallCabinet1:
AntiqueWallCabinet
getWallCabinet()
AntiqueWallCabinet()

Potential use of this Design Pattern?

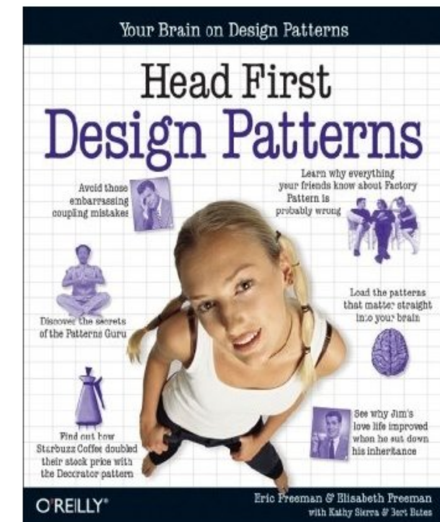


References

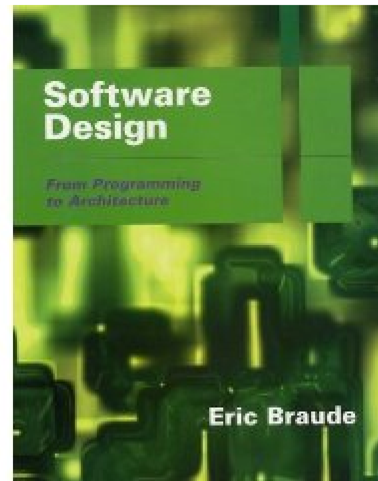
- Design Patterns



- Headfirst Design Patterns

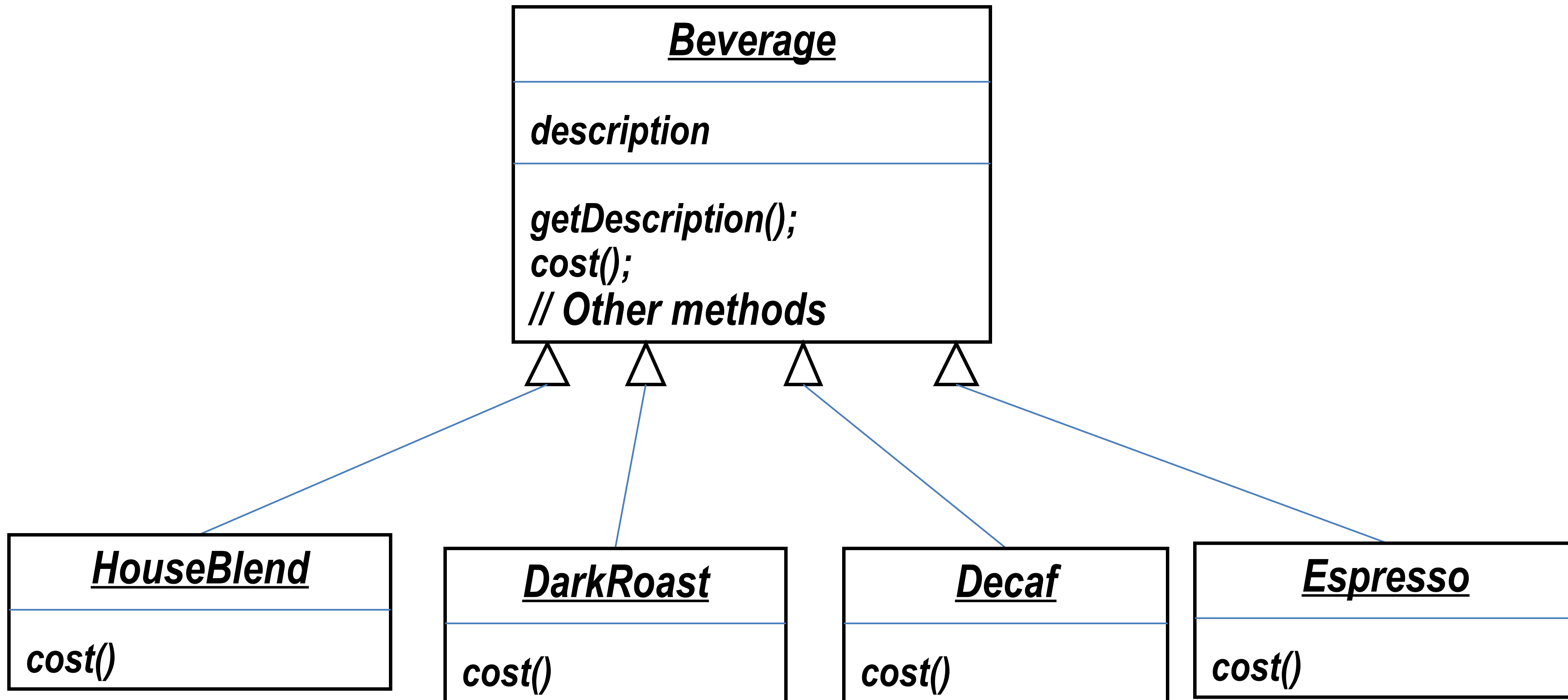


- Software Design

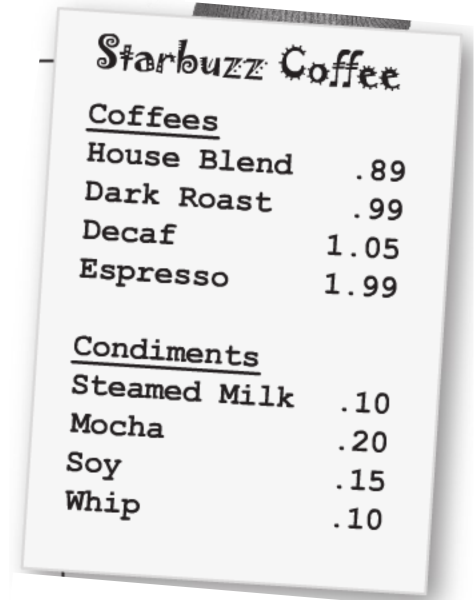


Example: Starbuzz Coffee

- The coffee shop offers a variety of beverages

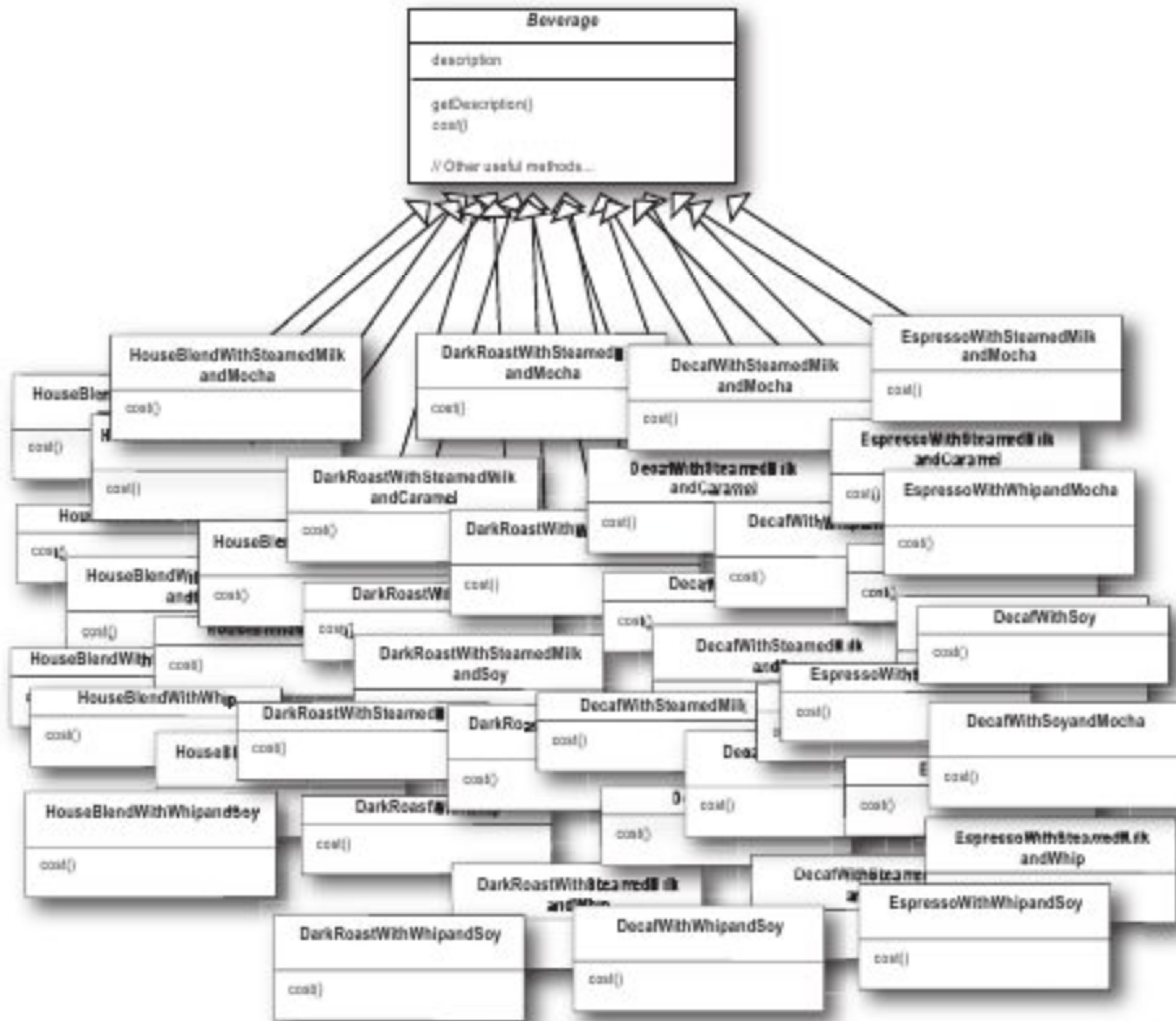


Problem



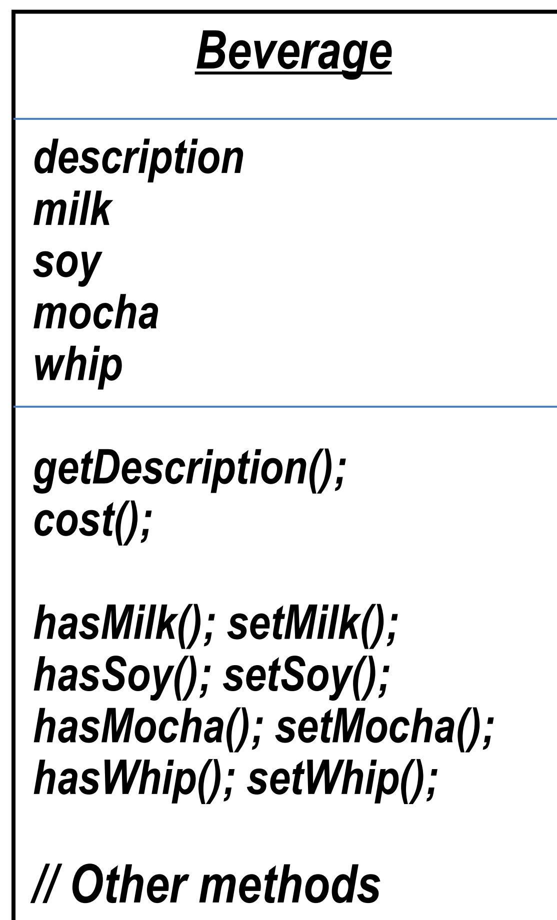
- A customer may also ask for condiments
  - steamed milk
  - soy
  - mocha (otherwise known as chocolate)
  - whipped milk

- Starbuzz charges a bit for each of these

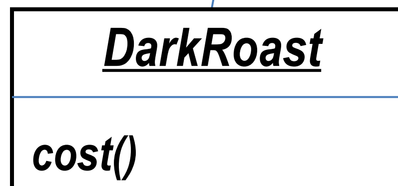


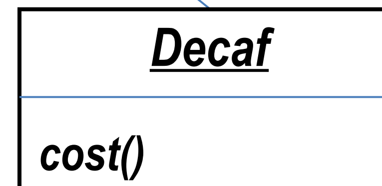
Beverage
description
getDescription()
cost()
// Other useful methods...
HouseBlendWithSteamedMilk
andMocha
cost()
DarkRoastWithSteamed
andMocha
cost()
DecafWithSteamedMilk
andMocha
cost()
EspressoWithSteamedMilk
andMocha
cost()
DarkRoastWithSteamedMilk
andCaramel
cost()
EspressoWithWhipandMocha
cost()
DecafWithSoy
cost()
DarkRoastWithSteamedMilk
andSoy
DecafWithSteamedMilk
cost()
DecafWithSoyandMocha
cost()
HouseBlendWithWhipandSoy
cost()
EspressoWithWhipandSoy
cost()
DarkRoastWithWhipandSoy
cost()
DecafWithWhipandSoy
cost()

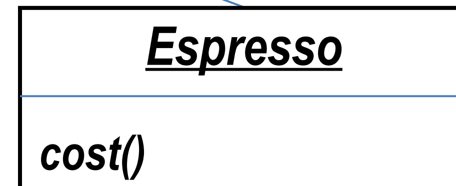
Attempt 1



Aspect of the system that may change/vary?







Potential Changes

- Potential changes:
  - Price change to condiments
  - New condiments
  - Double moca
  - …

Design idea

- Basic idea: extension at run time, not compile time

- Definition: The Decorator pattern attaches additional features to an object dynamically. It provides a flexible alternative to subclassing for extending functionality

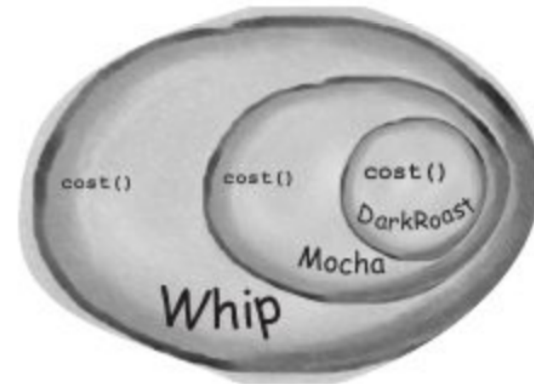
Design approach 1

- Each beverage contains a dynamic list of condiments
- Example
  - Take a DarkRoast object
  - Decorate it with a Mocha object
  - Decorate it with a Whip object

UML class model?

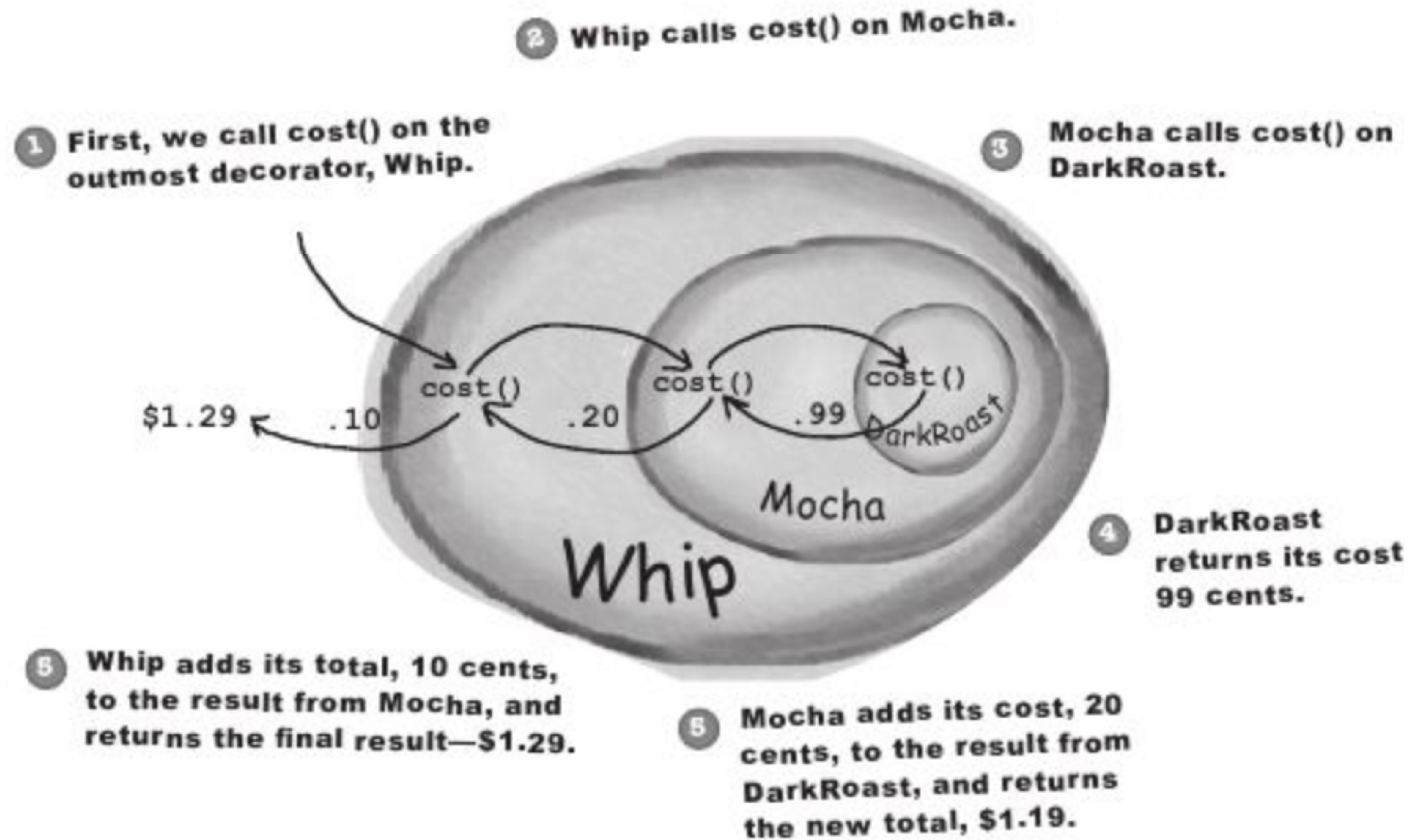
Decorator design

- Example
  - Take a DarkRoast object
  - Decorate it with a Mocha object
  - Decorate it with a Whip object
  - Call the cost() method and rely on delegation to add on the condiment cost

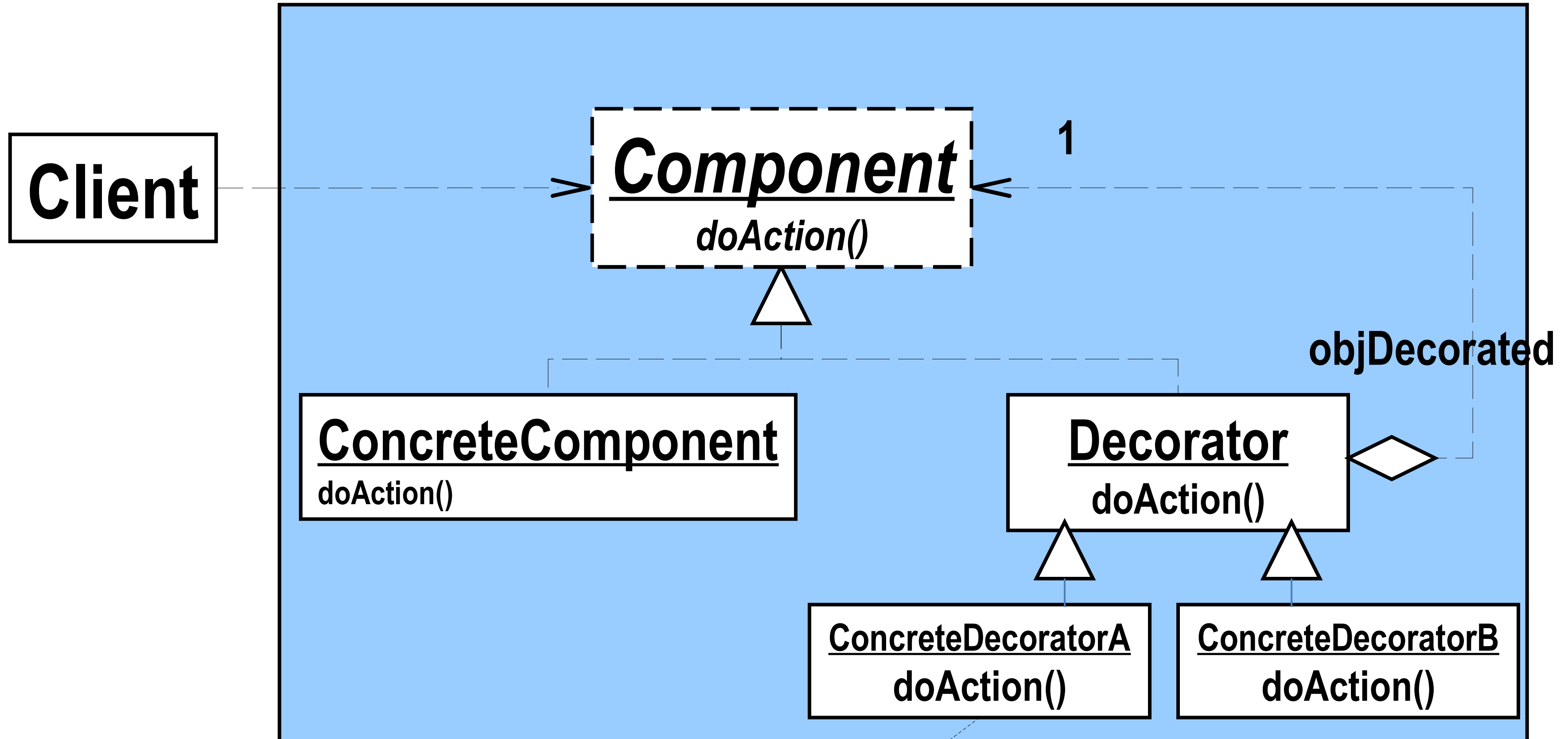


- Decorator adds its own behavior before or after calling the decorated object

Decoration Delegation Process



Decorator Class



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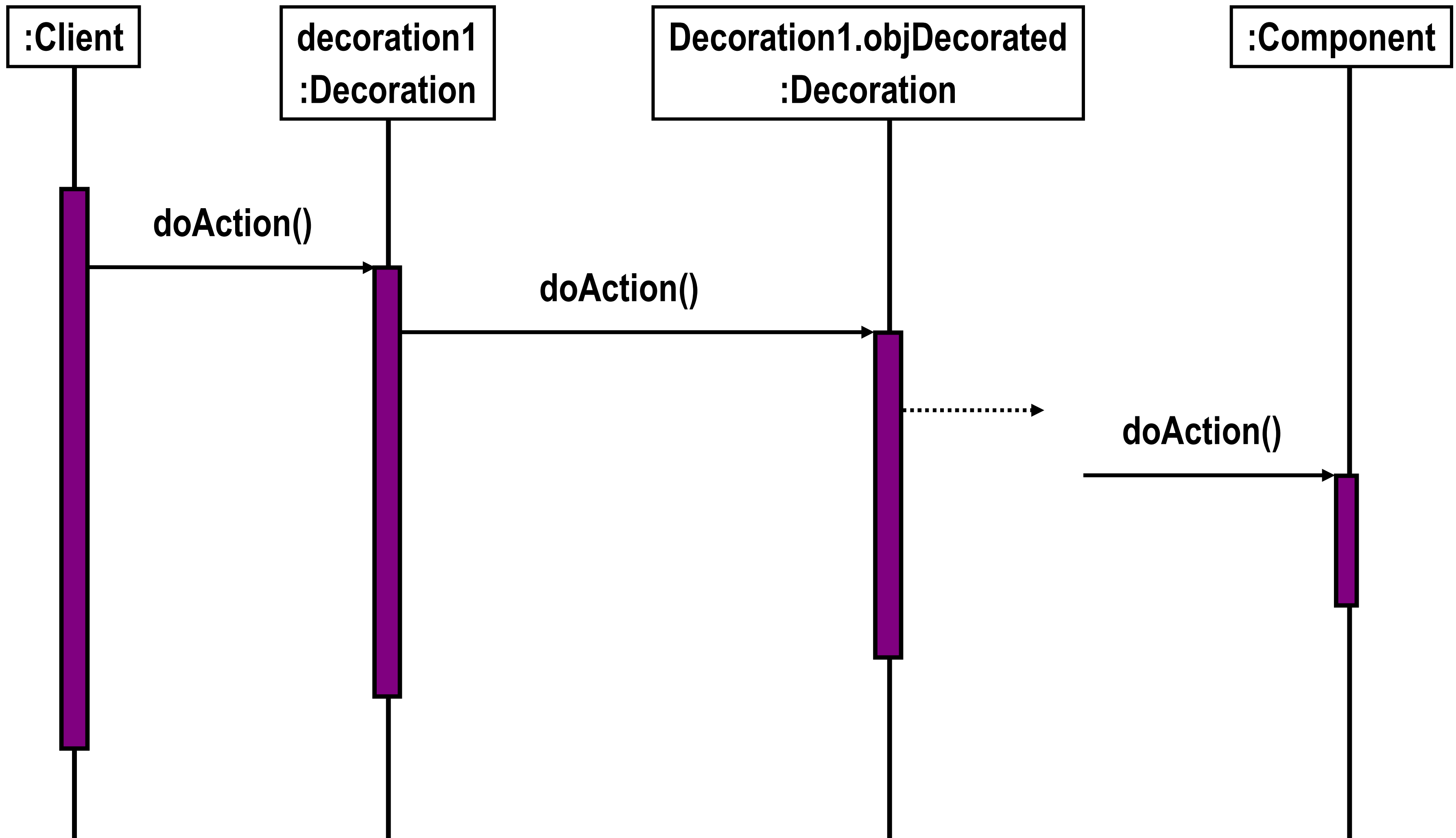
Sequence Diagram for *Decorator*



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Decoration Features

- Decorators have the same supertype as the objects they decorate
- You can use one or more decorators to wrap an object
  - Thus, you can pass decorated object in place of original (wrapped) object
- The decorator adds its own behavior either before or after delegating to the object it decorates to
- Objects can be decorated at any time, including run-time, with as many decorators as possible

Exercise

- Suppose we allow different sizes for the beverages
  - Tall (small)
  - Grande (medium)
  - Venti (large)

Some Common Design Patterns

		Purpose		
		Creational	**Structural**	**Behavioral**
Scope	**Class**	Factory Method	Adapter (class)	Interpreter Template Method
	Object	Abstract Factory Builder Prototype Singleton	Adapter (object) Bridge Composite Decorator Flyweight Facade Proxy	Chain of Responsibility Command Iterator Mediator Memento Observer State Strategy Visitor

Example: Weather-O-Rama

Weather-O-Rama, Inc.
100 Main Street
Tornado Alley, OK 45021

Statement of Work

Congratulations on being selected to build our next generation Internet-based Weather Monitoring Station!

The weather station will be based on our patent pending WeatherData object, which tracks current weather conditions (temperature, humidity, and barometric pressure). We'd like for you to create an application that initially provides three display elements: current conditions, weather statistics and a simple forecast, all updated in real time as the WeatherData object acquires the most recent measurements.

Further, this is an expandable weather station. Weather-O-Rama wants to release an API so that other developers can write their own weather displays and plug them right in. We'd like for you to supply that API!

Weather-O-Rama thinks we have a great business model: once the customers are hooked, we intend to charge them for each display they use. Now for the best part: we are going to pay you in stock options.

We look forward to seeing your design and alpha application.

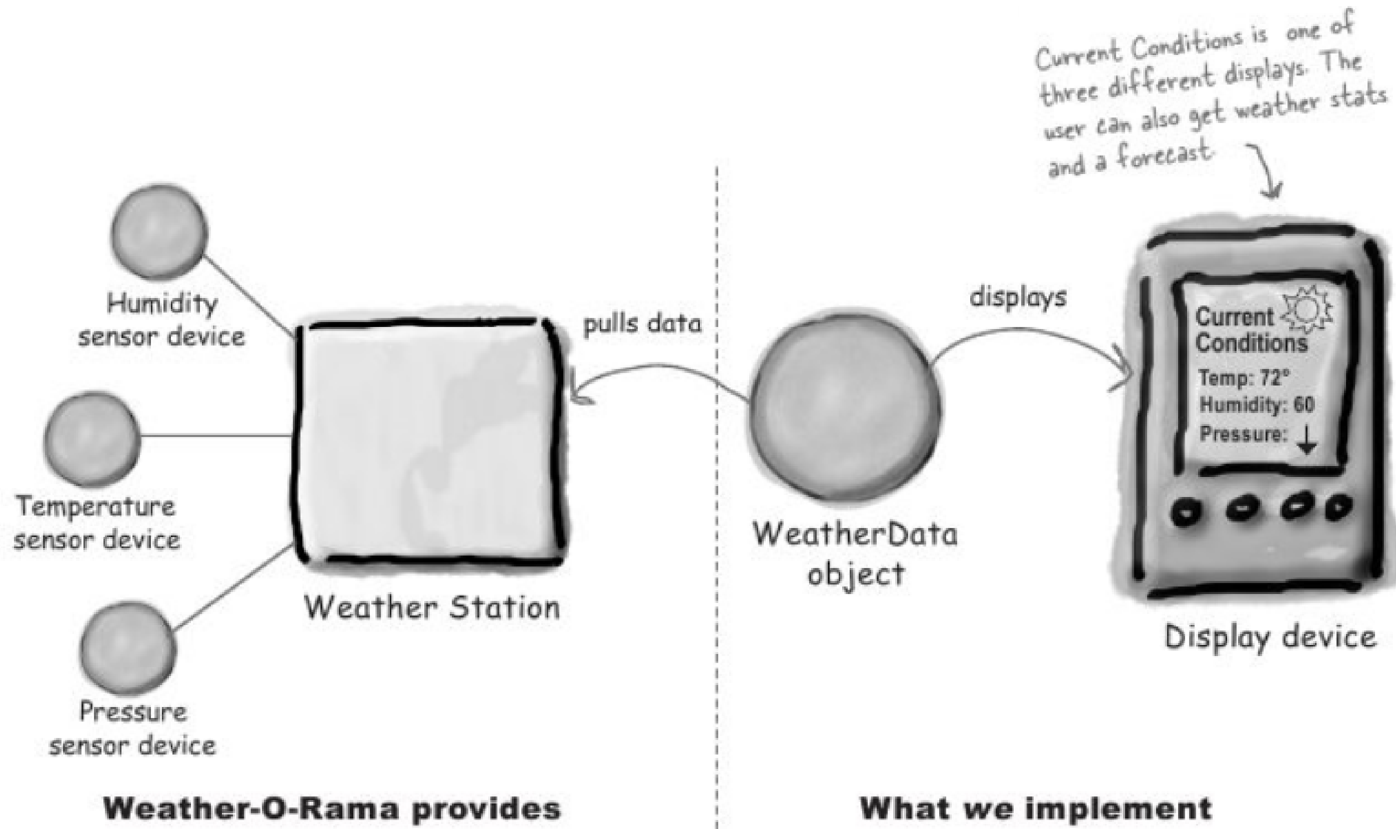
Sincerely,

Johnny Hurricane

Johnny Hurricane, CEO

P.S. We are overnighting the WeatherData source files to you.

Weather-O-Rama



Weather-O-Rama Interface

WeatherData
getTemperature(); *getHumidity();* *getPressure();* *measurementsChanged();* *setMeasurements();* *// other methods*

This method gets called whenever the weather measurements have been updated.

Display One

Display Two

First Implementation

```
void measurementsChanged() {

    float temp = getTemperature() ;
    float humidity = getHumidity() ;
    float pressure = getPressure() ;

    currentConditionsDisplay->update(temp, humidity,
    pressure) ;
    statisticsDisplay->update(temp, humidity, pressure) ;
    forecastDisplay->update(temp, humidity, pressure) ;
}
```

By coding to concrete implementation, we have no way of allowing other displays and plug in.

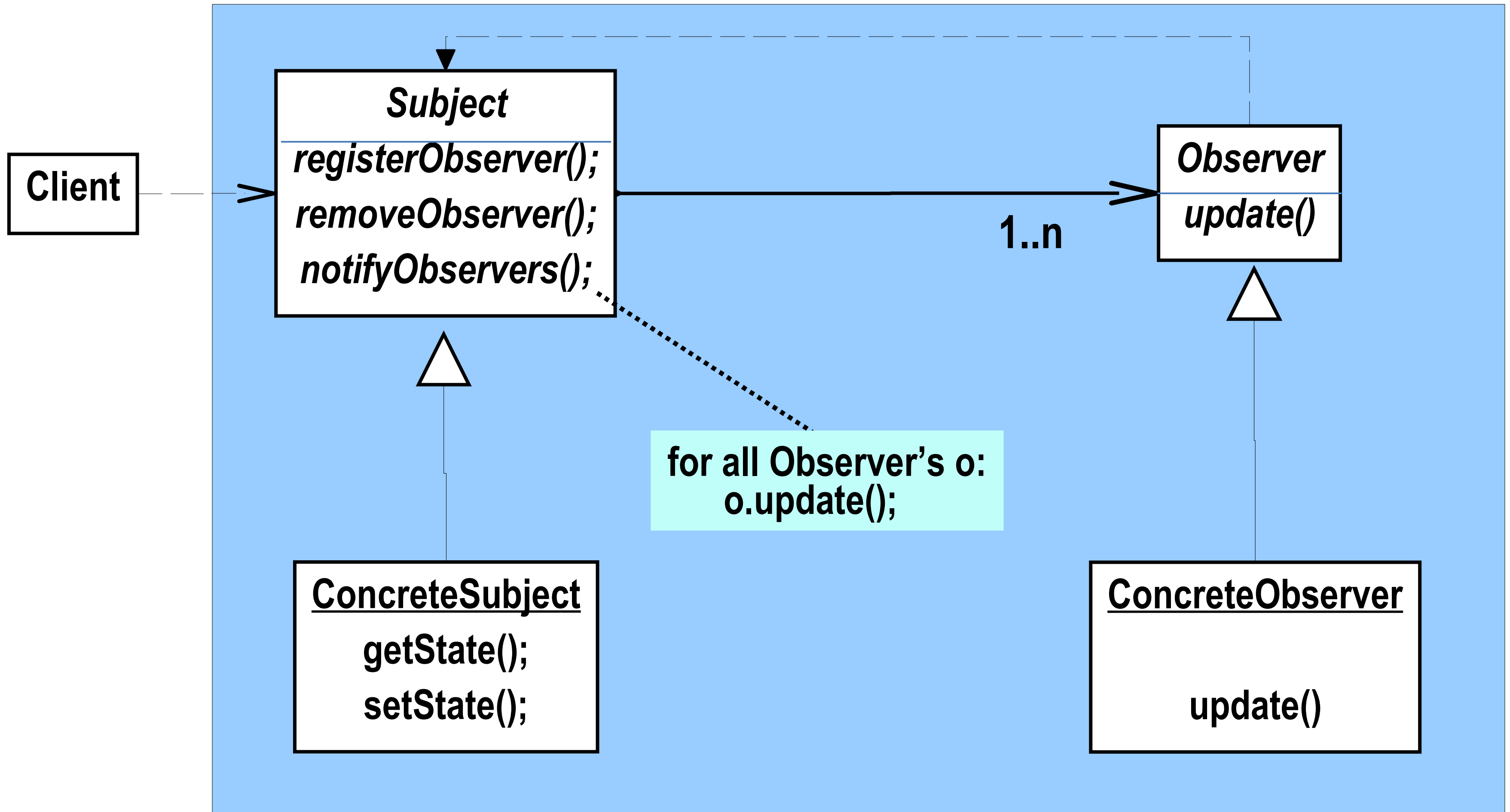
Observer Pattern

- Design Purpose: defines a run-time, one-to-many dependency between objects so that when one object (the subject) changes state, all of the dependents (observers) are notified.

Observer Design Pattern

Server part

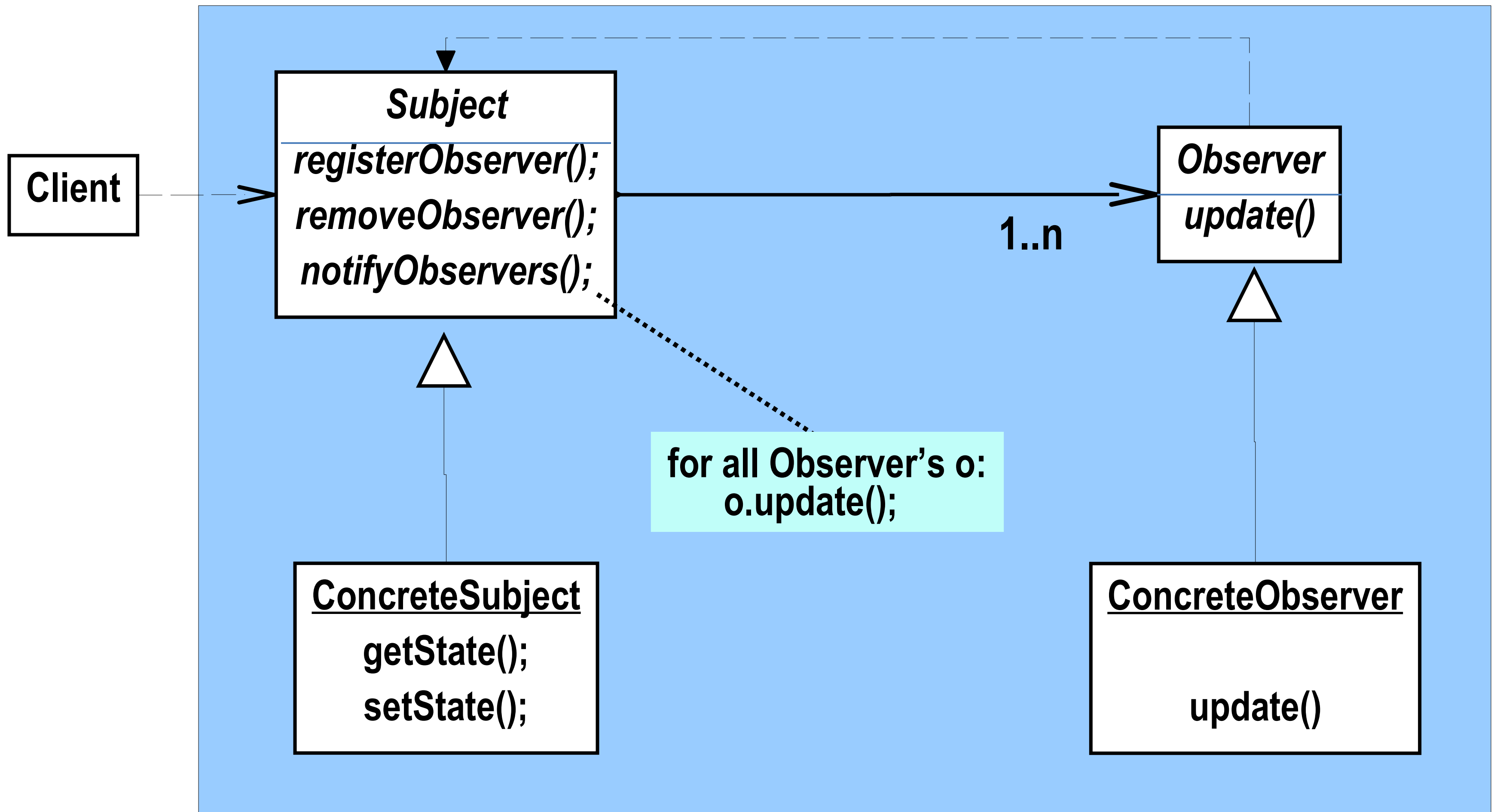
Client part



How does Observer apply these design principles?

- Identify the aspects of your application that vary and separate them from what stay the same
- Program to an interface not implementation
- Favor composition over inheritance

Discussion



- Java Observation design: update(Observable o, Object obj);