

Software methodology and snake oil

- **programming is hard**
 - programs are very expensive to create
 - full of errors
 - hard to maintain
- **how can we design and program better?**
- **a fruitful area for people selling "methodologies"**
 - for at least 30 years
- **each methodology has the germ of a useful idea**
- **each claims to solve major programming problems**
- **some are promoted with religious fervor**
- **in fact most don't seem to work well**
- **or don't seem to apply to all programs**
- **or can't be taught to others**
- **a few are genuinely useful and should be part of everyone's repertoire**

Examples...

- **modularity, information hiding (Parnas)**
 - coupling, cohesion (Constantine)
- **structured programming (programming without goto's)**
 - top-down development, successive refinement
 - structured everything
 - design, analysis, requirements, specification, walkthroughs...
 - chief programmer teams, egoless programming
- **CASE tools (Computer Aided Software Engineering)**
 - UML (Unified Modeling Language)
 - message sequence charts, state diagrams
- **formal methods**
 - verification, validation, proof of correctness
- **object-oriented programming**
 - object-oriented everything
 - design, analysis, requirements, specification, walkthroughs...
 - CRC cards (Class, Responsibilities, and Collaborators)
- **RAD (rapid application development)**
 - components, COTS (Components off the Shelf)
 - 4th generation languages, automatic programming
 - X by example, graphical programming
- **extreme programming, refactoring, ...**
- **design patterns**
 - patterns of everything

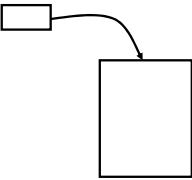
Design patterns

- "Design patterns ... describe simple and elegant solutions to specific problems in object-oriented software design."
 - *Design Patterns: Elements of Reusable Object-Oriented Software*, by Gamma, Helm, Johnson, Vlissides (the "Gang of Four")
- successful among broad group of programmers
- increasingly used to describe software structure

Bridge pattern

- "Decouple an abstraction from its implementation so that the two can vary independently"
- C++ string class: separate handle from body
 - implementation can be changed without changing abstraction of "string"

```
class String {  
private:  
    Srep *p;  
public:  
    ...  
};  
  
class Srep {  
    char *sp;      // data  
    int  n;        // ref count  
    ...  
};
```



```
graph TD
    A[String] --> B[Srep]
```

- sometimes called "Handle / Body"
- similar examples:
 - FILE * in C stdio
 - RE * in regexr interface
 - connection in MySQL interface

Bridge pattern, continued

- **change of implementation has no effect on client**
 - can even switch implementation at run time
- **(in C and C++) hides implementation completely**
 - C: hidden behind opaque type
 - C++: implementation class is invisible
- **can share implementation among multiple objects without revealing the sharing**
 - e.g., reference counting
 - e.g., sharing of open files in FILE*

Adapter pattern

- **"Convert the interface of one class into another interface that clients expect"**
- **maps one interface into another**
 - more or less at the same level
- **e.g., in the C stdio package:**
fread(buf, objsize, nobj, stream)
fwrite(buf, objsize, nobj, stream)

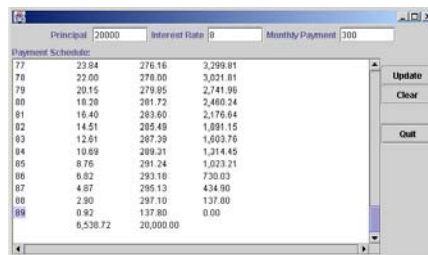
are wrappers around
read(fd, buf, size)
write(fd, buf, size)
- **also known as "wrapper" pattern**
- **real-world examples:**
 - electrical plugs, various other connectors

Decorator pattern

- "Attach additional responsibilities to an object dynamically"
- decorator conforms to interface it decorates
 - transparent to clients
 - forwards some requests
 - usually does some actions of its own before or after
- e.g., Java Swing JScrollPane class

```
JTextArea tpay = new JTextArea(15, 45);
```

```
JScrollPane jsp = new JScrollPane(tpay,  
    JScrollPane.VERTICAL_SCROLLBAR_ALWAYS,  
    JScrollPane.HORIZONTAL_SCROLLBAR_ALWAYS);
```



The screenshot shows a Java Swing window titled "Payment Scheduler". It contains three input fields at the top: "Principal" with the value "20000", "Interest Rate" with the value "0", and "Monthly Payment" with the value "100". Below these fields is a table with three columns. The first column lists months from 77 to 89. The second column shows the remaining balance, starting at 22.84 and ending at 0.00. The third column shows the total amount paid, starting at 276.16 and ending at 20,000.00. To the right of the table are three buttons: "Update", "Clear", and "Quit".

Month	Balance	Total Paid
77	22.84	276.16
78	22.00	278.00
79	20.15	279.95
80	18.28	281.72
81	16.40	283.60
82	14.51	285.49
83	12.61	287.39
84	10.69	289.31
85	8.76	291.24
86	6.82	293.16
87	4.87	295.13
88	2.90	297.10
89	0.92	137.80
	0.00	0.00
	0.00	20,000.00

Other structural patterns

- Facade: "Provide a unified interface to a set of interfaces in a subsystem."
 - provides a higher-level interface to something underneath that remains visible and accessible
 - Perl CGI package (and others)
 - simplified socket package (Perl and others)
 - graphics interfaces
 - (X widgets -> X toolkits -> X intrinsics -> Xlib)
 - ...
- Proxy: "Provide a surrogate or placeholder for another object to control access to it."
 - smart pointers
 - implicit initialization
 - load on demand (lazy evaluation)
 - ...
- how do we tell all of these patterns apart?
 - distinctions are not always clear

Iterator

- "Provide a way to access the elements of an aggregate object sequentially without exposing its underlying representation"
- the basis of algorithms in C++ STL

```
template <class InputIterator,
          class OutputIterator>
OutputIterator mycopy(InputIterator first,
                     InputIterator last, OutputIterator result)
{
    while (first != last)
        *result++ = *first++;
    return result;
}
```

- in Java, tokenizers and explicit iterators
- ```
StringTokenizer st =
 new StringTokenizer(str);
while (st.hasMoreTokens()) {
 String s = st.nextToken();
 ...
}
```

## Interpreter

- "Given a language, define a representation for its grammar along with an interpreter that uses the presentation to interpret sentences in the language"
- regular expression processor
  - variations of grep
  - int match(char \*regexp, char \*text) ...
- eval(...) or execute(...) in many languages
- printf format strings?

## Observer (/observable)

- **"Define a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically"**

- **Java ActionListener mechanism:**

**button.addActionListener(this)**

- tells **button** to notify **this** container when event happens
- usually called by container that contains object that will get the event
- can have more than one listener

**void actionPerformed(ActionEvent e) { ... }**

- called when event occurs
- determines type or instance that caused event
- handles it

## Others...

- **Abstract Factory:** "Provide an interface for creating families of related or dependent objects." (also Factory)
- **Singleton:** "Ensure a class only has one instance"
  - Java System, Runtime, Math classes
- **Visitor:** "Represent an operation to be performed on the elements of an object structure"
  - almost any tree walk that does some evaluation at each node
  - draw() where one kind of "Shape" is an entire picture made of Shapes
- **Memento:** "Without violating encapsulation, capture and externalize an object's internal state so that the object can be restored to this state later"
  - Java serialization