# Decorator Pattern

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# Objectives

- Definition
- Why
- How
- Design Considerations

# Definition

*"Attach additional responsibilities to an object dynamically. Decorators provide a flexible alternative to subclassing for extended functionality."*

-Gang of Four

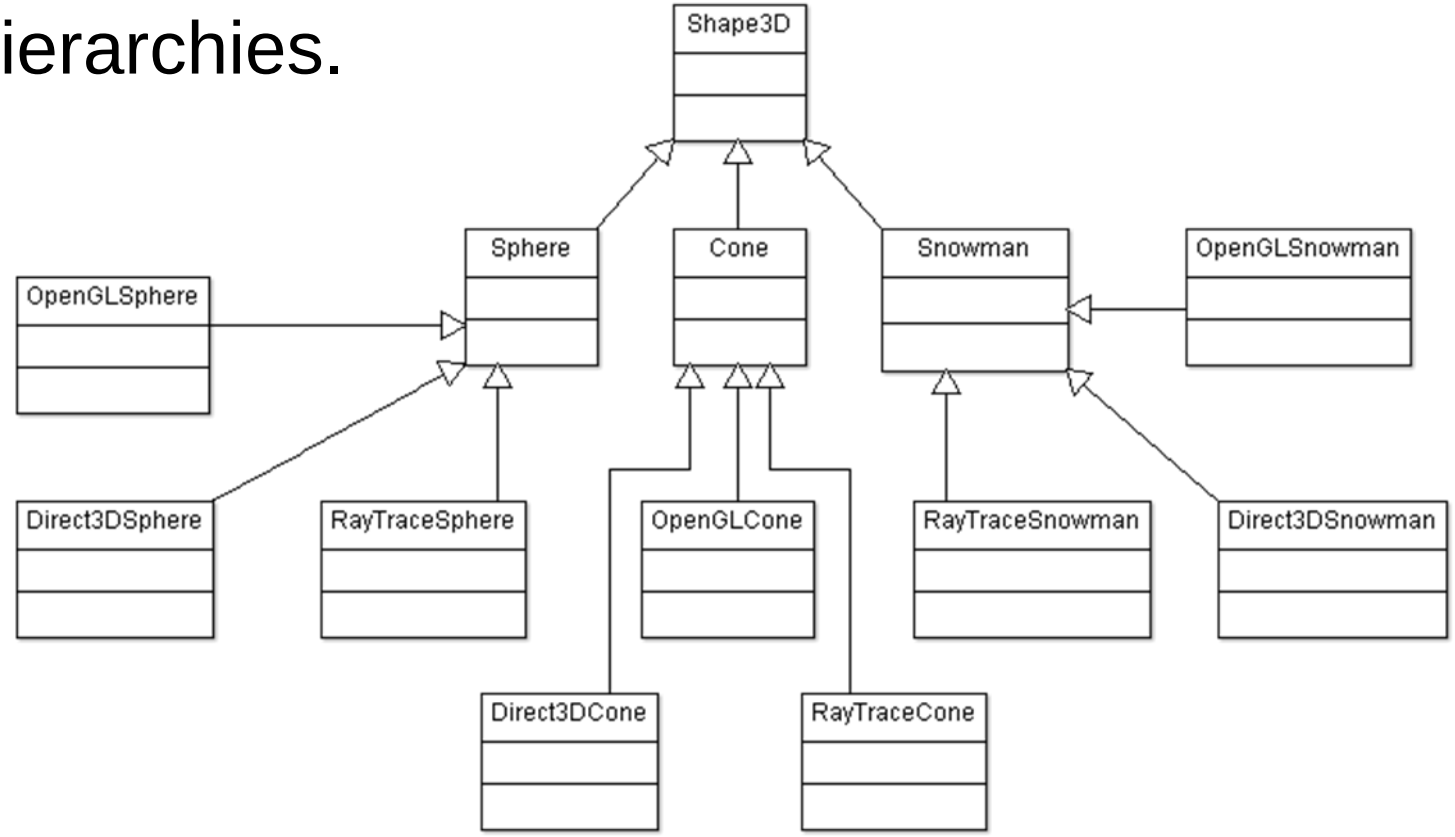
# Definition

- Name “Decorator”
  - Extended behavior or functionality build upon some existing substructure
- Intent
  - Dynamically add behavior to an object
    - ***Inheritance adds behavior statically – once the particular subclass is instantiated, the behavior is fixed***

# Why

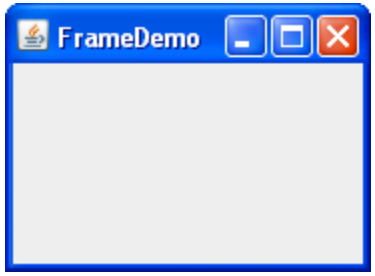
# Why

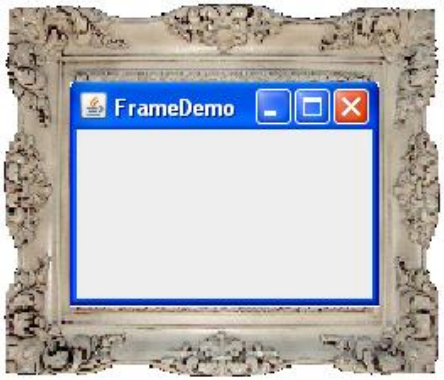
- As we've seen before, subclassing can lead to classes with low cohesion, and *very* large class hierarchies.

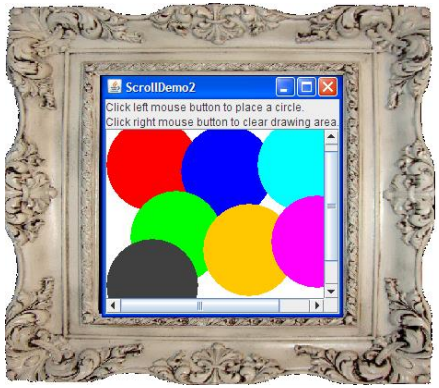


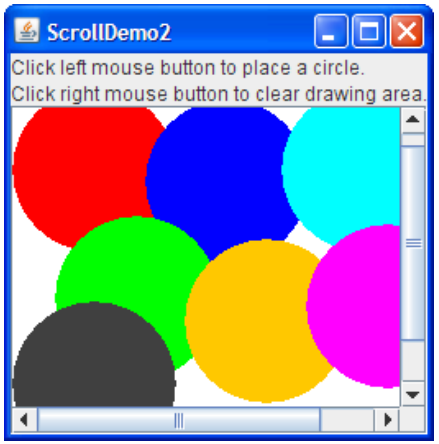
# Why

- Sometimes, subclassing makes sense
  - One type of object may be a *specialization* of another
  - Still can lead to large hierarchies
    - ***Window, ScrollWindow, FancyBorderWindow, FancyBorderScrollWindow…***



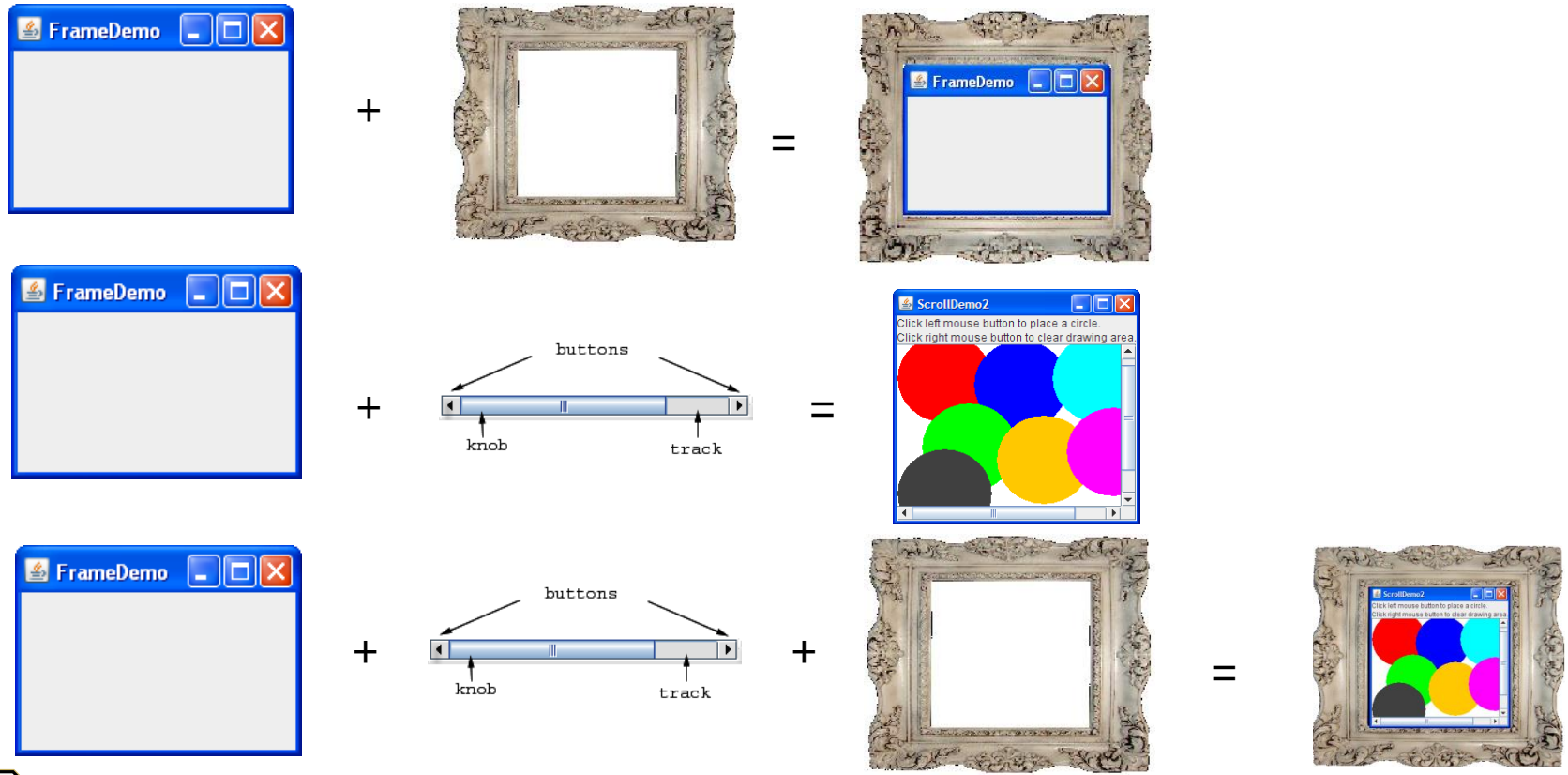



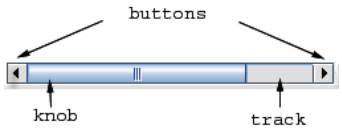
# Why

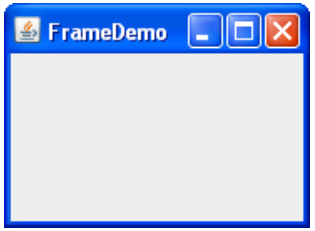
- In this case, the core window remains unchanged, but we're *adding* specific details



# Why

- Rather than creating several subclasses, it'd be preferable to have some common interface, and be able to compose what we want, where every piece follows the same interface



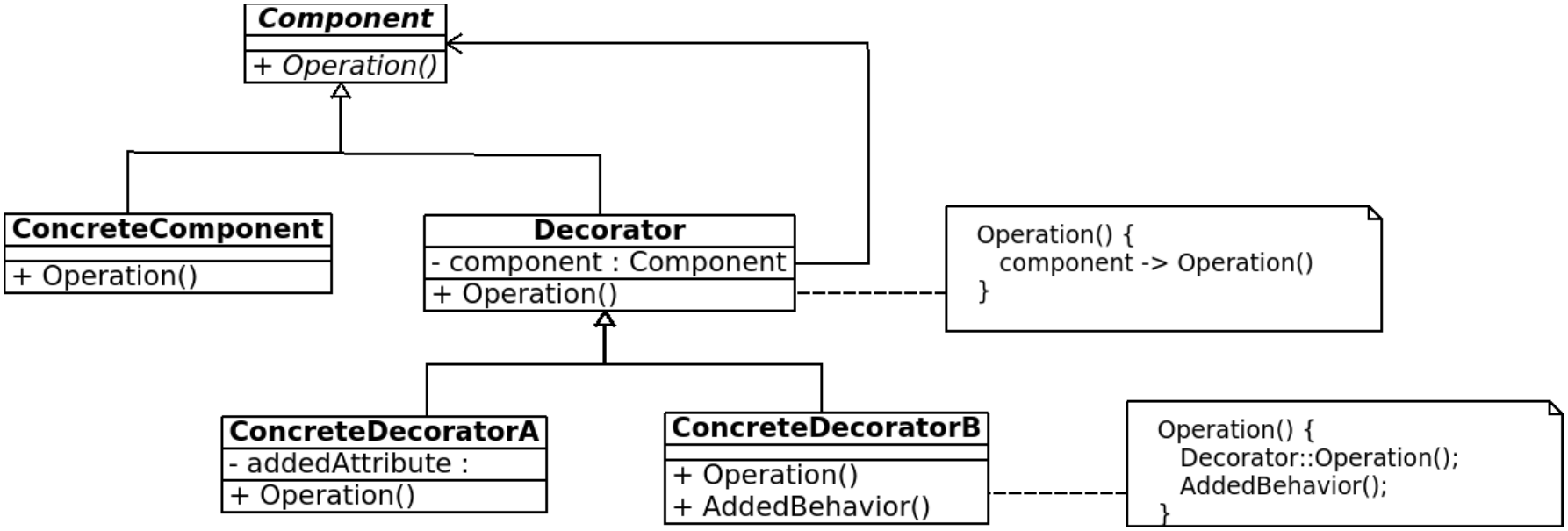

***myWindow.draw()*** → ***fancyFrame.draw()*** → ***scrollBar.draw()*** → ***basicFrame.draw()***

# How

# Decorator Pattern - Participants

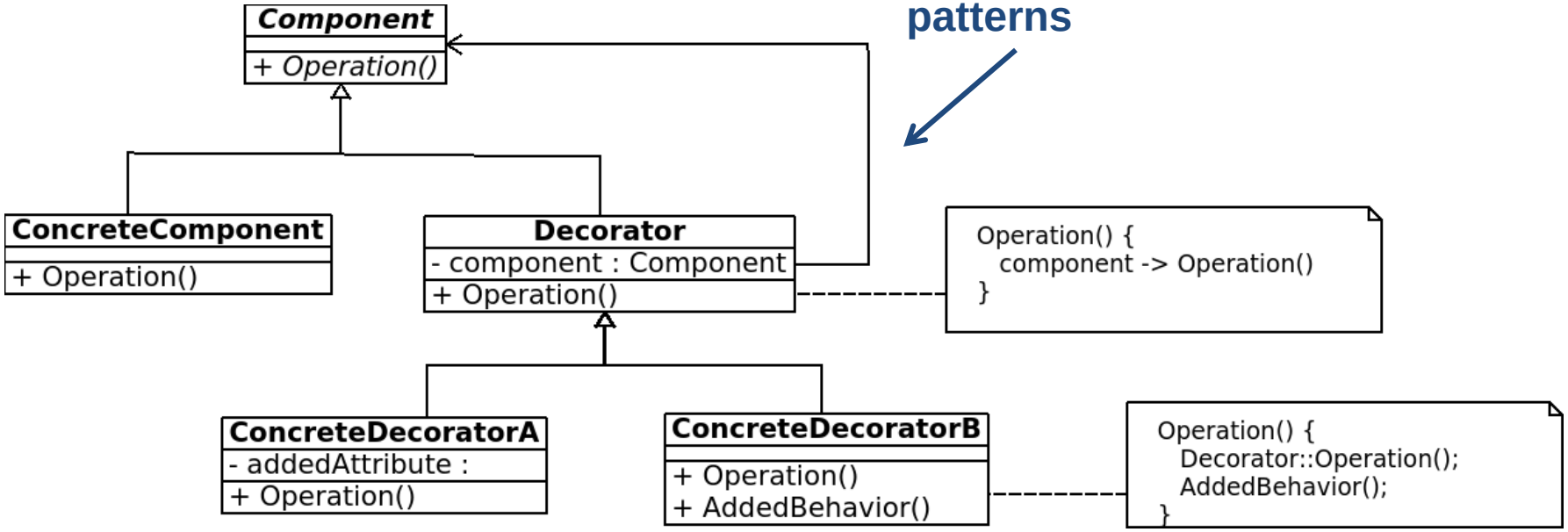
- **Component**
  - Defines the interface for objects that can have responsibilities added dynamically
- **ConcreteComponent**
  - Defines an object to which additional responsibilities can be attached
- **Decorator**
  - Maintains a reference to a Component object and defined an interface that conforms to Component's interface
- **ConcreteDecorator**
  - Adds responsibilities to the component

# Decorator Pattern - Structure

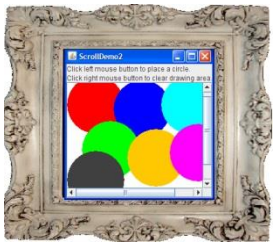


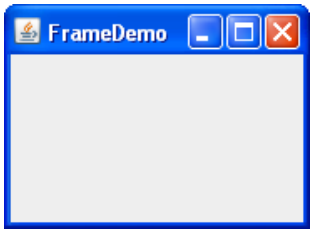
# Decorator Pattern - Structure

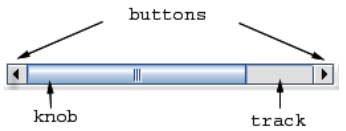
**Recall: Composites tend to be central to a lot of other patterns**



# Decorator Pattern –Example





# Decorator Pattern –Example

**Component**

```
public abstract class Window {
  public abstract void draw();
}
```

**ConcreteComponent**

```
public class PlainWindow extends Window {
  public void draw() { … };
}
```

**Decorator**

```
public abstract class Decorator extends Component {
  private Window baseWindow;
  public void draw() { baseWindow.draw(); }
}
```

**ConcreteDecorator**

```
public class ScrollBar extends Decorator
{
  public void draw() {
    super.draw();
    // Extra drawing
  }
  public void scroll() {
    // added behavior
  }
}
```

**ConcreteDecorator**

```
public class FancyBorder extends
   Decorator
{
  public void draw() {
    super.draw();
    // Extra drawing
  }
}
```

# Decorator Example

- Can create a base instance of some plain window

```
Window myWindow = new PlainWindow();
```

- Then, add some decoration

```
Window oldWindow = myWindow;
Window myWindow = new FancyBorder();
myWindow.baseWindow = oldWindow;
```

- Modify the window to use another decoration

```
Window oldWindow = myWindow.baseWindow;
Window myWindow = new ScrollBar();
myWindow.baseWindow = oldWindow;
```

# Design Considerations

# Consequences

- More flexible than static inheritance
  - ***Add responsibilities to an object by wrapping it in a decorator, vs. creating a new class for each added responsibility***
- Avoid feature-laden classes
  - ***Create objects consisting of only the decorations you need, not objects with several inherited features, only some of which you use***
- Decorators and components are not identical
  - ***A decorator is a different object, not a modification of the same object (e.g., as through delegation). Hence, don't rely on object identity with decorators***
- Lots of little moving parts
  - ***Very flexible system, but hard to learn and debug***

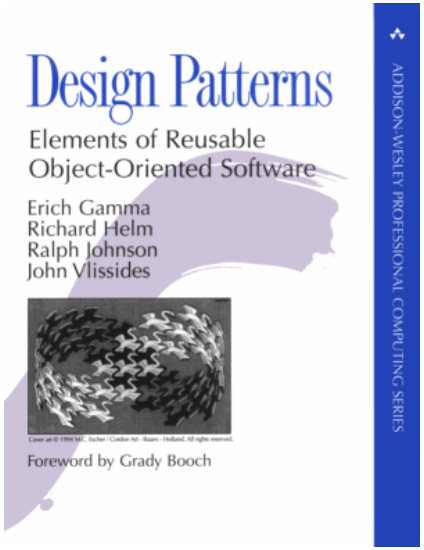
# Implementation Considerations

- Interface conformance
  - ***All Decorator and Component classes must share the same interface, though decorators can add to this interface***
- Omitting Decorator abstract class
  - ***If only adding one responsibility, Decorator and ConcreteDecorator can be merged. Let ConcreteDecorator call Operation() on its component***
- Keep Component lightweight
  - ***Decorator inherits from Component. If Component stores lots of data, then every decorator also stores this data, resulting in lots of memory being used***
  - ***Component should just define a lightweight interface, not many implementation details***

# Pattern Comparison

| | Decorator | Composite | Proxy |
|---|---|---|---|
| Recursive Composition | **YES**, but intent is to provide a means of adding responsibility in a recursive manner | **YES**, intent is to provide a recursive representation to a composed object where parts can be treated in the same manner as a whole | **NO,** proxy is usually a single object used to provide indirect access to another object |
| Provides a level of indirection to an object | **YES**, the intent is to *add* behavior to the base object | **NO**, the composed object can be accessed directly | **YES,** the intent is to act as a *stand-in* to the base object |
| Common interface | **YES,** common interface allows for behavior to be attached or detached dynamically | **YES,** common interface allows for clients to interact with any part of the composed object in a common way | **YES**, common interface allows proxy to be used as base object, but *intercept* and handle messages |

# Further Reading




- **Design Patterns**
  pp. 175 - 184

- **Design Patterns Explained**
  Chapter 17
  pp. 297-310