Outline

✓ Introduction to design patterns
✓ Creational patterns (constructing objects)
⇒ Structural patterns (controlling heap layout)
• Behavioral patterns (affecting object semantics)
Structural patterns: Wrappers

- A wrapper translates between incompatible interfaces
- Wrappers are a thin veneer over an encapsulated class
  - modify the interface
  - extend behavior
  - restrict access
- The encapsulated class does most of the work

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Functionality</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapter</td>
<td>same</td>
<td>different</td>
</tr>
<tr>
<td>Decorator</td>
<td>different</td>
<td>same</td>
</tr>
<tr>
<td>Proxy</td>
<td>same</td>
<td>same</td>
</tr>
</tbody>
</table>
Adapter

- Change an interface without changing functionality
  - rename a method
  - convert units
  - implement a method in terms of another
- Example: angles passed in radians vs. degrees
Adapter example: scaling rectangles

• We have this `Rectangle` interface
  
  ```java
  interface Rectangle {
    // grow or shrink this by the given factor
    void scale(float factor);
    ...
    float getWidth();
    float area();
  }
  ```

• Goal: we want to use instances of this class to “implement” `Rectangle`:
  
  ```java
  class NonScaleableRectangle { // not a Rectangle
    void setWidth(float width) { ... }
    void setHeight(float height) { ... }
    // no scale method
    ...
  }
  ```
Adaptor: Use subclassing

class ScaleableRectangle1 extends NonScaleableRectangle
    implements Rectangle {
    
    void scale(float factor) {
        setWidth(factor * getWidth());
        setHeight(factor * getHeight());
    }

}
Adaptor: use delegation

Delegation: forward requests to another object

class ScaleableRectangle2 implements Rectangle {
    NonScaleableRectangle r;
    ScaleableRectangle2(w,h) {
        this.r = new NonScaleableRectangle(w,h);
    }

    void scale(float factor) {
        setWidth(factor * r.getWidth());
        setHeight(factor * r.getHeight());
    }

    float getWidth() { return r.getWidth(); }
    float circumference() { return r.circumference(); }
    ...
}
Subclassing vs. delegation

- **Subclassing**
  - automatically gives access to all methods of superclass
  - built into the language (syntax, efficiency)
- **Delegation**
  - permits cleaner removal of methods (compile-time checking)
  - wrappers can be added and removed dynamically
  - objects of arbitrary concrete classes can be wrapped
  - multiple wrappers can be composed

- Some wrappers have qualities of more than one of adapter, decorator, and proxy

- **Delegation vs. composition**
  - Differences are subtle
  - For CSE 331, consider them to be equivalent
Decorator

• Add functionality without changing the interface

• Add to existing methods to do something additional (while still preserving the previous specification)

• Not all subclassing is decoration
Decorator example: Bordered windows

interface Window {
    // rectangle bounding the window
    Rectangle bounds();
    // draw this on the specified screen
    void draw(Screen s);
    ...
}

class WindowImpl implements Window {
    ...
}
Bordered window implementations

Via subclassing:

```java
class BorderedWindow1 extends WindowImpl {
    void draw(Screen s) {
        super.draw(s);
        bounds().draw(s);
    }
}
```

Via delegation:

```java
class BorderedWindow2 implements Window {
    Window innerWindow;
    BorderedWindow2(Window innerWindow) {
        this.innerWindow = innerWindow;
    }
    void draw(Screen s) {
        innerWindow.draw(s);
        innerWindow.bounds().draw(s);
    }
}
```

Delegation permits multiple borders on a window, or a window that is both bordered and shaded (or either one of those)
A decorator can remove functionality

• Remove functionality without changing the interface

• Example: `UnmodifiableList`
  – What does it do about methods like `add` and `put`?
Proxy

• Same interface and functionality as the wrapped class

• Control access to other objects
  – communication: manage network details when using a remote object
  – locking: serialize access by multiple clients
  – security: permit access only if proper credentials
  – creation: object might not yet exist (creation is expensive)
    • hide latency when creating object
    • avoid work if object is never used