CS 635 Advanced Object-Oriented Design & Programming

Spring Semester, 2006
Doc 17 Bridge, Chain of Responsibility
Apr 19, 2007

References

Design Patterns: Elements of Resuable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, Addison Wesley, 1995, pp. 223-232,151-163

The Design Patterns Smalltalk Companion, Alpert, Brown, Woolf, Addision-Wesley, 1998, pp. 225-245

Logger Example, Wikipedia, http://en.wikipedia.org/wiki/Chain_of_responsibility_pattern

Pipe & Filter References

Pattern-Oriented Software Architecture: Vol 1 A System of Patterns, Buschmann et al, Wiley, 1996, pp 53-70.

http://www.enterpriseintegrationpatterns.com/PipesAndFilters.html

Detailed Discussion
http://john.cs.olemiss.edu/~hcc/softArch/notes/pipes.html

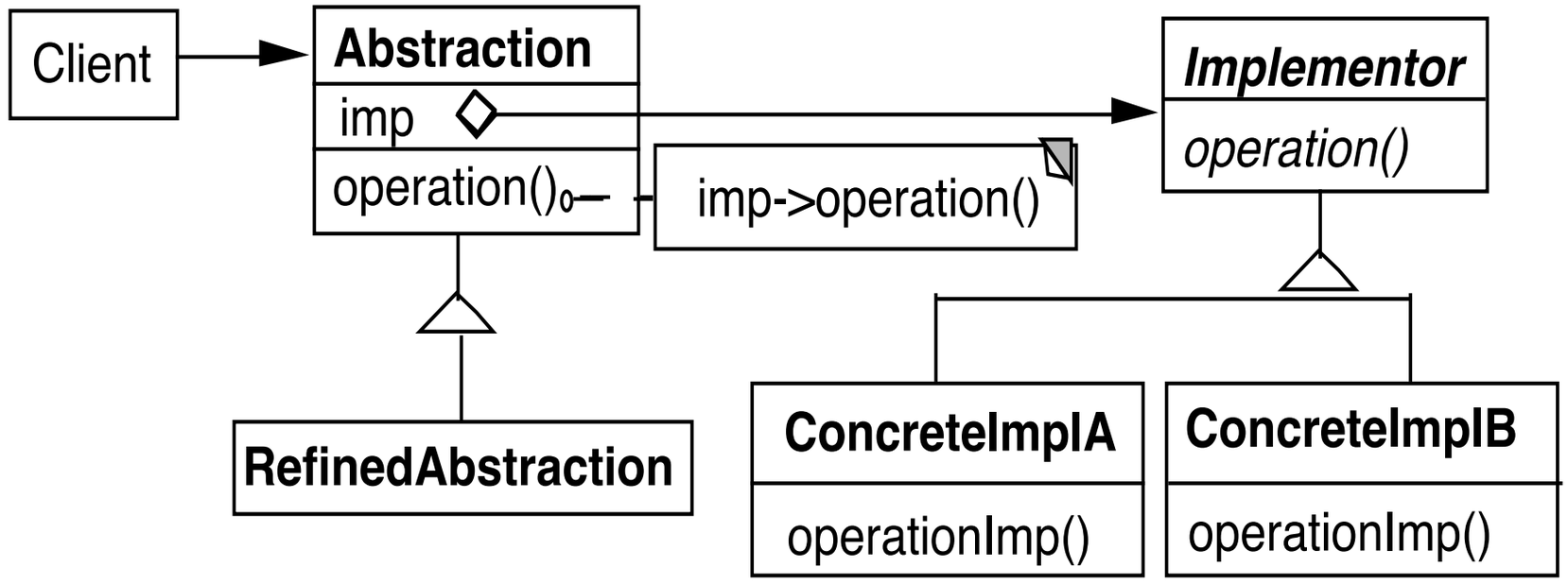
Intercepting Filter References

Core J2EE Patterns, 2nd Ed. Alur, Crupi, Malks, Sun Microsystems Press, Prentice Hall, 2003, pp 144-165

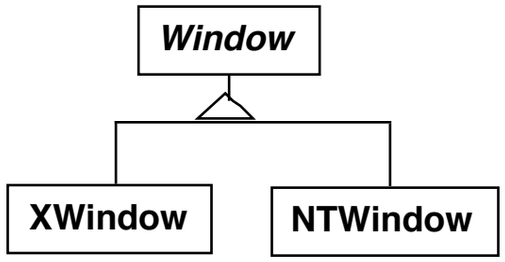
http://java.sun.com/blueprints/corej2eepatterns/Patterns/InterceptingFilter.html

Bridge

Decouple an abstraction from its implementation



Windows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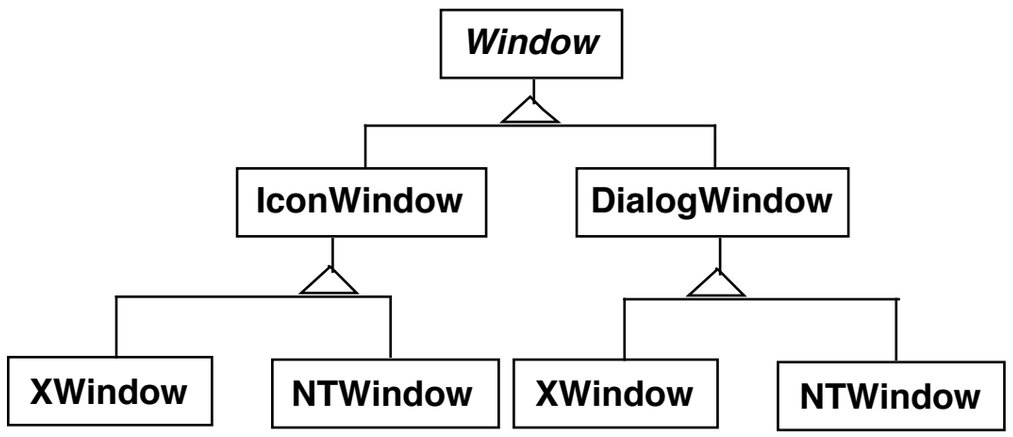
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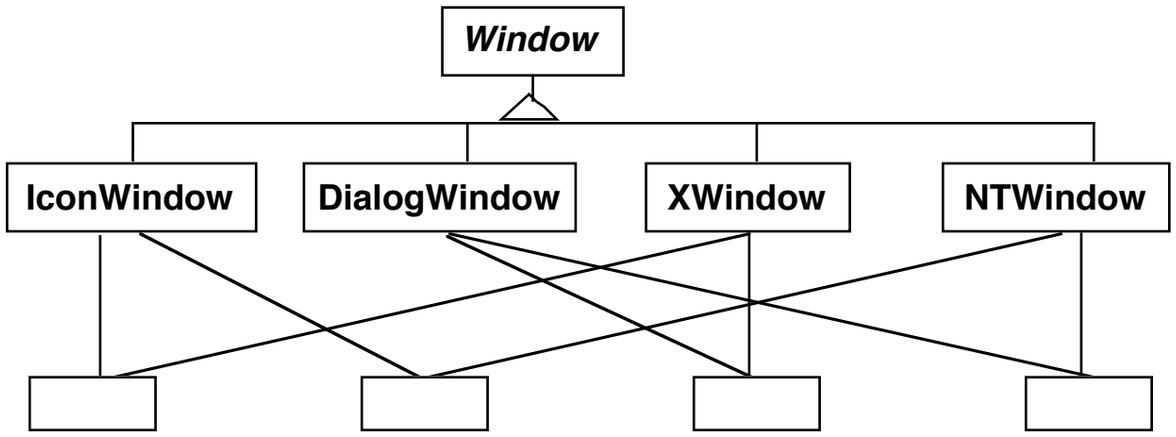
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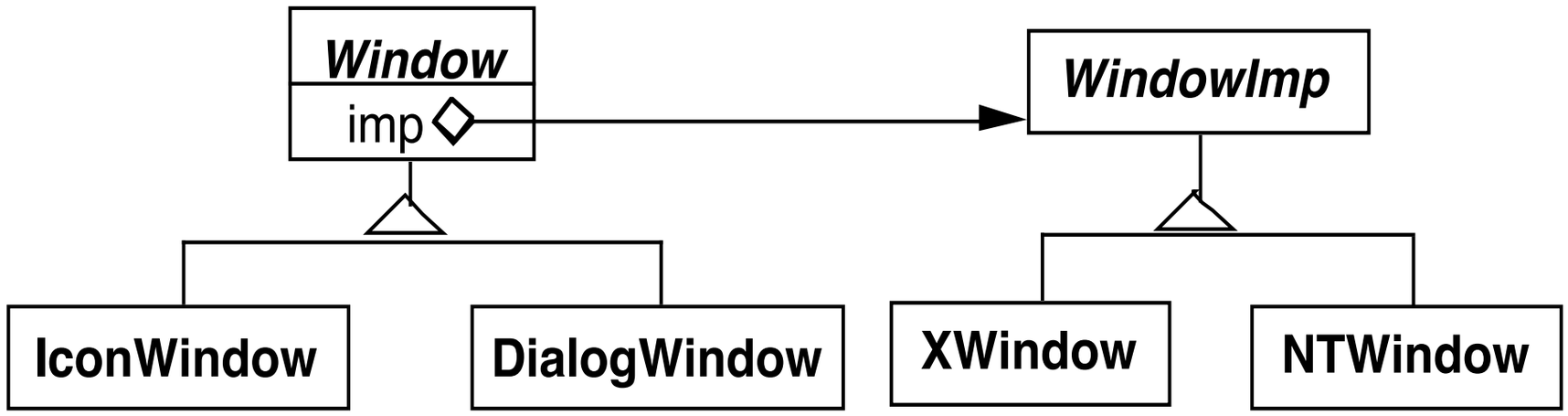
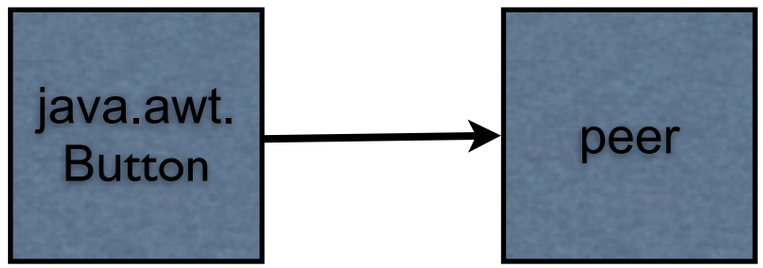
Using the Bridge Pattern



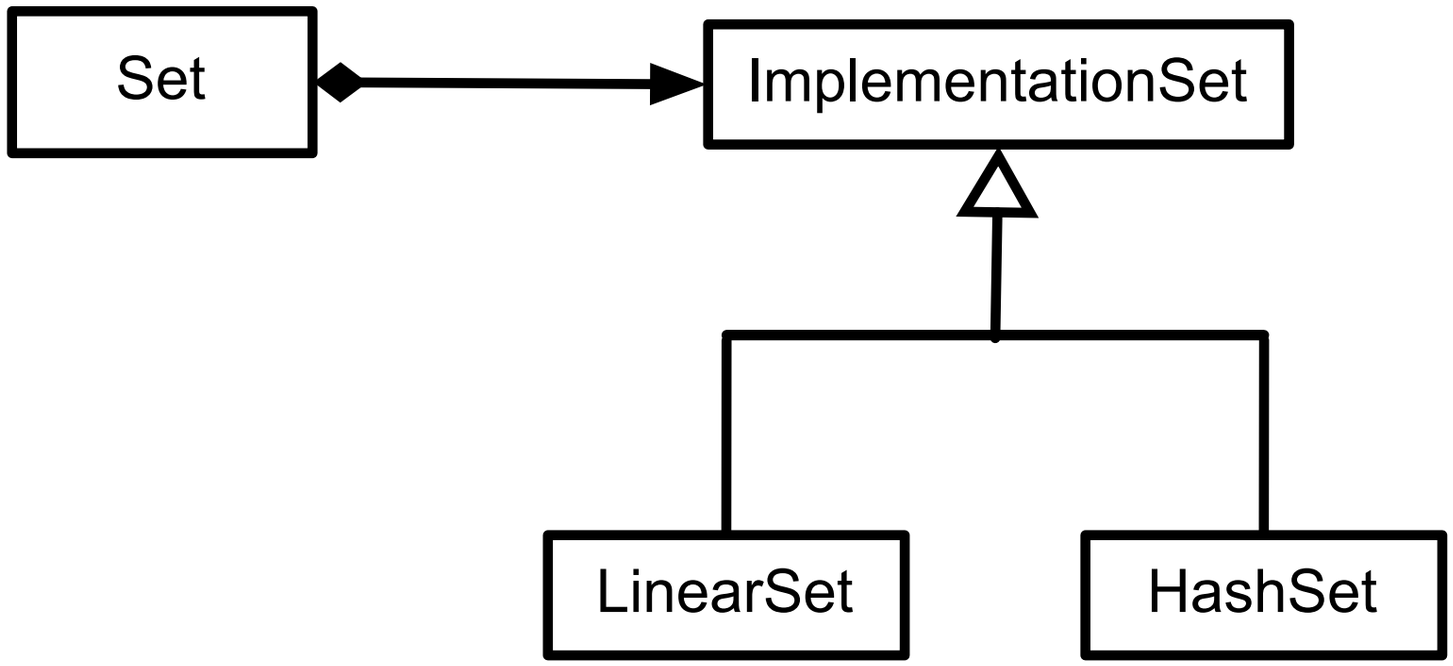
Peers in Java's AWT



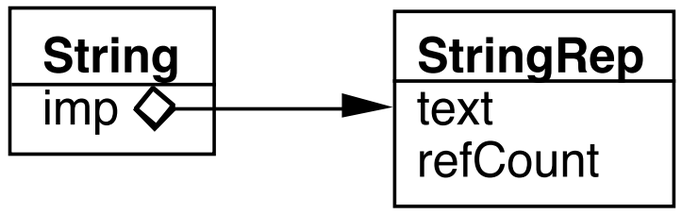
Peer = implementation

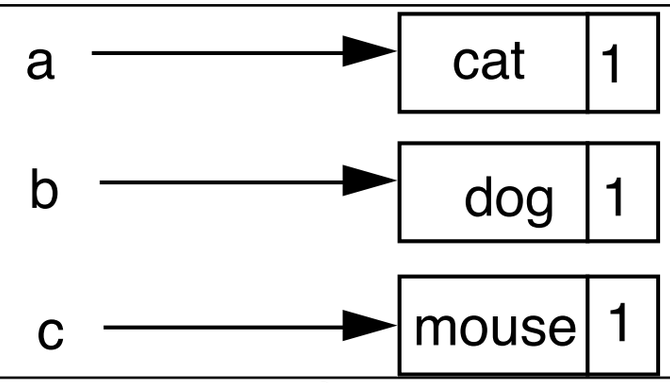
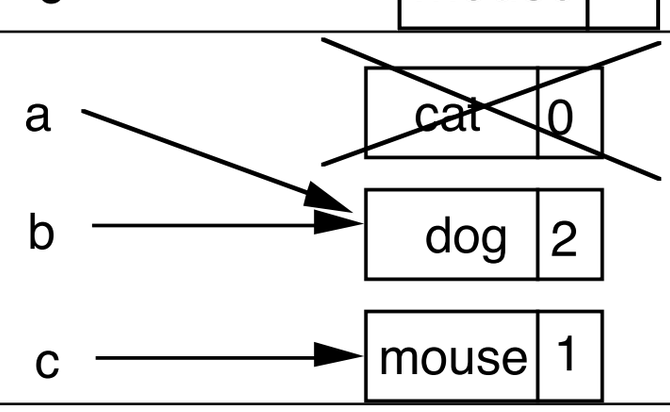
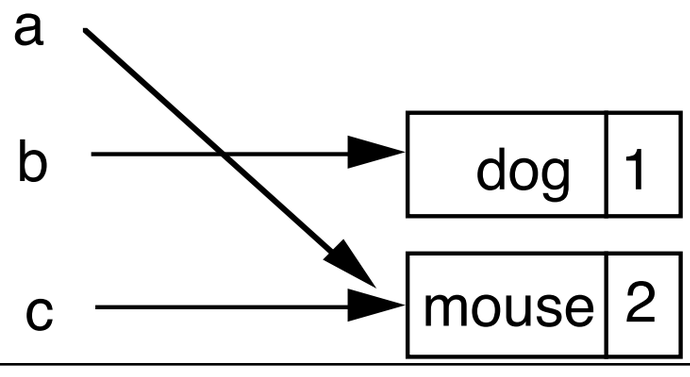
```
public synchronized void setCursor(Cursor
cursor) {
        this.cursor = cursor;
        ComponentPeer peer = this.peer;
        if (peer != null) {
            peer.setCursor(cursor);
        }
}
```

IBM Smalltalk Collections



Smart Pointers in C++



String a(“cat”); String b(“dog”); String c(“mouse”);	
a = b;	
a = c;	

Coplien's Implementation

```
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 ); }
}
```

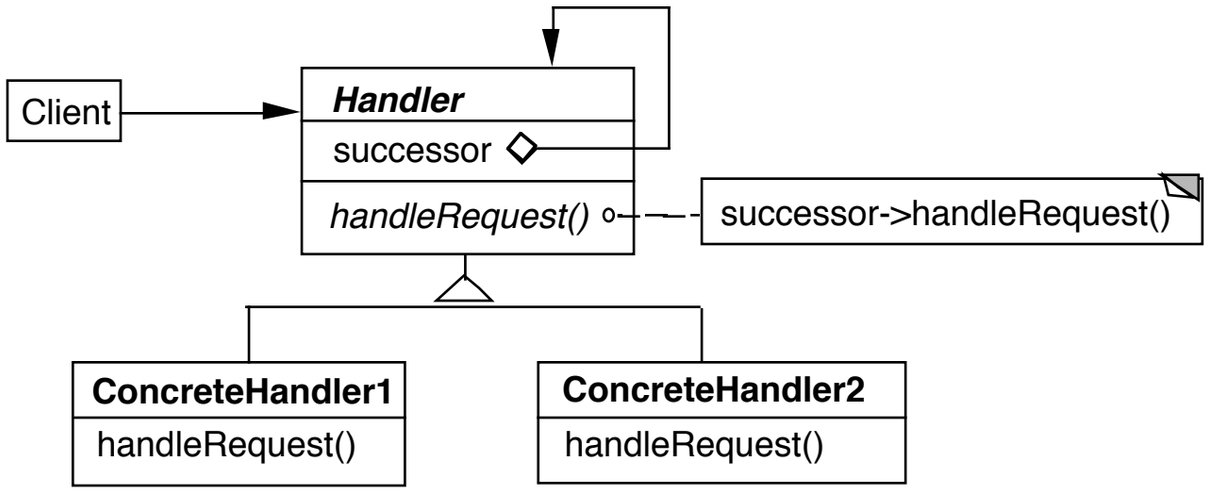
```
class String        {
        friend StringRep
        public:
                String operator+(const String& add) const { return *imp + add; }
                StringRep* operator->() const        { return imp; }
                String()      { (imp = new StringRep()) -> refCount = 1;       }
                String(const char* charStr)    { (imp = new StringRep(charStr)) -> refCount = 1; }
                String operater=( 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;
};
```

Bridge verses Adapter

Bridge verses Decorator

Bridge & Abstract Factory

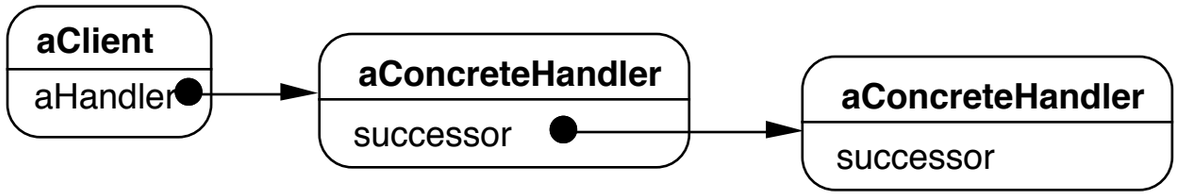
Chain of Responsibility - Composition on steroids



Dynamically create chain of handlers

Multiple handlers may be able to handle a request

Only one handler actually handles the request



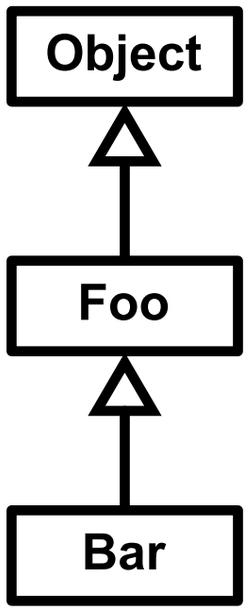
Consequences

Reduced coupling

Added flexibility in assigning responsibilities to objects

Not guaranteed that request will be handled

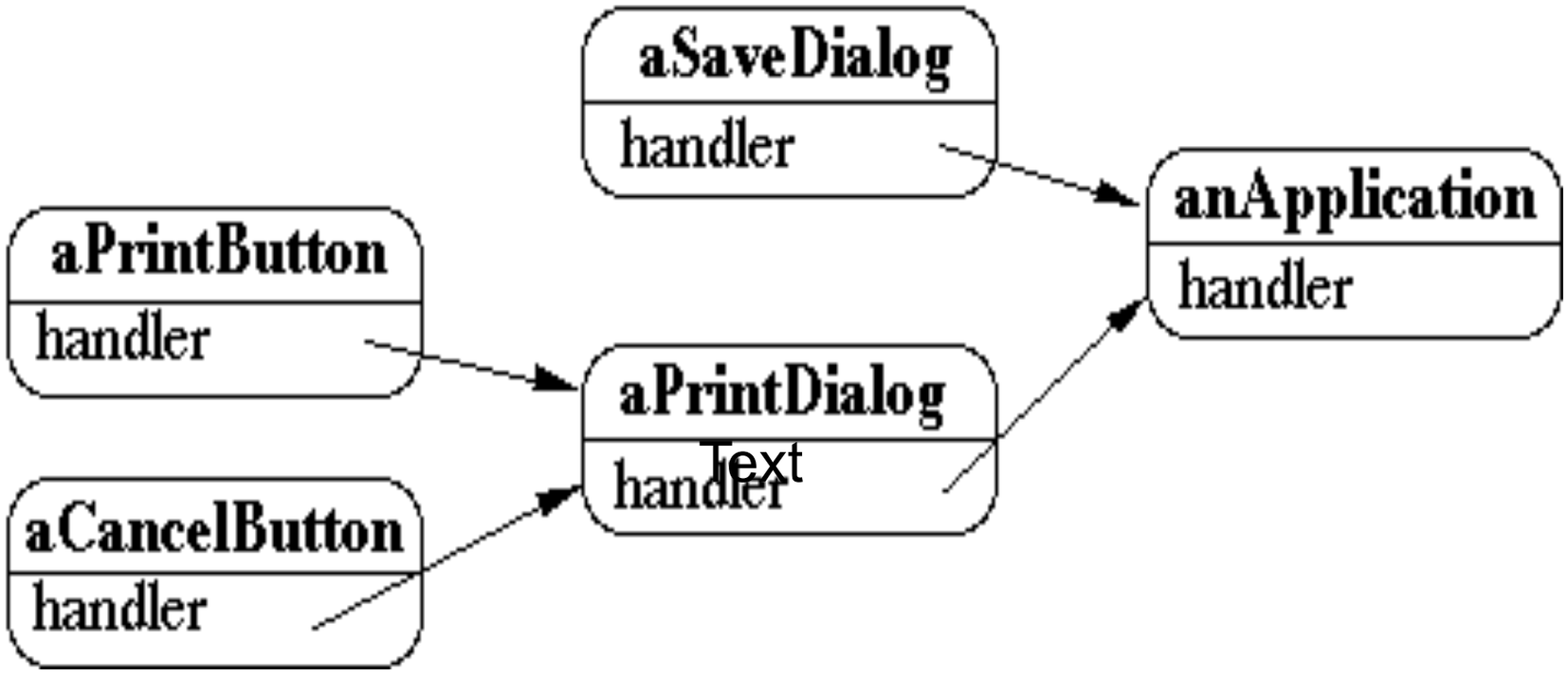
Finding Methods




```
test = new Bar();
test.toString();
```

Context Help System

User clicks on component for help



Tree of handlers

From specific to general

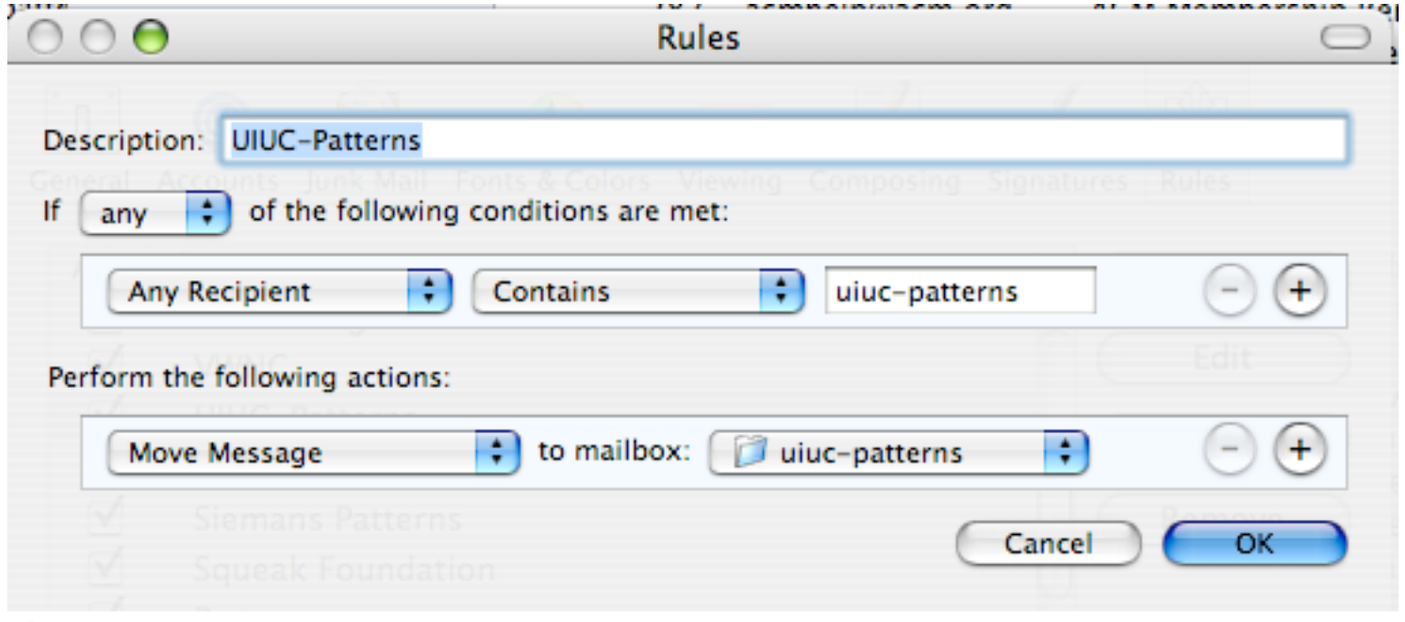
Email Filters in Mail Client

User creates a set of rules

- delete
- move
- modify

Chain the rules

- First rule that applies handles the mail



Other Examples

Java 1.0 AWT action(Event)

http://wiki.cs.uiuc.edu/PatternStories/JavaAWT

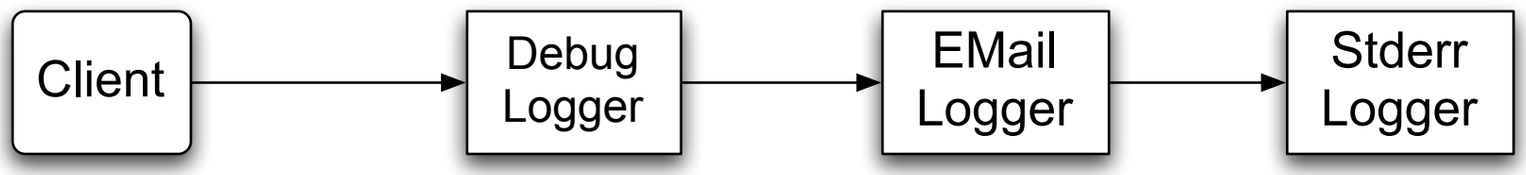
javax.servlet.Filter

http://tomcat.apache.org/tomcat-4.1-doc/servletapi/javax/servlet/Filter.html

Microsoft Windows global keyboard events

http://www.javaworld.com/javaworld/jw-08-2004/jw-0816-chain.html

Logger Example




```
class ChainOfResponsibilityExample {
   public static void main(String[] args) {
       // building the chain of responsibility
       Logger l = new DebugLogger(Logger.DEBUG).setNext(
                  new EMailLogger(Logger.ERR).setNext(
                  new StderrLogger(Logger.NOTICE) ) );

       l.message("Entering function x.", Logger.DEBUG);    // handled by DebugLogger
       l.message("Step1 completed.", Logger.NOTICE);       // handled by Debug- and
StderrLogger
       l.message("An error has occurred.", Logger.ERR);    // handled by all three Logger
   }
}
```

First Attempt

```
abstract class Logger {
   public static int ERR = 3;
   public static int NOTICE = 5;
   public static int DEBUG = 7;
   protected int mask;

   protected Logger next;
   public Logger setNext(Logger l) {
      next = l;
      return this; }

   abstract public void message(String msg, int priority);
}

class DebugLogger extends Logger {
   public DebugLogger(int mask) {
      this.mask = mask; }

   public void message(String msg, int priority) {
      if (priority <= mask) debug log here
      if (next != null) next.message(msg, priority);
   }
}
```

```
class EMailLogger extends Logger {
   public EMailLogger(int mask) { this.mask = mask; }

   public void message(String msg, int priority) {
      if (priority <= mask) send email here;
      if (next != null) next.message(msg, priority);
   }
```

Improved Logger

```
abstract class Logger {
   public static int ERR = 3;
   public static int NOTICE = 5;
   public static int DEBUG = 7;
   protected int mask;

   protected Logger next;
   public Logger setNext(Logger l) {
         next = l;
        return this; }

   public void message(String msg, int priority) {
      if (priority <= mask) log(msg);
      if (next != null) next.message(msg, priority);
   }

   abstract void log(String message);
}

class StderrLogger extends Logger {
   public StderrLogger(int mask) { this.mask = mask; }

   void message(String msg, int priority) { send to err}
}
```

```
class EMailLogger extends Logger {
   public EMailLogger(int mask) { this.mask = mask; }

    void message(String msg, int priority) { email here}
   }
}

class DebugLogger extends Logger {
   public DebugLogger(int mask) { this.mask = mask; }

   void message(String msg, int priority) { debug stuff}
   }
}
```

Is this the Chain of Responsibility?

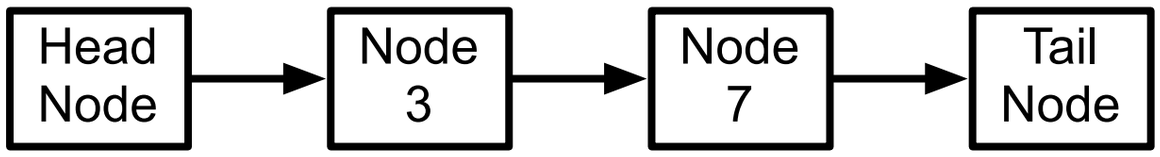
Object-Oriented Recursion

A method polymorphically sends its message to a different receiver

Eventually a method is called that performs the task

The recursion then unwinds back to the original message send

Linked List toString



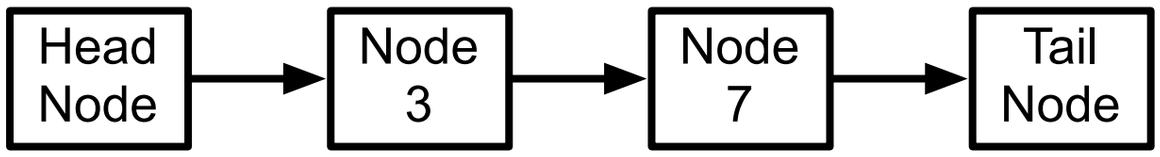
(3 7)

```
class HeadNode {
        public String toString() {
                return "(" + next.toString();
        }
}
```

```
class TailNode {
        public String toString() {
                return " )";
        }
}
```

```
class Node {
        public String toString() {
                return " " + element + next.toString();
        }
}
```

Linked List add




```
class HeadNode {
        public void add(int value) {
                next.add(value);
        }
}
```

```
class TailNode {
        public void add(int value) {
                prependNode(value);
        }
}
```

```
class Node {
        public void add(int value) {
                if (element > value)
                        prependNode(value);
                else
                        next.add(value);
        }
}
```

OO Recursion

Decorator

Chain of Responsibility

Architectural Patterns

Specify basic structure of an application

Pipes & Filters

ls | grep -i b | wc -l

Context

Processing data streams

Problem

Building a system that processes or transforms a stream of data

Forces

Small processing steps are easier to reuse than large components

Non-adjacent processing steps do not share information

System changes should be possible by exchanging or recombining processing steps, even by users

Final results should be presented or stored in different ways

Solution

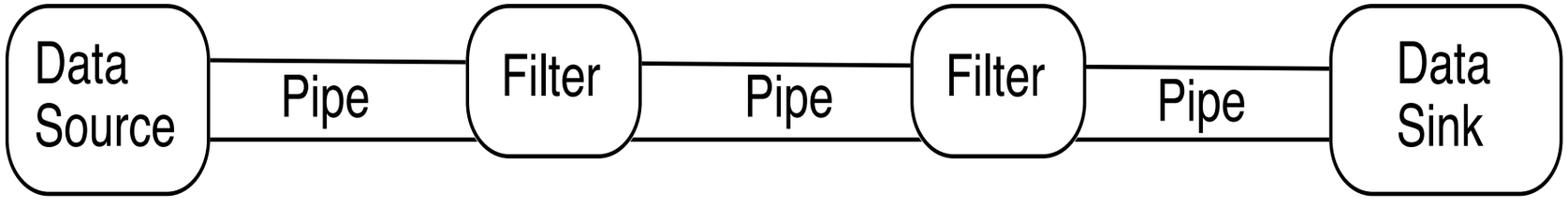
Divide task into multiple sequential processing steps or filter components

Output of one filter is the input of the next filter

Filters process data incrementally

Filter does not wait to get all the data before processing

Solution Continued



Data source – input to the system

Data sink – output of the system

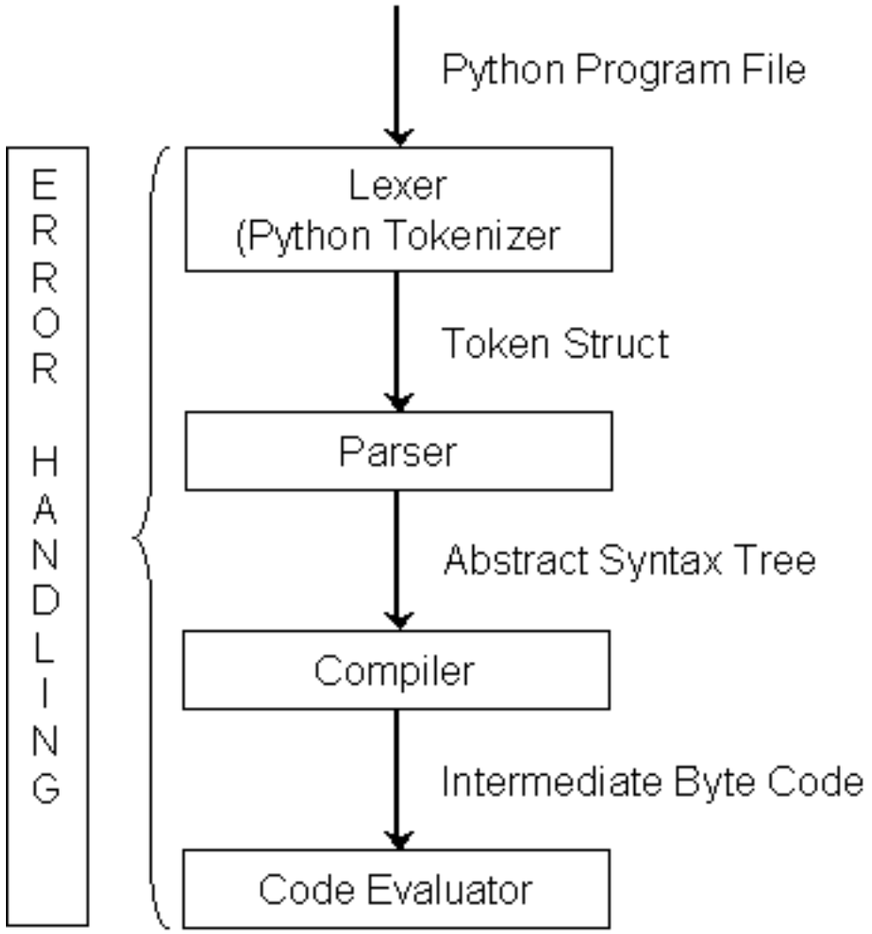
Pipes - connect the data source, filters and data sink

Pipe implements the data flow between adjacent processes steps

Processing pipeline – sequence of filters and pipes

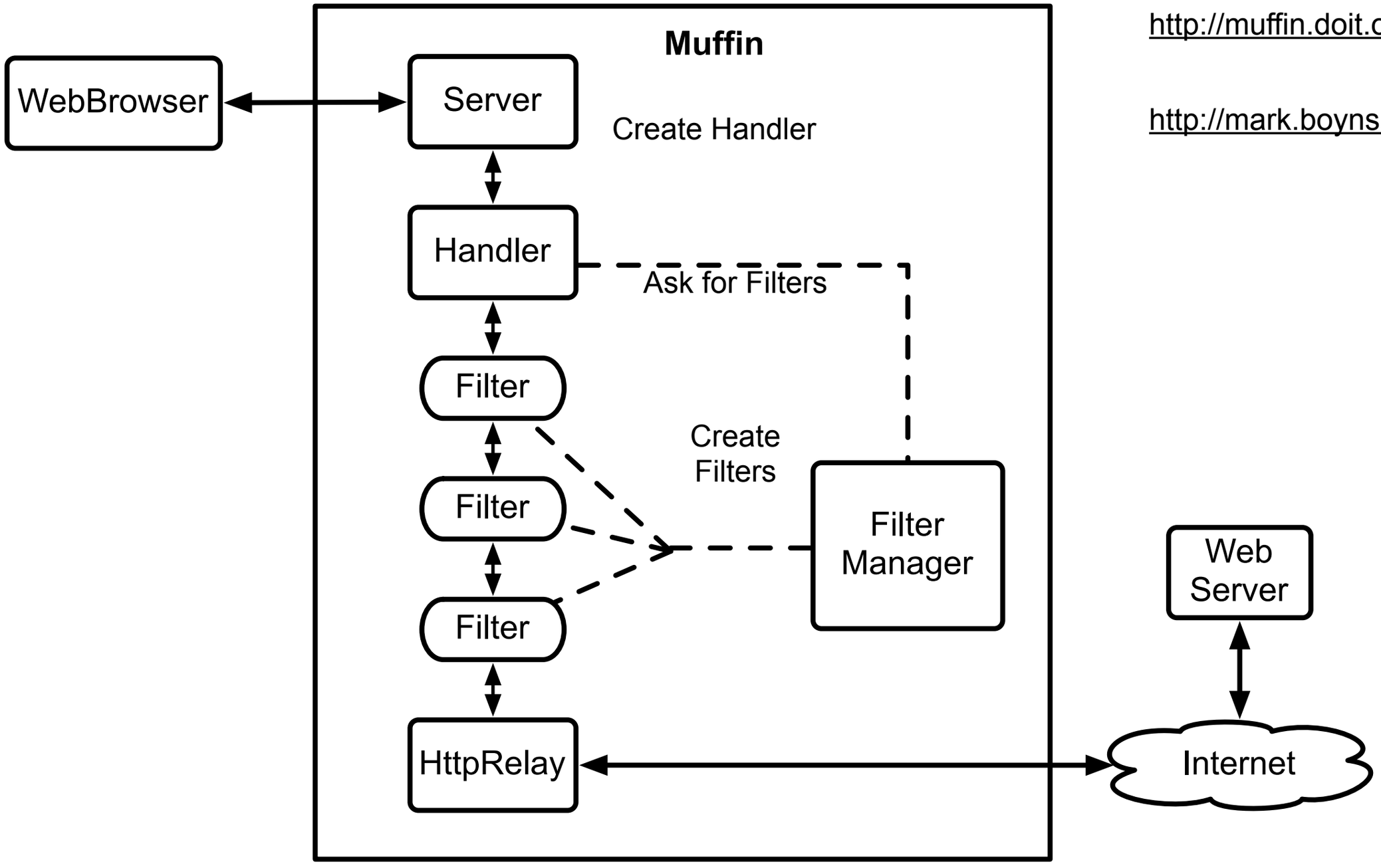
Pipeline can process batches of data

Python Interpreter



http://wiki.cs.uiuc.edu/cs427/Python+-+Batch+Sequential

Muffin - Client Side Http Filter



http://muffin.doit.org/

http://mark.boyns.org/

Intercepting Filter - Problem

Preprocessing and post-processing of a client Web request and response

A Web request often must pass several tests prior to the main processing

- Has the client been authenticated?
- Does the client have a valid session?
- Is the client's IP address from a trusted network?
- Does the request path violate any constraints?
- What encoding does the client use to send the data?
- Do we support the browser type of the client?

Nested if statements lead to fragile code

Intercepting Filter - Forces

Common processing, such as checking the data-encoding scheme or logging information about each request, completes per request.

Centralization of common logic is desired.

Services should be easy to add or remove unobtrusively without affecting existing components, so that they can be used in a variety of combinations, such as

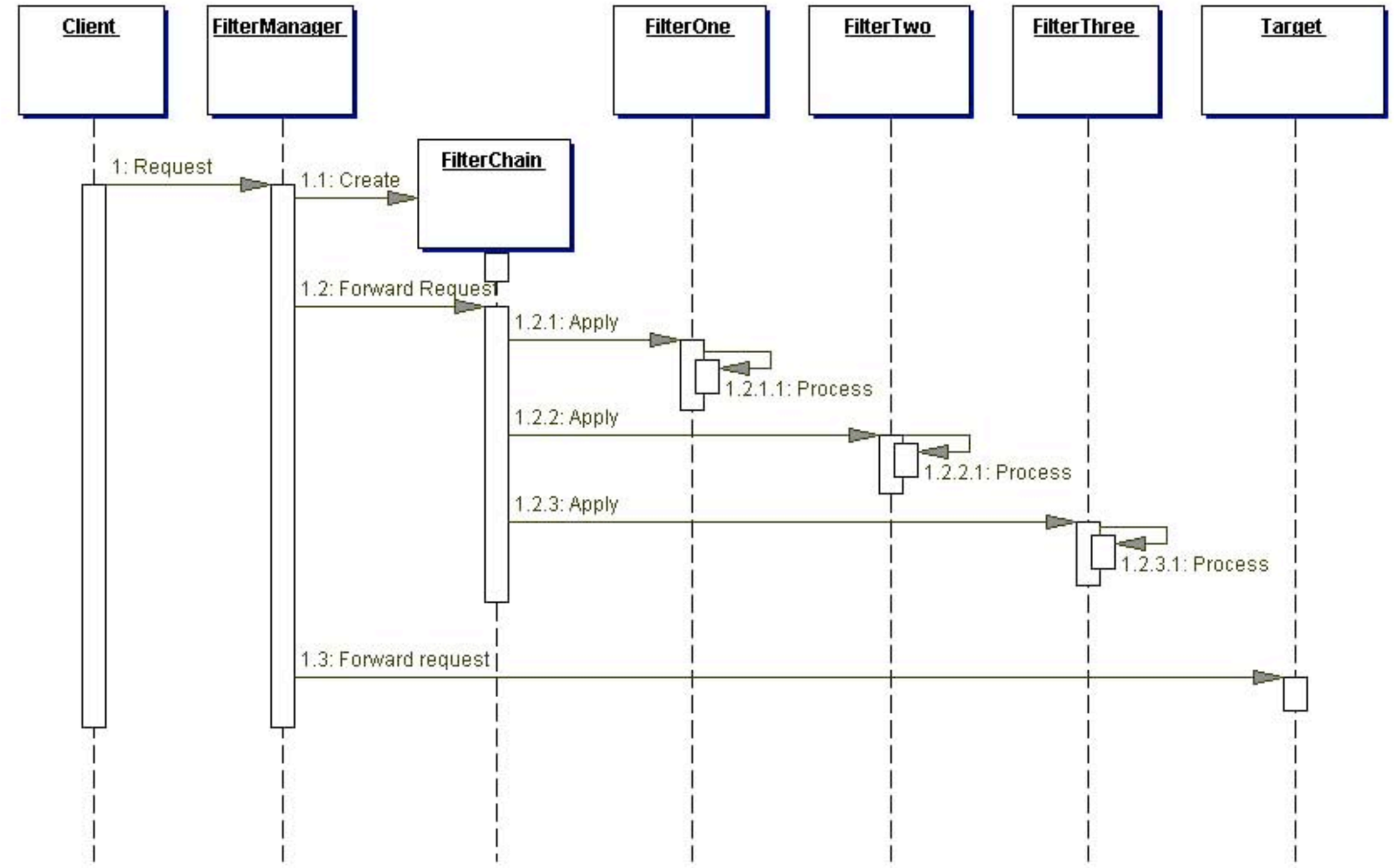
Logging and authentication

Debugging and transformation of output for a specific client

Uncompressing and converting encoding scheme of input

Intercepting Filter - Solution

Create pluggable filters to process common services



http://java.sun.com/blueprints/corej2eepatterns/Patterns/InterceptingFilter.html