

Design Patterns II

See also: Chapter 26

Design Patterns II

CS193D, 3/8/06

The Proxy Pattern

Proxies are stand-ins for other objects. You might use a proxy to perform access control, serve as a middleman, or mask issues with the underlying object.

Virtual Proxy – Allows you to create a low-overhead object until the full underlying object is needed.

Remote Proxy – Allows you to access an object on a network as though it were local.

Access Proxy – Allows you to check permissions before using the protected functionality.

Smart Proxy – Allows you to provide additional functionality.

Example: Apache Axis (Remote Proxy)

A SOAP library that can generate client-side proxy objects (stubs):

```
// on the client
int main() {
    Calculator c;
    int intOut;
    c.add(20, 40, intOut);
    cout << "result is = " << intOut << endl;
}

// Calculator.cpp (pseudocode)
void Calculator::add(int x, int y, int& result) {
    SOAPEnvelope env("http://foo.com/action/add");
    env.addArgument("x", x);
    env.addArgument("y", y);
    SOAPResult response = env.sendRequest();
    result = response.getIntValue();
}
```

Example: Persisted Object Proxy (a Smart Proxy)

```
class User : public DatabaseObject {
    public:
        string getName();
        void setName(string inName);
};

class UserProxy {
    public:
        void setName(string inName) {
            if (!isNameValid(inName)) throw "bad name";
            mUser.setName(inName);
        }
        string getName() {
            if (mUser.getName() == "#NULL#") return "";
            return mUser.getName();
        }
    private:
        User mUser;
};
```

The Adapter (Wrapper) Pattern

An adapter or wrapper gives a new interface to an existing class. Usually, it's for compatibility reasons, but it could also be for ease of use.

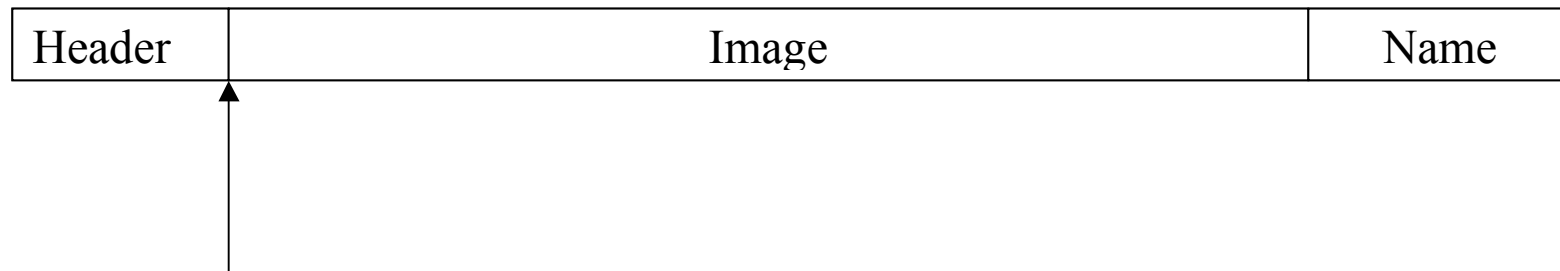
Example: wrap a new version of a library with the old version's API:

```
class LibTranslateWrapper : public LibTranslate {
    public:
        string translate(string inText, string inLang) {
            // the new API uses language codes
            int langCode = lookupLangCode(inLang);
            return translate(inText, langCode);
        }
};
```

The Decorator Pattern

A decorator is a temporary embellishment to an object that adds new functionality or allows access through a new lens.

Example: Reading a stream that contains a particular type of data:



```
int imageFormat; string name;  
inputFile >> imageFormat;  
ImageReader ireader(inputFile);  
Image* theImage = ireader.readImage();  
inputFile >> name;
```

Example: Web Page Styles

HTML uses an XML-like syntax for styles:

```
<B>For those about to rock, we salute you.</B>  
<I><B>For those about to rock, we salute you.</B></I>
```

```
class Paragraph {  
    public:  
        Paragraph(const string& inText) : mText(inText) {}  
        virtual string getHTML() const { return mText; }  
    protected:  
        string mText;  
};
```

```

class BoldParagraph : public Paragraph {
public:
    BoldParagraph(const Paragraph& inPara) :
        Paragraph(""), mDecorated(inParagraph) {}

    virtual string getHTML() const {
        return "<B>" + mDecorated.getHTML() + "</B>";
    }
protected:
    const Paragraph& mDecorated;
};

```

```

class ItalicParagraph : public Paragraph {
public:
    ItalicParagraph(const Paragraph& inPara) :
        Paragraph(""), mDecorated(inParagraph) {}
    virtual string getHTML() const {
        return "<I>" + mDecorated.getHTML() + "</I>";
    }
protected:
    const Paragraph& mDecorated;
};

```

Using the HTML Decorators

The decorators haven't changed the interface, just the functionality:

```
Paragraph p("For those about to rock...");
```

```
// Bold
```

```
cout << BoldParagraph(p).getHTML() << endl;
```

```
// Bold Italic
```

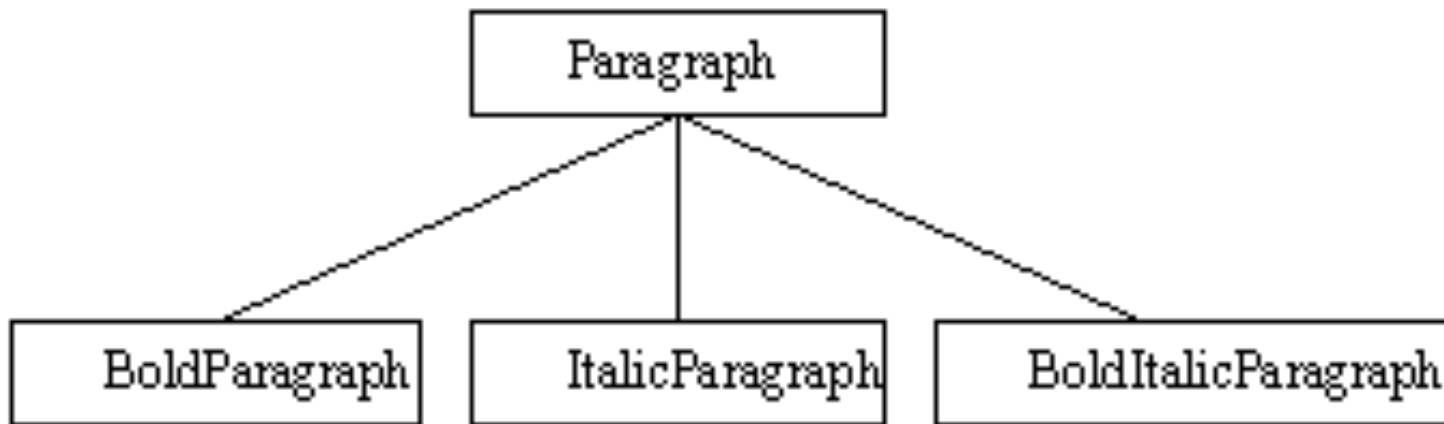
```
cout << ItalicParagraph(BoldParagraph(p)).getHTML() << endl;
```

```
<B>For those about to rock...</B>
```

```
<I><B>For those about to rock...</B></I>
```

Decorating versus Subclassing

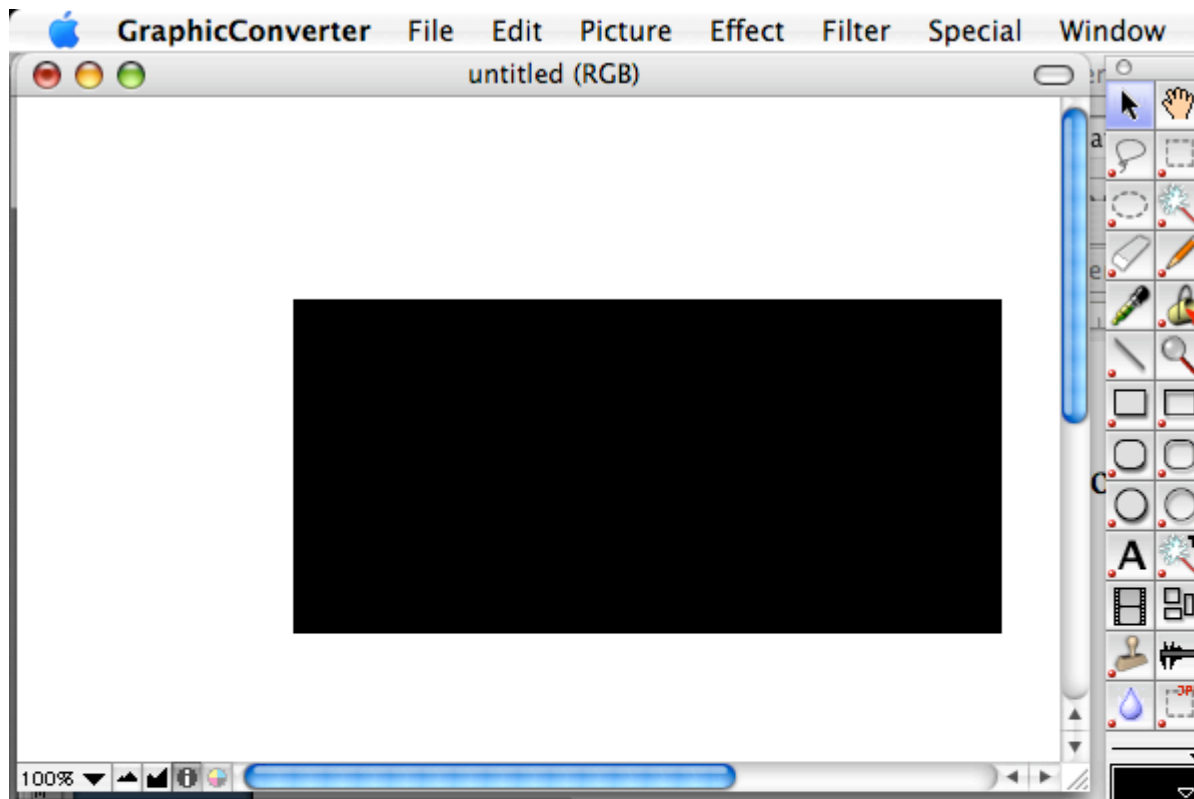
Styled paragraphs as *types* of paragraphs:



Decorators allow you to apply behavior without introducing new types.

The Chain of Responsibility Pattern

This is a behavioral pattern that gives you a way to give multiple objects a crack at handling a particular task.



```
void Rectangle::handleMessage(int msg) {
    switch (msg) {
        case kDraw:
            drawSelf();
            break;
        default:
            // Rectangle doesn't handle this message
            Shape::handleMessage(msg);
    }
}
```

```
void Shape::handleMessage(int msg) {
    switch (msg) {
        case kClick:
            gCurrentSelection = this;
            break;
        default:
            // Shape doesn't handle this message
            mCanvas.handleMessage(msg);
    }
}
```

Notes about Chain of Responsibility

- The chain often mirrors an object hierarchy, but doesn't have to (e.g. Canvas is not the superclass of Shape)
- It can be brittle in some implementations. One class could break the chain or cause an infinite loop.
- It's a reasonable way to model layering, where some objects should have the first shot at a command.
- It's a common way of handling menu selections in a graphical application.

The Observer Pattern

The Observer Pattern, like the Chain of Responsibility, provides a way for objects to react to some sort of event.

An Observer registers a priori for the events it is interested in, and is notified when the event is broadcast. This is often called *publish-subscribe*.

Example: Alert tool that listens for certain system events

Example: Graphical application where multiple objects might want to do something when a button is pressed.

The Abstract Factory Pattern

A factory is an object whose job is to create other objects:

```
class EchoTaskFactory
{
    public:
        Task* make() {
            return new EchoTask();
        }
};
```

Factories versus Constructors

The advantages of Factories over constructors are:

- 1) **Centrality.** By creating a separate object to create instances, you can easily create an object pool.
- 2) **Polymorphic Creation.** You can structure factories into a hierarchy and create objects where the type is determined at runtime.

The abstract factory is just a formalization of one approach to HW3.

Abstract Factory Hierarchies

```
class TaskFactory {
    public:
        virtual Task* make() = 0;
};
```

```
class EchoTaskFactory :
    public TaskFactory {
    public:
        virtual Task* make() {
            return new EchoTask();
        }
};
```

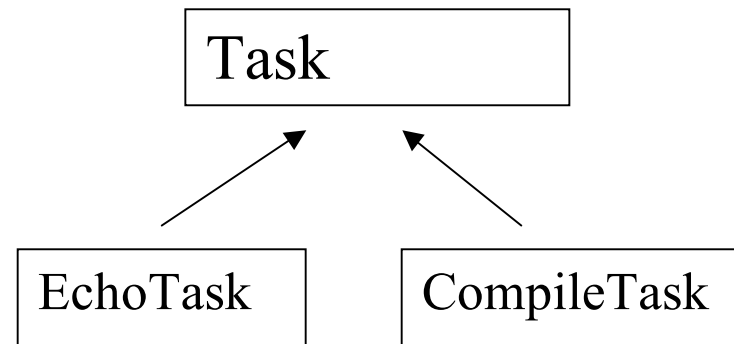
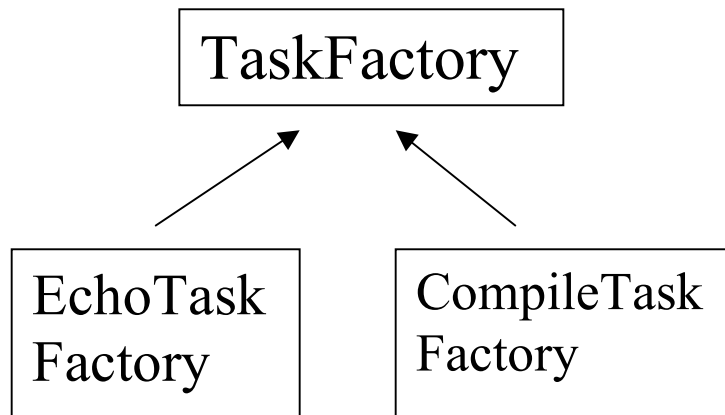
```
class CompileTaskFactory :
    public TaskFactory {
    public:
        virtual Task* make() {
            return new CompileTask();
        }
};
```

```
class Task {
    [etc]
};
```

```
class EchoTask :
    public Task {
    [etc]
};
```

```
class CompileTask :
    public Task {
    [etc]
};
```

The New Parallel Hierarchies



So?

By building polymorphic objects that create subclasses of Tasks, we can determine the type of task to create at runtime.

```
TaskFactory currentFactory = getCurrentTaskFactory();  
Task* theTask = currentFactory.make();
```

```
// What is theTask? Could be an EchoTask... could be a  
// CompileTask. Could be peaches, could be lunchmeat.
```

Next step: Determining what factory to use.

Storing Factories in a Table

The method for dealing with which factory to use varies from application to application.

- Factories based on resource availability (TCP versus AppleTalk)
- Factories based on user preferences (Valentines Card versus BDay)
- Factories stored for later lookup (XML-driven)

```
void TaskManager::init()
{
    sTaskMap["compile"] = new CompileTaskFactory();
    sTaskMap["echo"] = new EchoTaskFactory();
}
```

Factories for Modal Behavior and Data

Factories are often used to group together a collection of data or functionality that varies based on some mode, like language.

```
void handleError(int errNum) {
    if (errNum == kFileError) {
        cerr << gLanguageFactory.getFileErrorString();
    } else if (errNum == kLoadError) {
        cerr << gLanguageFactory.getLoadErrorString();
    }
}

class FrenchLanguageFactory : public LanguageFactory {
public:
    string getFileErrorString() const {
        return "Je suis un essuie-glace";
    }
    [etc]
};
```