CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2016
Doc 7 Decorator, Pipes, Visitor
Feb 11, 2015

Decorator

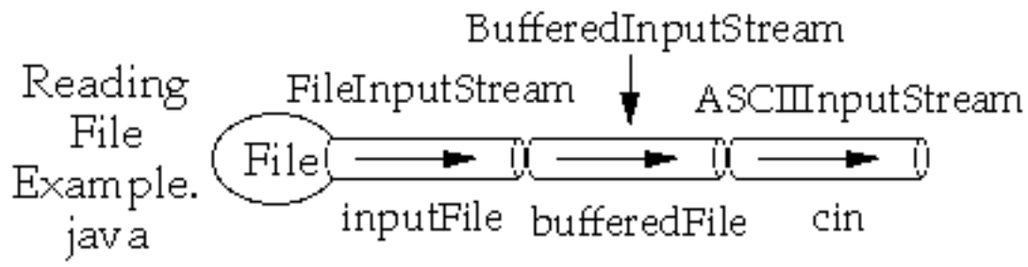
Prime Directive

Data + Operations

Decorator Pattern

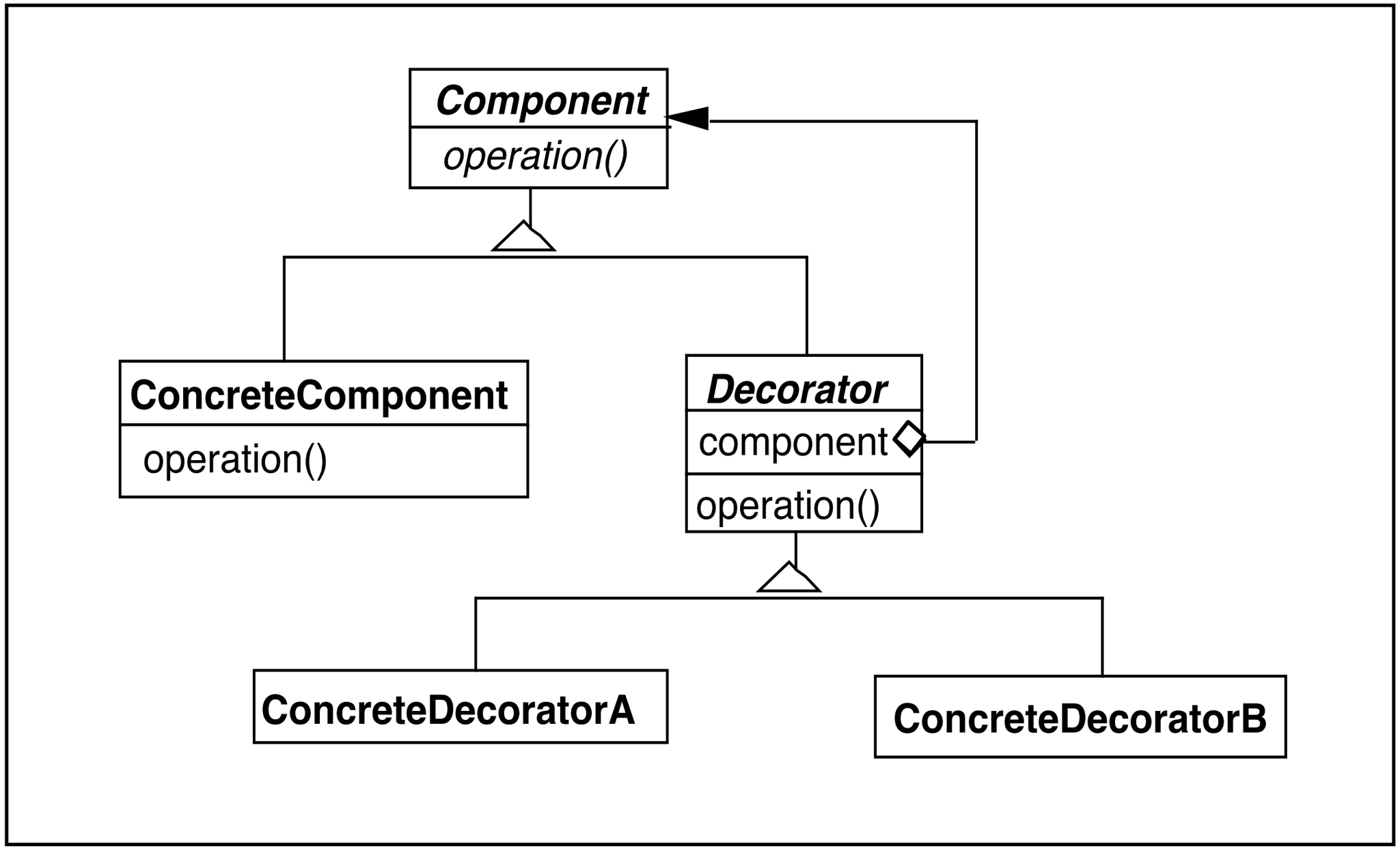
Adds responsibilities to individual objects

Dynamically
Transparently



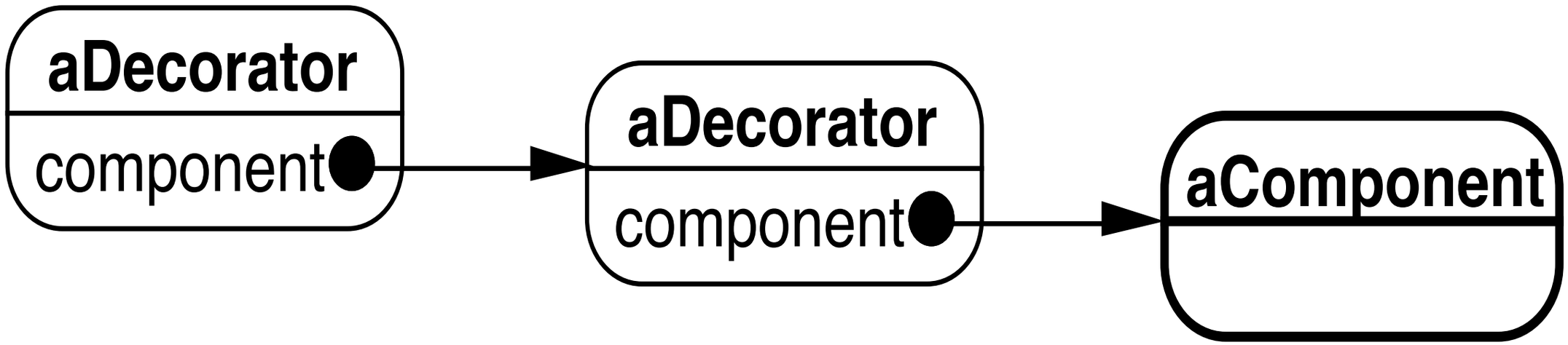

```
import java.io.*;
import sdsu.io.*;
class  ReadingFileExample
     {
     public  static  void  main( String  args[]  ) throws Exception
          {
          FileInputStream inputFile;
          BufferedInputStream bufferedFile;
          ASCIIInputStream  cin;

          inputFile = new FileInputStream( "ReadingFileExample.java" );
          bufferedFile = new BufferedInputStream( inputFile );
          cin = new ASCIIInputStream( bufferedFile );
```


Component
operation()
ConcreteComponent
operation()
Decorator
component
operation()
ConcreteDecoratorA
ConcreteDecoratorB

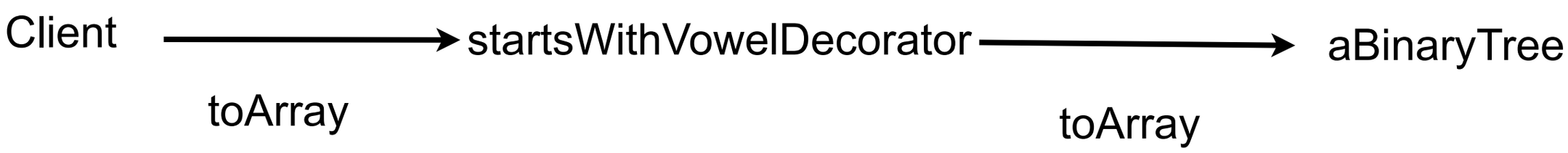

POLICE LINE DO NOT CROSS

Decorator forwards all component operations



Favor Composition over Inheritance

Refactoring: Move Embellishment to Decorator



Benefits & Liabilities

Benefits

Simplifies a class
Distinguishes a classes core responsibilities from embellishments

Liabilities

Changes the object identity of a decorated object
Code harder to understand and debug
Combinations of decorators may not work correctly together

Clojure Threading Macro

```
(-> "a b c d"
    .toUpperCase
    (.replace "A" "X")
    (.split " ")
    first)
```

```
(.toUpperCase "a b c d")
(.replace "A B C D"  "A" "X")
(.split "X B C D"  " ")
(first {"X", "B", "C", "D"} )
```

```
(first (.split (.replace (.toUpperCase “a b c d”) “A” “X”) “ “))
```


From Clojure Docs

Pipes and Filters

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

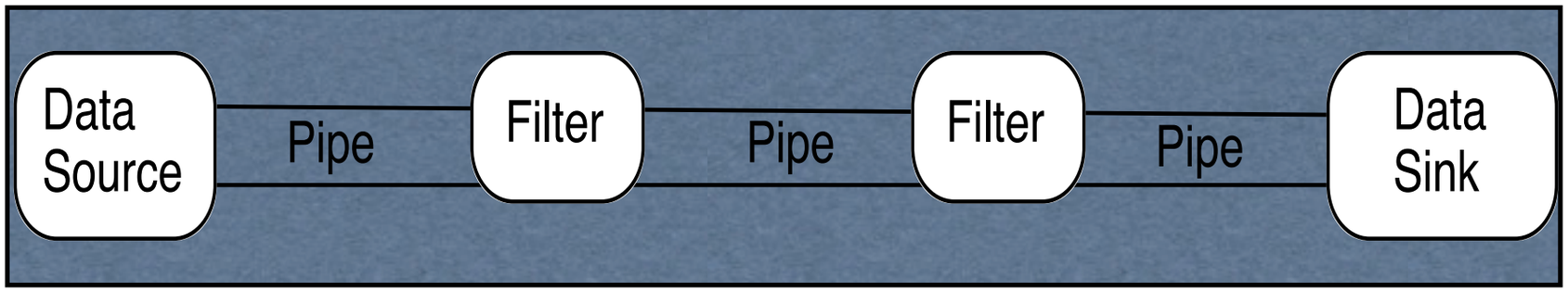
Divide task into multiple sequential processing steps or filter components

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

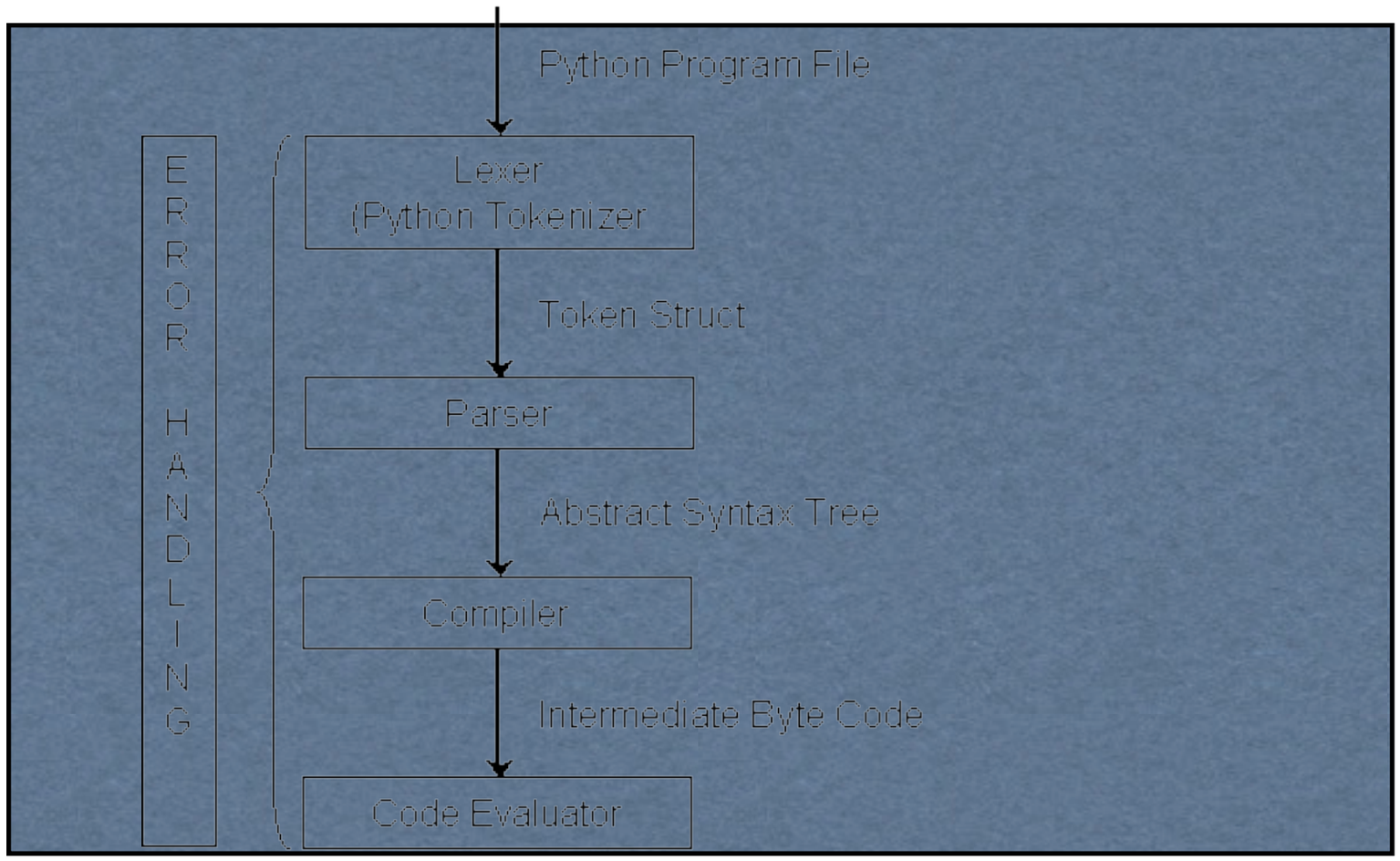
Pipes - connect the data source, filters and data sink

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

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

Visitor Pattern

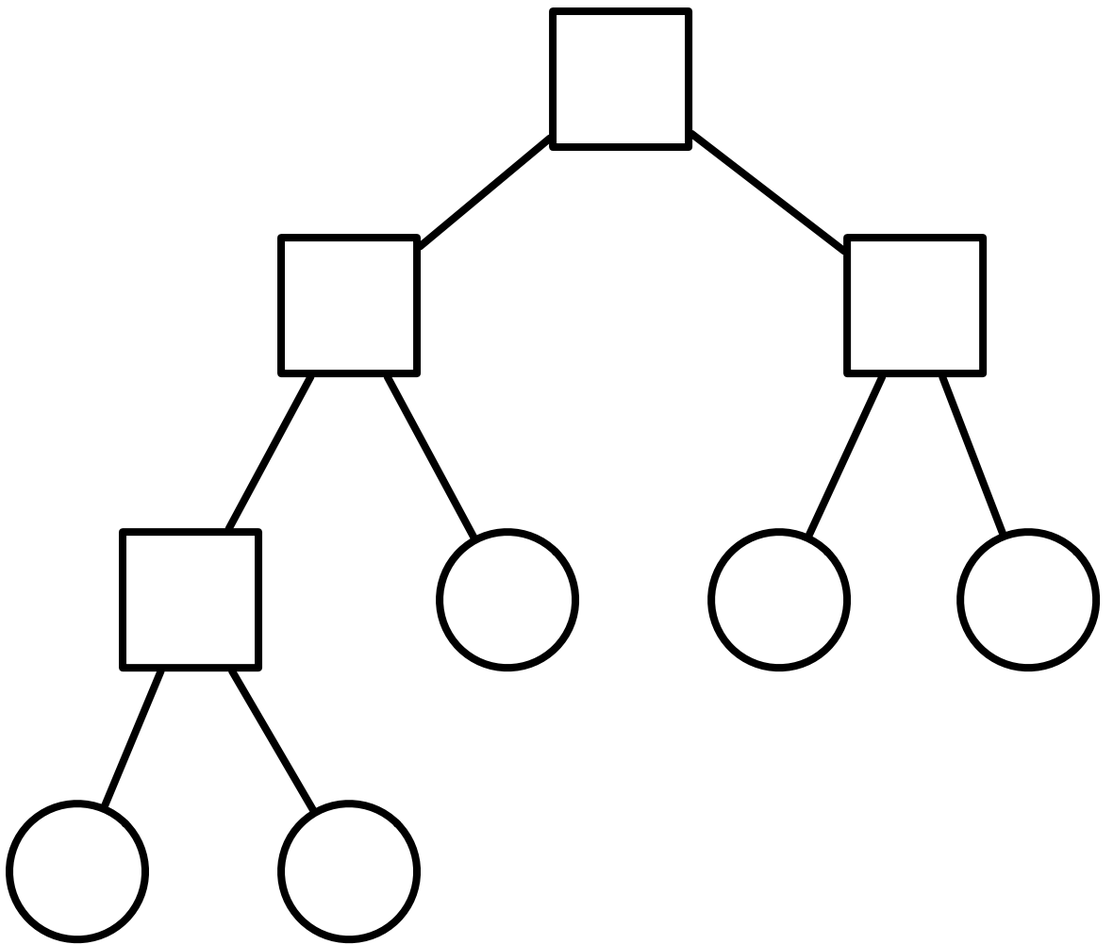
Visitor

Intent

Represent an operation to be performed on the elements of an object structure

Visitor lets you define a new operation without changing the classes of the elements on which it operates

Tree Example



```
class Node { ... }

class InnerNode extends Node {...}

class LeafNode extends Node {...}

class Tree { ... }
```

Tree Printing

HTML Print

PDF Print

TeX Print

RTF Print

Others likely in future

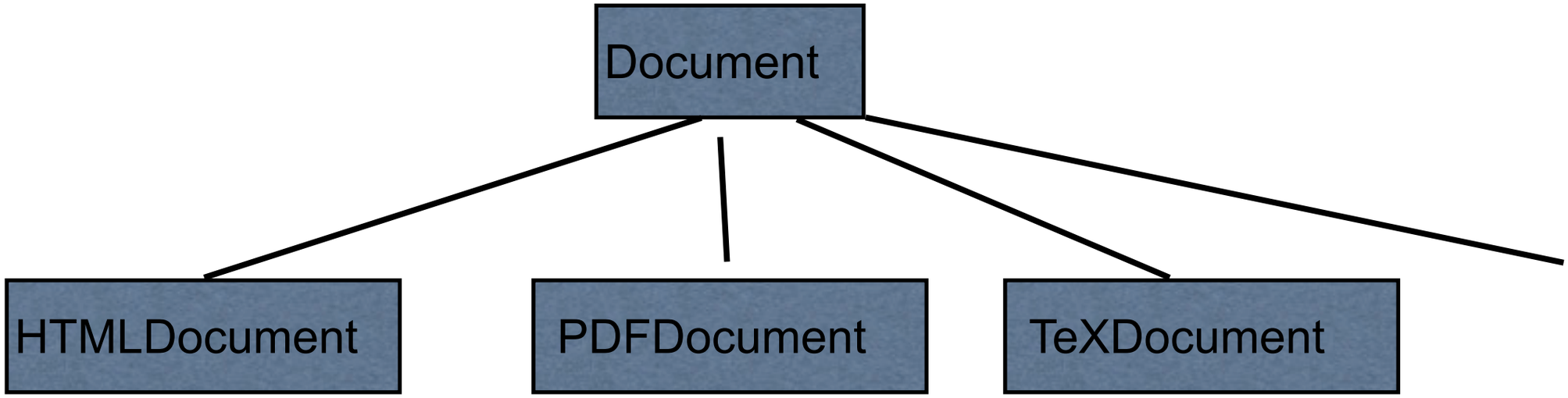
Operations are complex

Do different things on different types of nodes

Need to traverse tree

Not part of BST abstraction

Assume



First Attempt

```
print(Tree source, Document output) {
    foreach( Node current : source ) {
        if current.isInnerNode() && output.isHtml() {
            print inner node on html document
        } else if current.isLeafNode() && output.isHtml() {
            print leaf node on html document
        } else if current.isInnerNode() && output.isPDF() {
            print inner node on pdf document
        } else if current.isLeafNode() && output.isPDF() {
            print leaf node on pdf document
        } etc.
```

Second Attempt

Create Printer Classes

Use iterator to access all elements

Process each element

Second Attempt

```
class TreePrinter {
    public void printTree (Tree toPrint, Document output) {
        foreach( Node current : source ) {
            if (current.isLeafNode())
                printLeafNode(current, output);
            else if (current.isInternalNode() )
                printInternalNode(current, output);
        }
    }


    private void printLeafNode(Node current, Document output) {
        if output.isHtml()
            print leaf node on html document
        else if output.isPDF()
            print leaf node on PDF document
        else if etc
    }
```

Hidden case statements

What we would like

```
class TreePrinter {
    public void printTree (Tree source, Document output) {
        foreach( Node current : source ) {
                printNode(current, output);
        }
    }

    private void printNode(InnerNode current, HTMLDocument output) {
        print inner node on html document
    }

    private void printNode(LeafNode current, HTMLDocument output) {
        print leaf node on html document
    }

    private void printNode(InnerNode current, PDFDocument output) {
        print inner node on html document
    }
    etc
```

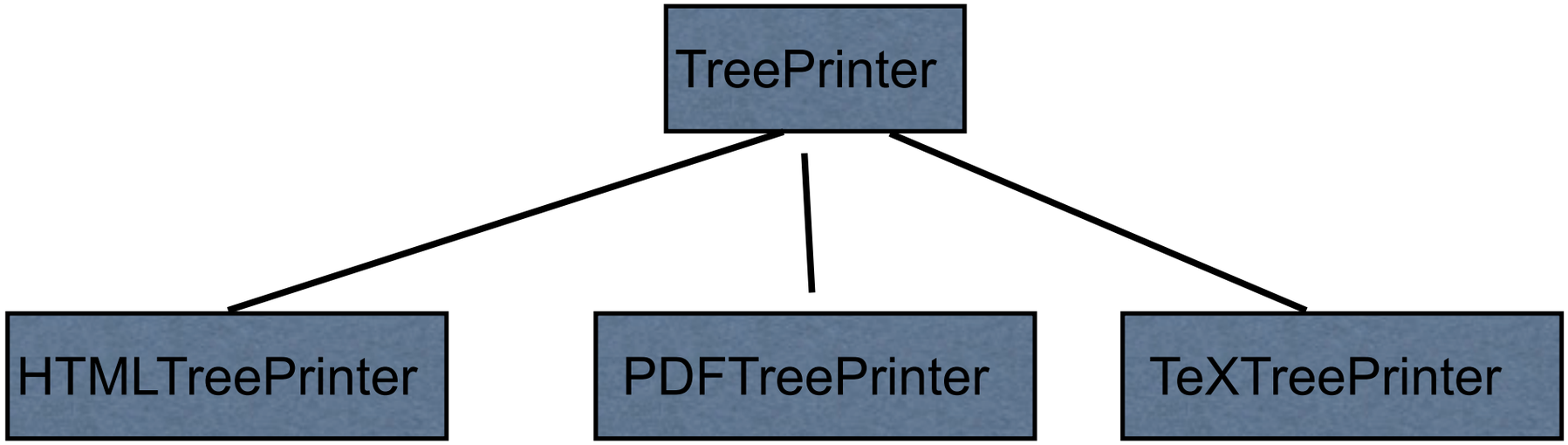
Compile Error

Overloaded Methods

Which overloaded method to run

- Selected at compile time
- Based on declared type of parameter
- Does not use runtime information

Use Subclasses



Third Attempt

```
class TreePrinter {
    Document output;
    public void printTree (Tree toPrint) {
        foreach( Node current : source ) {
            if (current.isLeafNode())
                printLeafNode(current, output);
            else if (current.isInternalNode() )
                printInternalNode(current, output);
        }
    }

    public Document getDocument() { return output;}

    private abstract void printLeafNode(Node current);
    private abstract void printInnerNode(Node current);

}
```

Third Attempt

```
class HTMLTreePrinter extends TreePrinter {

    private void printLeafNode(Node current) {
            print leaf node on html document
    }

    private void printInnerNode(Node current) {
            print inner node on html document
    }
}
```

Overloaded Method

```
class TreePrinter {
    Document output;
    public void printTree (Tree toPrint) {
        foreach( Node current : source ) {
            printNode(current);
        }
    }

    public Document getDocument() { return output;}

    private abstract void printNode(LeafNode current);
    private abstract void printNode(InnerNode current);
    }
```

Compile Error

Key Idea

Receiver of method is determined at runtime

```
x.toString();
```

Send a message to Nodes to determine what type of node we have

Add Methods to Nodes

```
class Node {
    abstract public void print(TreePrinter printer);
}


class InnerNode extends Node {
    public void print(TreePrinter printer) {
        printer.printInnerNode( this );
    }
}

class LeafNode extends Node {
    public void print(TreePrinter printer) {
        printer.printLeafNode( this );
    }
}
```

Now we can Use Polymorphism

```
class TreePrinter {
    Document output;
    public void printTree (Tree toPrint) {
        foreach( Node current : source ) {
                current.print(this);
        }
    }

    public Document getDocument() { return output;}

    public abstract void printLeafNode(Node current);
    public abstract void printInnerNode(Node current);

    }
```

What Have we gained

No if statements

Can add more types of Documents by adding subclasses

Work for a Document is in one place

Divided work into small parts

We can use method overloading

```
class TreePrinter {
    Document output;
    public void printTree (Tree toPrint) {
        foreach( Node current : source ) {
            current.print(this);
        }
    }

    public Document getDocument() { return output;}

    public abstract void printNode(InnerNode current);
    public abstract void printNode(LeafNode current);

    }
```

```
class InnerNode extends Node {
    public void print(TreePrinter printer)
{
        printer.printNode( this );
    }
}

class LeafNode extends Node {
    public void print(TreePrinter printer)
{
        aVisitor.printNode( this );
    }
}
```

But We don’t gain anything

```
class TreePrinter {
    Document output;
    public void printTree (Tree toPrint) {
        foreach( Node current : source ) {
            current.print(this);
        }
    }

    public Document getDocument() { return output;}

    public abstract void printNode(InnerNode current);
    public abstract void printNode(LeafNode current);

    }
```

Still need to know about each node type

One Last Problem

Modified the nodes for a specific issue

For each issue need to add methods to node!?!

Make the structure generic

In The Nodes

```
class Node {
    abstract public void accept(Visitor aVisitor);
}


class BinaryTreeNode extends Node {
    public void accept(Visitor aVisitor) {
        aVisitor.visitBinaryTreeNode( this );
    }
}

class BinaryTreeLeaf extends Node {
    public void accept(Visitor aVisitor) {
        aVisitor.visitBinaryTreeLeaf( this );
    }
}
```

Visitor

```
abstract class Visitor {

    abstract void visitBinaryTreeNode( BinaryTreeNode );

    abstract void visitBinaryTreeLeaf( BinaryTreeLeaf );
}

class HTMLPrintVisitor extends Visitor {

    public void visitBinaryTreeNode( BinaryTreeNode x ) {
        HTML print code here
    }

    public void visitBinaryTreeLeaf( BinaryTreeLeaf x){ ...}
}
```

```
Visitor printer = new HTMLPrintVisitor();
Tree toPrint;

Iterator nodes = toPrint.iterator();
foreach( Node current : source ) {
    current.accept(printer);
}
```

Node object calls correct method in Printer

Tree Example

```
class BinaryTreeNode extends Node {
        public void accept(Visitor aVisitor) {
                aVisitor.visitBinaryTreeNode( this );
        }
}

class BinaryTreeLeaf extends Node {
        public void accept(Visitor aVisitor) {
                aVisitor.visitBinaryTreeLeaf( this );
        }
}

abstract class Visitor {
        abstract void visitBinaryTreeNode( BinaryTreeNode );
        abstract void visitBinaryTreeLeaf( BinaryTreeLeaf );
}

class HTMLPrintVisitor extends Visitor {
        public void visitBinaryTreeNode( BinaryTreeNode x ) {
                HTML print code here
        }
        public void visitBinaryTreeLeaf( BinaryTreeLeaf x){ ...}
}
```

Put operations into separate object - a visitor

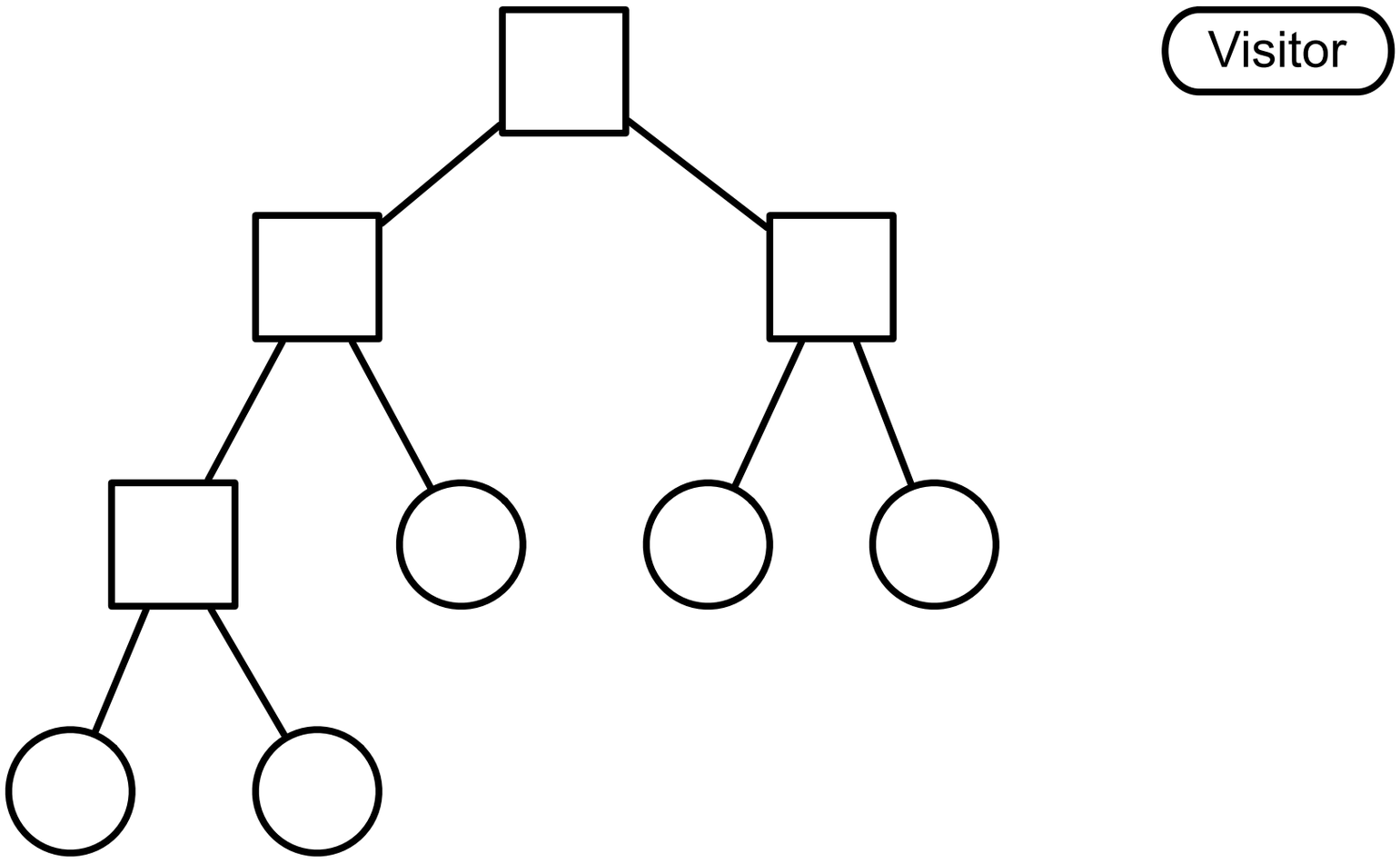
Pass the visitor to each element in the structure

The element then activates the visitor

Visitor performs its operation on the element

Each visitX method only deals with on type of element

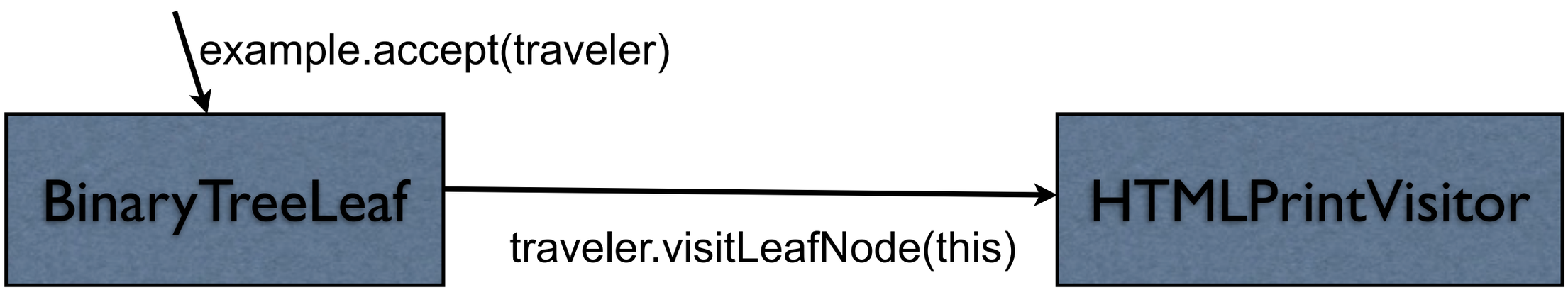
Tree Example



Double Dispatch

Note that a visit to one node requires two method calls

```
Node example = new BinaryTreeLeaf();
Visitor traveler = new HTMLPrintVisitor();
example.accept( traveler );
```



Issue - Who does the traversal?

Visitor

Elements in the Structure

Iterator

When to Use the Visitor

Have many classes of objects with differing interfaces, and you want to perform operations on these objects that depend on their concrete classes

When many distinct and unrelated operations need to be preformed on objects in an object structure and you want to avoid cluttering the classes with these operations

When the classes defining the structure rarely change, but you often want to define new operations over the structure

Consequences

Visitors makes adding new operations easier

Visitors gathers related operations, separates unrelated ones

Adding new ConcreteElement classes is hard

Visiting across class hierarchies

Accumulating state

Breaking encapsulation

Avoiding the accept() method

Visitor pattern requires elements to have an accept method

Sometimes this is not possible

- You don’t have the source for the elements

Aspect Oriented Programming

AspectJ eleminates the need for an accept method in aspect oriented Java

AspectS provides a similar process for Smalltalk

Example - Magritte

Web applications have data (domain models)

We need to

- Display the data
- Enter the data
- Validate data
- Store Data

Magritte

For each field in a domain model (class) provide a description

Description contains

Data type Display string

Field name Constraints

```
descriptionFirstName
    ^ (MAStringDescription auto: 'firstName' label: 'First Name' priority: 20)
            beRequired;
            yourself.

descriptionBirthday
    ^ (MADateDescription auto: 'birthday' label: 'Birthday' priority: 70)
            between:(Date year: 1900) and:Datetoday;
            yourself
```

Magritte

Each domain model has a collection of descriptions

Different visitors are used to

- Generate html to display data
- Generate form to enter the data
- Validate data from form
- Save data in database

Sample Page

```
editor := (Person new  asComponent)
                addValidatedSwitch;
                yourself.
result := self call: editor.
```

Refactoring: Move Accumulation to Visitor

A method accumulates information from heterogenous classes

so

Move the accumulation task to a Visitor that can visit each class to accumulate the information

See Refactoring to Patterns, Kerievsky, 2005, pp 320-338 for details

Clojure, Lisp & Multi-methods

```
(defmulti printNode (fn [node document] [(class node) (class document)]))

(defmethod printNode [InnerNode HTMLDocument]
    [node document]
    code to print InnerNode on HTMLDocument)

(defmethod printNode [InnerNode PDFDocument]
    [node document]
    code to print InnerNode on PDFDocument)

(defmethod printNode [LeafNode PDFDocument]
    [node document]
    code to print InnerNode on PDFDocument)
```

etc.

Clojure, Lisp & Multi-methods

Multi-methods in Clojure do select overloaded method

- At run-time
- Based on argument types

No need for visitor pattern