Design Patterns: Part 2
ENGI 5895: Software Design

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with code samples from Dr. Rodrigue Byrne and [Martin(2003)]

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Outline

1. Adapter
2. Observer
3. Decorator
4. Command
Adapter

Adapter converts the interface of a class into another form. For example, a Switch is used to control a Light. To adhere to the DIP and OCP we introduce a Switchable interface for various devices that can be switched on and off:
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However, perhaps Light is provided by a third party and has only a toggle method. We need a class to translate between calls to turnOn and turnOff and calls to toggle.
Notice the stereotype `<delegates>`. The responsibility of actually controlling the Light is delegated to Light. If you delegate `Adapter`, implement what you are delegating.

In this example, LightAdapter has an associated Light. This is the object form of adapter. There is also a class form...

**Figure 25-4** Solving the Table Lamp with Adapter
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This is the class form of adapter. The only difference is whether the Adapter class inherits from Light or "has a" Light. Inheritance is slightly easier since LightAdapter will not need a pointer to Light. However, inheritance forever binds LightAdapter to Light. It may be the case that we can re-use LightAdapter in another situation. In this case, we would prefer association over inheritance.

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**Figure 25-5**  Solving the Table Lamp with **ADAPTOR**
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Classes which are the subject of observation should extend Subject. Observers should implement Observer!
A class such as Subject should either be abstract (some implementation allowed) or a pure interface (no implementation). It is often convenient for Subject to be abstract and provide implementations for methods such as Attach and Notify.

The designers of Java were so taken with Observer that they provided classes called java.util.Observable (i.e. Subject) and java.util.Observer. They also use Observer for Java's GUI event processing model (as we will see).
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e.g. Temperature Observer

```java
public class TemperatureSensor {
    public double getTemp() {
        // get temperature
    }
    public void setTemp(double currentTemp) {
        // set temperature
    }
}

public interface Observer {
    void update(Observable observable, Object arg);
}

public class NotifyWorld implements Observer {
    public void update(Observable observable, Object arg) {
        // notify the world
    }
}

public class UpdateDisplay implements Observer {
    public void update(Observable observable, Object arg) {
        // update display
    }
}
```
import java.util.Observable;

class TemperatureSensor extends Observable {
    private double currentTemp;

    public double getTemp() {
        return currentTemp;
    }

    public void setTemp(double currentTemp) {
        if (this.currentTemp != currentTemp) {
            this.currentTemp = currentTemp;
            setChanged(); // setChanged is protected
            notifyObservers();
        }
    }
}
import java.util.Observer;
import java.util.Observable;
class NotifyWorld implements Observer {
    public void update(Observable obs, Object obj) {
        TemperatureSensor sens = (TemperatureSensor)obs;
        System.out.printf("World new temp is %g\n", sens.getTemp());
    }
}
import java.util.Observer;
import java.util.Observable;
class NotifyWorld implements Observer {
    public void update(Observable obs, Object obj) {
        TemperatureSensor sens = (TemperatureSensor) obs;
        System.out.printf("World new temp is %g%n", sens.getTemp());
    }
}

import java.util.Observable;
import java.util.Observer;

class UpdateDisplay implements Observer {
    public void update(Observable obs, Object obj) {
        TemperatureSensor sens = (TemperatureSensor) obs;
        System.out.printf("display: %g%n", sens.getTemp());
    }
}
public class ObserverDemo {
    public static void main(String[] args) {
        TemperatureSensor ts = new TemperatureSensor();
        ts.addObserver(new NotifyWorld());
        ts.addObserver(new UpdateDisplay());
        ts.setTemp(16.0);
    }
}
The Decorator pattern is used to add new behaviours to an object, without inheritance. Inheritance is used for adding new behaviours but must be specified at compile-time. Decorator allows new behaviours to be added at run-time!
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- LineNumberReader: Keeps track of line numbers

The constructors for BufferedReader and LineNumberReader require a Reader. We build a Reader with the required set of behaviour by instantiating a chain of objects— with each one being decorated by the next.
import java.io.IOException;
import java.io.BufferedReader;
import java.io.FileReader;
import java.io.LineNumberReader;

public class BufferLineCountReader {
    public static void main(String[] args) throws IOException {
        if (args.length != 1) {
            System.out.println("usage: java BufferLineCountReader file");
            System.exit(1);
        }

        FileReader fr = new FileReader(args[0]);
        BufferedReader br = new BufferedReader(fr);
        LineNumberReader lnr = new LineNumberReader(br);

        String line = null;
        while ((line = lnr.readLine()) != null) {
            System.out.printf("%5d: %s%n",
                                lnr.getLineNumber(), line);
        }

        lnr.close();
    }
}
Here is the general structure of Decorator from [Gamma et al. (1995) Gamma, Helm, Johnson, and Vlissides]:

- **Component**: Defines the interface for objects that can be decorated with new behaviours (e.g., Reader).
- **ConcreteComponent**: A basic object that can be decorated (but is not a Decorator) (e.g., FileReader).
- **Decorator**: Decorates some Component (already decorated or a ConcreteComponent) with new behaviour (e.g., BufferedReader, LineNumberReader).
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![UML Diagram]

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Here is the class diagram for this example:
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interface Command {
    void execute();
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```

We need a Command specifically for `receiver.doStuff(int)`...
public class DoStuffCommand implements Command {
    Receiver receiver;
    int value;

    public DoStuffCommand(Receiver receiver, int value) {
        this.receiver = receiver;
        this.value = value;
    }

    public void execute() {
        receiver.doStuff(value);
    }
}

// Now let's see how this is used:
import java.util.ArrayList;

public class TestCommand {
    public static void main(String[] args) {
        Receiver receiver = new Receiver();
        ArrayList<Command> commands = new ArrayList<Command>();

        // commands.add(new DoStuffCommand(receiver, 12));
        // ...
        // other commands added...

        // time passes...
        for (Command cmd : commands) {
            cmd.execute();
        }
    }
}
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- Support transactions (e.g. bank account transactions) such that new transactions are created not by modifying existing code, but by create new concrete Command classes
- Support unlimited undo / redo:
  - Incorporate an undo method into Command to reverse the effects of execute
    - Requires some storage of the previous state of the receiver by execute
  - Executed commands are maintained in a history list that is traversed backwards for undo operations (by calling undo) and forwards for redo operations (by calling execute)
The following is the overall structure for Command [Gamma et al.(1995)Gamma, Helm, Johnson, and Vlissides]:

- Client
- Invoker
- Receiver
- Command
  - Execute()
- ConcreteCommand
  - Execute()
  - state
  - receiver->Action()
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Sequence diagram:
Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides.  
*Design Patterns: Elements of Reusable Object-Oriented Software.*  
Addison-Wesley Professional, 1995.

Robert C. Martin.  