CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2010
Doc 17 Bridge & Interpreter
March 25, 2010

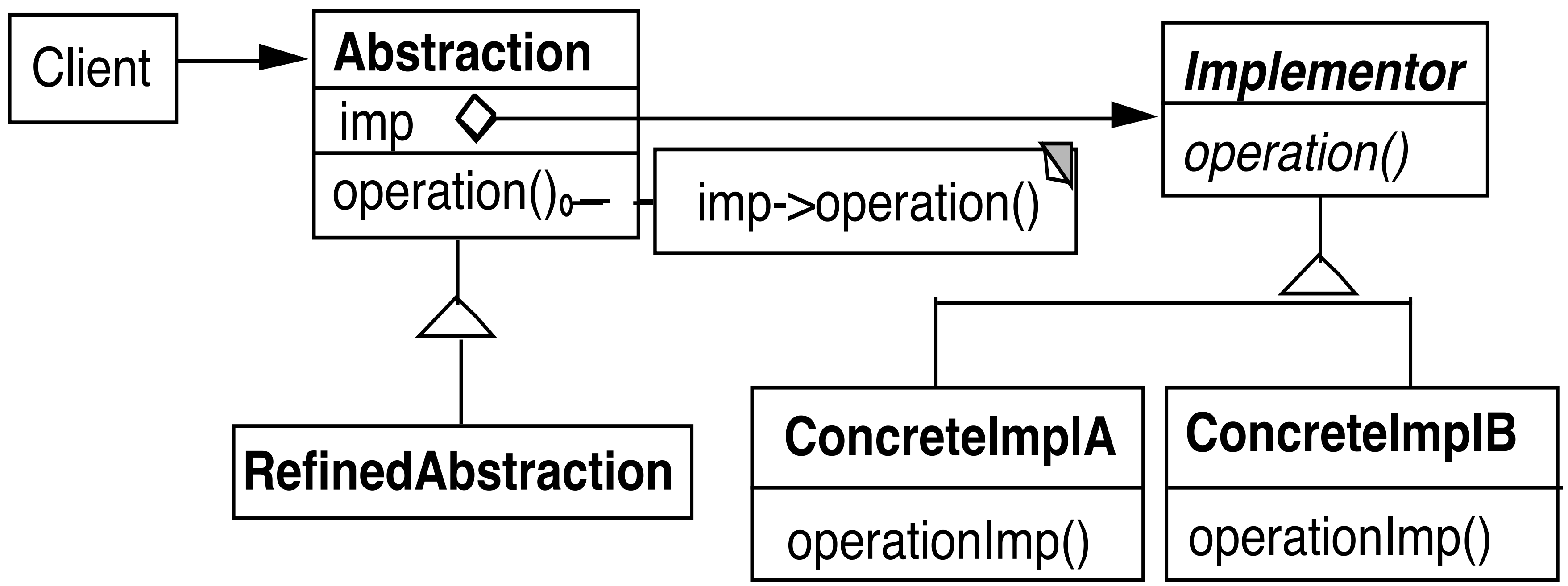
References

Design Patterns: Elements of Reusable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, 1995, pp. 151-162, 243-256

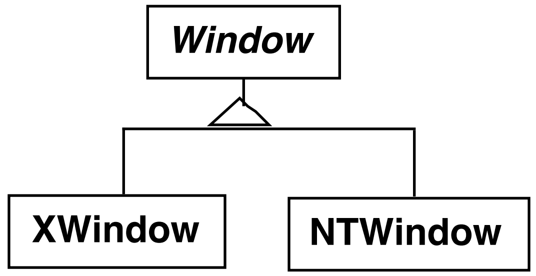
The Design Patterns Smalltalk Companion, Alpert, Brown, Woolf, 1998, 121-136

Bridge

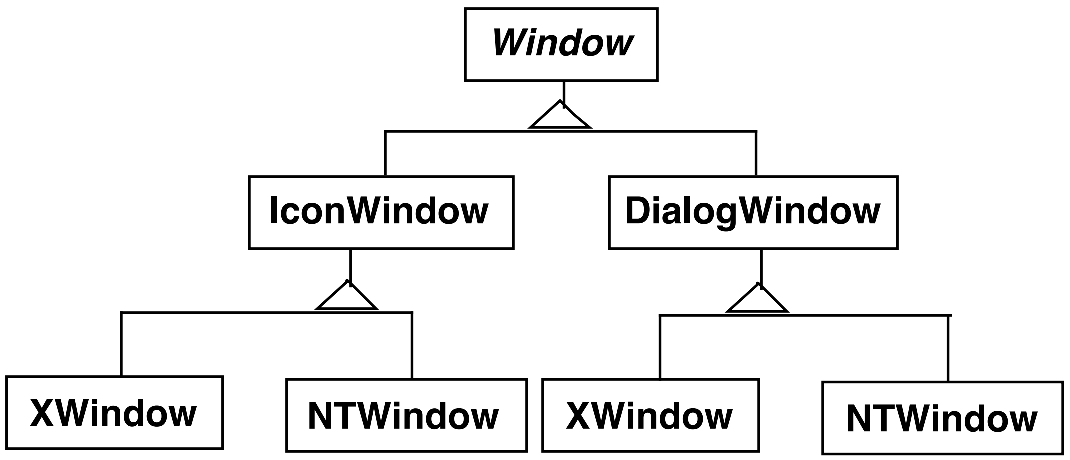
Decouple an abstraction from its implementation



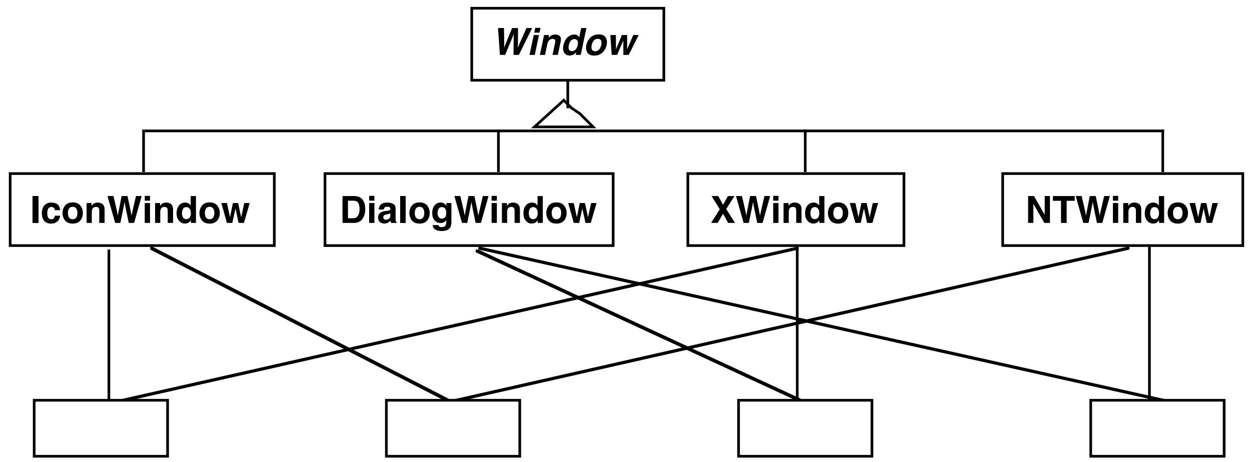
Windows



Window
XWindow
NTWindow

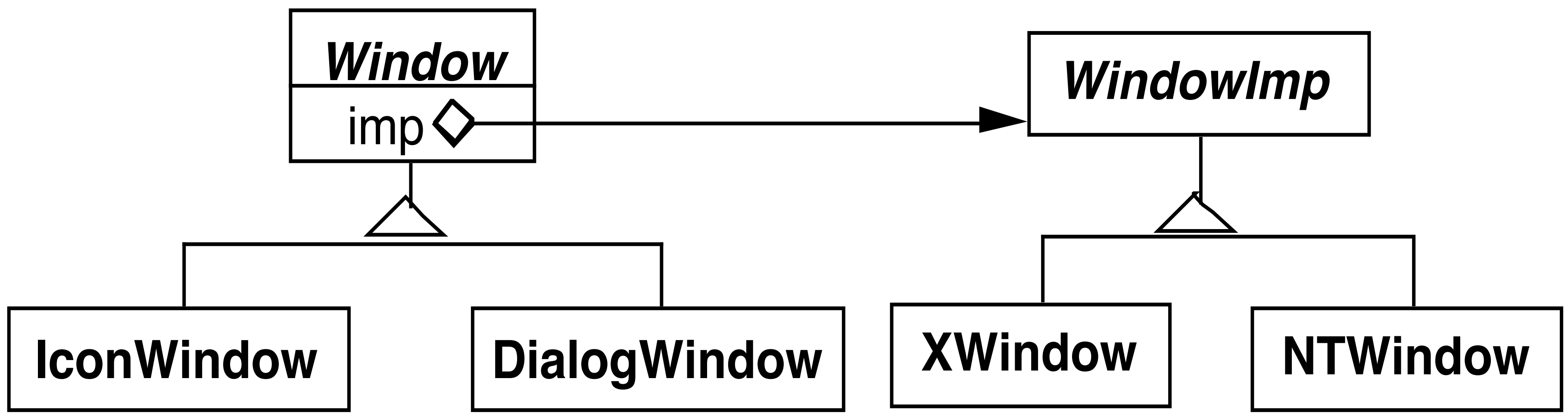


Window
IconWindow
DialogWindow
XWindow
NTWindow
XWindow
NTWindow

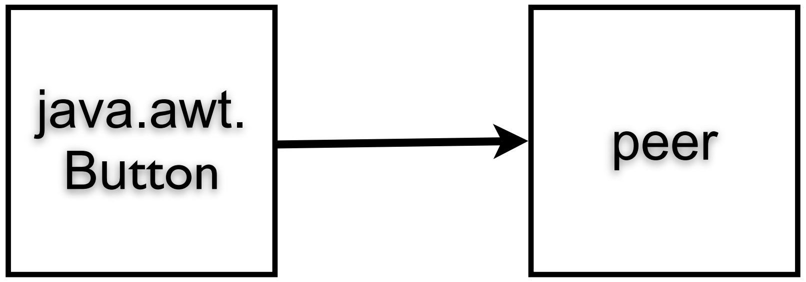


Window
IconWindow
DialogWindow
XWindow
NTWindow

Using the Bridge Pattern



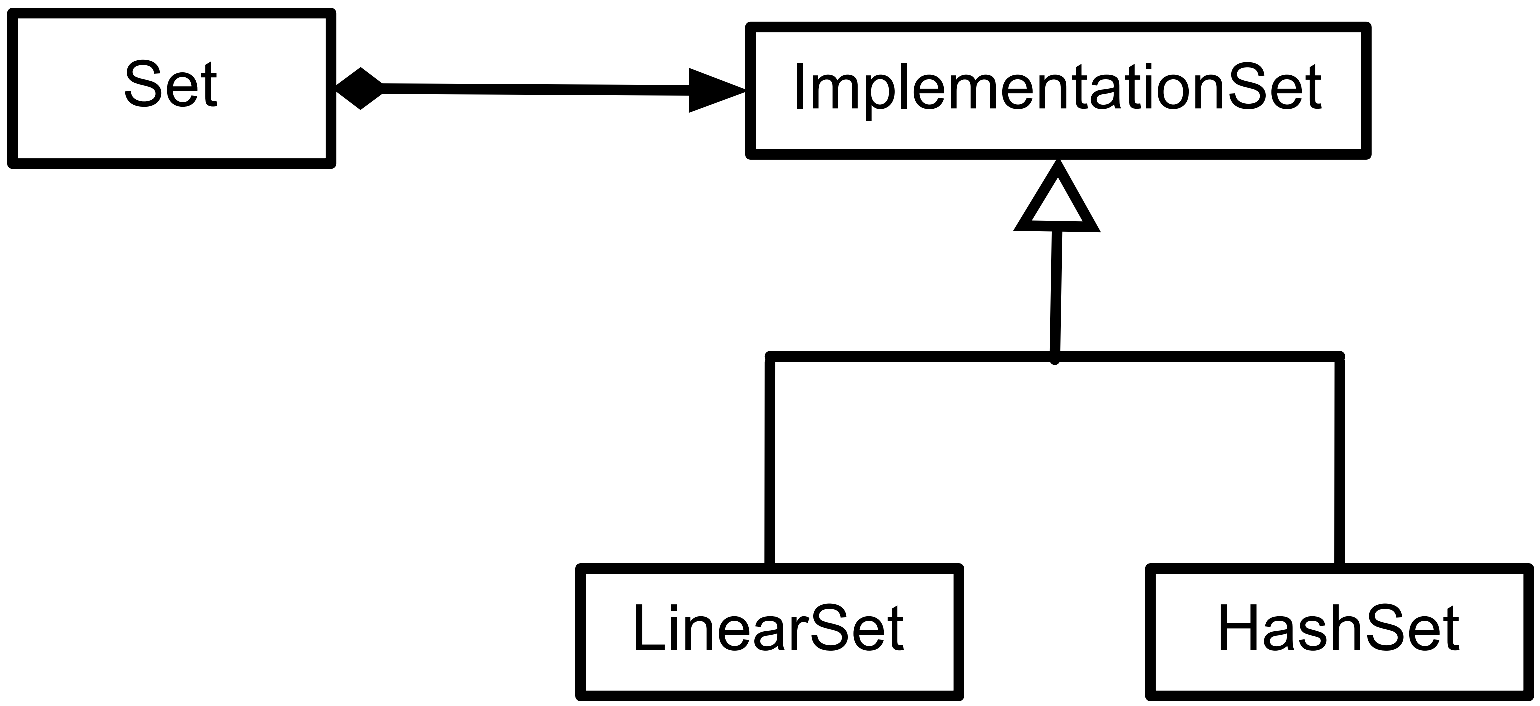
Peers in Java's AWT



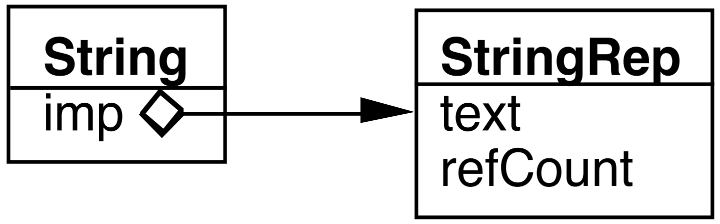
Peer = implementation

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

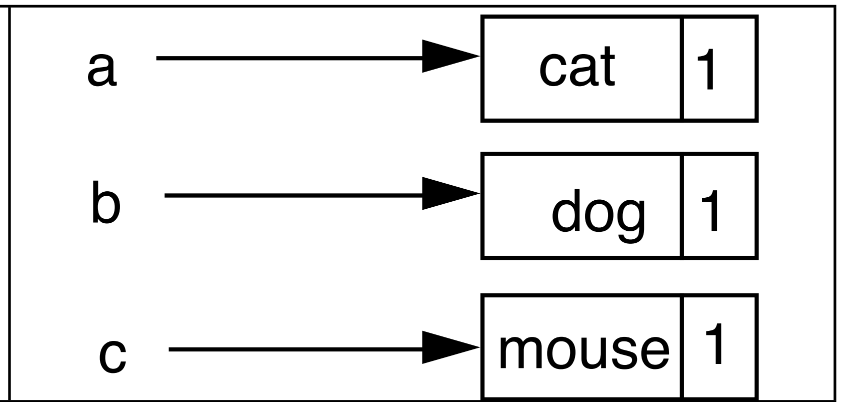
IBM Smalltalk Collections



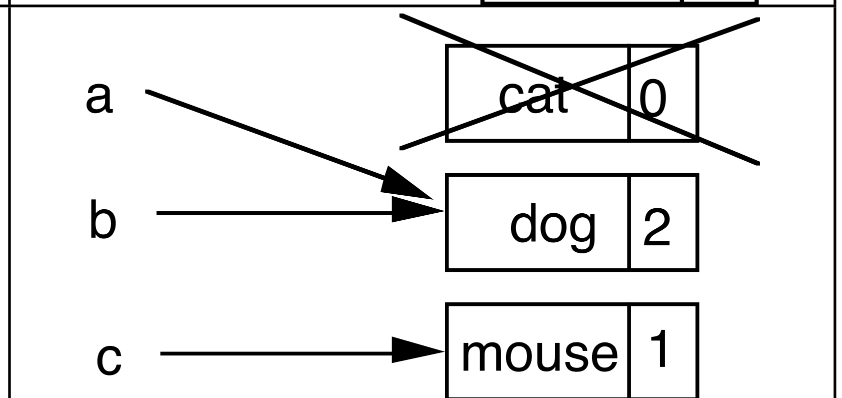
Smart Pointers in C++



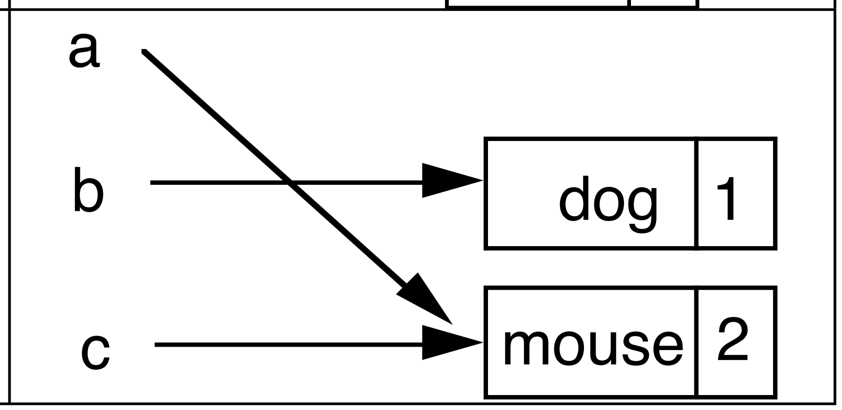
String a(“cat”);
String b(“dog”);
String c(“mouse”);



a = b;



a = c;

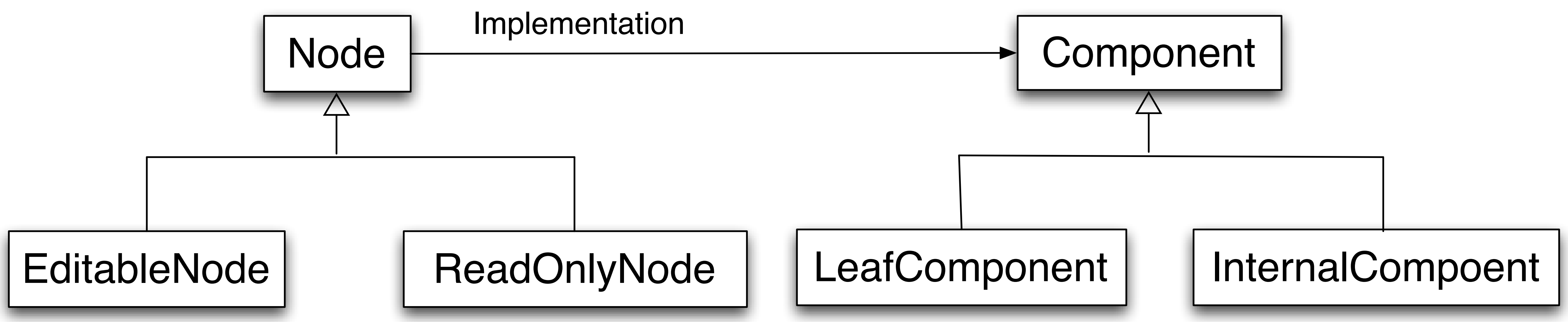


Hypothetical Example

Tree with different type of nodes

LeafNode
InternalNode

ReadOnlyNode
EditableNode



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;
};
```

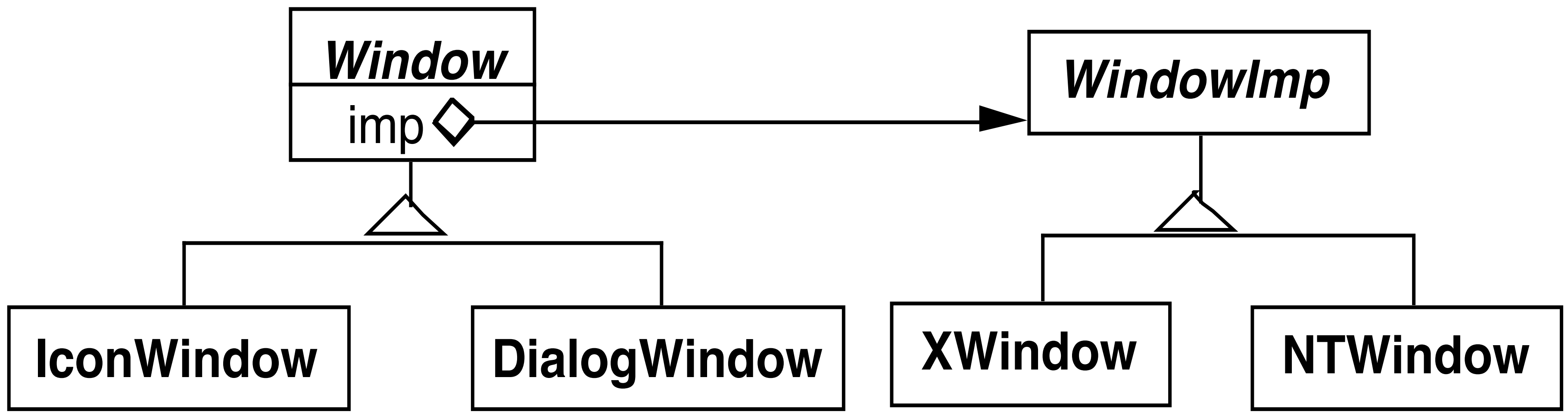
Why Use Bridge

Implementation selected at run-time

Implementation changed during run-time

Why Use Bridge

Abstraction & implementations are extensible by subclassing

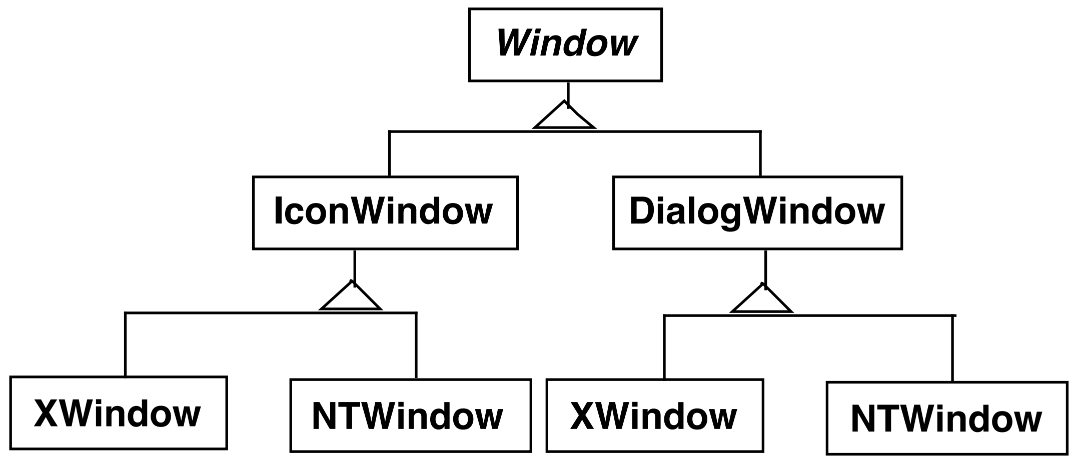


Why Use Bridge

When changes in the implementation should not require client code to be recompiled

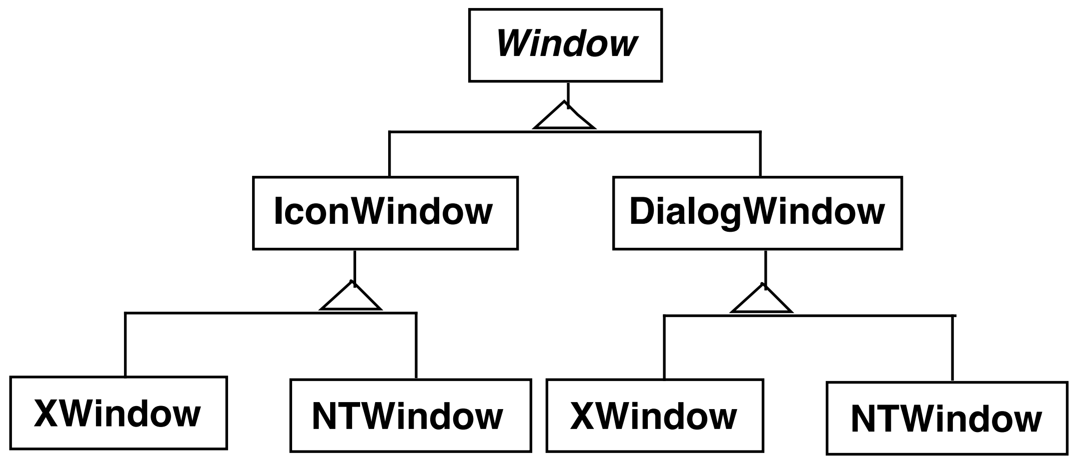
Why Use Bridge

Proliferation of classes



Why Use Bridge

Share implementation among multiple objects



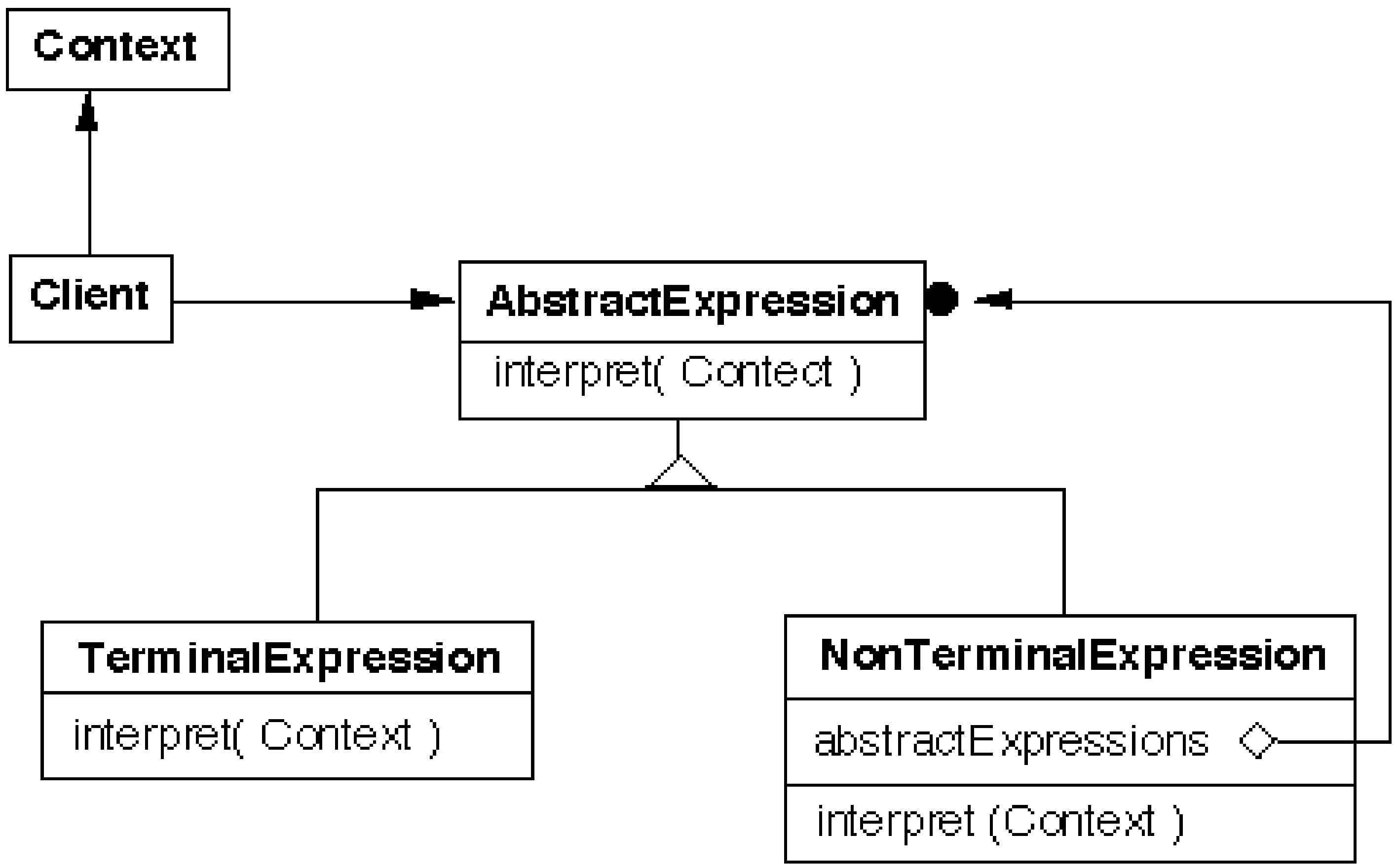
Bridge verses Adapter

Bridge verses Decorator

Bridge & Abstract Factory

Interpreter

Given a language, define a representation for its grammar along with an interpreter that uses the representation to interpret sentences in the language



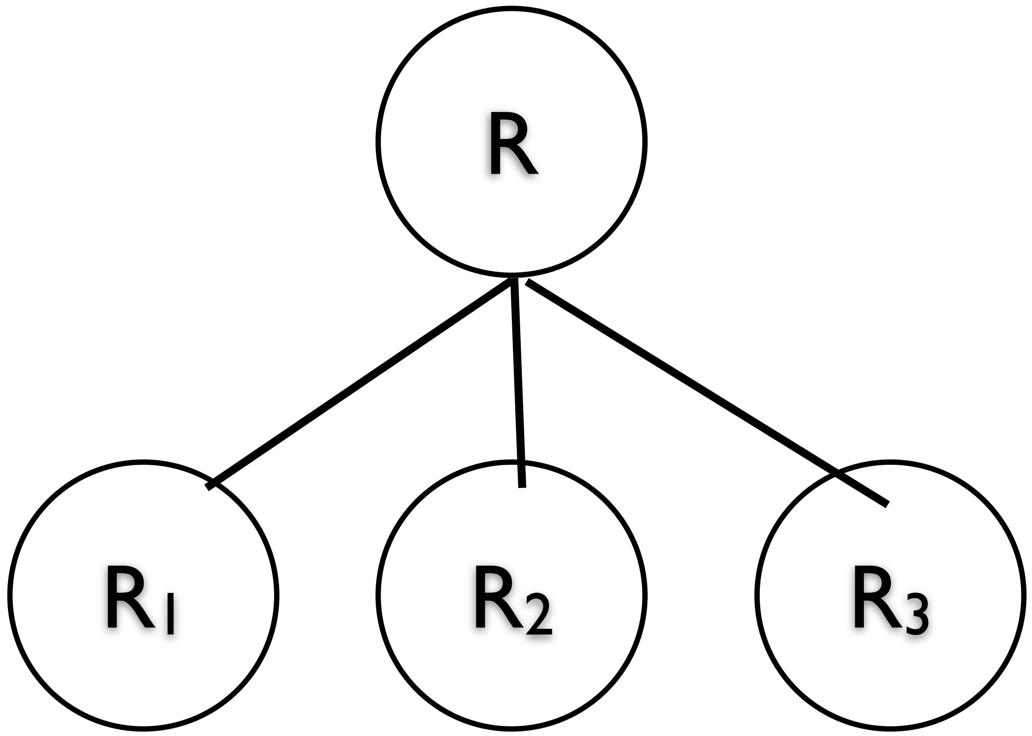
Grammar & Classes

Given a language defined by a grammar like:

$R ::= R_1 \ R_2 \ R_3$

you create a class for each rule

The classes can be used to construct a tree that represents elements of the language



Example - Boolean Expressions

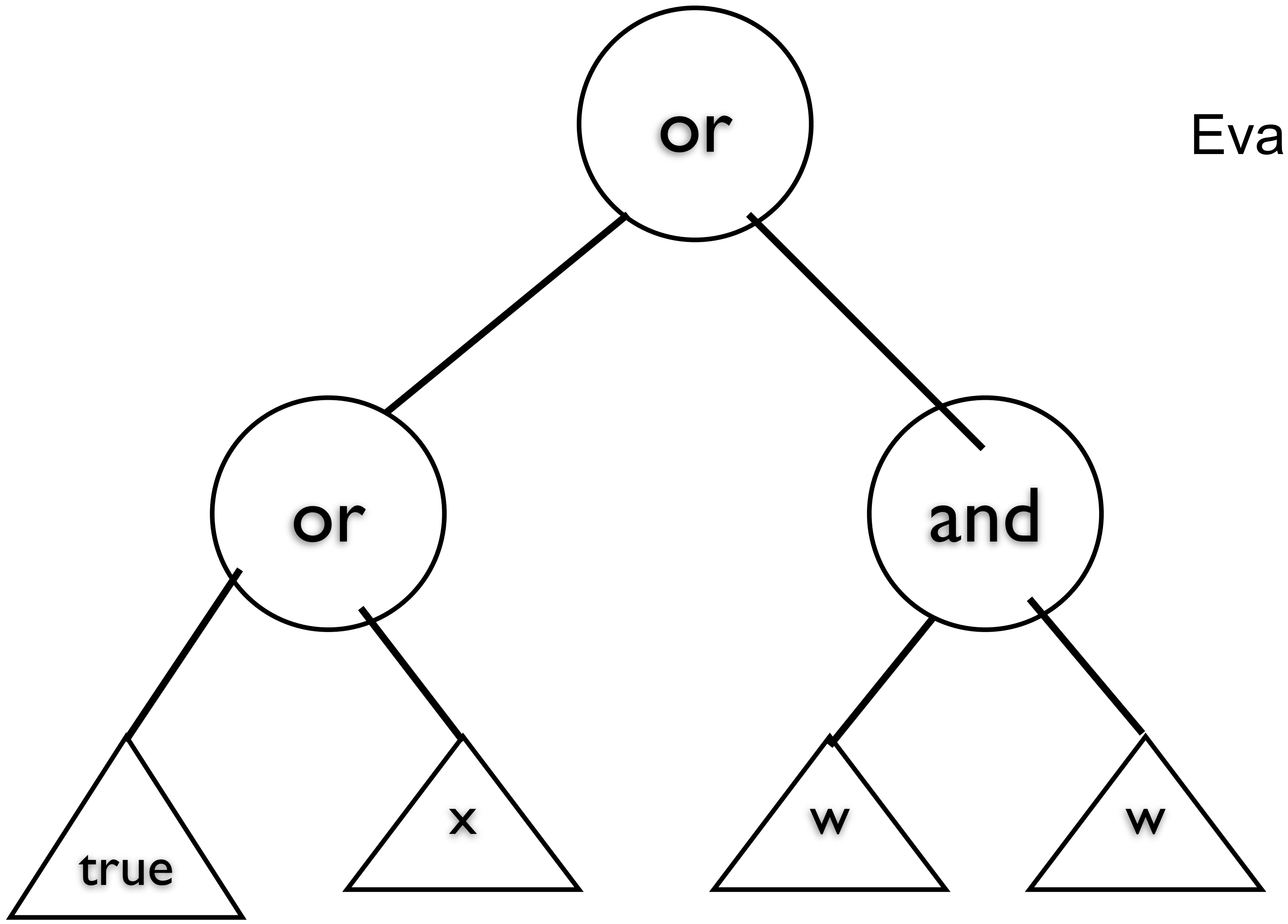
```
BooleanExpression ::=
                        Variable            |
                        Constant            |
                        Or                  |
                        And                 |
                        Not                 |
                        BooleanExpression

And     ::= '(' BooleanExpression ‘and’ BooleanExpression ')'
Or      ::= '(' BooleanExpression ‘or’ BooleanExpression ')'
Not ::= ‘not’ BooleanExpression

Constant ::= ‘true’ | ‘false’
Variable ::= String
```

Sample Expression

((true or x) or (w and x))



Evaluate with
x = true
w = false

Sample Classes

```
public interface BooleanExpression{
	public boolean evaluate( Context values );
	public String toString();
}
```

And

```
public class And implements BooleanExpression {
	private BooleanExpression leftOperand;
	private BooleanExpression rightOperand;

	public And( BooleanExpression leftOperand, BooleanExpression rightOperand) {
		this.leftOperand = leftOperand;
		this.rightOperand = rightOperand;
	}

	public boolean evaluate( Context values ) {
		return leftOperand.evaluate( values ) &&  rightOperand.evaluate( values );
	}

	public String toString(){
		return "(" + leftOperand.toString() + " and " + rightOperand.toString() + ")";
	}
}
```

Constant

```
public class Constant implements BooleanExpression {
	private boolean value;
	private static Constant True = new Constant( true );
	private static Constant False = new Constant( false );

	public static Constant getTrue() {	return True; }

	public static Constant getFalse(){	return False; }

	private Constant( boolean value) { this.value = value; }

	public boolean evaluate( Context values ) { return  value;  }

	public String toString() {
		return String.valueOf( value );
	}
}
```

Variable

```
public class Variable implements BooleanExpression {

	private String name;

	private Variable( String name ) {
		this.name = name;
	}

	public boolean evaluate( Context values ) {
		return values.getValue( name );
	}

	public String toString() { return name; }
}
```

Context

```
public class Context {
	Hashtable<String,Boolean> values = new Hashtable<String,Boolean>();

	public boolean getValue( String variableName ) {
		return values.get( variableName );
	}

	public void setValue( String variableName, boolean value ) {
		values.put( variableName,  value ) );
	}
}
```

((true or x) or (w and x))

```
public class Test {
    public static void main( String args[] ) throws Exception  {
        BooleanExpression left =
            new Or(  Constant.getTrue(), new Variable( "x" ) );
        BooleanExpression right =
            new And(  new Variable( "w" ), new Variable( "x" ) );

        BooleanExpression all = new Or(  left, right );

        System.out.println( all );
        Context values = new Context();
        values.setValue( "x", true );
        values.setValue( "w", false );

        System.out.println( all.evaluate( values ) );
        }
    }
```

Consequences

It's easy to change and extend the grammar

Implementing the grammar is easy

Complex grammars are hard to maintain

- Use JavaCC or SmaCC instead

Adding new ways to interpret expressions

- The visitor pattern is useful here

Complicates design when a language is simple

Supports combinations of elements better than implicit language

Implementation

The pattern does not talk about parsing!

Flyweight

If terminal symbols are repeated many times using the Flyweight pattern can reduce space usage

Composite

Abstract syntax tree is an instance of the composite

Iterator

Can be used to traverse the structure

Visitor

Can be used to place behavior in one class