CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2012
Doc 20 Composite, Facade, Flyweight, Mediator
April 12, 2012

References

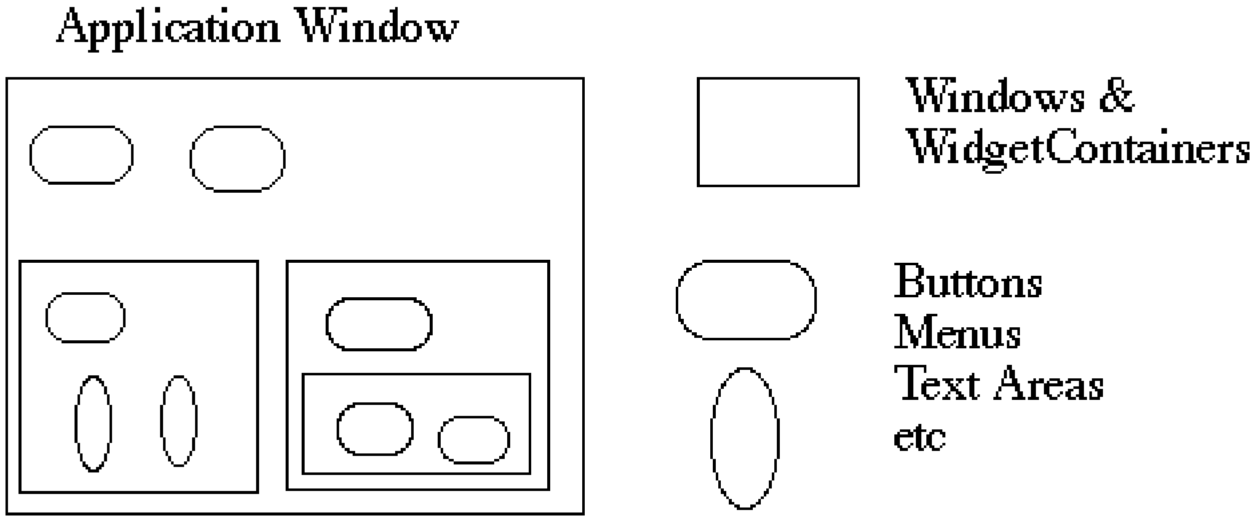
Design Patterns: Elements of Reusable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, 1995, pp. 163-174, 185-194, 195-206, 273-282

This Car Runs on Code, http://spectrum.ieee.org/green-tech/advanced-cars/this-car-runs-on-code

Source lines of code, http://en.wikipedia.org/wiki/Source_lines_of_code

Composite

Composite Motivation



How does the window hold and deal with the different items it has to manage?

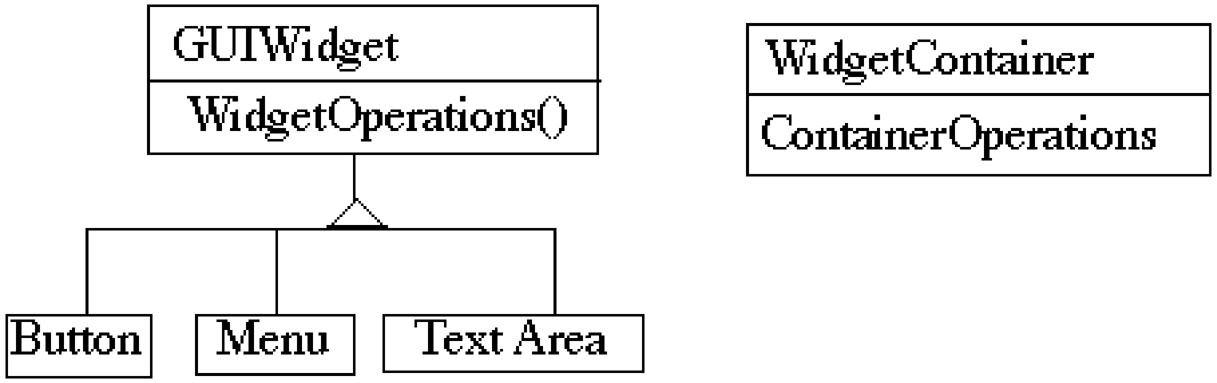
Widgets are different that WidgetContainers

Bad News

```
class Window {
    Buttons[] myButtons;
    Menus[] myMenus;
    TextAreas[] myTextAreas;
    WidgetContainer[] myContainers;

    public void update() {
        if ( myButtons != null )
            for ( int k = 0; k < myButtons.length(); k++ )
                myButtons[k].refresh();
        if ( myMenus != null )
            for ( int k = 0; k < myMenus.length(); k++ )
                myMenus[k].display();
        if ( myTextAreas != null )
            for ( int k = 0; k < myButtons.length(); k++ )
                myTextAreas[k].refresh();
        if ( myContainers != null )
            for ( int k = 0; k < myContainers.length(); k++ )
                myContainers[k].updateElements();
        etc.
    }
    public void fooOperation(){
        if (myButtons != null)
        etc.
```

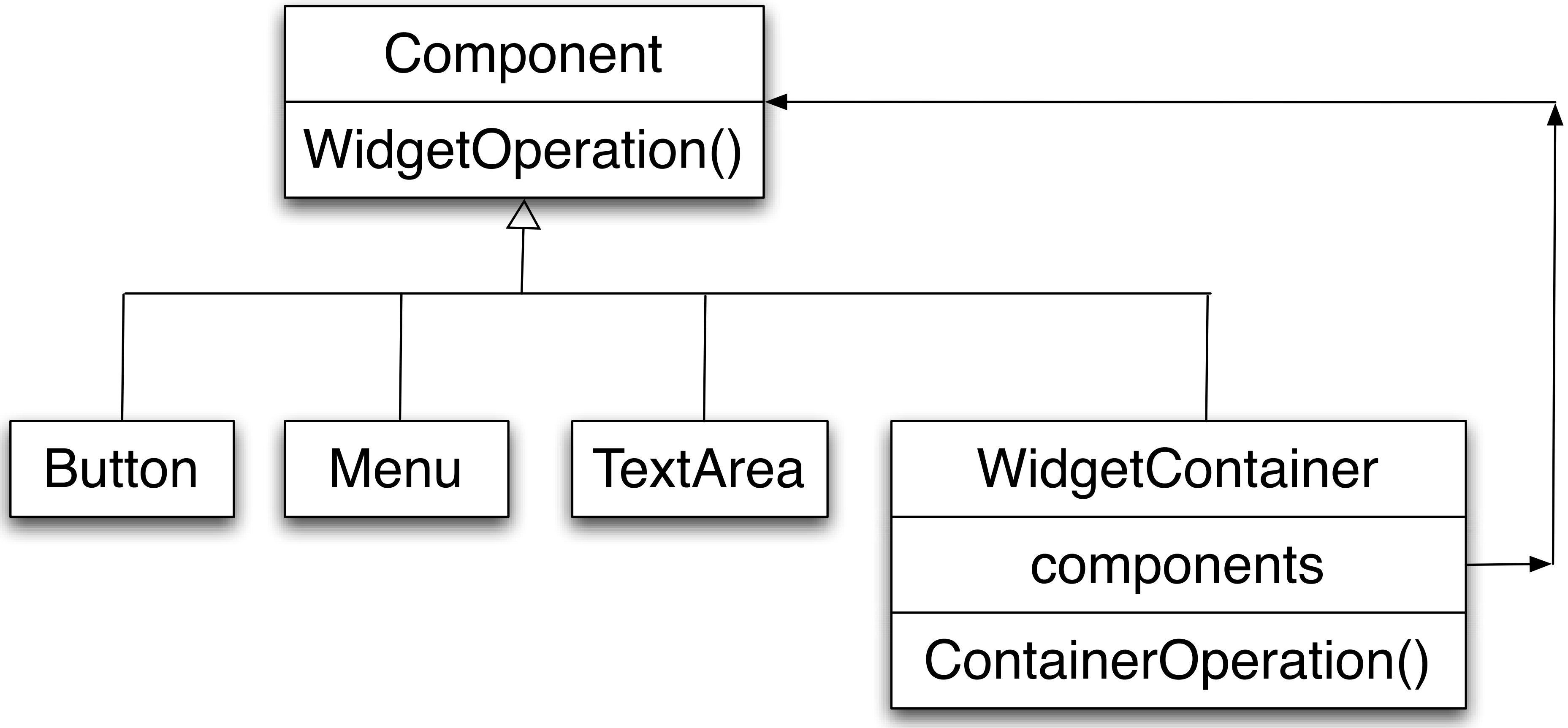
An Improvement



```
class Window {
    GUIWidgets[] myWidgets;
    WidgetContainer[] myContainers;

    public void update(){
        if ( myWidgets != null )
            for ( int k = 0; k < myWidgets.length(); k++ )
                myWidgets[k].update();
        if ( myContainers != null )
            for ( int k = 0; k < myContainers.length(); k++ )
                myContainers[k].updateElements();
        etc.
    }
}
```

Composite Pattern



Composite Pattern

Component implements default behavior for widgets when possible

Button, Menu, etc overrides Component methods when needed

WidgetContainer will have to overrides all widgetOperations

```
class WidgetContainer {
        Component[] myComponents;

        public void update() {
                if ( myComponents != null )
                        for ( int k = 0; k < myComponents.length(); k++ )
                                myComponents[k].update();
        }
}
```

Issue - WidgetContainer Operations

Should the WidgetContainer operations be declared in Component?

Pro - Transparency

Declaring them in the Component gives all subclasses the same interface

All subclasses can be treated alike. (?)

Con - Safety

Declaring them in WidgetContainer is safer

Adding or removing widgets to non-WidgetContainers is an error

One out is to check the type of the object before using a WidgetContainer operation

Issue - Parent References

```
class WidgetContainer
        {
        Component[] myComponents;

        public void update() {
                if ( myComponents != null )
                        for ( int k = 0; k < myComponents.length(); k++ )
                                myComponents[k].update();
        }

        public add( Component aComponent ) {
                myComponents.append( aComponent );
                aComponent.setParent( this );
        }
}

class Button extends Component {
        private Component parent;
        public void setParent( Component myParent) {
                parent = myParent;
        }

        etc.
```

More Issues

Should Component implement a list of Components?

The button etc. will have a useless data member

Child ordering is important in some cases

Who should delete components?

Applicability

Use Composite pattern when you want

To represent part-whole hierarchies of objects

Clients to be able to ignore the difference between compositions of objects and individual objects

Facade

Size

Item	Source Lines of Code (Millions)
F-22 Raptor US jet fighter	1.7
Boeing 787	6.5
S-class Mercedes-Benz radio & navigation system	20
Mac OS 10.4	86
Premium class automobile	~100
Debian 4.0	283

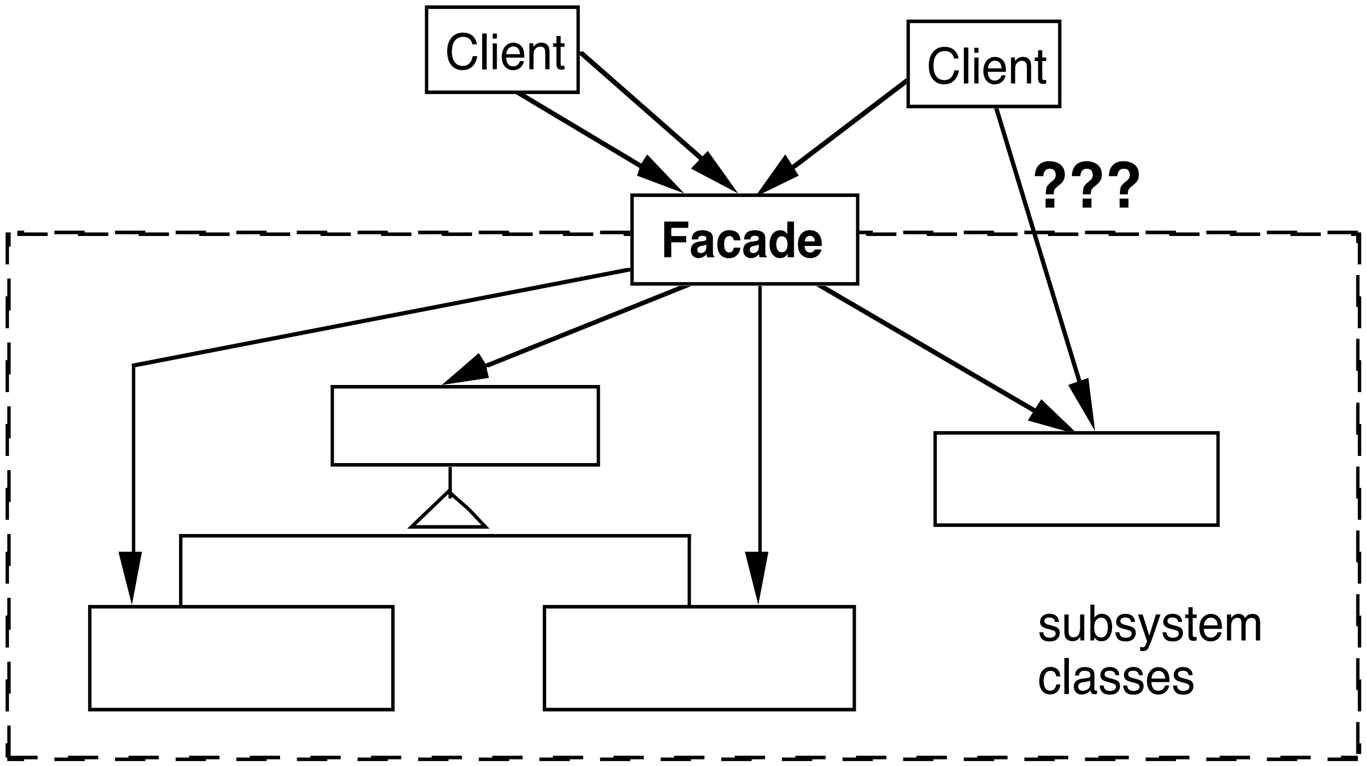
Design Patterns text contains under 8,000 lines

Reference: This Car Runs on Code, http://spectrum.ieee.org/green-tech/advanced-cars/this-car-runs-on-code
Source lInes of code, http://en.wikipedia.org/wiki/Source_lines_of_code

The Facade Pattern

Create a class that is the interface to the subsystem

Clients interface with the Facade class to deal with the subsystem



Consequences of Facade Pattern

It hides the implementation of the subsystem from clients

It promotes weak coupling between the subsystems and its clients

It does not prevent clients from using subsystem classes directly, should it?

Facade does not add new functionality to the subsystem

Public versus Private Subsystem classes

Some classes of a subsystem are

- public
  - facade
- private

Compiler Example

The VisualWorks Smalltalk compiler system has 75 classes

Programmers only use Compiler, which uses the other classes

```
Compiler evaluate: '100 factorial'

    | method compiler |
    method := 'reset
        "Resets the counter to zero"
        count := 0.'.

    compiler := Compiler new.
    compiler
        parse:method
        in: Counter
        notifying: nil
```

Flyweight

Flyweight

Use sharing to support large number of fine-grained objects efficiently

Text Example

A document has many instances of the character 'a'

Character has

- Font
- width
- Height
- Ascenders
- Descenders
- Where it is in the document

Most of these are the same for all instances of 'a'

Use one object to represent all instances of 'a'

Java String Example

```
public void testInterned() {
    String a1 = "catrat";
    String a2 = "cat";
    assertFalse(a1 == (a2+ "rat"));

    String a3 = (a2 + "rat").intern();
    assertTrue(a1 == a3);
    String a4 = "cat" + "rat";
    assertTrue(a1 == a4);
    assertTrue(a3 == a4);
}
```

public String intern()

Returns a canonical representation for the string object.

A pool of strings, initially empty, is maintained privately by the class String.

Intrinsic State

Information that is independent from the object's context

The information that can be shared among many objects

So can be stored inside of the flyweight

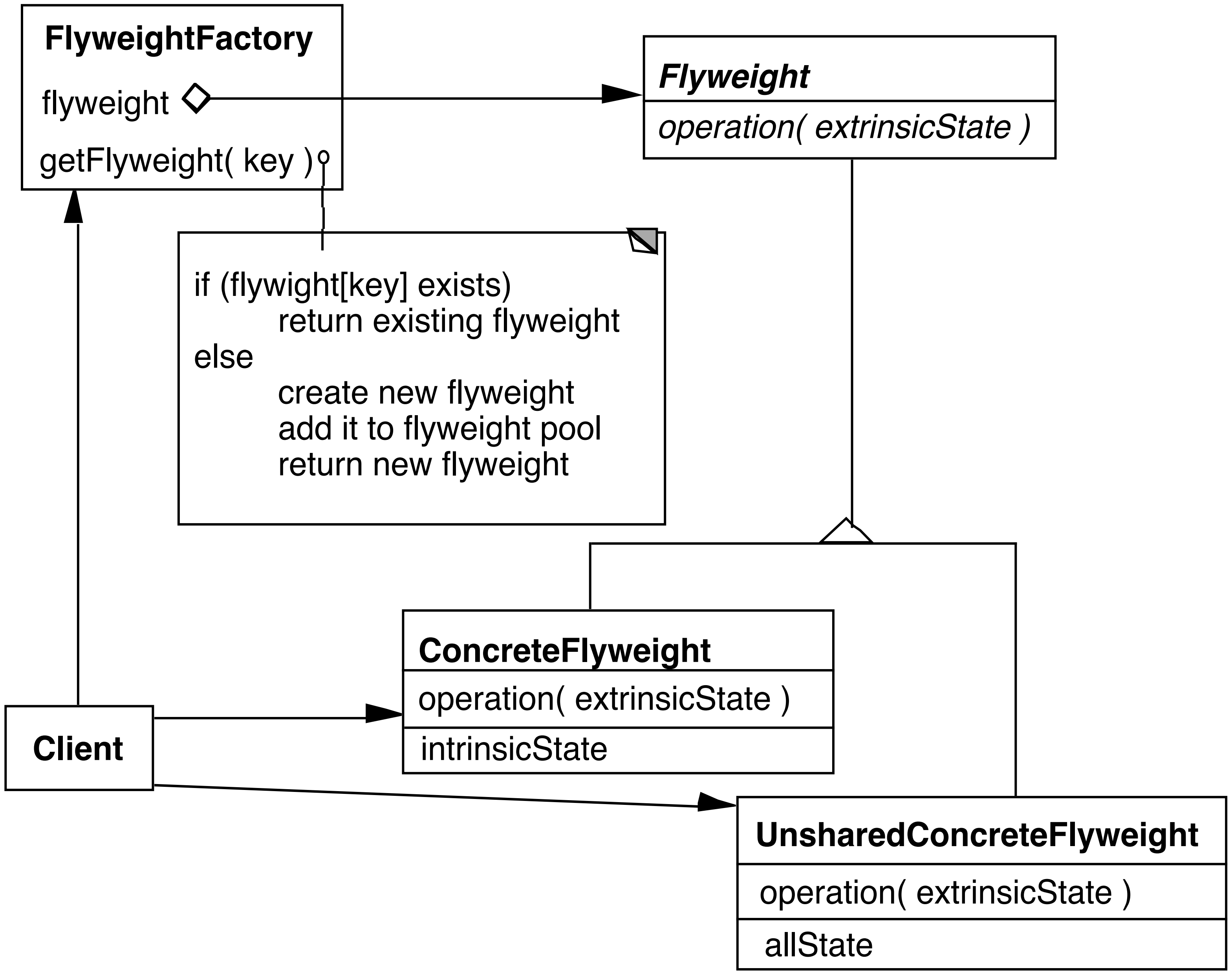
Extrinsic State

Information that is dependent on the object's context

The information that can not be shared among objects

So has to be stored outside of the flyweight

Structure


FlyweightFactory
flyweight
getFlyweight(key)
Flyweight
operation(extrinsicState)
ConcreteFlyweight
operation(extrinsicState)
intrinsicState
Client
UnsharedConcreteFlyweight
operation(extrinsicState)
allState

```
if (flywight[key] exists)
        return existing flyweight
else
        create new flyweight
        add it to flyweight pool
        return new flyweight
```

The Hard Part

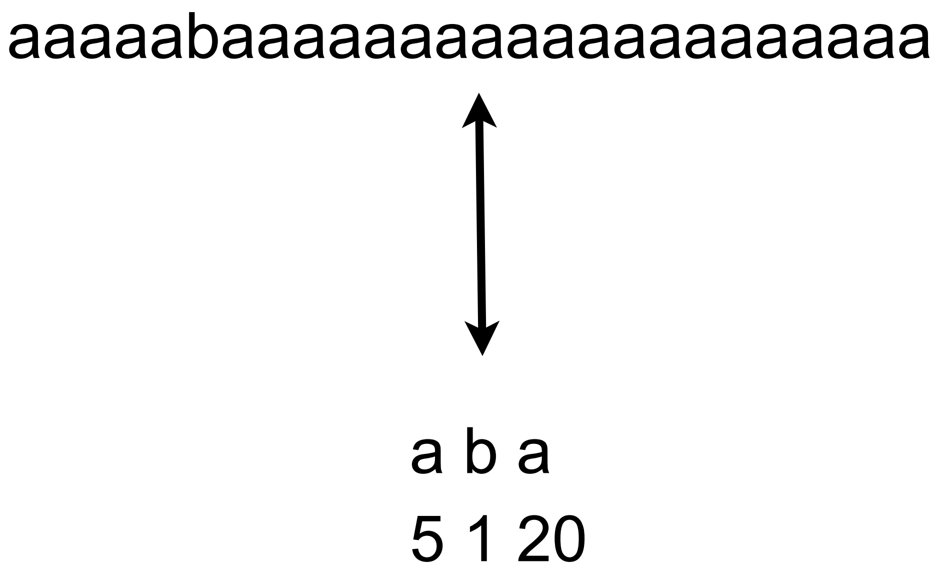
Separating state from the flyweight

How easy is it to identify and remove extrinsic state

Will it save space to remove extrinsic state

Example Text

Run Arrays



aaaaabaaaaaaaaaaaaaaaaaaaa

a b a

5 1 20

Text Example

Lexi Document Editor

Uses character objects with font information

(To support graphic elements)

"A Cat in the hat came ***back*** the very next day"

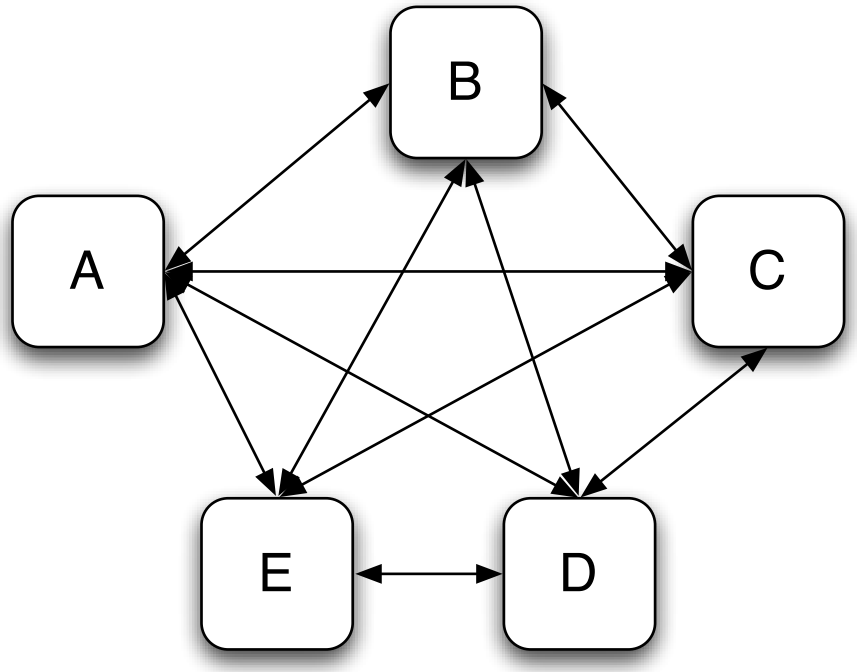
Use run array to store font information (extrinsic state)

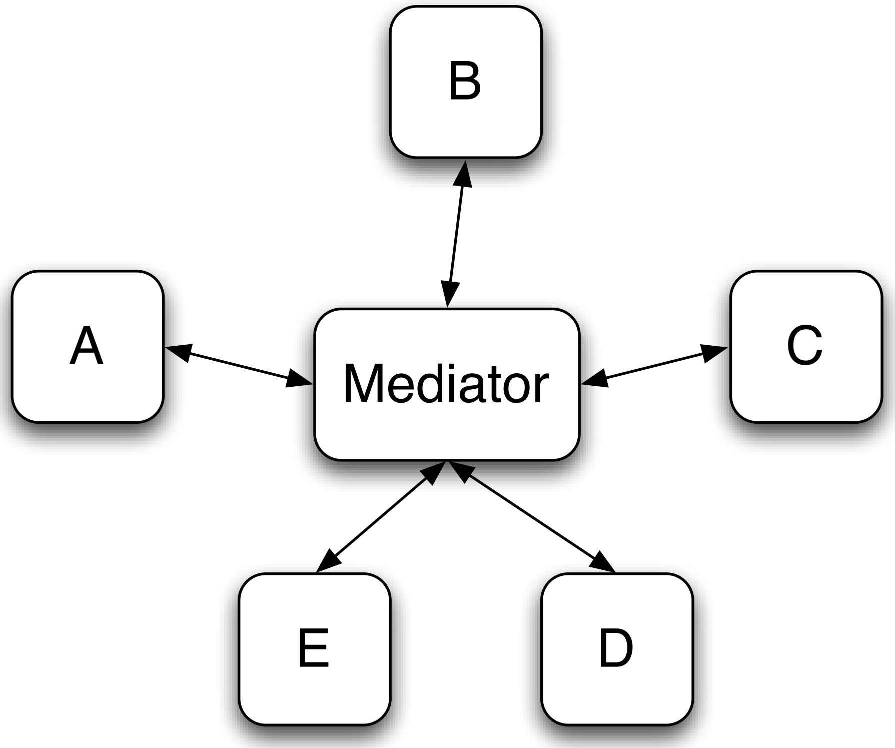
Normal	Bold	Normal
22	4	18

Mediator

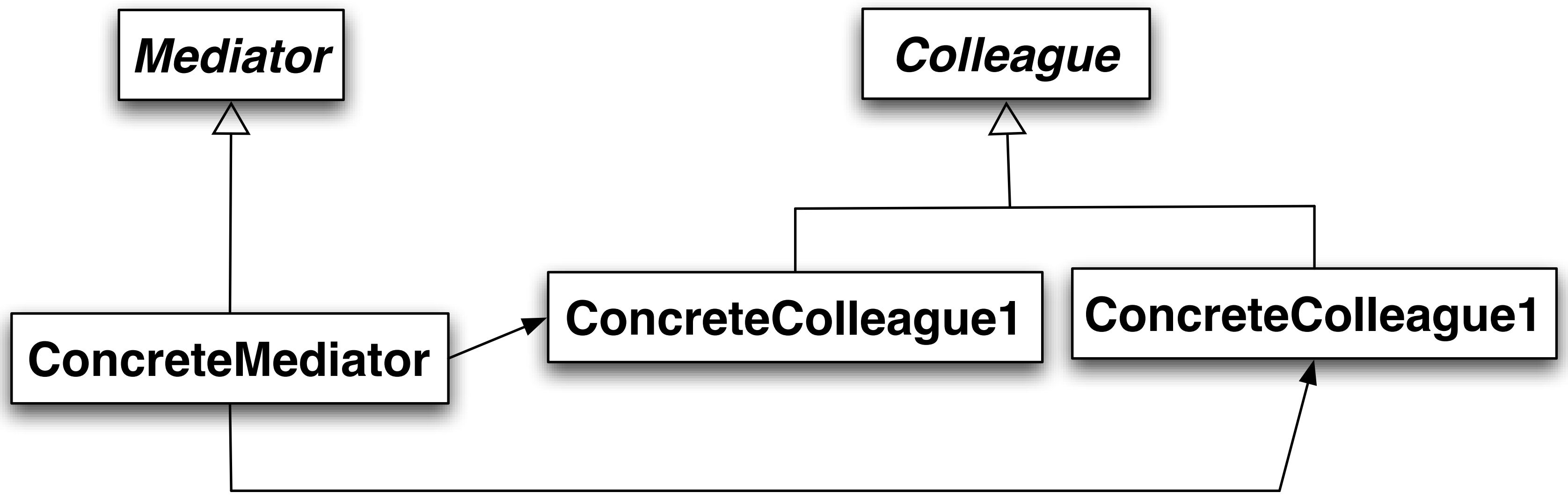
Mediator

A mediator controls and coordinates the interactions of a group of objects





Structure


Mediator
Colleague
ConcreteMediator
ConcreteColleague1
ConcreteColleague1

Participants

Mediator

Defines an interface for communicating with Colleague objects

ConcreteMediator

Implements cooperative behavior by coordinating Colleague objects

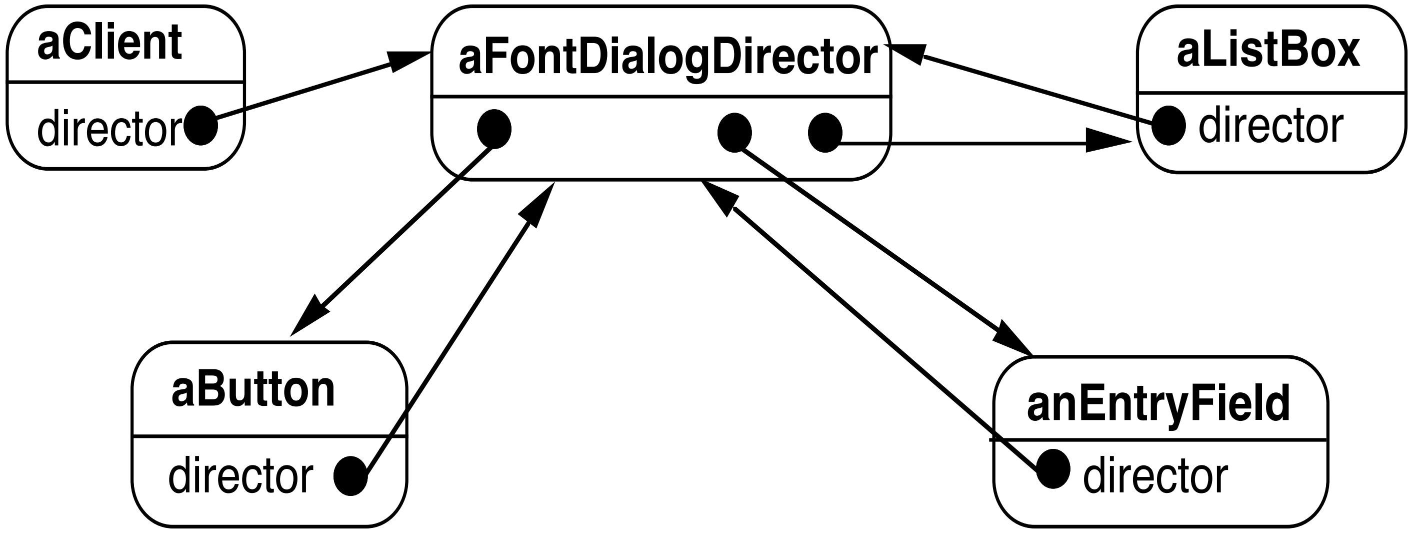
Knows and maintains its colleagues

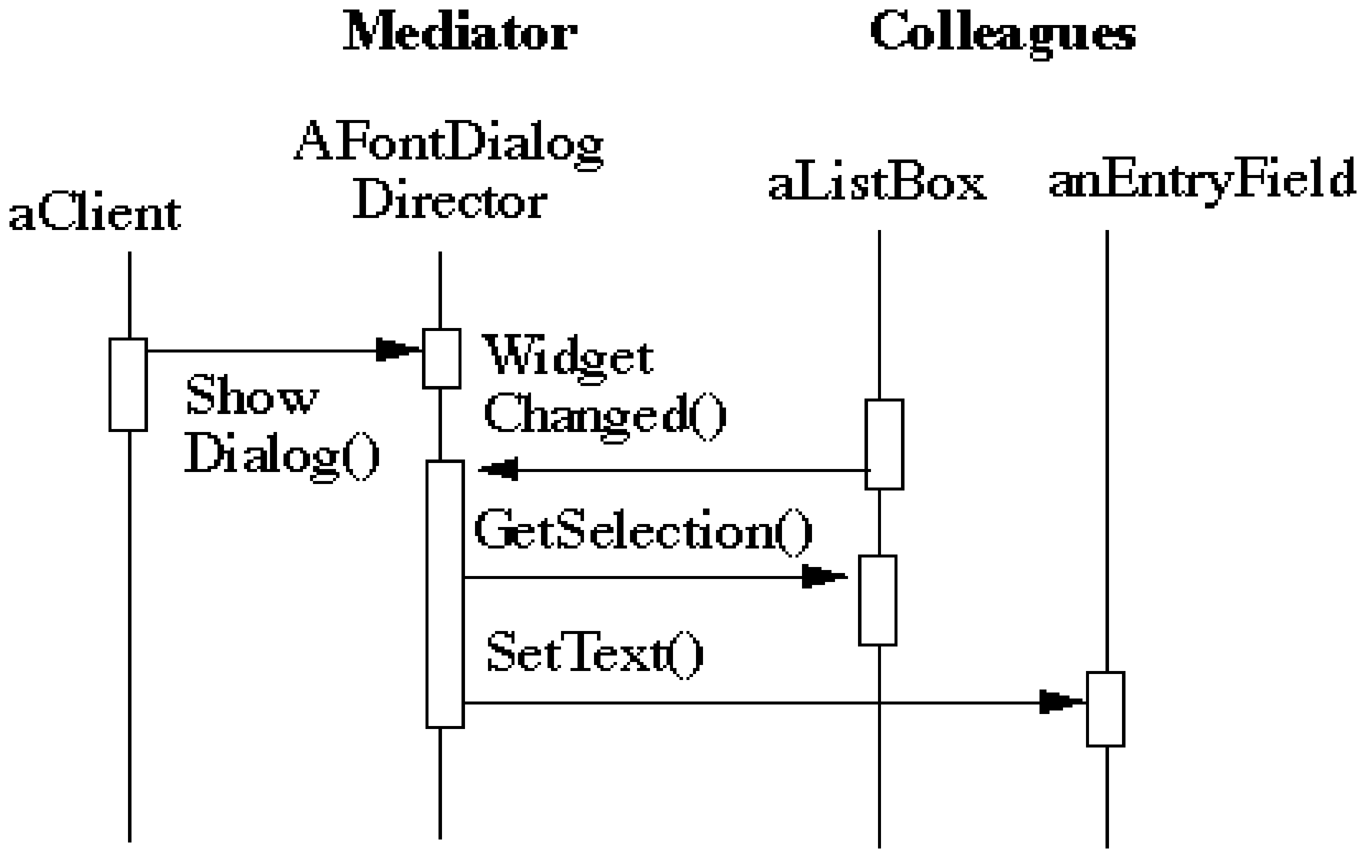
Colleague classes

Each Colleague class knows its Mediator object

Each colleague communicates with its mediator whenever it would have otherwise communicated with another colleague

Motivating Example - Dialog Boxes





How does this differ from a God Class?

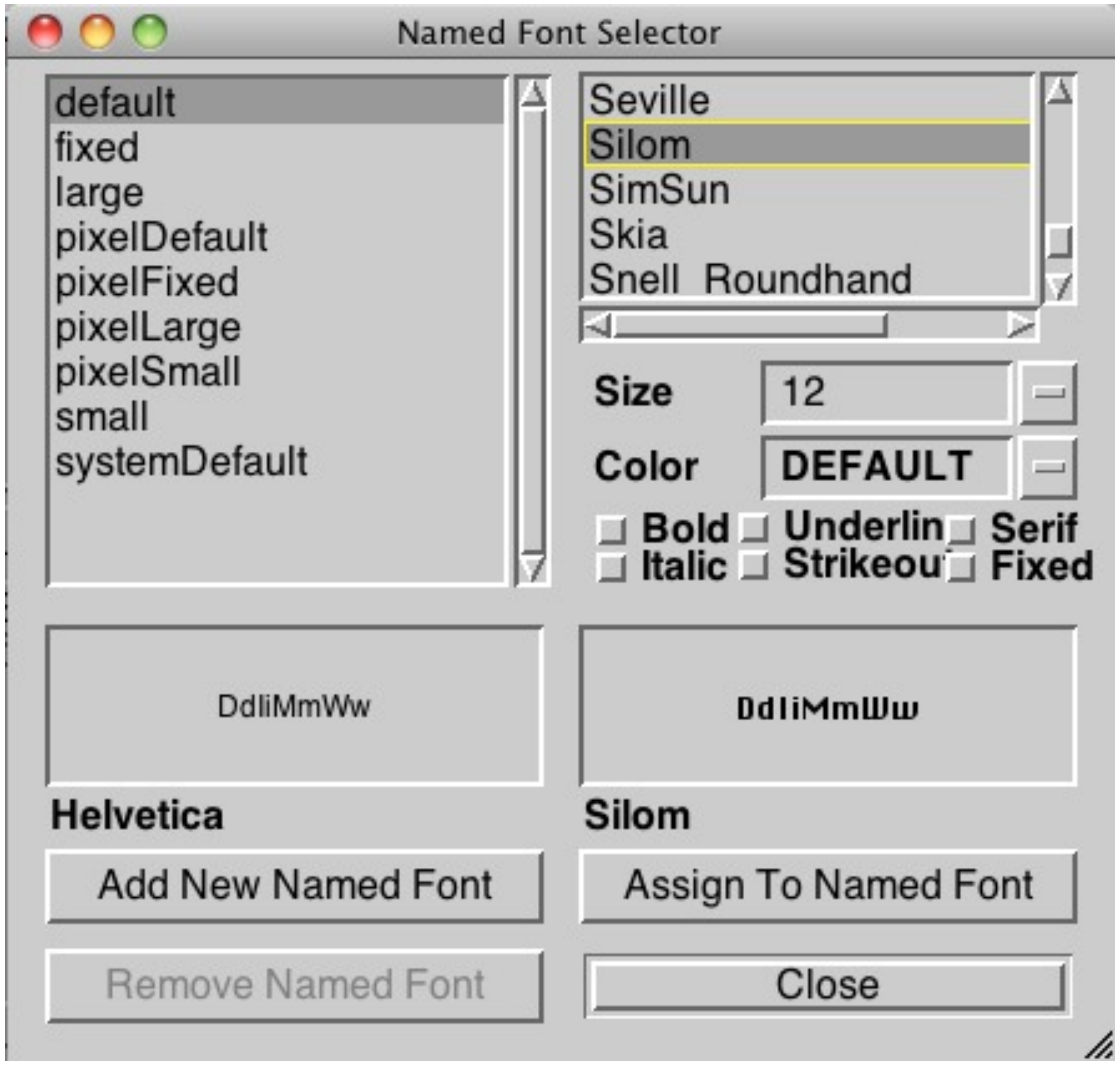
When to use the Mediator Pattern

When a set of objects communicate in a well-defined but complex ways

When reusing an object is difficult because it refers to and communicates with many other objects

When a behavior that's distributed between several classes should be customizable without a lot of subclassing

Classic Mediator Example



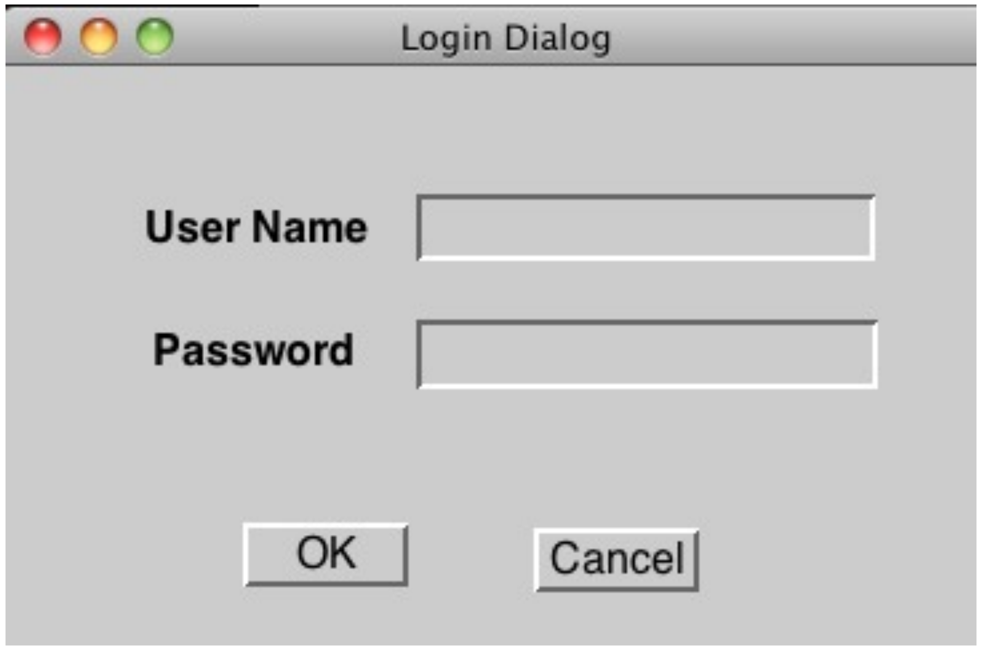
Size 12

Color DEFAULT

□ Bold □ Underlin □ Serif

□ Italic □ Strikeou □ Fixed

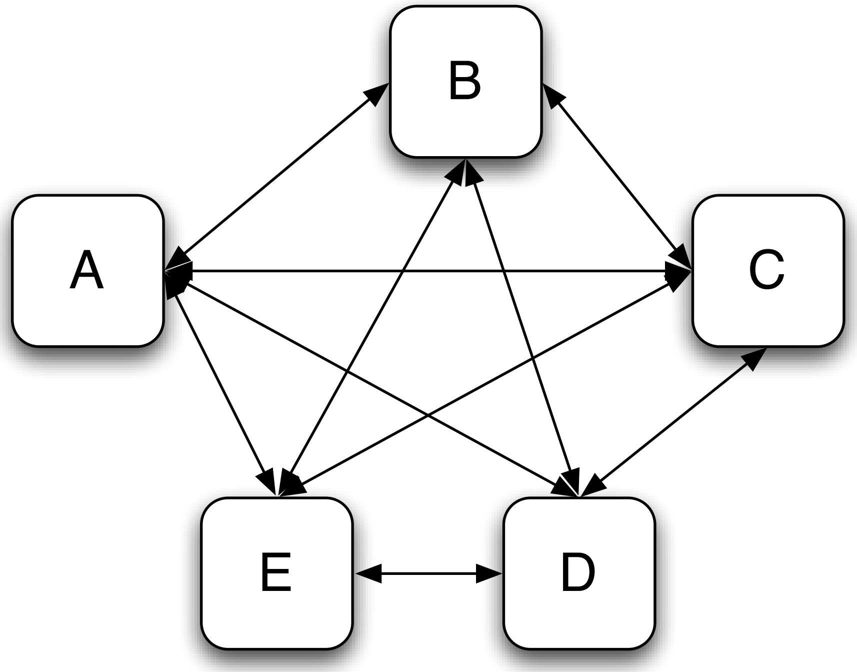
Simpler Example



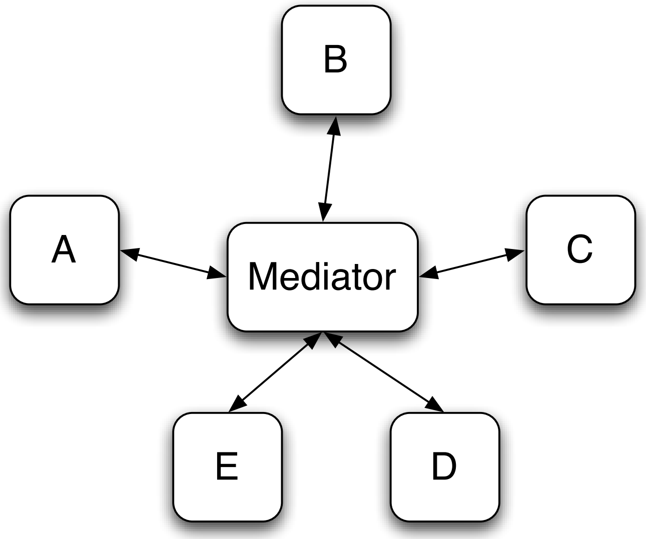
Non Mediator Solution

```
class OKButton extends Button {
    TextField password;
    TextField username;
    Database userData;
    Model application;

    protected void processEvent(AWTEvent e) {
        if (!e.isButtonPressed()) return;
        e.consume();
        if (password.getText() = "") {
            notifyUser("Must enter password");
            return;
        }
        if (username.getText() = "") {
            notifyUser("Must enter user name");
            return;
        }
        if (!userData.validUser(password.getText(), username.getTest()))
            notifyUser("Invalid username & password");
            return;
        }
```



Mediator Solution



```
class LoginDialog extends Panel {
    TextField password;
    TextField username;
    Database userData;
    Button ok, cancel;

    protected void actionPerformed(ActionEvent e)  {
        if (!e.isButtonPressed() or e.getSource() != ok) return;
        if (password.getText() = "") {
            notifyUser("Must enter password");
            return;
        }
        if (username.getText() = "") {
            notifyUser("Must enter user name");
            return;
        }
        if (!userData.validUser(password.getText(), username.getTest()))
            notifyUser("Invalid username & password");
            return;
        }
```

What is Different?

Non Mediator Example

- Special Button class
- OK button coupled to text fields

Mediator Example

- No specialButton class
- LoginDialog coupled to text fields

Logic moved from button class to LoginDialog

But

Java's event mechanism promotes mediator solution