Lecture 21: Design Patterns (Part 3)

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Object-Oriented Analysis and Design

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Credit where Credit is Due

- Some of the material for this lecture is taken from "Head First Design Patterns" by Eric and Elisabeth Freeman; as such some of this material is copyright © O'Reilly, 2004

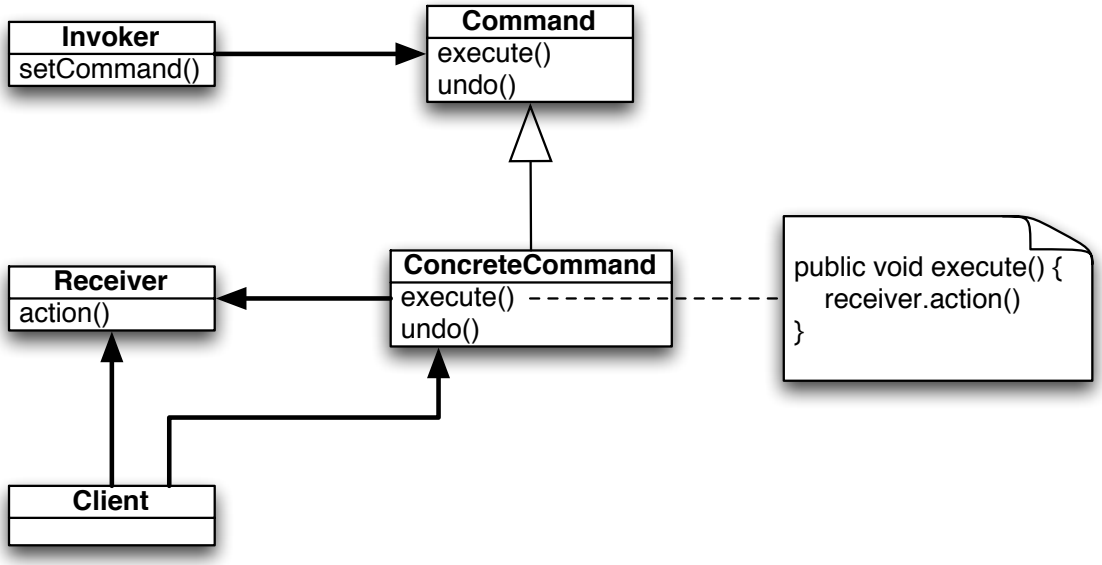
Goals for this (short) lecture

- Cover three more useful design patterns
  - Command
  - Facade
  - Proxy
- This will bring the number of design patterns covered in this class to at least 15
  - Twelve from lectures 13, 17, and 21 plus Double Dispatch, Blackboard, and Model-View-Controller.

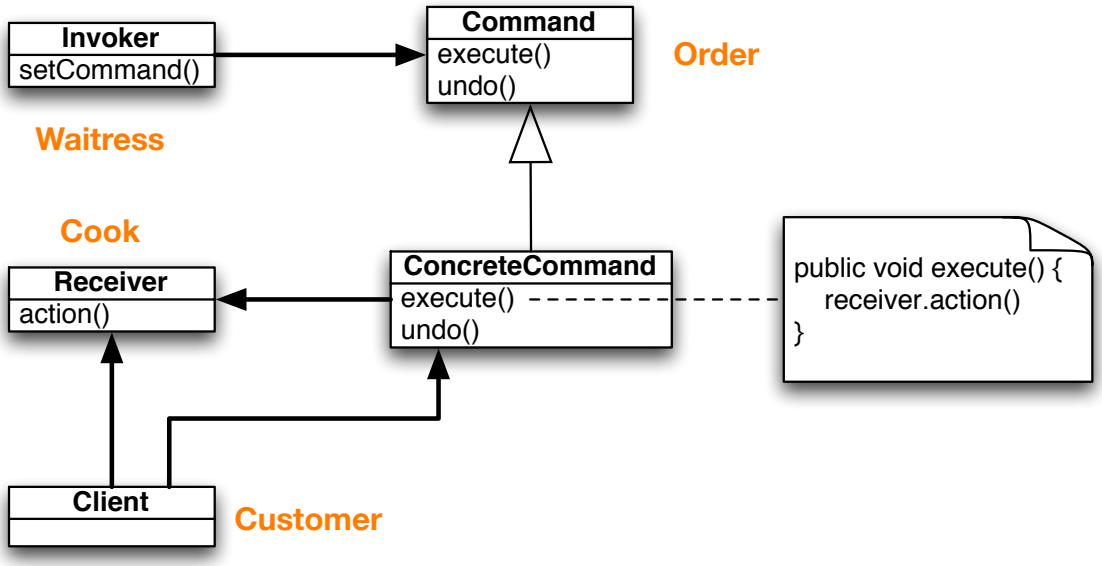
Command

- The Command Pattern encapsulates a request as an object, thereby letting you parameterize other objects with different requests, queue or log requests, and support undoable operations
- Consider the operation of a restaurant
  - You, the Customer, give your Waitress an Order
  - The Waitress takes the Order to the kitchen and says “Order Up”
  - The Cook prepares your meal from the Order
    - Think of the order as making calls on the Cook like “makeBurger()”
- A request is given to one object but implemented by another one
  - This decouples the object making the request from the object that responds to the request

Command's Structure and Roles



Back to the analogy...



Example: Home Remote Control

- Imagine a programmable remote control that can control various devices around your home
  - e.g. lights, TV, DVD player, etc.
- We'll show code that has commands to turn a light on and off and an undo button to reverse the previously executed command
- First, we need a light class; plays the role of Receiver

```
public class Light {
   public Light(String name) { ... }
   public void on() { ... }
   public void off() { ... }
}
```


Command Interface; LightOn

- Next, we need the Command interface

```
public interface Command {
   public void execute();
   public void undo();
}
```

- And a Command to turn the Light on

```
public class LightOnCommand implements Command {
   Light light;
   public LightOnCommand(Light light) {this.light = light;}
   public void execute() {light.on();}
   public void undo() {light.off;}
}
```

LightOffCommand

- And, a command to turn the light off

```
public class LightOffCommand implements Command {
   Light light;
   public LightOffCommand(Light light) {this.light = light;}
   public void execute() {light.off();}
   public void undo() {light.on();}
}
```


Remote Control

- The remote control stores three commands; acts as Invoker

```
public class RemoteControl {
   Command onCommand;
   Command offCommand;
   Command undoCommand;
   public void setOnCommand(Command c) {onCommand = c;}
   public void setOffCommand(Command c) {offCommand = c;}
   public void on() { onCommand.execute(); undoCommand = onCommand;}
   public void off() { offComand.execute(); undoCommand = offCommand;}
   public void undo() {undoCommand.undo();}
}
```

Client

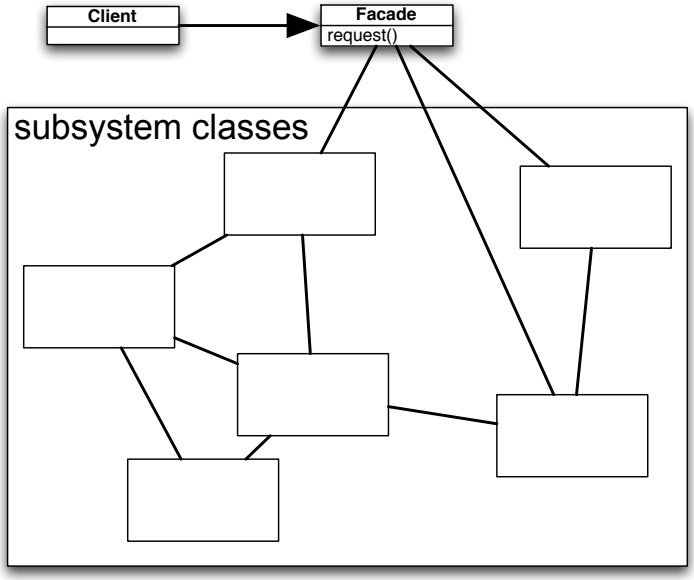
- The client configures the remote control and then uses it

```
public static void main(...) {
   RemoteControl rc = new RemoteControl();
   Light kitchenLight = new Light("Kitchen");
   LightOnCommand on = new LightOnCommand(kitchenLight);
   LightOffCommand off = new LightOffCommand(kitchenLight);
   rc.setOnCommand(on);
   rc.setOffCommand(off);
   rc.on(); -- Light On
   rc.undo(); -- Light Off
}
```


Facade

- The Facade Pattern provides a unified interface to a set of interfaces in a subsystem. The Facade defines a higher level interface that makes the subsystem easier to use
- Principle of Least Knowledge
  - Talk only to your immediate friends
    - or, for any one object, try to limit its knowledge of other objects
- The principle recommends the following
  - given an object, code in one of its methods can invoke methods on
    - the object itself
    - Objects passed as a parameter to the method
    - Any object the method creates
    - Any components of the object (HAS-A relationships)

Facade's Structure and Roles



Clients ask the Facade to perform a service; the Facade responds by making appropriate calls on the objects contained within the subsystem; the Client has no direct access or knowledge of the classes contained within the subsystem

Example: Home Theater System

- Imagine a home theater system represented as a bunch of objects
  - You might have objects like
    - Amplifier, tuner, DVDPlayer, Projector, CDPlayer, TheaterLights, Screen, and PopcornPopper
  - To watch a DVD, you might have to:
    - Turn the popcorn popper on
    - Start making popcorn
    - Dim the lights
    - Put the screen down
    - Turn the projector on
    - Set the projector input to DVD
    - ...

Watching a DVD via Code

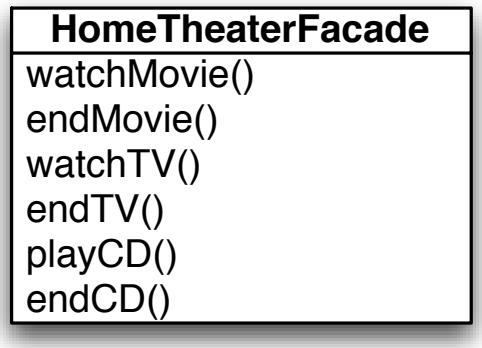
- In code, this cooresponds to manipulating a lot of different objects

```
popper.on();
popper.pop();
lights.dim(10);
screen.down();
projector.on();
projector.setInput(dvd);
...
```

Plus, if you want to watch TV, you may need a way to undo these settings and then configure your system for TV viewing

Facade to the Rescue

- Lets create an object to simplify our interactions with the Home Theatre "sub system"
- For instance:



- We would now only call these methods and not interact directly with the individual components

Implement watchMovie()

- watchMovie() would look something like this

```
public void watchMovie(...) {
   popper.on(); popper.pop();
   lights.dim(10); screen.down();
   projector.on(); ...
}
```

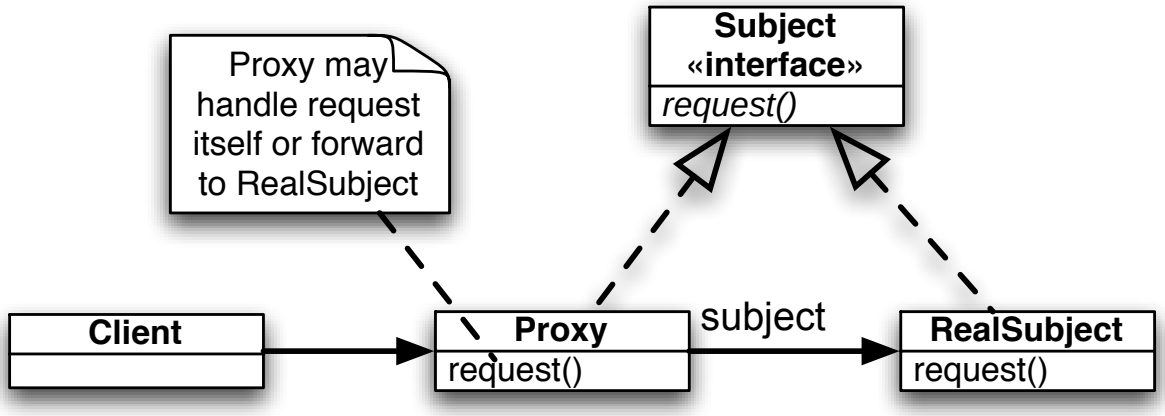
- while endMovie() would look something like this

```
public void endMovie() {
   popper.off; lights.on();
   screen.up(); projector.off();
   ...
}
```


Proxy

- The Proxy Pattern provides a surrogate or placeholder for another object to control access to it
- Use the Proxy pattern to create a representative object that controls access to another object, which may be remote, expensive to create or in need of securing
- Two common forms of the proxy pattern
  - Remote Proxy: used in client-server programming; code on the client side interacts with a proxy object that forwards method invocations to an object on the server side
  - Virtual proxy: some objects are expensive to create (example: large, high-resolution images); client code interacts with a proxy to avoid creating the expensive object for as long as possible

Proxy's Structure and Roles



Example: Image Files

- On the class website, you can download code that implements the virtual proxy pattern
  - An ImageProxy class is used to display an "Image Loading" message while image data is loaded in a background thread
    - Once the image is loaded, the proxy delegates calls to the actual image
  - Note: if you compile this code on your own machine, you will need to modify the useImageProxy.java file to point to image files located on your computer