CS 635 Advanced Object-Oriented Design & Programming  
Spring Semester, 2001  
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Bridge

Decouple the abstraction from its implementation

This allows the implementation to vary from its abstraction

The abstraction defines and implements the interface

All operations in the abstraction call method(s) its implementation object
What is Wrong with Using an Interface?

Abstraction

operation()

ConcreteImplA

operation()

ConcreteImplB

operation()

Make Abstraction a pure abstract class or Java interface

In client code:

Abstraction widget = new ConcreteImplA();
widget.operation();

This will separate the abstraction from the implementation

We can vary the implementation!
Applicability

Use the Bridge pattern when

- You want to avoid a permanent binding between an abstraction and its implementation

- Both the abstractions and their implementations should be independently extensible by subclassing

- Changes in the implementation of an abstraction should have no impact on the clients; that is, their code should not have to be recompiled

- You want to hide the implementation of an abstraction completely from clients (users)

- You want to share an implementation among multiple objects (reference counting), and this fact should be hidden from the client
Binding between abstraction & implementation

In the Bridge pattern:

- An abstraction can use different implementations
- An implementation can be used in different abstraction
Hide implementation from clients

Using just an interface the client can cheat!

    Abstraction widget = new ConcreteImplA();
    widget.operation();
    ((ConcreteImplA) widget).concreteOperation();

In the Bridge pattern the client code can not access the implementation

Java uses Bridge to prevent programmer from accessing platform specific implementations of interface widgets, etc.

Peer = implementation

    public synchronized void setCursor(Cursor cursor) {
        this.cursor = cursor;
        ComponentPeer peer = this.peer;
        if (peer != null) {
            peer.setCursor(cursor);
        }
    }
Abstractions & Imps independently subclassable

Start with Widow interface and two implementations:

```
    Window
       /\            /\            /\            /\            /\           /\           /\           /\           /\
      XWindow   NTWindow  IconWindow   DialogWindow  XWindow   NTWindow
```

Now what do we do if we need some more types of windows: say IconWindow and DialogWindow?
Or using multiple inheritance

```
Window

IconWindow  DialogWindow  XWindow  NTWindow
```

[Diagram showing the inheritance relationships between Window, IconWindow, DialogWindow, XWindow, and NTWindow]
The Bridge pattern provides a cleaner solution

```
Window
    imp
    \-- WindowImp
        \-- IconWindow
        \-- DialogWindow
        \-- XWindow
        \-- NTWindow
```

IconWindow and DialogWindow will add functionality to or modify existing functionality of Window.

Methods in IconWindow and DialogWindow need to use the implementation methods to provide the new/modified functionality.

This means that the WindowImp interface must provide the base functionality for window implementation.

This does not mean that WindowImp interface must explicitly provide an iconifyWindow method.
Share an implementation among multiple objects

Example use is creating smart pointers in C++

String contains a StringRep object
StringRep holds the text and reference count
String passes actual string operations to StringRep object
String handles pointer operations and deleting StringRep object when reference count reaches zero

```
String a("cat");
String b("dog");
String c("mouse");
```

```
a = b;
```

```
a = c;
```

```
<table>
<thead>
<tr>
<th>String</th>
<th>StringRep</th>
</tr>
</thead>
<tbody>
<tr>
<td>imp</td>
<td>text</td>
</tr>
<tr>
<td></td>
<td>refCount</td>
</tr>
</tbody>
</table>
```

```
| a    | cat 1 |
| b    | dog 1 |
| c    | mouse 1 |
```

```
| a    | cat 0 |
| b    | dog 2 |
| c    | mouse 1 |
```

```
| a    | dog 1 |
| b    |       |
| c    | mouse 2 |
```
C++ Implementation from Coplien

class StringRep {
  friend String;

  private:
  char *text;
  int refCount;

  StringRep() { *(text = new char[1] = '\0'; }

  StringRep( const StringRep& s ) { ::strcpy( text = new char[::strlen(s.text) + 1, s.text); }

  StringRep( const char *s) {
    ::strcpy( text = new char[::strlen(s) + 1, s);
  }

  StringRep( char** const *r) {
    text = *r;
    *r = 0;
    refCount = 1;;
  }

  ~StringRep() { delete[] text; }  

  int length() const { return ::strlen( text ); }

  void print() const { ::printf("%s\n", text ); }
}
class String { 
    friend StringRep

public:
    String operator+(const String& add) const {
        return *imp + add;
    }
    StringRep* operator->() const { return imp; }
    String() { (imp = new StringRep()); -> refCount = 1; }
    String(const char* charStr) {
        (imp = new StringRep(charStr)); -> refCount = 1;
    }
    String operator=(const String& q) {
        (imp->refCount) --;
        if (imp->refCount <= 0 &&
            imp != q.imp )
            delete imp;

        imp = q.imp;
        (imp->refCount)++;
        return *this;
    }
    ~String() {
        (imp->refCount) --;
        if (imp->refCount <= 0) delete imp;
    }

private:
    String(char** r) { imp = new StringRep(r); }
    StringRep *imp;
};
Using Counter Pointer Classes

```c
int main() {
    String a( "abcd");
    String b( "efgh");

    printf( "a is ");
    a->print();

    printf( "b is ");
    b->print();

    printf( "length of b is %d\n", b->length() );

    printf( " a + b ");
    (a+b)->print();
}
```
Bridge and Other Patterns

Adapter

- Used to make unrelated classes work together
- Usually applied after they’re designed

State?

Strategy?