UNIVERSITÄT BERN

# 10. Guidelines, Idioms and Patterns

Oscar Nierstrasz

## Roadmap

- > Idioms, Patterns and Frameworks
  - —Programming style: Code Talks; Code Smells
- > Basic Idioms
  - —Delegation, Super, Interface
- > Some Design Patterns
  - —Adapter, Proxy, Template Method, Composite, Observer, Visitor, State

# Roadmap

- **Idioms, Patterns and Frameworks**
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- Some Design Patterns
  - Adapter, Proxy, Template Method, Composite, Observer, Visitor, State

# Sources

Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, *Design Patterns*, Addison Wesley, Reading, MA, 1995.

Frank Buschmann, et al., *Pattern-Oriented Software Architecture — A System of Patterns*, Wiley, 1996

Mark Grand, *Patterns in Java, Volume 1*, Wiley, 1998

Kent Beck, *Smalltalk Best Practice Patterns*, Prentice Hall, 1997

“Code Smells”, http://c2.com/cgi/wiki?CodeSmell

or http://sis36.berkeley.edu/projects/streek/agile/bad-smells-in-code.html

# Style

## *Code Talks*

- Do the simplest thing you can think of (KISS)
  - Don't over-design
  - Implement things *once and only once*
  - *First do it, then do it right, then do it fast* (don’t optimize too early)

- Make your intention clear
  - Write *small methods*
  - Each method should *do one thing only*
  - Name methods for *what they do*, not how they do it
  - Write to an *interface*, not an implementation

# Refactoring

*Redesign and refactor when the code starts to "smell"*

***Code Smells*** (http://sis36.berkeley.edu/projects/streek/agile/bad-smells-in-code.html)

> Methods *too long* or too complex
>
> — decompose using helper methods

> *Duplicated code*
>
> — factor out the common parts
> (e.g., using a *Template method* Pattern)

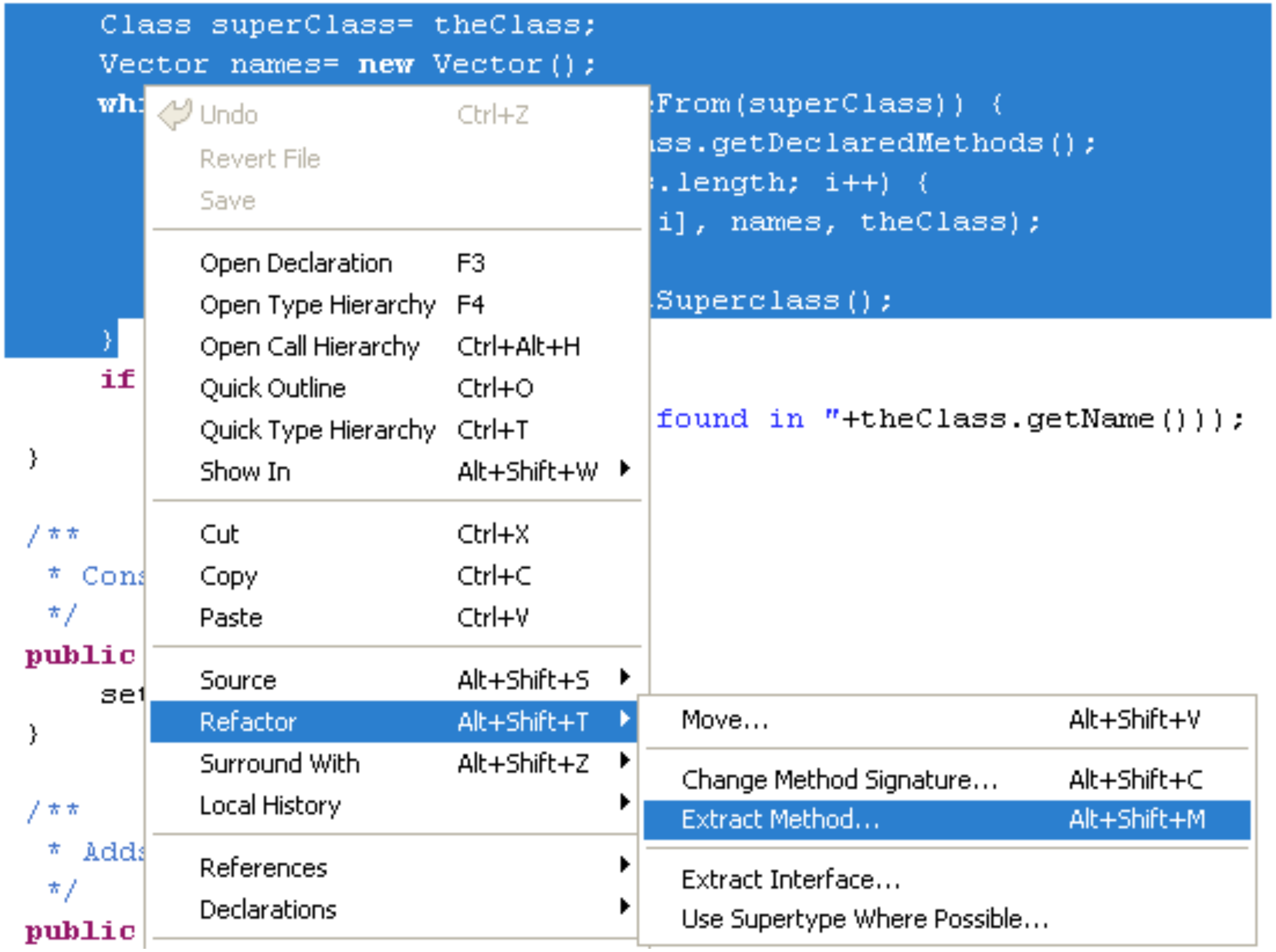
> Violation of *encapsulation*
>
> — redistribute responsibilities

> Too much communication *(high coupling)*
>
> — redistribute responsibilities

*Many idioms and patterns can help you improve your design ...*

# Refactoring Long Methods

2. From the selection's context menu in the editor, select **Refactor > Extract Method...**.



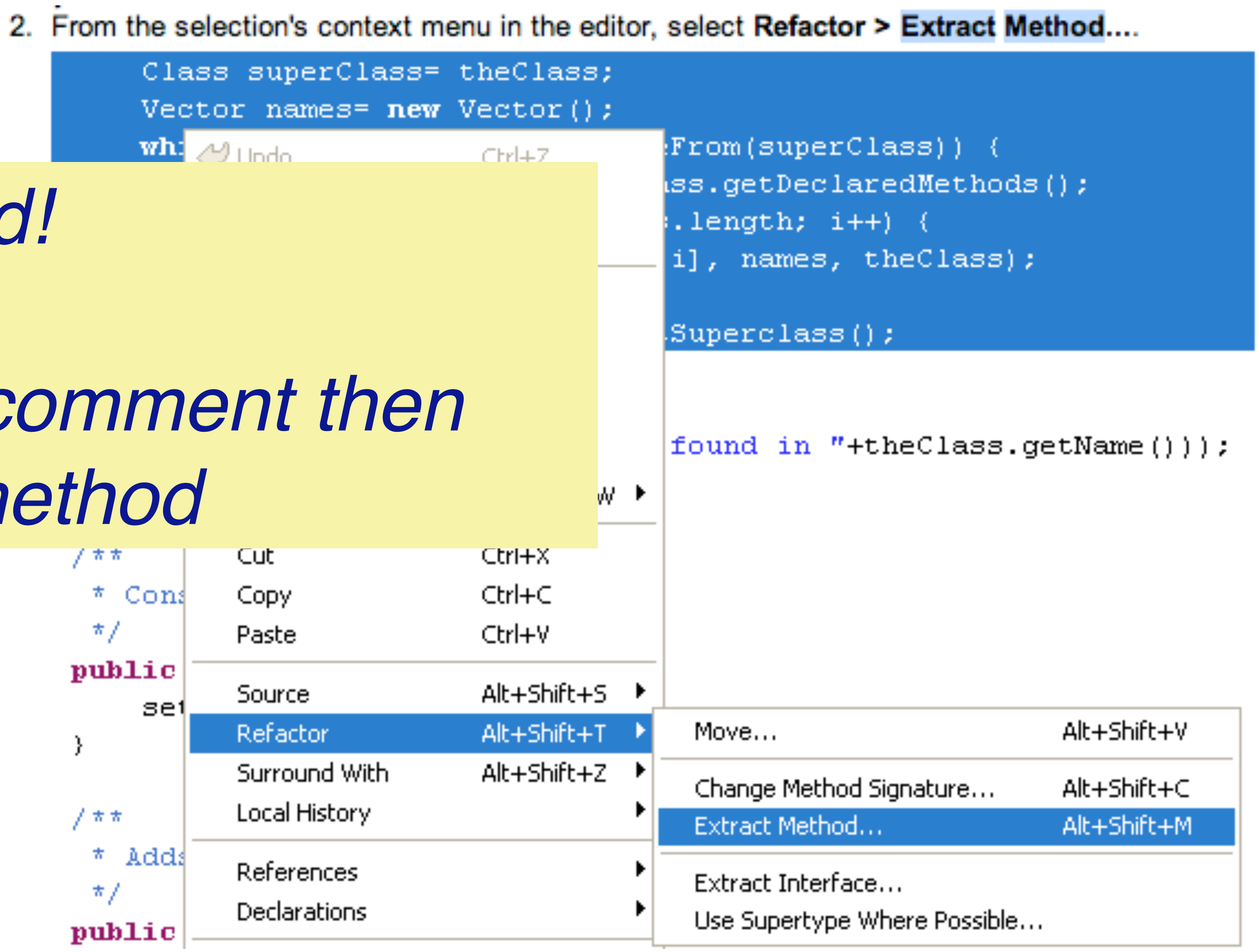
```
    Class superClass= theClass;
    Vector names= new Vector();
    whi                                    From(superClass)) {
                                           ss.getDeclaredMethods();
                                           .length; i++) {
                                           i], names, theClass);

                                           Superclass();
    }
    if                                     found in "+theClass.getName()));
}

/**
 * Cons
 */
public
    se
}

/**
 * Adds
 */
public
```

# Refactoring Long Methods



2. From the selection's context menu in the editor, select **Refactor > Extract Method...**.

```
        Class superClass= theClass;
        Vector names= new Vector();
        whi                                 From(superClass)) {
                                            ss.getDeclaredMethods();
                                            .length; i++) {
                                            i], names, theClass);

                                            Superclass();


                                            found in "+theClass.getName()));

    /**
     * Cons
     */
    public
        set
    }

    /**
     * Adds
     */
    public
```

*short is good!*

*If I need to comment then extract as method*

# What are Idioms and Patterns?

| | |
|---|---|
| ***Idioms*** | Idioms are *common programming techniques* and conventions. They are often language-specific.<br>(http://c2.com/ppr/wiki/JavaIdioms/JavaIdioms.html) |
| ***Patterns*** | Patterns document *common solutions to design problems*. They are language-independent. |
| ***Libraries*** | Libraries are *collections of functions, procedures or other software components* that can be used in many applications. |
| ***Frameworks*** | Frameworks are open libraries that define the *generic architecture* of an application, and can be extended by adding or deriving new classes.<br>(http://martinfowler.com/bliki/InversionOfControl.html) |

Frameworks typically make use of common idioms and patterns.

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# Delegation

✎ How can an object share behaviour without inheritance?

✔ *Delegate some of its work to another object*

Inheritance is a common way to extend the behaviour of a class, but can be *an inappropriate way to combine features.*

*Delegation reinforces encapsulation by keeping roles and responsibilities distinct.*

# Delegation

***Example***

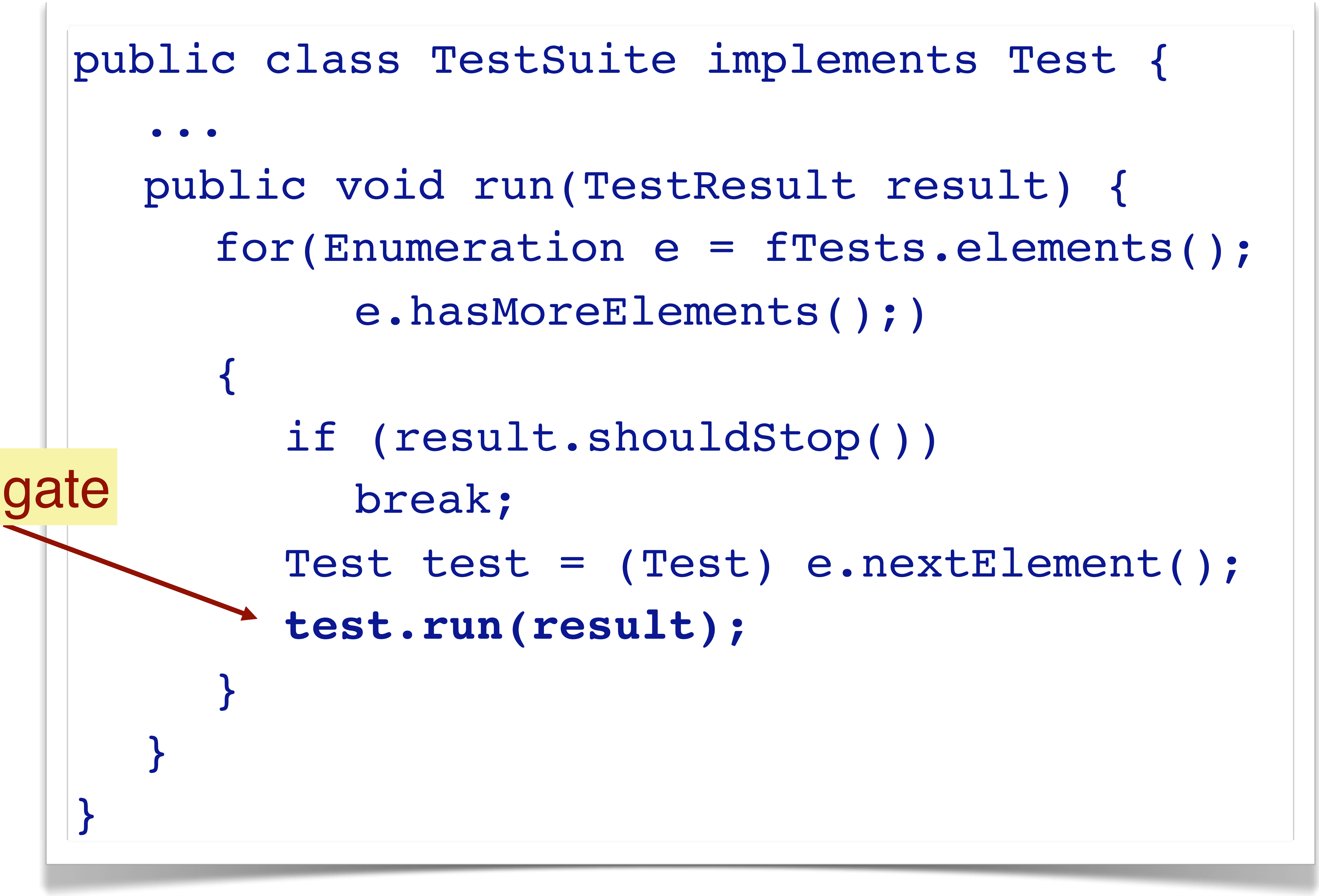
> When a `TestSuite` is asked to `run()`, it delegates the work to each of its `TestCases`.

***Consequences***

> More *flexible, less structured* than inheritance.

*Delegation is one of the most basic object-oriented idioms, and is used by almost all design patterns.*

# Delegation example



```
public class TestSuite implements Test {
   ...
   public void run(TestResult result) {
      for(Enumeration e = fTests.elements();
            e.hasMoreElements();)
      {
         if (result.shouldStop())
            break;
         Test test = (Test) e.nextElement();
         test.run(result);
      }
   }
}
```

delegate

# Super

✎ How do you extend behavior inherited from a superclass?

✔ *Overwrite the inherited method, and send a message to "super" in the new method.*

Sometimes you just want to *extend* inherited behavior, rather than replace it.

# Super

### *Examples*

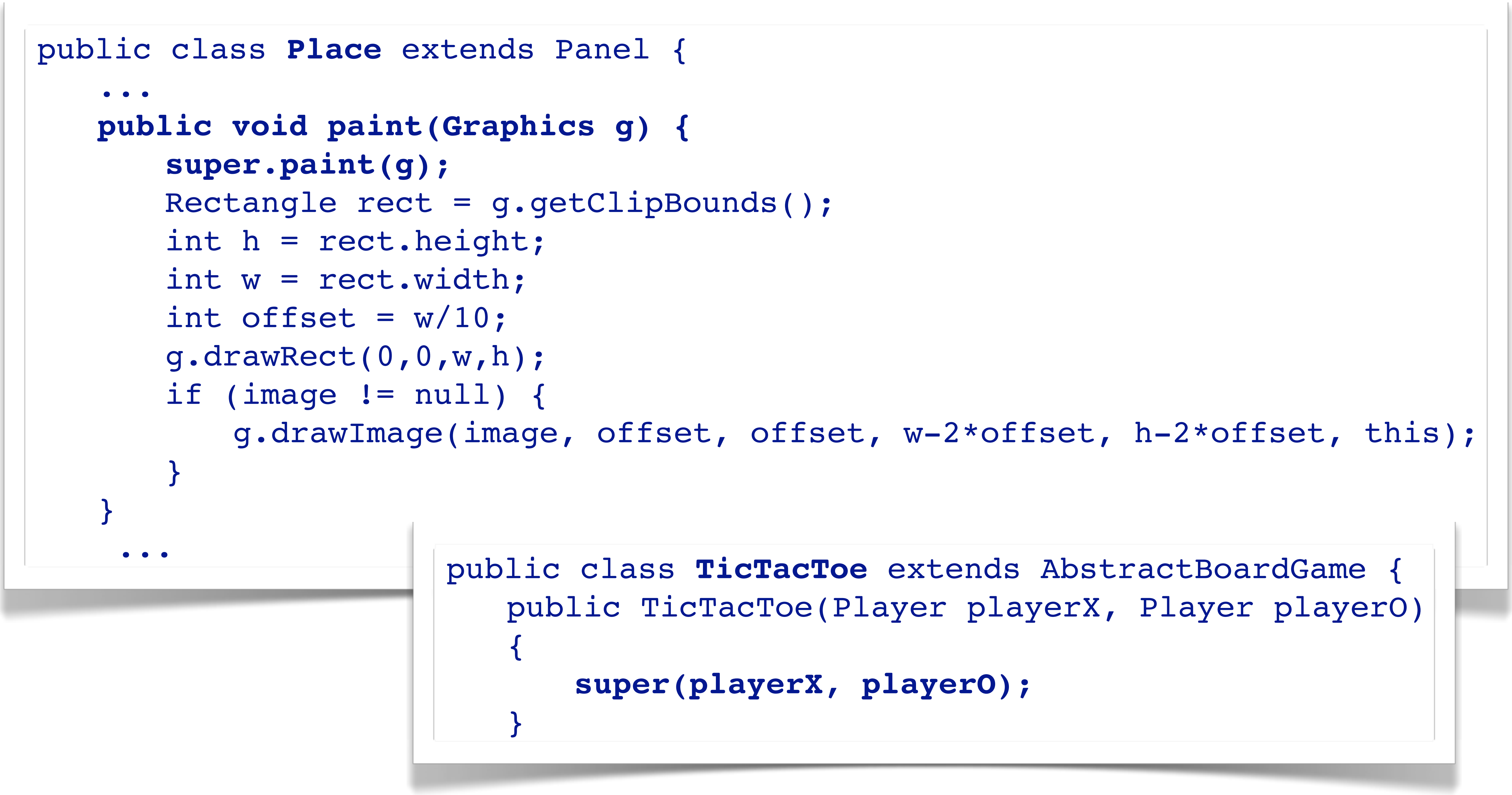
- `Place.paint()` extends `Panel.paint()` with specific painting behaviour
- Constructors for many classes, e.g., `TicTacToe`, invoke their superclass constructors.

### *Consequences*

- *Increases coupling* between subclass and superclass: if you change the inheritance structure, super calls may break!

*Never use super to invoke a method different than the one being overwritten — use "this" instead!*

# Super examples



```
public class Place extends Panel {
   ...
   public void paint(Graphics g) {
       super.paint(g);
       Rectangle rect = g.getClipBounds();
       int h = rect.height;
       int w = rect.width;
       int offset = w/10;
       g.drawRect(0,0,w,h);
       if (image != null) {
           g.drawImage(image, offset, offset, w-2*offset, h-2*offset, this);
       }
   }
    ...
```

```
public class TicTacToe extends AbstractBoardGame {
   public TicTacToe(Player playerX, Player playerO)
   {
       super(playerX, playerO);
   }
```

# Interface

✎ How do you keep a client of a service independent of classes that provide the service?

✔ *Have the client use the service through an interface rather than a concrete class.*

If a client *names a concrete class* as a service provider, then *only instances of that class* or its subclasses can be used in future.

By naming an interface, an instance of *any* class that implements the interface can be used to provide the service.

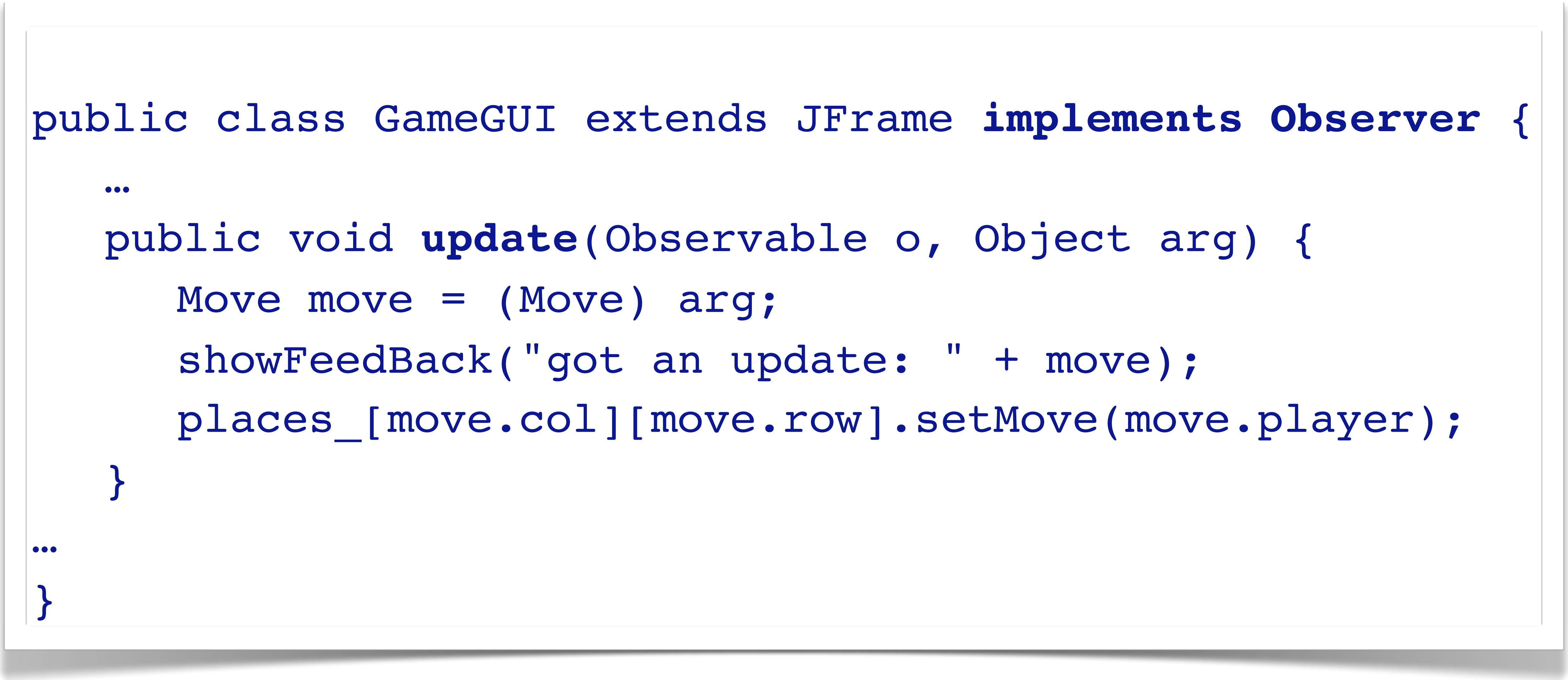
# Interface

***Example***

- Any object may be registered with an `Observable` if it implements the `Observer` interface.

- ***Consequences***
- Interfaces *reduce coupling* between classes.
- They also *increase complexity* by adding indirection.

# Interface example



```
public class GameGUI extends JFrame implements Observer {
   …
   public void update(Observable o, Object arg) {
      Move move = (Move) arg;
      showFeedBack("got an update: " + move);
      places_[move.col][move.row].setMove(move.player);
   }
…
}
```

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# Adapter Pattern

✎ How do you use a class that provide the right features but the wrong interface?

✔ *Introduce an adapter.*

An adapter *converts the interface* of a class into another interface clients expect.

> The client and the adapted object *remain independent.*
> An adapter adds *an extra level of indirection.*

*Also known as Wrapper*

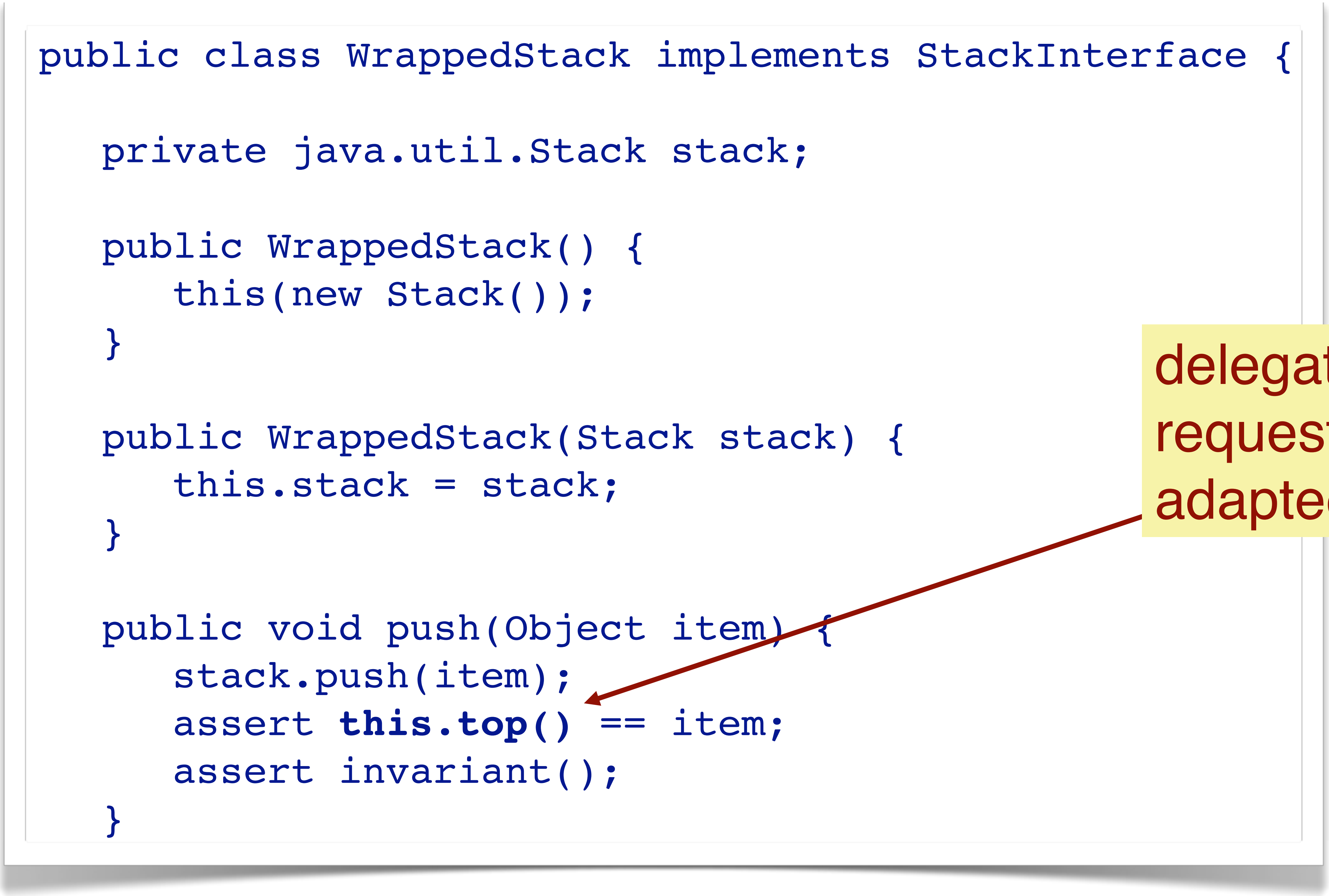
# Adapter Pattern

## *Examples*

- A `WrappedStack` adapts `java.util.Stack`, throwing an `AssertionException` when `top()` or `pop()` are called on an empty stack.
- An `ActionListener` converts a call to `actionPerformed()` to the desired handler method.

- ***Consequences***
- The client and the adapted object *remain independent.*
- An adapter adds *an extra level of indirection.*

# Adapter Pattern example



```
public class WrappedStack implements StackInterface {

   private java.util.Stack stack;

   public WrappedStack() {
      this(new Stack());
   }

   public WrappedStack(Stack stack) {
      this.stack = stack;
   }

   public void push(Object item) {
      stack.push(item);
      assert this.top() == item;
      assert invariant();
   }
```

delegate request to adaptee

# Proxy Pattern

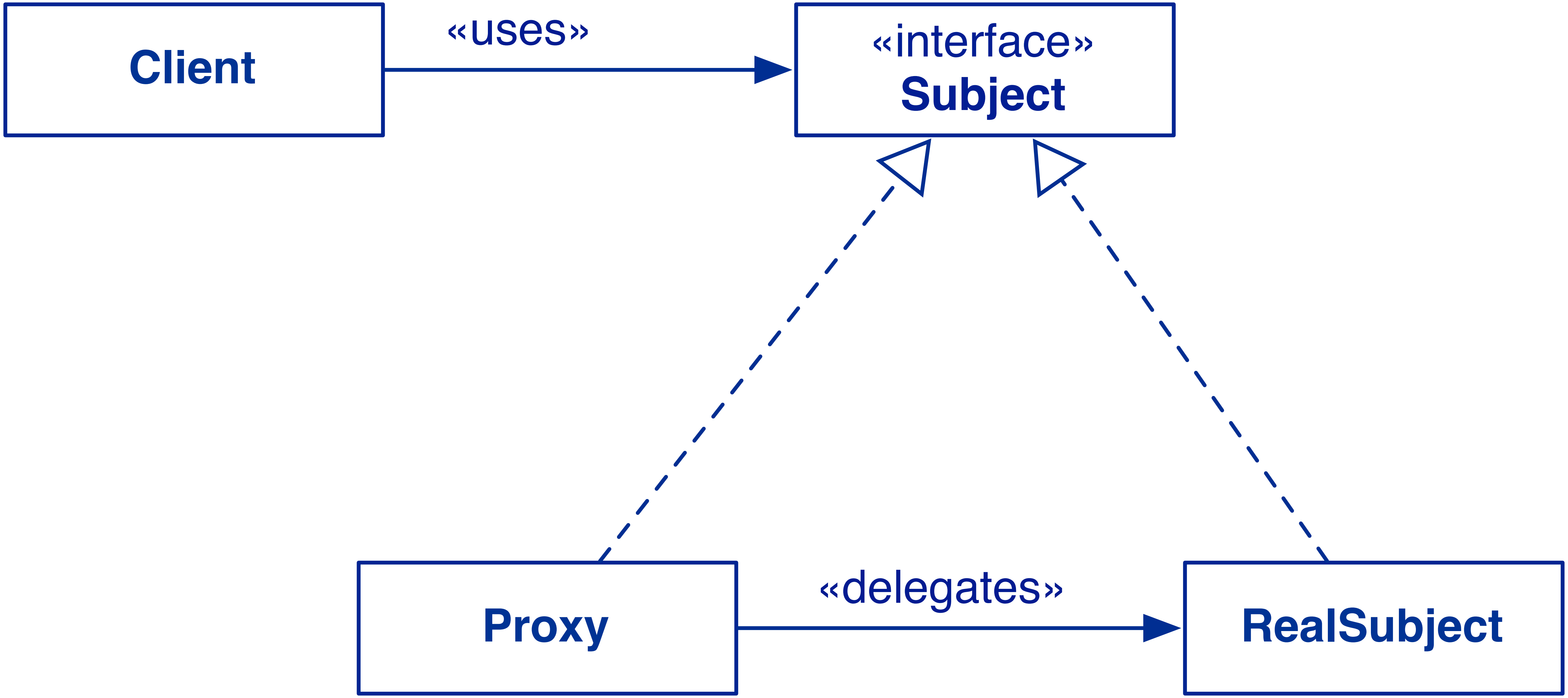
✎ How do you hide the complexity of accessing objects that require pre- or post-processing?

✔ *Introduce a proxy to control access to the object.*

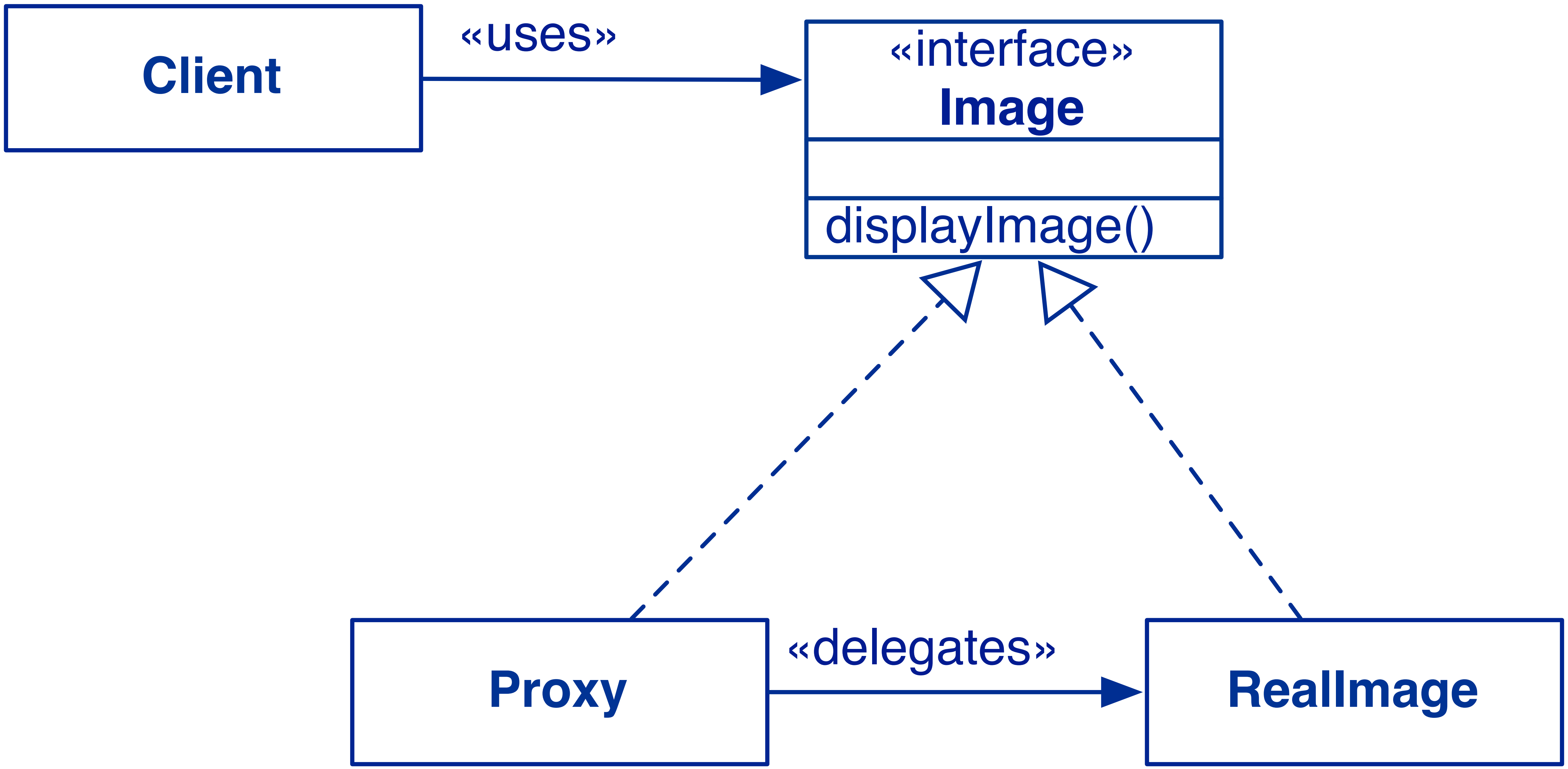
Some services require special pre or post-processing. Examples include objects that reside on a remote machine, and those with security restrictions.

*A proxy provides the same interface as the object that it controls access to.*

# Proxy Pattern - UML

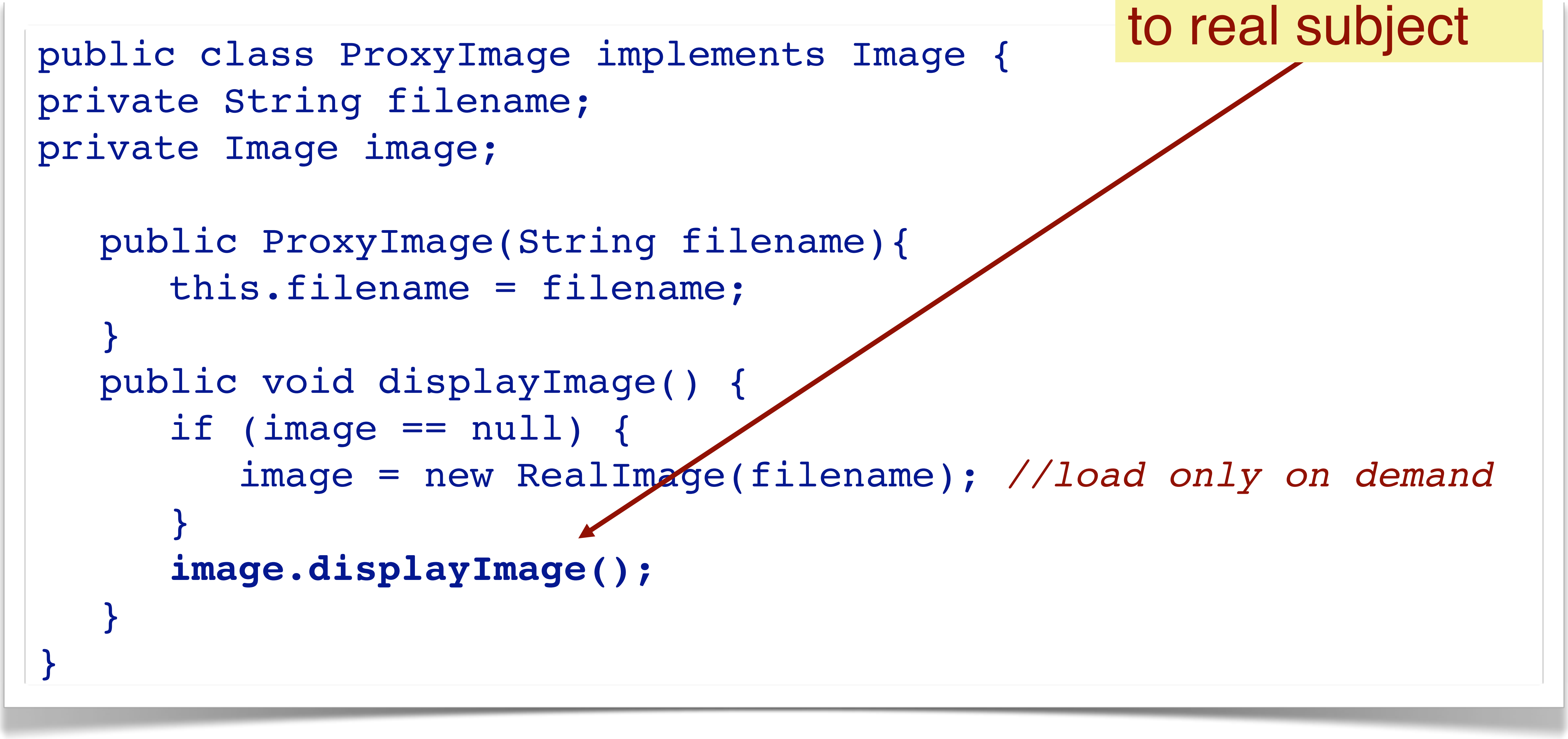


# Proxy Pattern Example (1)



# Proxy Pattern Example (2)

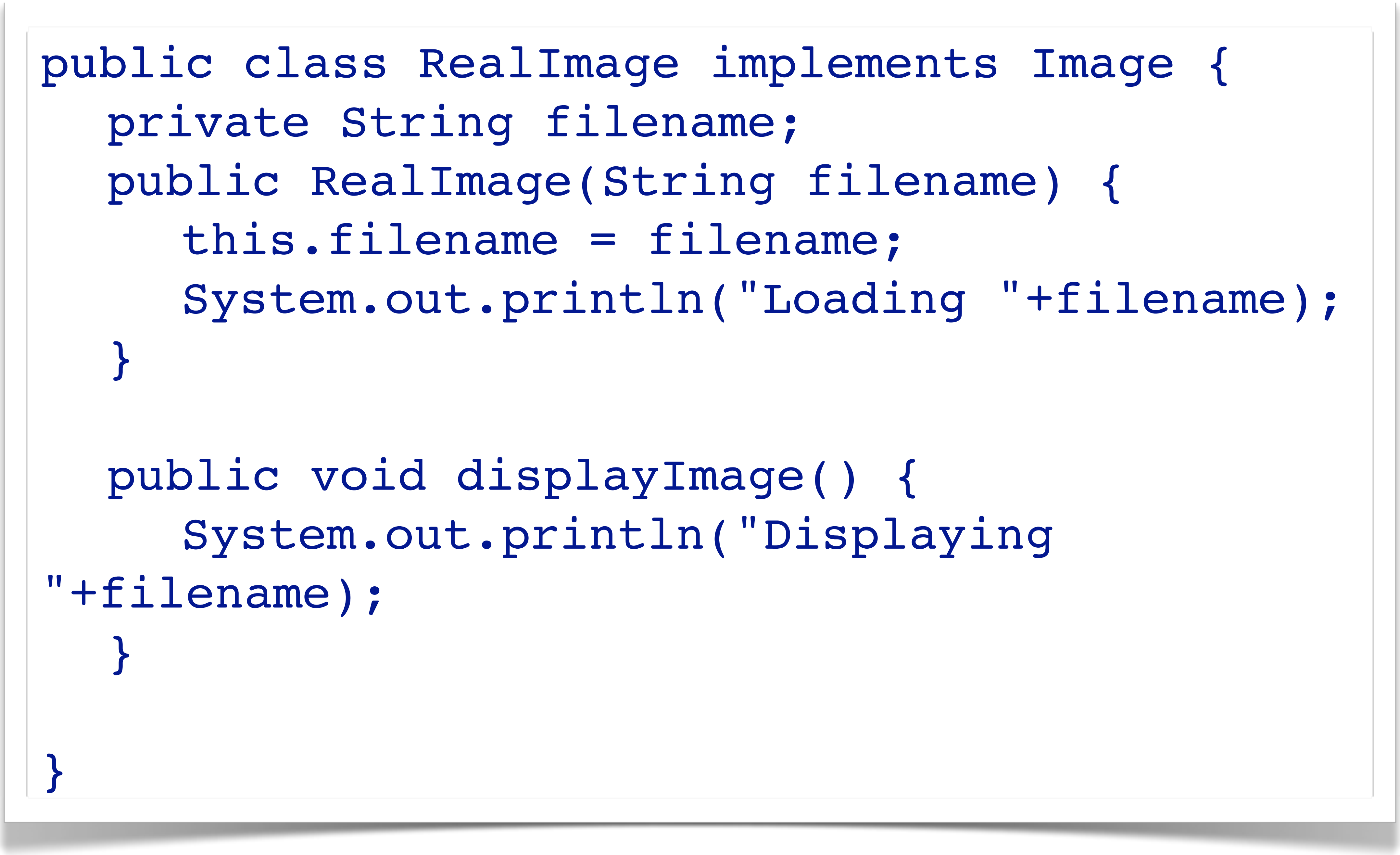
delegate request to real subject



```
public class ProxyImage implements Image {
private String filename;
private Image image;

   public ProxyImage(String filename){
      this.filename = filename;
   }
   public void displayImage() {
      if (image == null) {
         image = new RealImage(filename); //load only on demand
      }
      image.displayImage();
   }
}
```

# Proxy Pattern Example (3)

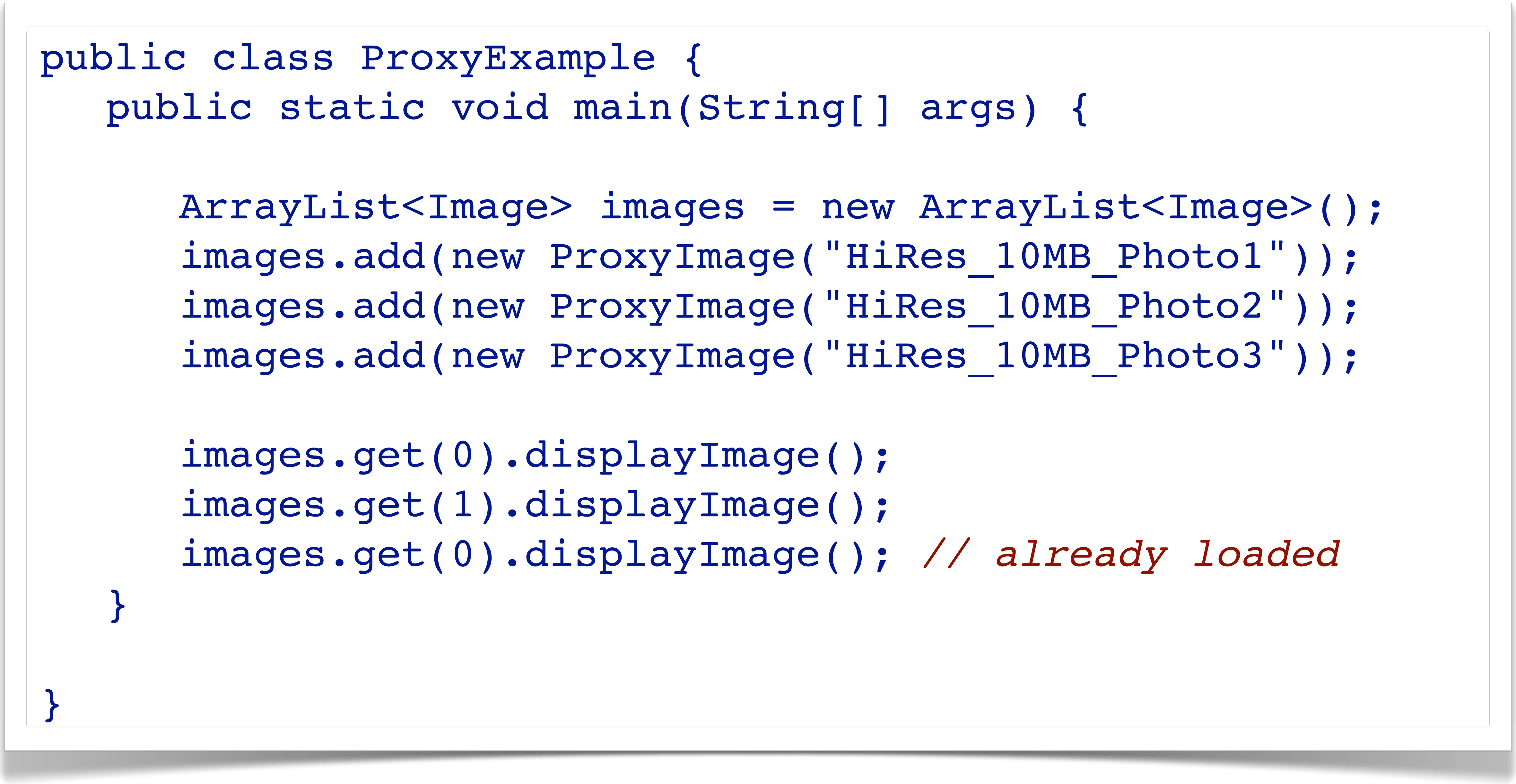


```
public class RealImage implements Image {
   private String filename;
   public RealImage(String filename) {
      this.filename = filename;
      System.out.println("Loading "+filename);
   }

   public void displayImage() {
      System.out.println("Displaying
"+filename);
   }

}
```

# Proxy Pattern Example (4) - the Client



```
public class ProxyExample {
   public static void main(String[] args) {

      ArrayList<Image> images = new ArrayList<Image>();
      images.add(new ProxyImage("HiRes_10MB_Photo1"));
      images.add(new ProxyImage("HiRes_10MB_Photo2"));
      images.add(new ProxyImage("HiRes_10MB_Photo3"));

      images.get(0).displayImage();
      images.get(1).displayImage();
      images.get(0).displayImage(); // already loaded
   }

}
```

# Proxies are used for remote object access

### *Example*

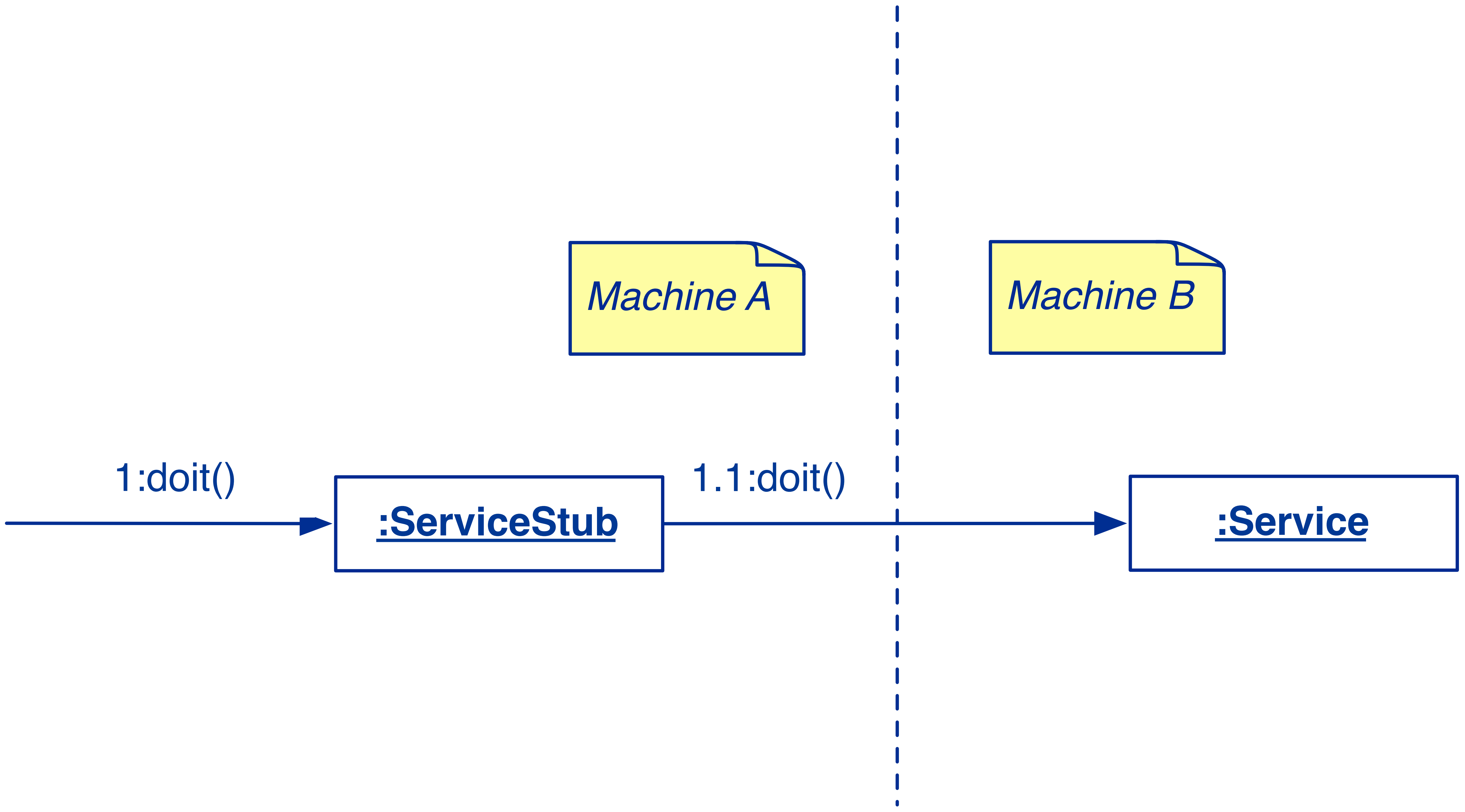
- A Java “stub” for a remote object accessed by Remote Method Invocation (RMI).

### *Consequences*

- A Proxy decouples clients from servers. A Proxy introduces a level of indirection.

*Proxy differs from Adapter in that it does not change the object’s interface.*

# Proxy remote access example



# Template Method Pattern

✎ How do you implement a generic algorithm, deferring some parts to subclasses?

✔ *Define it as a Template Method.*

A Template Method *factors out the common part of similar algorithms*, and delegates the rest to:

- —*hook methods* that subclasses *may extend*, and
- —*abstract methods* that subclasses *must implement*.

# Template Method Pattern (2)

***Example***

> `TestCase.runBare()` is a template method that calls the hook method `setUp()`.

> `AbstractBoardGame`'s constructor defers initialization to the abstract `init()` method

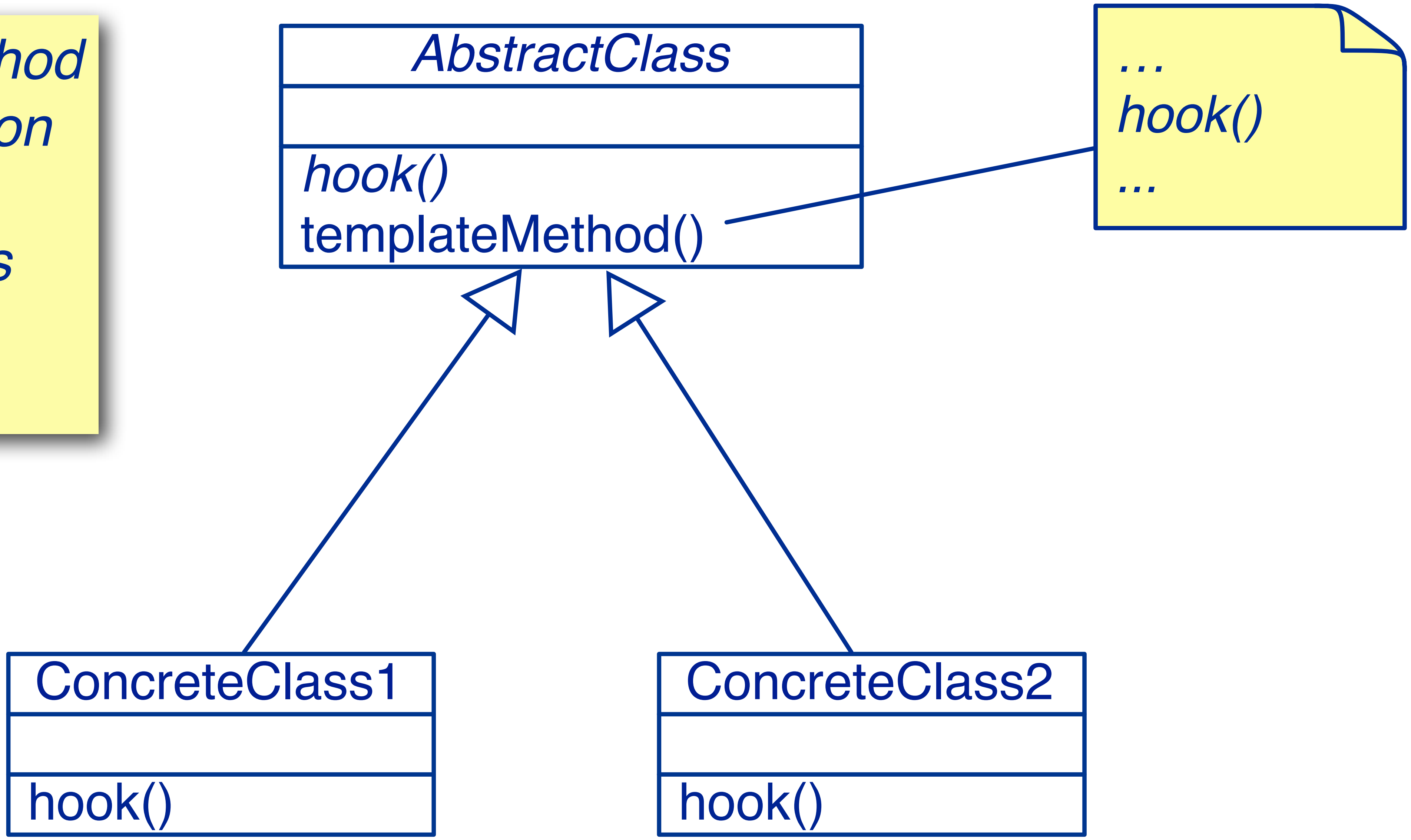
***Consequences***

> Template methods lead to an *inverted control structure* since a parent classes calls the operations of a subclass and not the other way around.

*Template Method is used in most frameworks to allow application programmers to easily extend the functionality of framework classes.*

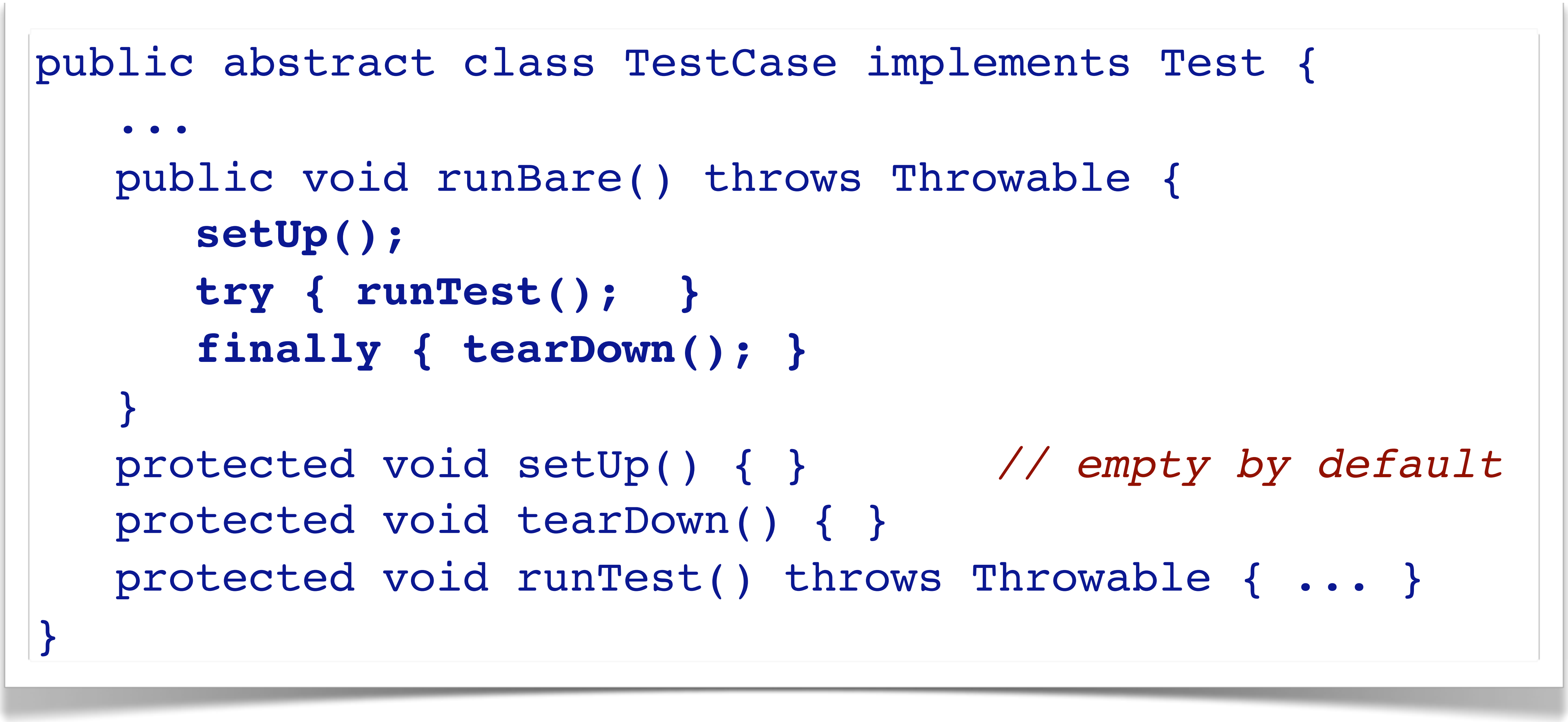
# Template Method Pattern - UML

*The template method defines the skeleton of an algorithm. Concrete methods override the hook methods.*



# Template Method Pattern Example

Subclasses of TestCase are expected to *override hook method* `setUp()` and possibly `tearDown()` and `runTest()`.



```
public abstract class TestCase implements Test {
   ...
   public void runBare() throws Throwable {
      setUp();
      try { runTest();  }
      finally { tearDown(); }
   }
   protected void setUp() { }       // empty by default
   protected void tearDown() { }
   protected void runTest() throws Throwable { ... }
}
```

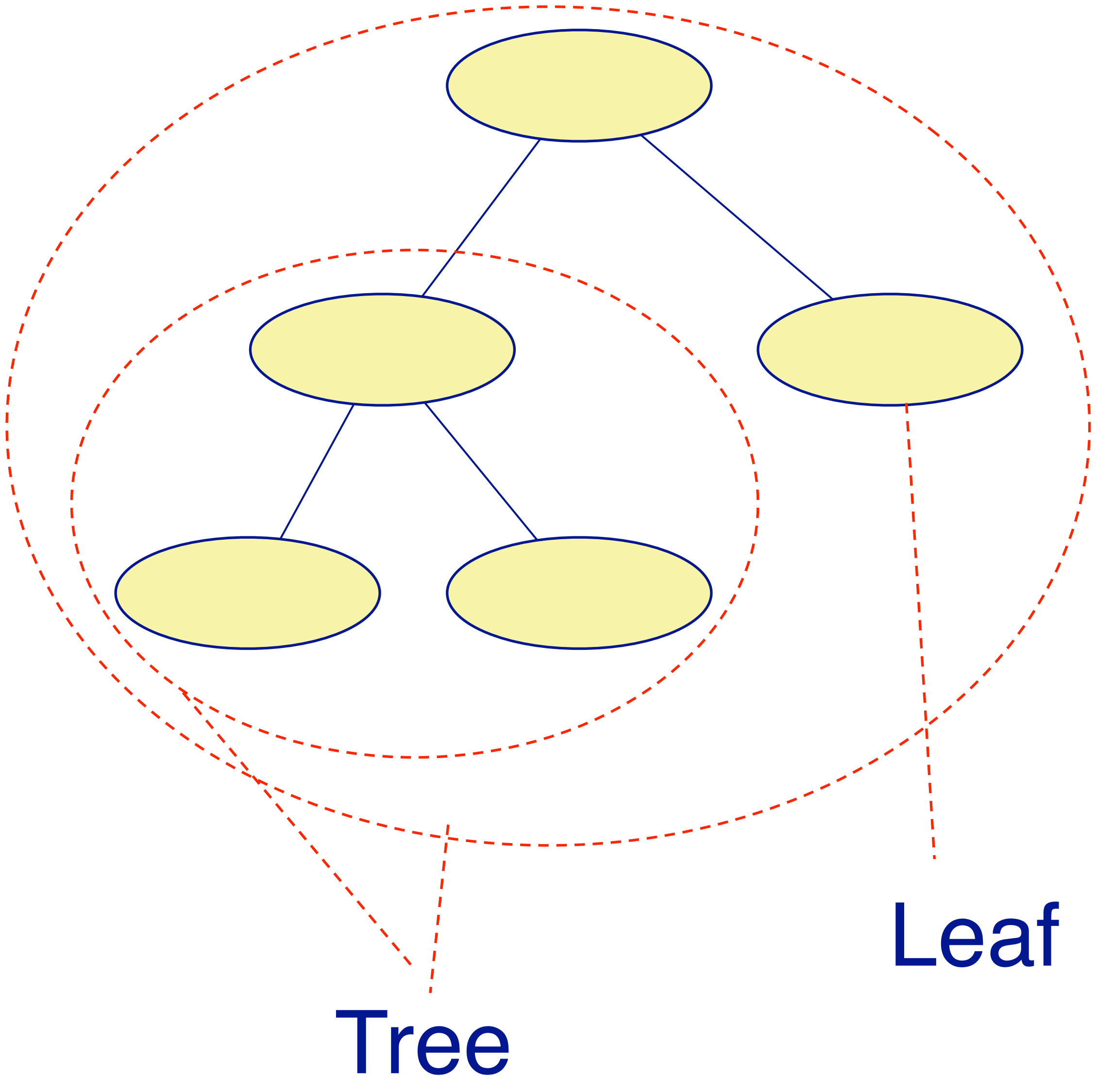
# Composite Pattern

- ✎ How do you manage a part-whole hierarchy of objects in a consistent way?
- ✔ *Define a common interface that both parts and composites implement.*

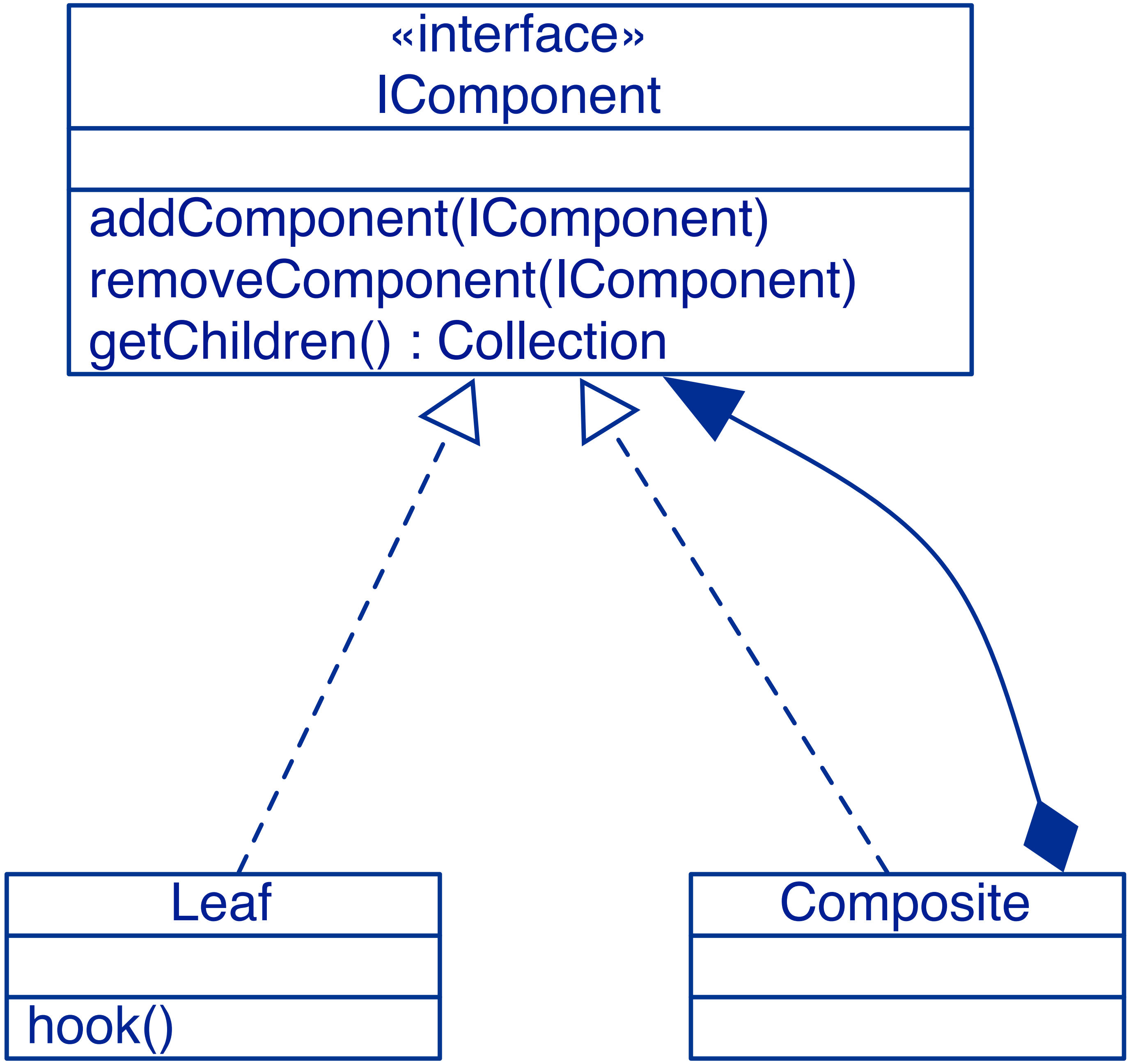
Typically composite objects will implement their behavior by *delegating to their parts.*

# Composite Pattern Example

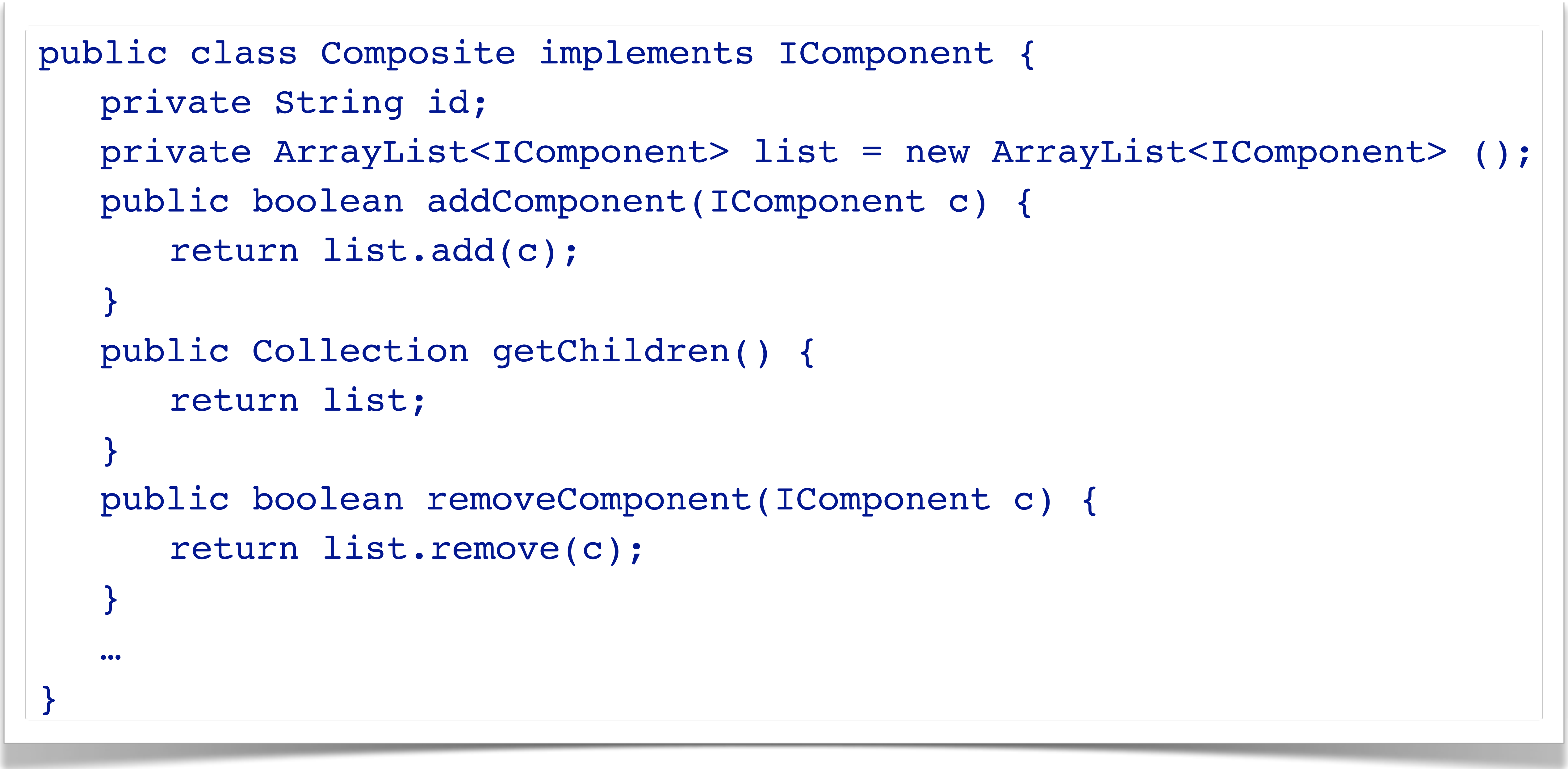
- *Composite* allows you to treat a single instance of an object the same way as a *group* of objects.
- Consider a *Tree*. It consists of Trees (subtrees) and *Leaf* objects.



# Composite Pattern Example (2)

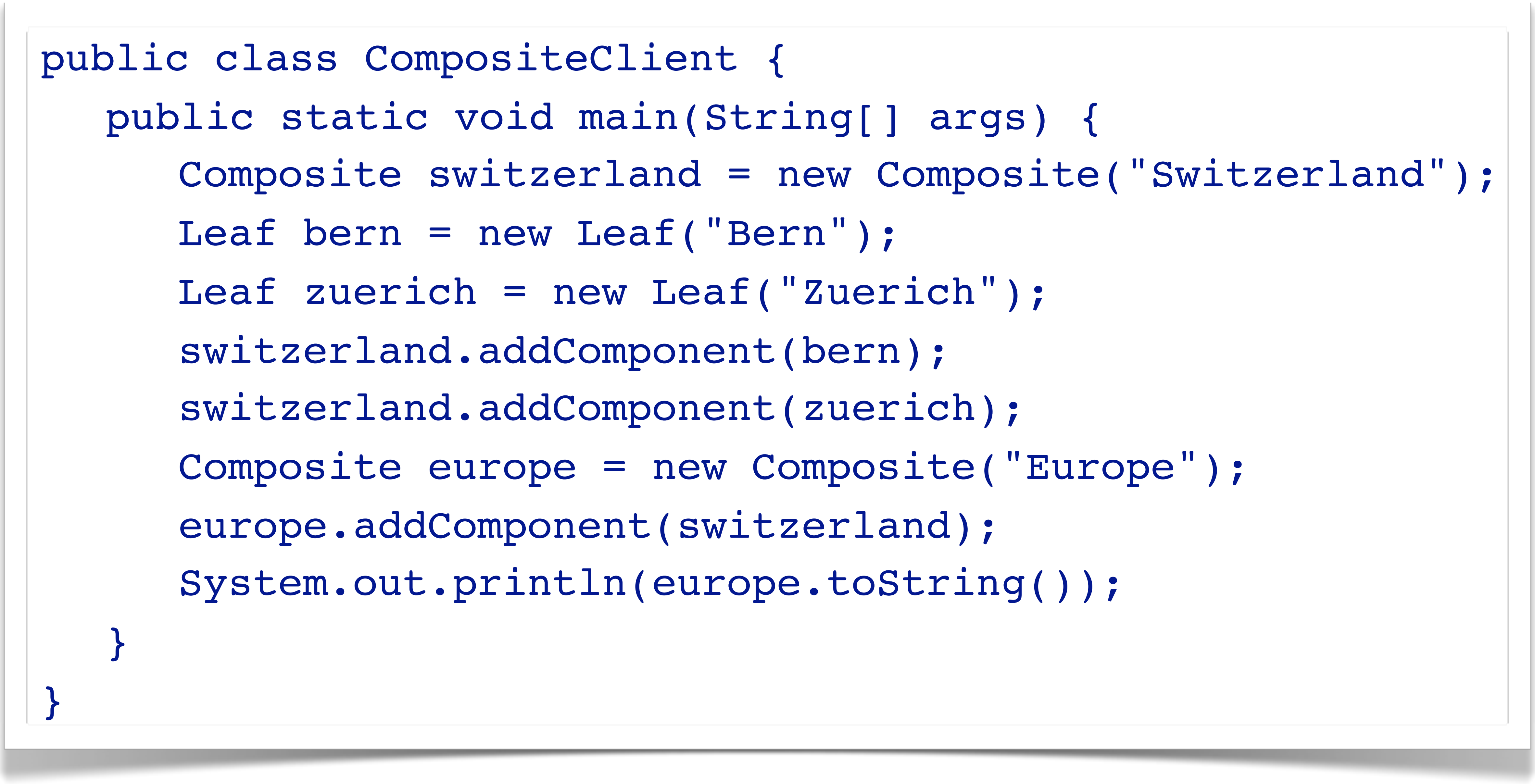


# Composite Pattern Example (3)



```
public class Composite implements IComponent {
   private String id;
   private ArrayList<IComponent> list = new ArrayList<IComponent> ();
   public boolean addComponent(IComponent c) {
      return list.add(c);
   }
   public Collection getChildren() {
      return list;
   }
   public boolean removeComponent(IComponent c) {
      return list.remove(c);
   }
   …
}
```

# Composite Pattern Example — Client Usage (4)



```
public class CompositeClient {
   public static void main(String[] args) {
      Composite switzerland = new Composite("Switzerland");
      Leaf bern = new Leaf("Bern");
      Leaf zuerich = new Leaf("Zuerich");
      switzerland.addComponent(bern);
      switzerland.addComponent(zuerich);
      Composite europe = new Composite("Europe");
      europe.addComponent(switzerland);
      System.out.println(europe.toString());
   }
}
```

# Observer Pattern

- ✎ How can an object inform arbitrary clients when it changes state?
- ✔ *Clients  implement a common Observer interface and register with the “observable” object; the object notifies its observers when it changes state.*

An observable object *publishes* state change events to its *subscribers*, who must implement a common interface for receiving notification.

# Observer Pattern (2)

***Example***

- ***See GUI Lecture***
- A `Button` expects its observers to implement the `ActionListener` interface.
  *(see the Interface and Adapter examples)*

***Consequences***

- Notification can be *slow* if there are many observers for an observable, or if observers are themselves observable!

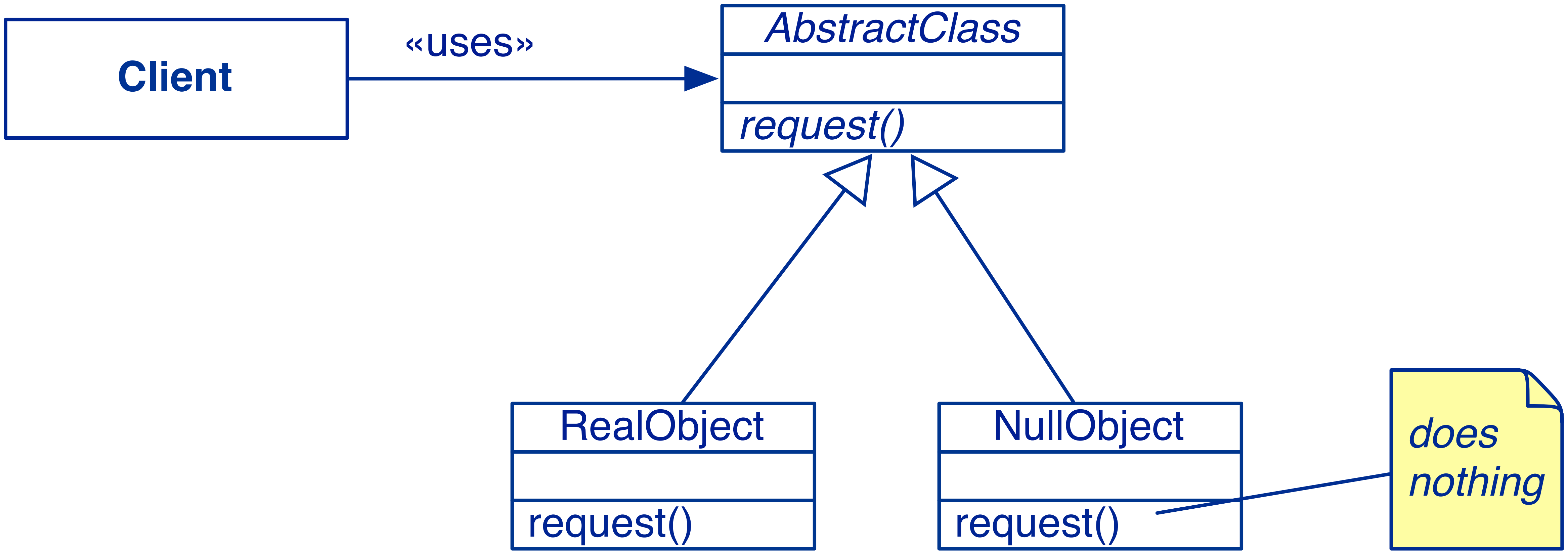
# Null Object Pattern

✎ How do you avoid cluttering your code with tests for null object pointers?

✔ *Introduce a Null Object that implements the interface you expect, but does nothing.*

Null Objects may also be Singleton objects, since you never need more than one instance.

# Null Object Pattern — UML



# Null Object

### *Examples*

- `NullOutputStream` extends `OutputStream` with an empty `write()` method

### *Consequences*

- Simplifies client code
- Not worthwhile if there are only few and localized tests for null pointers

# Some other Design Patterns…

| | |
|---|---|
| ***State*** | The state pattern is a behavioral design pattern, also known as the objects for states pattern. This pattern is used in to represent the state of an object. This is a clean way for an object to partially change its type at runtime. |
| ***Decorator*** | that allows new/additional behaviour to be added to an existing method of an object dynamically. |
| ***Visitor*** | a way of separating an algorithm from an object structure. A practical result of this separation is the ability to add new operations to existing object structures without modifying those structures. |

*and many more…*

# What Problems do Design Patterns Solve?

***Patterns:***

> document *design experience*
> 
> enable widespread *reuse of software architecture*
> 
> *improve communication* within and across software development teams
> 
> *explicitly capture knowledge* that experienced developers already understand implicitly
> 
> arise from *practical experience*
> 
> help *ease the transition* to object-oriented technology
> 
> *facilitate training* of new developers
> 
> help to transcend “programming language-centric” viewpoints

*Doug Schmidt, CACM Oct 1995*

# What you should know!

- What’s wrong with long methods? How long should a method be?
- What’s the difference between a pattern and an idiom?
- When should you use delegation instead of inheritance?
- When should you call “super”?
- How does a Proxy differ from an Adapter?
- How can a Template Method help to eliminate duplicated code?
- When do I use a Composite Pattern? Do you know any examples from the Frameworks you know?

# *Can you answer these questions?*

- *What idioms do you regularly use when you program? What patterns do you use?*
- *What is the difference between an interface and an abstract class?*
- *When should you use an Adapter instead of modifying the interface that doesn't fit?*
- *Is it good or bad that java.awt.Component is an abstract class and not an interface?*
- *Why do the Java libraries use different interfaces for the Observer pattern (java.util.Observer, java.awt.event.ActionListener etc.)?*

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