Goals of the Lecture

- Introduce two design patterns
  - Facade
  - Adapter
- Compare and contrast the two patterns
Facade (I)

“Provide a unified interface to a set of interfaces in a subsystem. Facade defines a higher-level interface that makes the subsystem easier to use.”

Design Patterns, Gang of Four, 1995

There can be significant benefit in wrapping a complex subsystem with a simplified interface

If you don't need the advanced functionality or fine-grained control of the former, the latter makes life easy
Facade Pattern: Structure
Facade (II)

- Facade works best when you are accessing a subset of the subsystem’s functionality

- You can also add new features by adding it to the Facade (not the subsystem); still get simpler interface

- Facade not only reduces the number of methods you are dealing with but also the number of classes

- Imagine having to pull Employees out of Divisions that come from Companies that you pull from a Database

- A Facade in this situation can fetch Employees directly
Example (Without a Facade)

Without a Facade, Client contacts the Database to retrieve Company objects. It then retrieves Division objects from them and finally gains access to Employee objects.

It uses four classes.
Example (With a Facade)

With a Facade, the Client is shielded from most of the classes. It uses the Database Facade to retrieve Employee objects directly.
Facade Example (I)

Imagine a library of classes with a complex interface and/or complex interrelationships

Home Theater System

Amplifier, DvdPlayer, Projector, CdPlayer, Tuner, Screen, PopcornPopper (!), and TheatreLights

each with its own interface and interclass dependencies
Facade Example (II)

- Imagine steps for “watch movie”
  - turn on popper, make popcorn, dim lights, screen down, projector on, set projector to DVD, amplifier on, set amplifier to DVD, DVD on, etc.

- Now imagine resetting everything after the movie is done, or configuring the system to play a CD, or play a video game, etc.
Facade Pattern: Definition

- For this example, we can place high level methods like “watch movie”, “reset system”, “play cd” in a facade object and encode all of the steps for each high level service in the facade; **Demo**

- Client code is simplified and dependencies are reduced
  - A facade not only simplifies an interface, it decouples a client from a subsystem of components
  - Indeed, Facade lets us **encapsulate subsystems**, hiding them from the rest of the system
Adapters in the Real World

Our next pattern provides steps for converting an incompatible interface with an existing system into a different interface that is

- Real World Example: AC Power Adapters

- Electronic products made for the USA cannot be used directly with outlets found in most other parts of the world

- To use, you need an AC power adapter
**OO Adapters (I)**

- **Pre-Condition:** You are maintaining an existing system that makes use of a third-party class library from vendor A.

- **Stimulus:** Vendor A goes belly up and corporate policy does not allow you to make use of an unsupported class library.

- **Response:** Vendor B provides a similar class library but its interface is completely different from the interface provided by vendor A.

- **Assumptions:** You don’t want to change your code, and you can’t change vendor B’s code.

- **Solution?** Write new code that adapts vendor B’s interface to the interface expected by your original code.
OO Adapters (II)

Interface Mismatch
Need Adapter

Create Adapter

And then...
...plug it in

Benefit: Existing system and new vendor library do not change, new code is isolated within the adapter.
Example: A turkey amongst ducks! (I)

- If it walks like a duck and quacks like a duck, then it must be a duck!

Or...
Example: A turkey amongst ducks! (II)

- If it walks like a duck and quacks like a duck, then it must **might** be a duck **turkey wrapped with a duck adapter**... (!)
Example: A turkey amongst ducks! (III)

Recall the Duck simulator from last lecture?

```java
public interface Duck {
    public void quack();
    public void fly();
}

public class MallardDuck implements Duck {
    public void quack() {
        System.out.println("Quack");
    }

    public void fly() {
        System.out.println("I'm flying");
    }
}
```
Example: A turkey amongst ducks! (IV)

- An interloper wants to invade the simulator

```java
public interface Turkey {
    public void gobble();
    public void fly();
}

public class WildTurkey implements Turkey {
    public void gobble() {
        System.out.println("Gobble Gobble");
    }
    public void fly() {
        System.out.println("I'm flying a short distance");
    }
}
```
Example: A turkey amongst ducks! (V)

- Write an adapter, that makes a turkey look like a duck

```java
public class TurkeyAdapter implements Duck {
    private Turkey turkey;

    public TurkeyAdapter(Turkey turkey) {
        this.turkey = turkey;
    }

    public void quack() {
        turkey.gobble();
    }

    public void fly() {
        for (int i = 0; i < 5; i++) {
            turkey.fly();
        }
    }
}
```

1. Adapter implements target interface (Duck).
2. Adaptee (turkey) is passed via constructor and stored internally
3. Calls by client code are delegated to the appropriate methods in the adaptee
4. Adapter is **full-fledged class**, could contain additional vars and methods to get its job done; **can be used polymorphically as a Duck**

**Demonstration**
Adapter Pattern: Definition

- The Adapter pattern converts the interface of a class into another interface that clients expect. Adapter lets classes work together that couldn’t otherwise because of incompatible interfaces.

- The client makes a request on the adapter by invoking a method from the target interface on it.

- The adapter translates that request into one or more calls on the adaptee using the adaptee interface.

- The client receives the results of the call and never knows there is an adapter doing the translation.
1. Client codes to an interface, not an implementation. Allows creation of multiple adapter classes, if needed.

2. Adapter makes use of delegation to access the behavior of Adaptee. We can pass any subclass of Adaptee to the Adapter, if needed.
Adapter Pattern: Structure (II)

1. Requires use of multiple inheritance, but now adapter does not need to re-implement target and/or adaptee behavior.

It simply overrides or inherits that behavior instead.

Demonstration
Comparison (I)

- To many people, these two patterns appear to be similar
  - They both act as wrappers of a preexisting class
  - They both take an interface that we don’t need
    - and convert it to an interface that we can use
  - With Facade, the intent is to simplify the existing interface
  - With Adapter, we have a target interface that we are converting to; we often want the adapter to plug into an existing framework and behave polymorphically
Comparison (II)

- Superficial difference
  - Facade hides many classes; Adapter hides only one
  - But
    - a Facade can simplify a single, very complex object
    - an adapter can wrap multiple objects at once in order to access all the functionality it needs
- The key is simplify (facade) vs convert (adapter)
Multiple Inheritance

Let's talk a little bit more about multiple inheritance

Some material for this section taken from

Object-Oriented Design Heuristics by Arthur J. Riel

Copyright © 1999 by Addison Wesley

ISBN: 0-201-63385-X
Multiple Inheritance

Riel does not advocate the use of multiple inheritance (it’s too easy to misuse it). As such, his first heuristic is

If you have an example of multiple inheritance in your design, assume you have made a mistake and prove otherwise!

Most common mistake

Using multiple inheritance in place of containment

That is, you need the services of a List to complete a task

Rather than creating an instance of a List internally, you instead use multiple inheritance to inherit from your semantic superclass as well as from List to gain direct access to List’s methods

You can then invoke List’s methods directly and complete the task
Inheriting from List in this way is bad, because “Hippo IS-A List” is FALSE

A Hippo is NOT a special type of List

Instead...
Do This

<table>
<thead>
<tr>
<th>Animal</th>
<th>What’s the Difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td>food type</td>
<td>elements</td>
</tr>
<tr>
<td>location</td>
<td>head</td>
</tr>
<tr>
<td>makeNoise()</td>
<td>addElement()</td>
</tr>
<tr>
<td>eat()</td>
<td>removeElement()</td>
</tr>
<tr>
<td>roam()</td>
<td>findElement()</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hippo</th>
<th>List</th>
</tr>
</thead>
<tbody>
<tr>
<td>makeNoise()</td>
<td>elements</td>
</tr>
<tr>
<td>eat()</td>
<td>head</td>
</tr>
<tr>
<td>submerge()</td>
<td>addElement()</td>
</tr>
<tr>
<td></td>
<td>removeElement()</td>
</tr>
<tr>
<td></td>
<td>findElement()</td>
</tr>
</tbody>
</table>
Another Problem

What's wrong with this?

Hint: think about what might happen when you create an instance of D
Multiple Inheritance

A Second Heuristic

Whenever there is inheritance in an OO design, ask two questions:

1) Am I a special type of the thing from which I’m inheriting?
2) Is the thing from which I’m inheriting part of me?

A yes to 1) and no to 2) implies the need for inheritance
A no to 1) and a yes to 2) implies the need for composition

Recall Hippo/List example

Example

Is an airplane a special type of fuselage? No
Is a fuselage part of an airplane? Yes
Multiple Inheritance

A third heuristic

Whenever you have found a multiple inheritance relationship in an object-oriented design, be sure that no base class is actually a derived class of another base class

Otherwise you have what Riel calls **accidental multiple inheritance**

Consider the classes “Citrus”, “Food”, and “Orange”; you can have Orange multiply inherit from both Citrus and Food…but Citrus IS-A Food, and so the proper hierarchy can be achieved with single inheritance
Example
Multiple Inheritance

So, is there a valid use of multiple inheritance?

Yes, sub-typing for combination

It is used to define a new class that is a special type of two other classes where those two base classes are from different domains.

In such cases, the derived class can then legally combine data and behavior from the two different base classes in a way that makes semantic sense.
Multiple Inheritance Example

Is a wooden door a special type of door? **Yes**
Is a door part of a wooden door? **No**
Is a wooden door a special type of wooden object? **Yes**
Is a wooden object part of a door? **No**
Is a wooden object a special type of door? **No**
Is a door a special type of wooden object? **No**

**All Heuristics Pass!**

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Wrapping Up

- Reviewed examples of Facade and Adapter
  - Saw how easy it was to implement them
- Compared the patterns
  - A Facade *simplifies* an interface
  - Adapter *converts* one interface into another
Coming Up Next

- Homework 3 Due on Wednesday
- Lecture 8: Expanding Horizons
  - Read Chapter 8 of the textbook
- Lecture 9: Strategy, Bridge, Abstract Factory
  - Read Chapters 9, 10, & 11
- No Homework this week!