Some Design Patterns

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Design Patterns: Elements of Reusable Object-Oriented Software

Erich Gamma, Richard Helm, Ralph Johnson, John M. Vlissides, 1994

Outline

1. Adapter
2. Proxy
3. Observer
4. State

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

Consequences

The client and the adapted object *remain independent*

An adapter adds *an extra level of indirection*

Adapter Pattern Example

```
class LegacyRectangle implements Shape
{
    public void draw(int x, int y, int w, int h)
    {
        System.out.println("rectangle at (" + x + ',' + y + ") with width "
          + w + " and height " + h);
    }
}
```

```
class Rectangle implements Shape
{
    private LegacyRectangle adaptee = new LegacyRectangle();
    public void draw(int x1, int y1, int x2, int y2)
    {
        adaptee.draw(Math.min(x1, x2), Math.min(y1, y2), Math.abs(x2 - x1),
          Math.abs(y2 - y1));
    }
}
```

Proxy Pattern

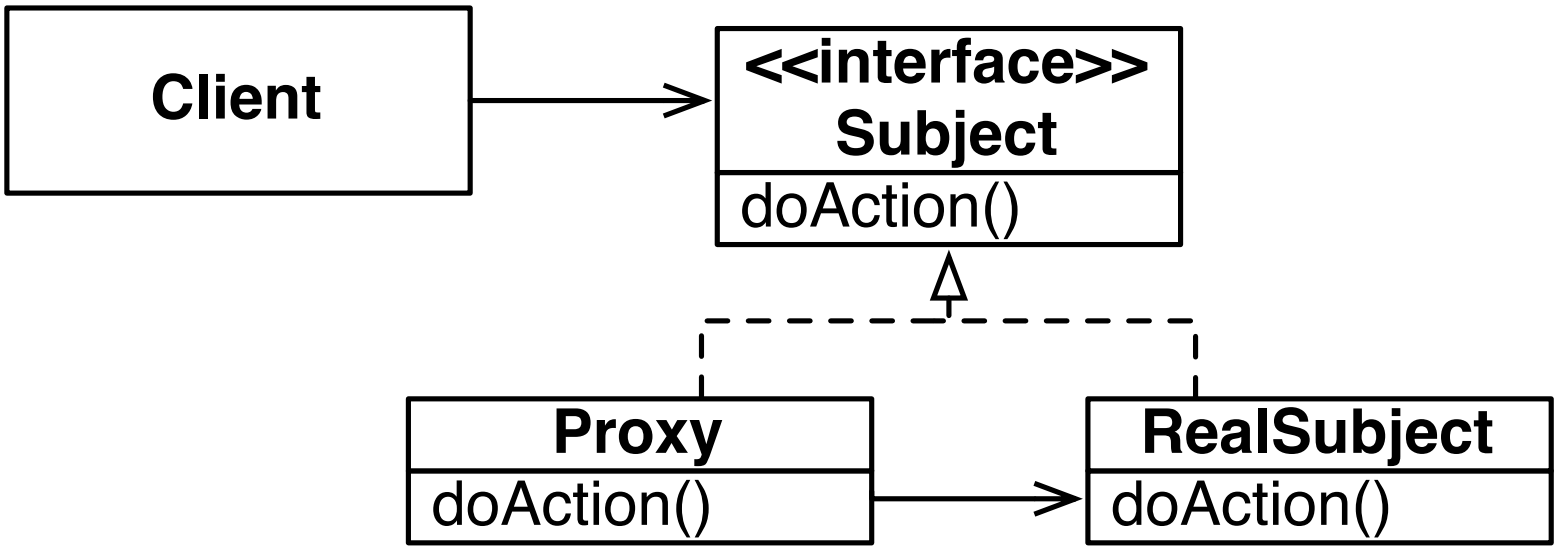
How do you hide the complexity of accessing objects that require pre- or post-processing?

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

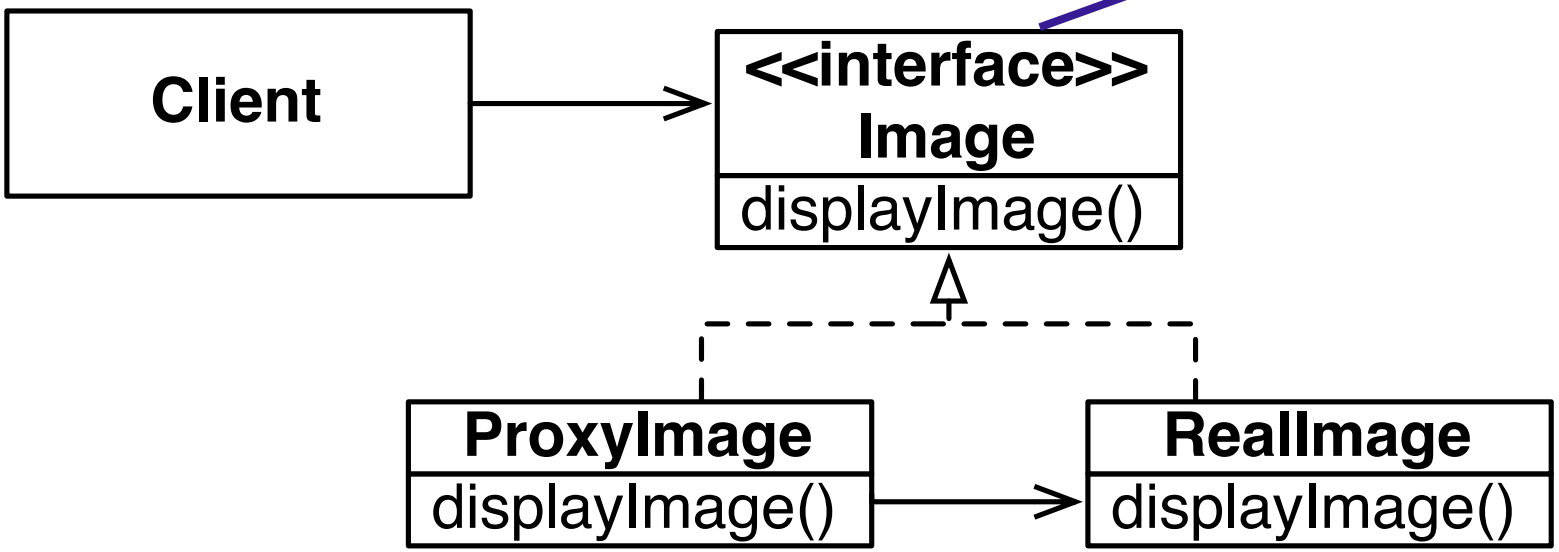
A proxy provides the same interface as the object that it controls access to

Proxy Pattern - UML



Proxy Pattern - Example

```
public interface Image {
   public void displayImage();
}
```



Proxy Pattern - Example

```
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();
   }
}
```

delegate request to real subject

Proxy Pattern - Example

```
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, 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

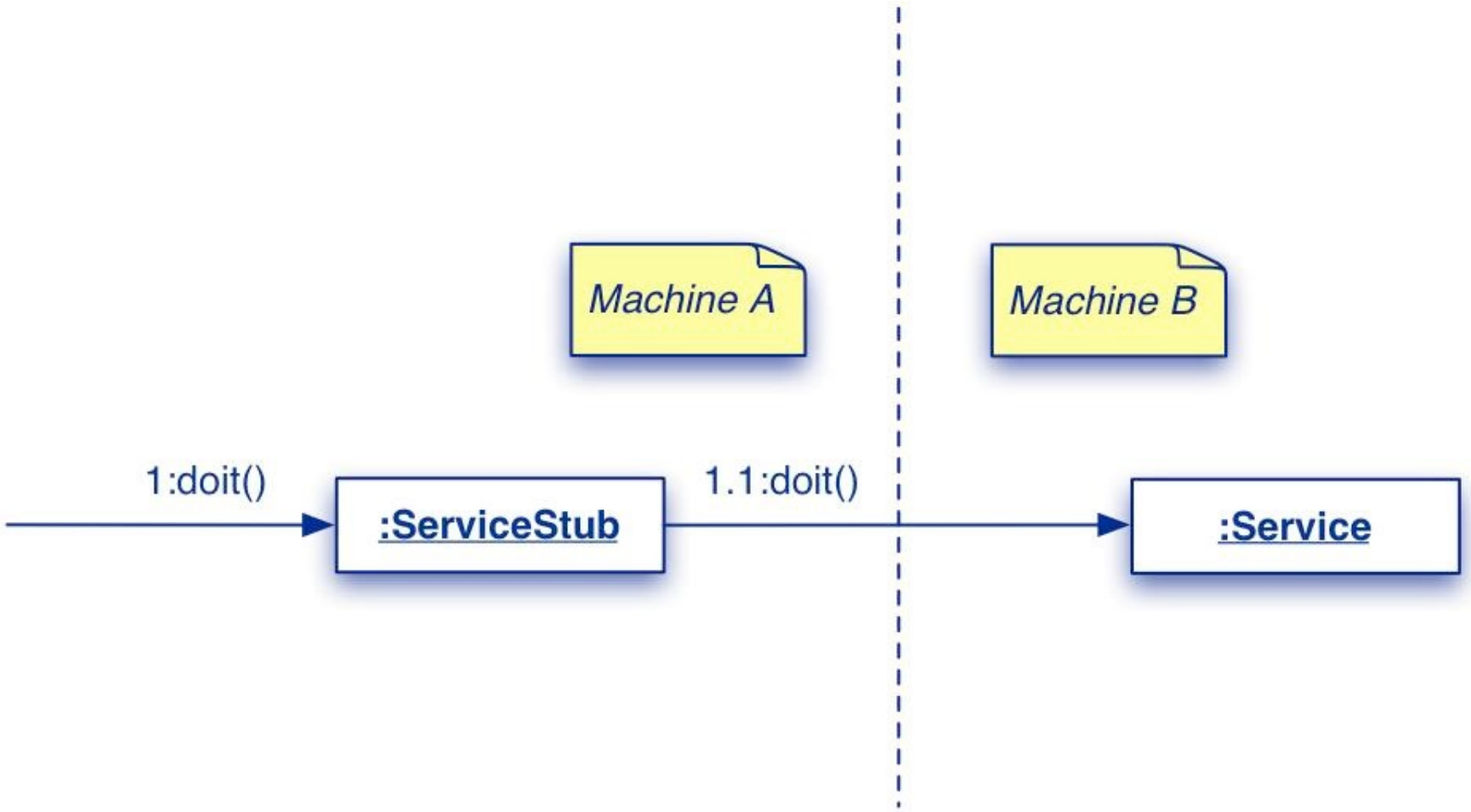
A Java “stub” for a remote object accessed by Remote Method Invocation (RMI)

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



Libraries for proxies

Java offers facilities to dynamically create type safe proxies

https://docs.oracle.com/javase/8/docs/technotes/guides/reflection/proxy.html

Remote object interaction

Remote Method Invocation (RMI) was popular some years ago

These days, *RESTful web services* are the way to go

- Use the HTTP protocol for communicating
- The client can be written in other language than Java
- Easy to put in place

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

Example

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*!

```
package obs;

import java.util.Observable;          //Observable is here
import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStreamReader;

public class EventSource extends Observable implements Runnable {
    public void run() {
        try {
            final InputStreamReader isr = new InputStreamReader( System.in );
            final BufferedReader br = new BufferedReader( isr );
            while( true ) {
                String response = br.readLine();
                setChanged();
                notifyObservers( response );
            }
        }
        catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

```
package obs;

import java.util.Observable;
import java.util.Observer;  /* this is Event Handler */

public class ResponseHandler implements Observer {
    private String resp;
    public void update (Observable obj, Object arg) {
        if (arg instanceof String) {
            resp = (String) arg;
            System.out.println("\nReceived Response: "+ resp );
        }
    }
}
```

```
package obs;

public class MyApp {
    public static void main(String args[]) {
        System.out.println("Enter Text >");

        // create an event source - reads from stdin
        final EventSource evSrc = new EventSource();

        // create an observer
        final ResponseHandler respHandler = new ResponseHandler();

        // subscribe the observer to the event source
        evSrc.addObserver( respHandler );

        // starts the event thread
        Thread thread = new Thread(evSrc);
        thread.start();
    }
}
```

Problem with Observer/Observable

As you can see, we need to use an `instanceof` and a downcast

This is a significant problem that was addressed since Java 9

You need to use the class `PropertyChangeSupport` and the interface `PropertyChangeListener` instead

In Java 9 and later

```
public class EventSource implements Runnable {

    private PropertyChangeSupport changes;

    public EventSource() {
        changes = new PropertyChangeSupport(this);
    }
    public void addObserver(ResponseHandler resp) {
        changes.addPropertyChangeListener(resp);
    }

    public void run() {
        try {
            // We declare two constant in the code
            // the final keyword forbid from later assignment
            final InputStreamReader isr = new InputStreamReader( System.in );
            final BufferedReader br = new BufferedReader( isr );
            while( true ) {
                String response = br.readLine();
                if(response.equals("quit")) return;

                changes.firePropertyChange(new PropertyChangeEvent(this, "entered
text", null, response));
            }
        }
        catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

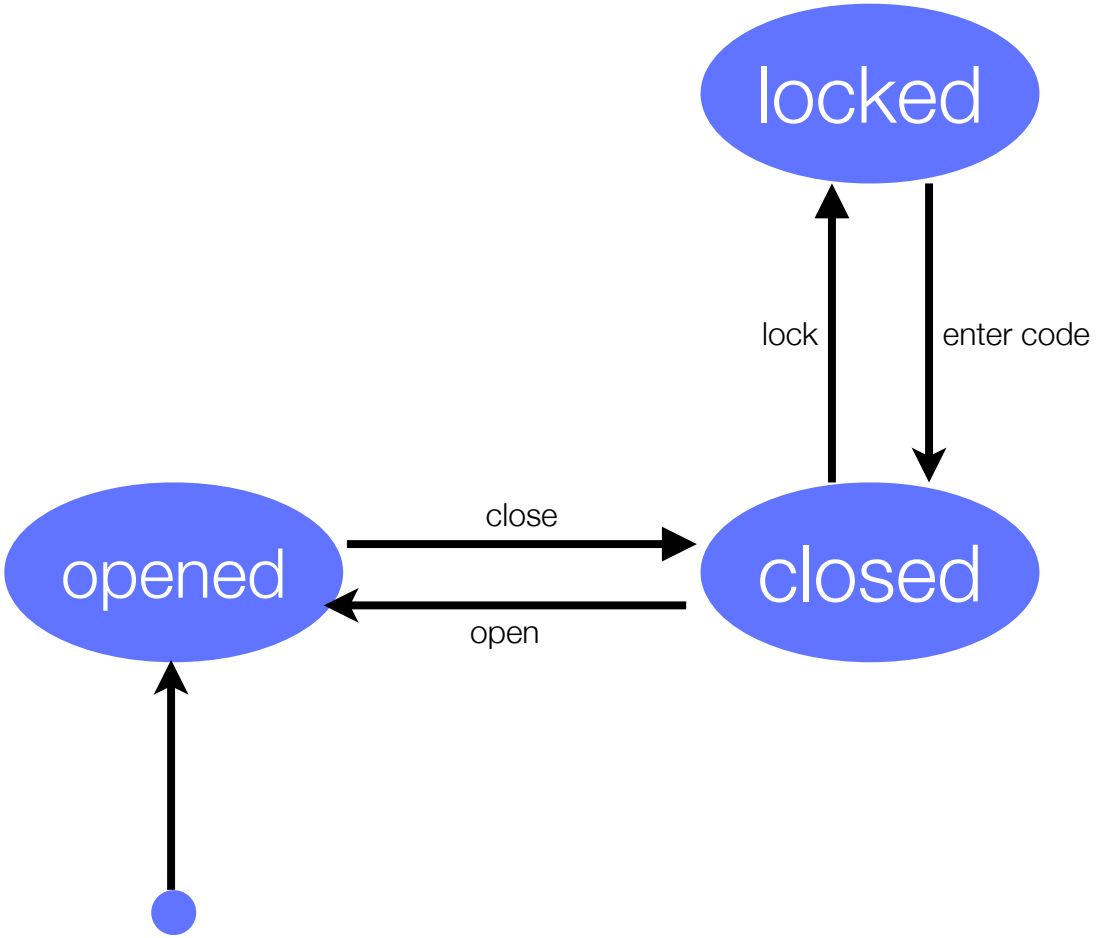
In Java 9 and later

```
public class ResponseHandler implements PropertyChangeListener {
    @Override
    public void propertyChange(PropertyChangeEvent evt) {
        System.out.println("\nReceived Response: "+ evt.getNewValue() );
    }
}
```

In Java 9 and later

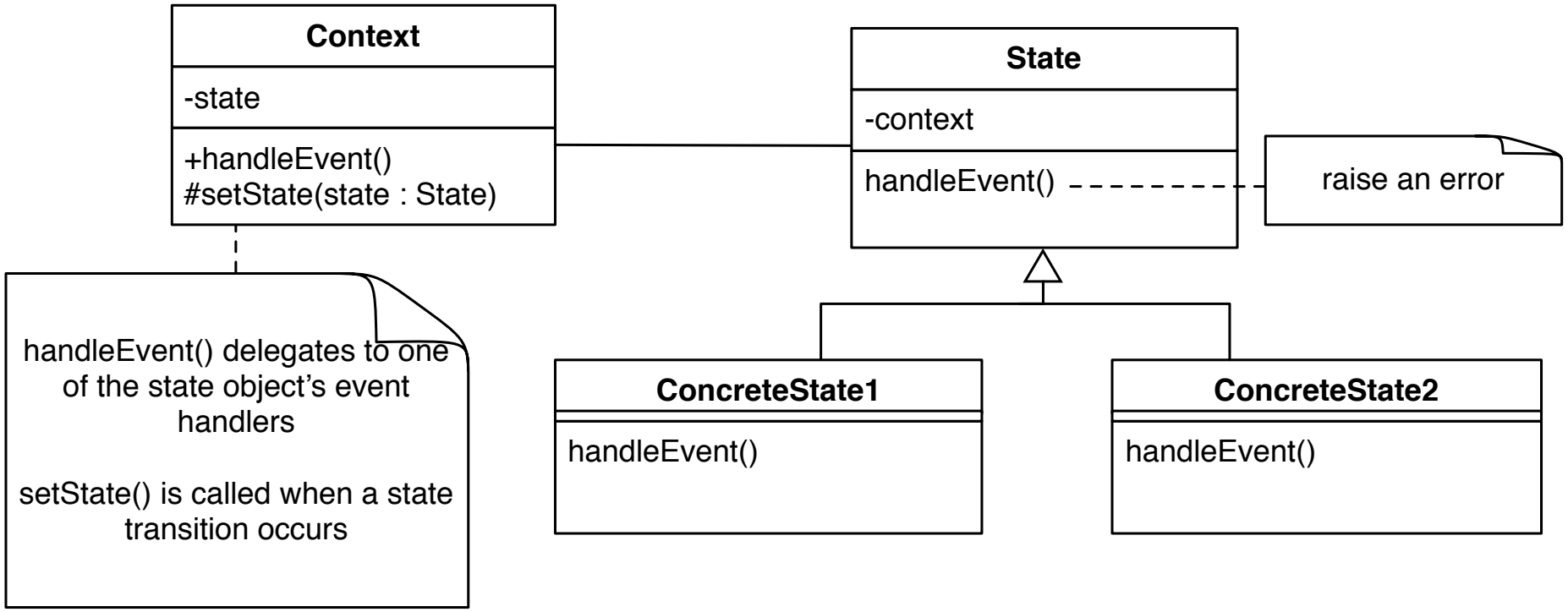
```
public class MyApp {
    public static void main(String args[]) {
        System.out.println("Enter Text >");

        // create an event source - reads from stdin
        final EventSource evSrc = new EventSource();

        // create an observer
        final ResponseHandler respHandler = new ResponseHandler();

        // subscribe the observer to the event source
        evSrc.addObserver(respHandler);

        // starts the event thread
        Thread thread = new Thread(evSrc);
        thread.start();
    }
```

Handling States



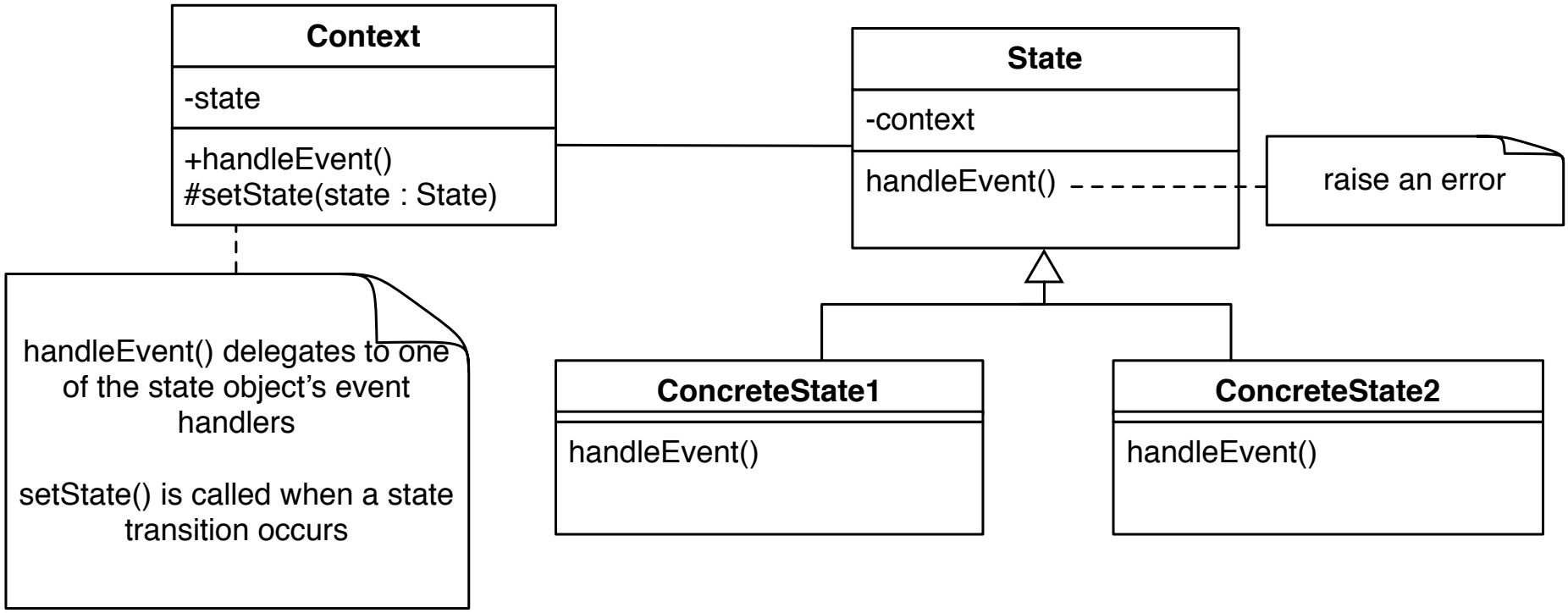
```
while ((line = in.readLine()) != null) {
   if (line.equals("open")){
      changeState(CLOSED, OPENED);
   }
   if (line.equals("close")){
      changeState(OPENED, CLOSED);
   }
   if (line.equals("lock")){
      changeState(CLOSED, LOCKED);
   }
   if (line.equals("unlock")){
      changeState(LOCKED, AWAITING_COMBINATION);
   }
   if (line.equals("combination")){
      changeState(AWAITING_COMBINATION, CLOSED);
   }
   if (line.equals("error")){
      changeState(AWAITING_COMBINATION, LOCKED);
   }
   this.prompt();
}
```

State Pattern - UML



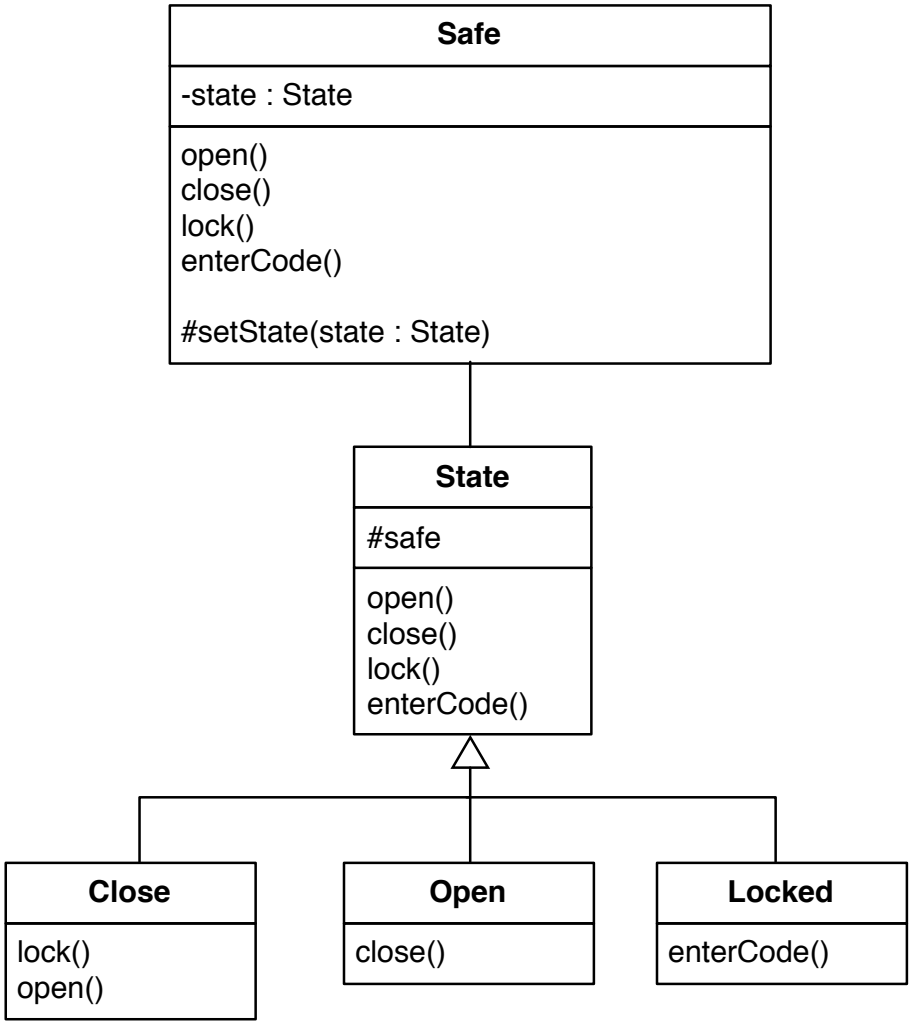
Context may be in a state ConcreteState1 or ConcreteState2

State Pattern - UML



Variant using an interface for State may be found in the literature.
However, using an interface leads to code duplication.

State Pattern Example



Each state is a separate object

```
public class Safe {
     private State state;

     public Safe () {
          this.setState(new Open());
     }

     void setState(State aState) {
          state = aState;
          state.setSafe(this);
     }

     public void open() { state.open(); }
     public void close() { state.close(); }
     public void lock() { state.lock(); }
     public void enterCode() { state.enterCode(); }

     public boolean isOpen() { return state.isOpen(); }
     public boolean isClosed() { return state.isClosed(); }
     public boolean isLocked() { return state.isLocked(); }
}
```

Each state is a separate object

```
public class State {
    private Safe safe;

    public void setSafe(Safe safe) {
        this.safe = safe;
    }

    protected void changeState(State state) {
        safe.setState(state);
    }

    void error() { throw new AssertionError("Wrong state"); }

    void open() { error(); }
    void close() { error(); }
    void enterCode() { error(); }
    void lock() { error(); }

    public boolean isOpen() { return false; }
    public boolean isClosed() { return false; }
    public boolean isLocked() { return false; }
}
```

Each state is a separate object

```
public class Open extends State {
     void close() { this.changeState(new Close()); }
     public boolean isOpen() { return true; }
}

public class Close extends State {
     void open() { this.changeState(new Open()); }
     void lock() { this.changeState(new Locked()); }
     public boolean isClosed() { return true; }
}

public class Locked extends State {
     void enterCode() { this.changeState(new Close()); }
     public boolean isLocked() { return true; }
}
```

Each state is a separate object

```
public class SafeTest {
    private Safe safe;

    @Before
    public void setUp() {
        safe = new Safe();
    }

    @Test
    public void testCreation() {
        assertTrue(safe.isOpen());
        assertFalse(safe.isClosed());
        assertFalse(safe.isLocked());
        safe.close();
        assertFalse(safe.isOpen());
        assertTrue(safe.isClosed());
        assertFalse(safe.isLocked());
    }
    …
}
```

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

What you should know!

What's wrong with *long methods*? How long should a method be?

When should you use *delegation* instead of *inheritance*?

How does a *Proxy* differ from an *Adapter*?

Can you give example for which it is beneficial to use a factory pattern?

Can you answer these questions?

What *patterns* do you use when you program?

What is the difference between an *interface* and an *abstract class*?

When should you use an *Adapter* instead of modifying the interface that does not fit?

In which situations the *factory pattern* is not appropriate?

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Original version of this lecture from Oscar Nierstrasz, Uni - Bern