Design Patterns
The Timeless Way of Coding

Designed and Presented by

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Illustrations by Edith Sher

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- Did PhD in Computer Science at the University of Cape Town, South Africa
- Trainer of Java and Design Patterns Courses in various places of the world
- Publish **The Java Specialists' Newsletter**
  - Only publication of its kind
  - Sent to over 100 countries
  - Archive on http://www.javaspecialists.co.za

Questions

- Please please please please ask questions!
- There are some stupid questions
  - They are the ones you didn't ask
  - Once you've asked them, they are not stupid anymore
- Assume that if you didn't understand something that it was my fault
- The more you ask, the more everyone learns (including me)

Structure of Talk

- Software Engineering
  - as it happens in the software factories
- How Design Patterns fit in
- Proxy Design Patterns
  - Demonstration: Virtual and security proxies with Java dynamic proxies
- Singleton Misunderstood (time permitting)
  - Common misconceptions with Singleton
- Discussion time

1. Software Engineering

- Why do companies want experience?
- What experience is most valuable?
- Experience in which language will guarantee you a job?

Classic Methodologies

- e.g. Waterfall Model: Analysis, Design, Implementation, Testing
- Suffered from “Analysis Paralysis”
- Bad decision during analysis very expensive
- Nice model for large teams with greatly varying skill-sets
- Each iteration takes months

Agile Methodologies

- e.g. eXtreme Programming
- All programming is done in pairs
  - For constant code reviewing, NOT mentoring
- Very short iterations (days or even hours)
- Testing is done several times a day
- Daily automated build and complete test
- Designing with Patterns
- Ruthless refactoring

Which Methodology to Use?

- Waterfall Model
  - One or two excellent analysts
  - Few good designers
  - Lots of average programmers
  - Suffers from “Peter Principle”
- eXtreme Programming
  - Between 6 and 12 **above** average programmers per team
  - Fosters cooperation, not competition in team
  - Low staff turnover
  - Chaos if not strictly managed!!!

Typical Day as Programmer

08:00 Arrive at work

08:30 Had first cup of coffee, erased SPAM

09:00 Chatted with coworker about soccer

10:00 Had project status meeting

11:00 Thought about design problems (Whilst playing minesweeper)

12:30 Looked at some critical bugs for important customer

13:30 Finished playing “Battlefield 1942” with colleagues

15:00 Wrote 200 lines of VB code, answered 5 phone calls

16:30 Company meeting entitled “Be more productive”

17:30 Wrote emails to bosses and colleagues (and friends)

23:30 Time to go home – finished writing TCP/IP stack in assembler

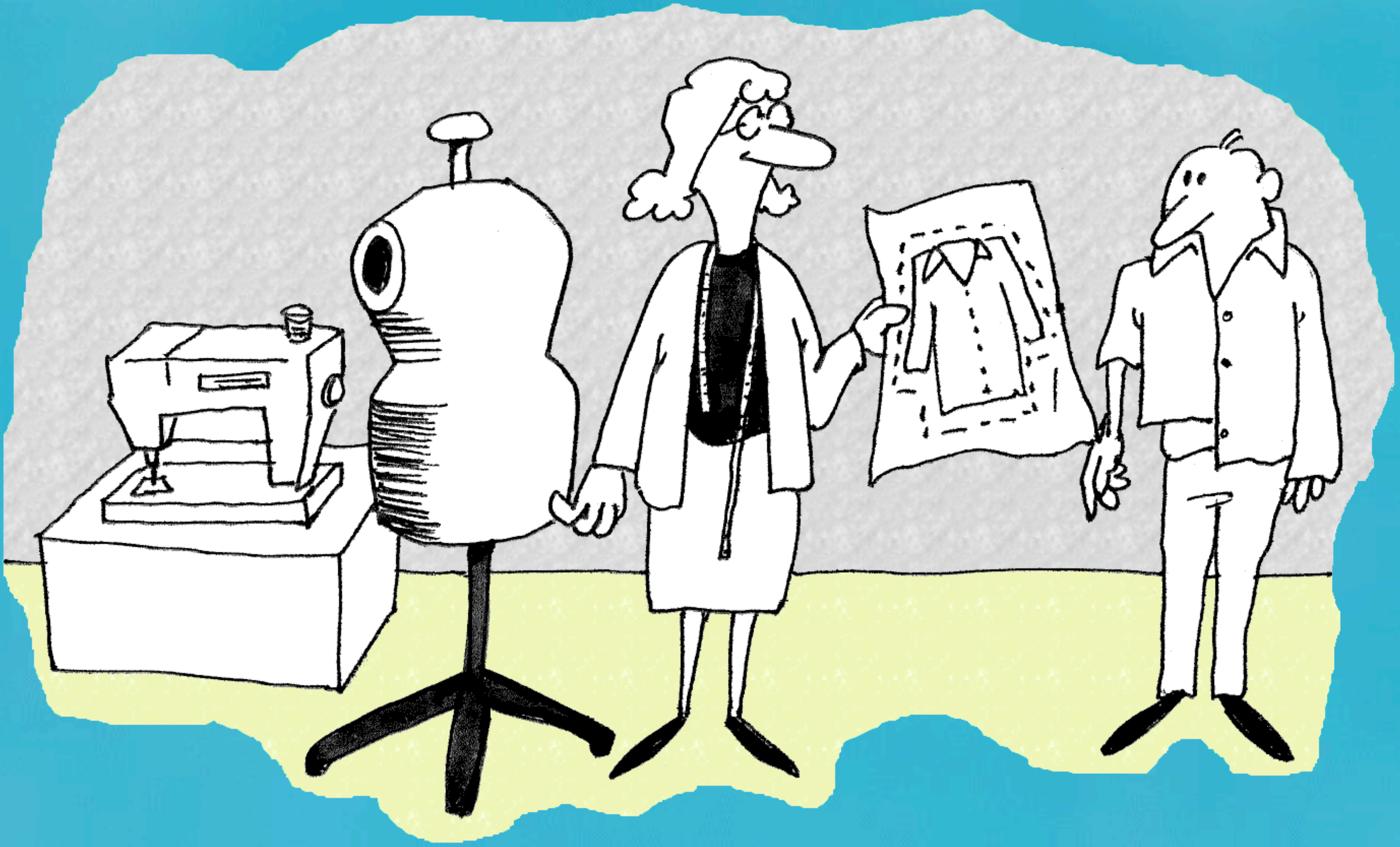
Programming is a Minority Task

- Most of your time is spent in:
  - Meetings
  - Documentation
  - Planning
  - Testing, bug fixing & support
  - Email
- Even brilliant programmers have to communicate!

Design Language can Help

- Meetings
  - Communicate more effectively about your designs to colleagues
- Documentation
  - Code documentation can refer to Design Pattern
- Planning
  - You can talk in higher-level components
- Testing, bug fixing & support
  - Better designs will reduce bugs and make code easier to change

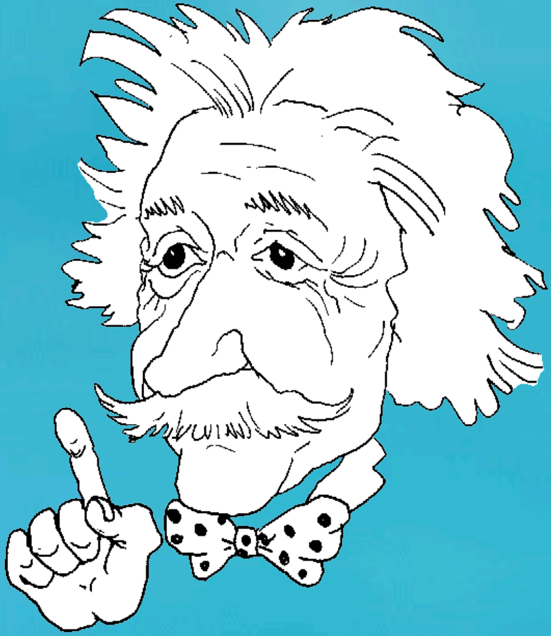
2: Introduction to Patterns



Vintage Wines

- Design Patterns are like good red wine
  - You cannot appreciate them at first
  - As you study them you learn the difference between table wine and vintage
  - As you become a connoisseur you experience the various textures you didn't notice before
- Warning: Once you are hooked, you will no longer be happy with plain table wine!

Why are patterns so important?



- Provide a view into the brains of OO experts
- Help you understand existing designs
- Patterns in Java, Volume 1, Mark Grand writes
  - "What makes a bright, experienced programmer much more productive than a bright, but inexperienced, programmer is experience."

Design Patterns Origin

The Timeless Way of Building

Christopher Alexander

There is a central quality which is the root criterion of life and spirit in a man, a town, a building, or a wilderness.

If you want to make a living flower, you don't build it physically, with tweezers, cell by cell. You grow it from the seed.

Textbook – "Design Patterns"

- "Design Patterns" book by Gang of Four (GoF)
- Contains a collection of basic "patterns" that experienced OO developers use regularly
- Cannot proceed very far in Java, C#, VB.NET without understanding patterns
- Facilitates better communication
- Based on work of renegade architect Christopher Alexander in "The Timeless Way of Building"

What’s in a name?

The Timeless Way of Building

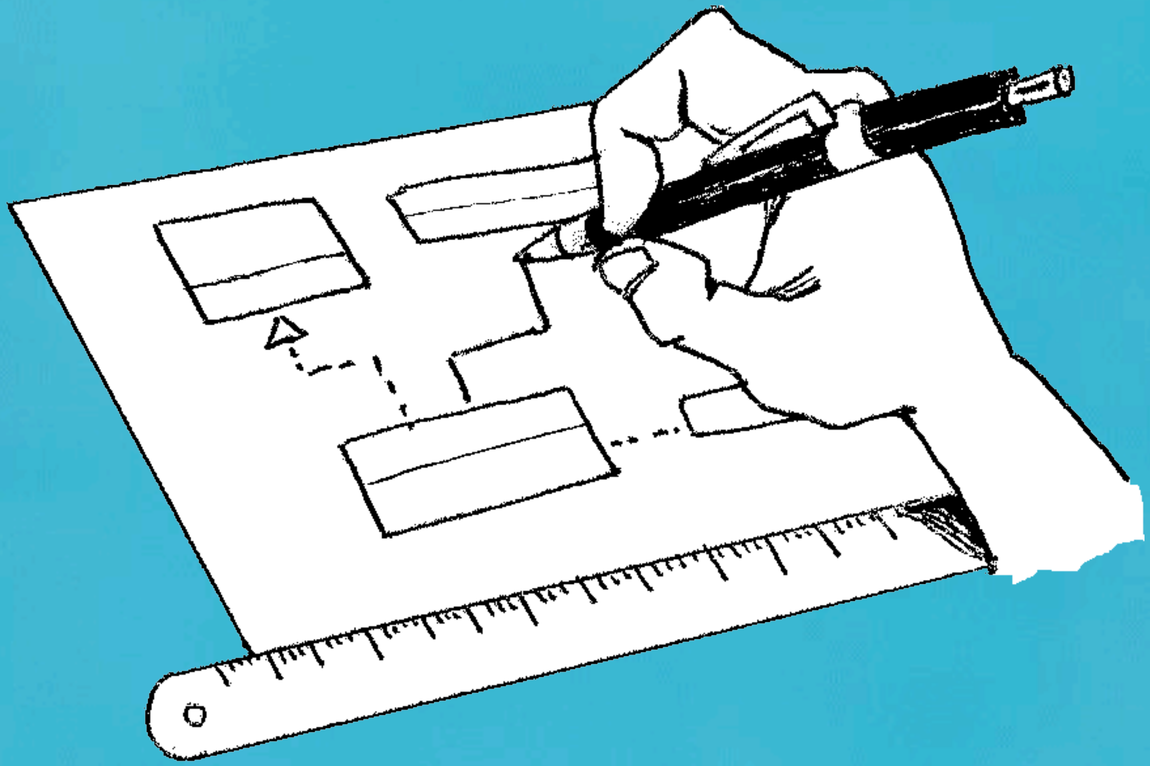
The search for a name is a fundamental part of the process of inventing or discovering a pattern.

So long as a pattern has a weak name, it means that it is not a clear concept, and you cannot tell me to make “one”.

Why do we need a diagram?

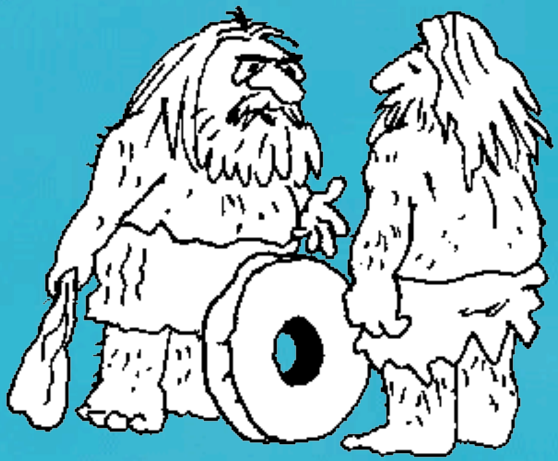
The Timeless Way of Building

If you can't draw a [class] diagram of it, it isn't a pattern



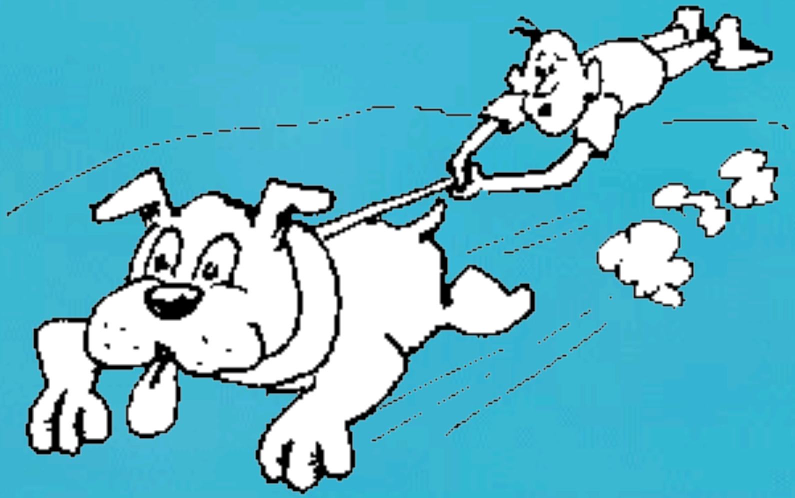
Misuse of Design Patterns

- Patterns Misapplied
  - “design” patterns should not be used during analysis
- Cookie Cutter Patterns
  - patterns are generalised solutions
- Misuse By Omission
  - reinventing a crooked wheel

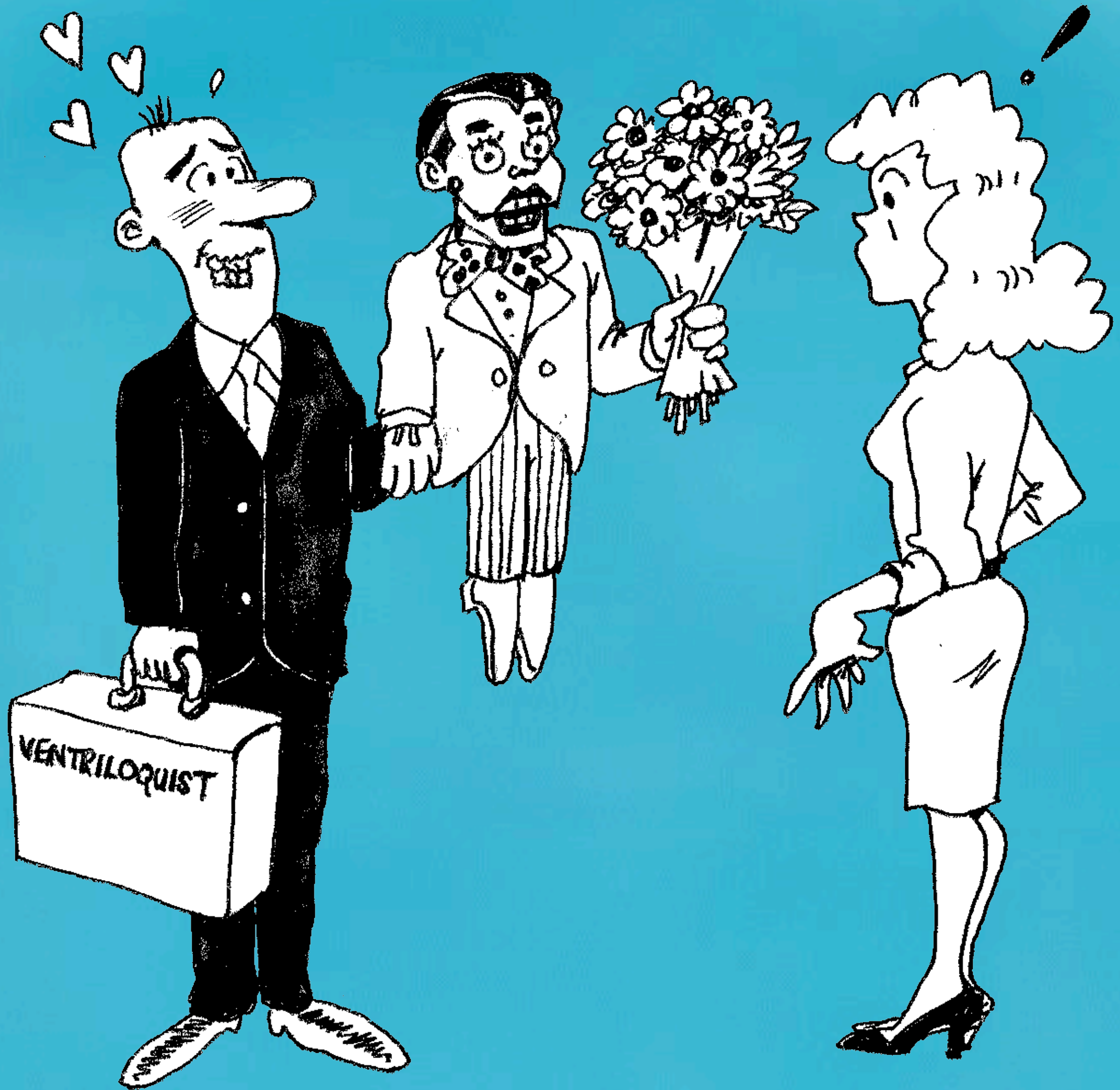


Summary

- Object Orientation is here to stay
- Design Patterns will fast-track you in learning how to design with objects

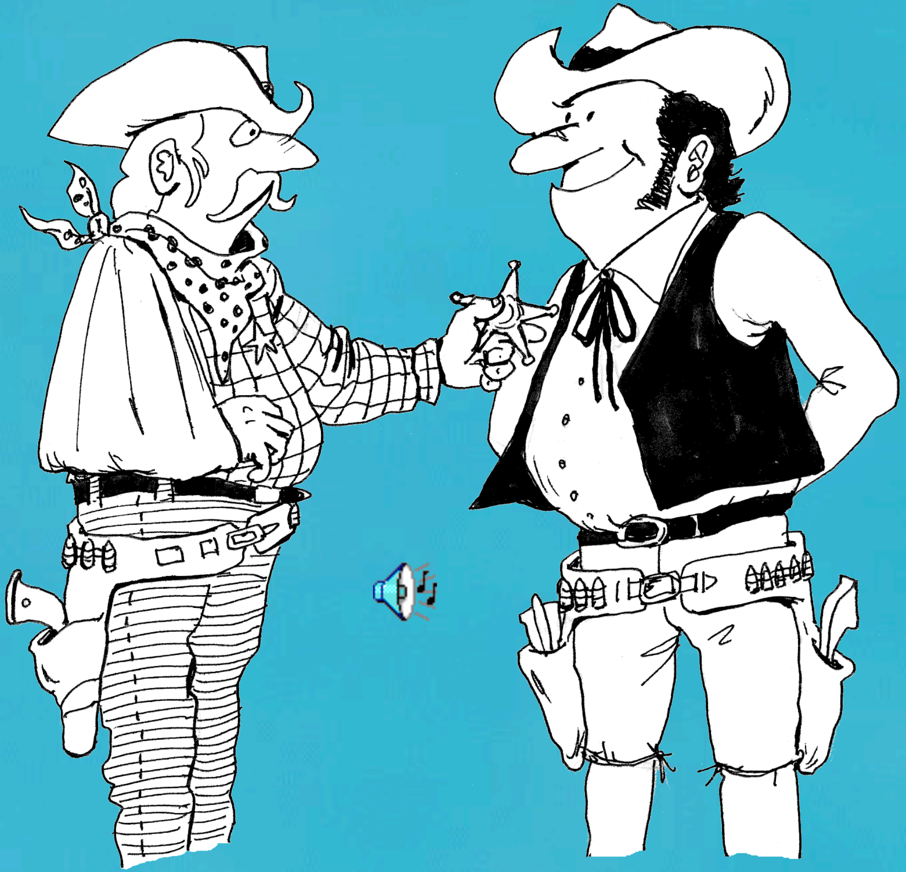


3: Proxy

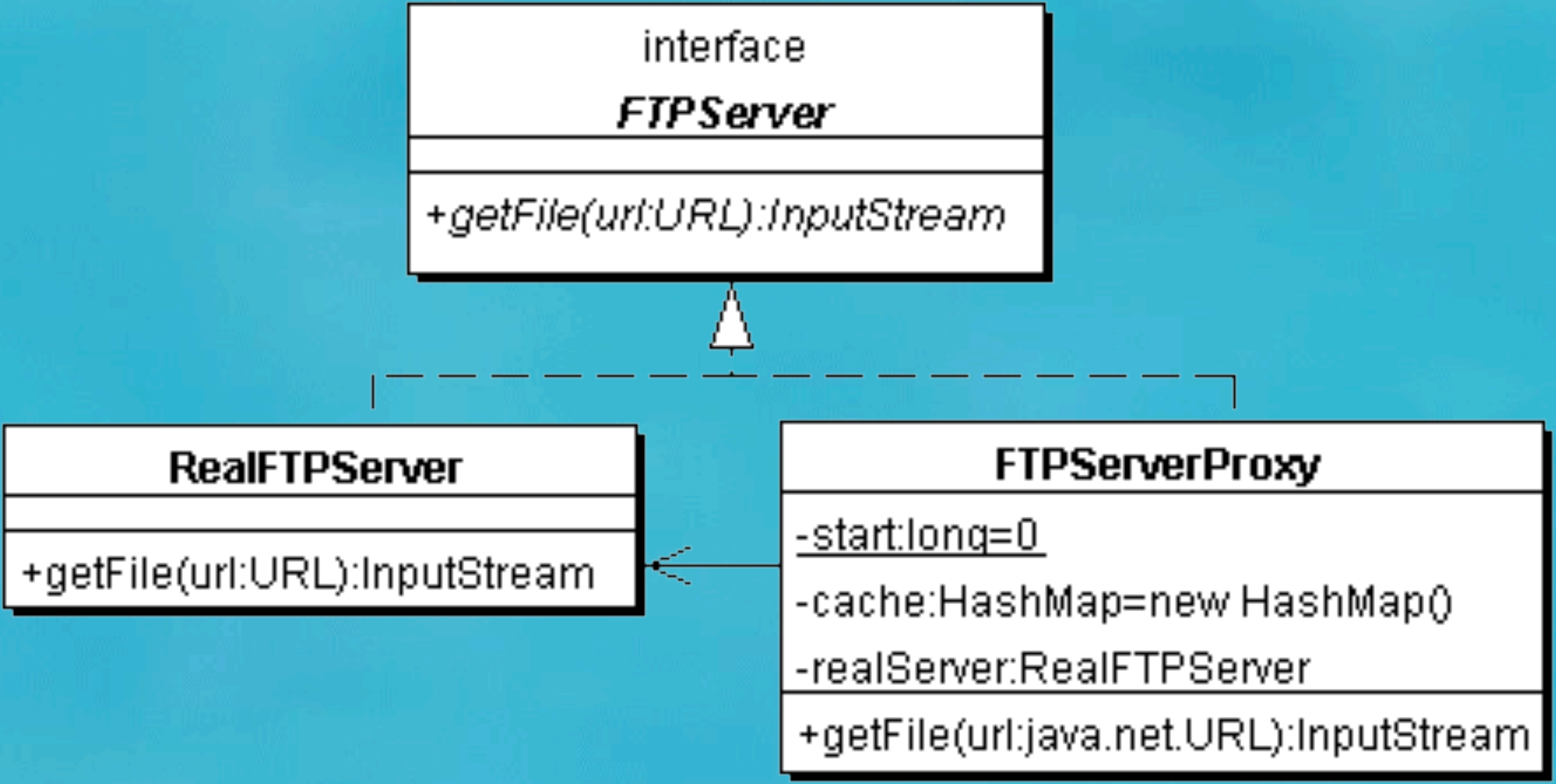


Proxy

- Intent
  - Provide a surrogate or placeholder for another object to control access to it.
- Also known as
  - Surrogate



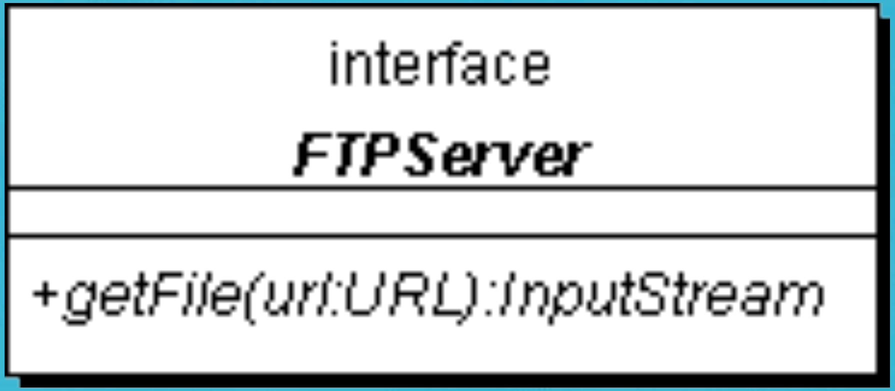
Motivation: Proxy


interface
FTPServer
+getFile(url:URL):InputStream
RealFTPServer
+getFile(url:URL):InputStream
FTPServerProxy
-start:long=0
-cache:HashMap=new HashMap()
-realServer:RealFTPServer
+getFile(url:java.net.URL):InputStream

FTPServer interface

- Defines a common method “getFile”

```
import java.net.URL;
import java.io.*;

public interface FTPServer {
  public InputStream getFile(URL url)
    throws IOException;
}
```



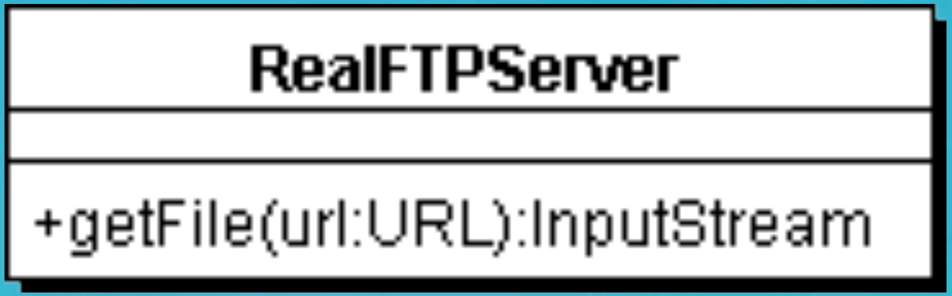
interface

FTPServer

+getFile(url:URL):InputStream

RealFTPServer

- Reading a file across the network
- Implements FTPServer interface



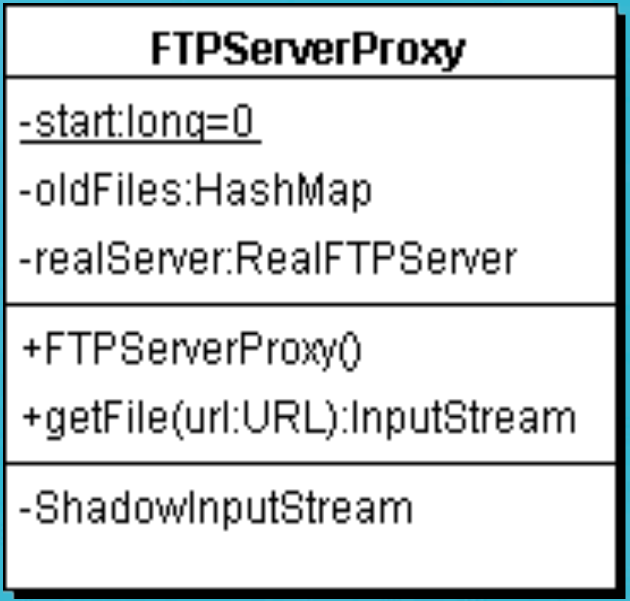
RealFTPServer

+getFile(url:URL):InputStream

```
import java.net.*;
import java.io.*;

public class RealFTPServer implements FTPServer {
  public InputStream getFile(URL url)
      throws IOException {
    System.out.println(
      "Getting file from real FTP Server");
    return url.openStream();
  }
}
```

FTPServerProxy

- Fetches files from RealFTPServer and writes them to disk with ShadowInputStream
- Next time the same file is requested it is returned directly
  from the disk
- Speeds up file retrieval



FTPServerProxy

-start:long=0

-oldFiles:HashMap

-realServer:RealFTPServer

+FTPServerProxy()

+getFile(url:URL):InputStream

-ShadowInputStream

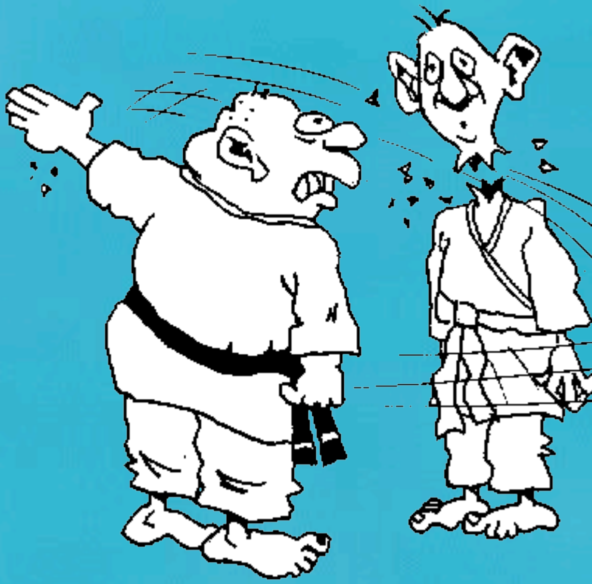
```
import java.util.*;
import java.io.*;
public class FTPServerProxy implements FTPServer {
  private static long cacheID = 0;
  private HashMap cache = new HashMap();
  private RealFTPServer realServer =
    new RealFTPServer();
  // write file to local disk as it gets read
  public InputStream getFile(java.net.URL url)
      throws IOException {
    if (cache.containsKey(url)) {
      System.out.println("Getting file from cache");
      return new FileInputStream(
        (String)cache.get(url));
    }
    String filename = cacheID++ + ".cache";
    cache.put(url, filename);
    return new ShadowInputStream(
      realServer.getFile(url),
        new FileOutputStream(filename));
  }
```

```java
// Copies the bytes read from the InputStream to the
// specified OutputStream
class ShadowInputStream extends FilterInputStream {
  private final OutputStream out;
  public ShadowInputStream(InputStream in,
      OutputStream out) {
    super(in);
    this.out = out;
  }
  public int read() throws IOException {
    int result = super.read();
    if (result != -1) out.write(result);
    return result;
  }
  public int read(byte[] buf, int offset, int length)
      throws IOException {
    int result = super.read(buf, offset, length);
    if (result != -1) out.write(buf, offset, result);
    return result;
  }
```

```
    public void close() throws IOException {
      super.close();
      out.close();
    }
  } // end of class ShadowInputStream
} // end of class FTPServerProxy
```

Not Robust Enough

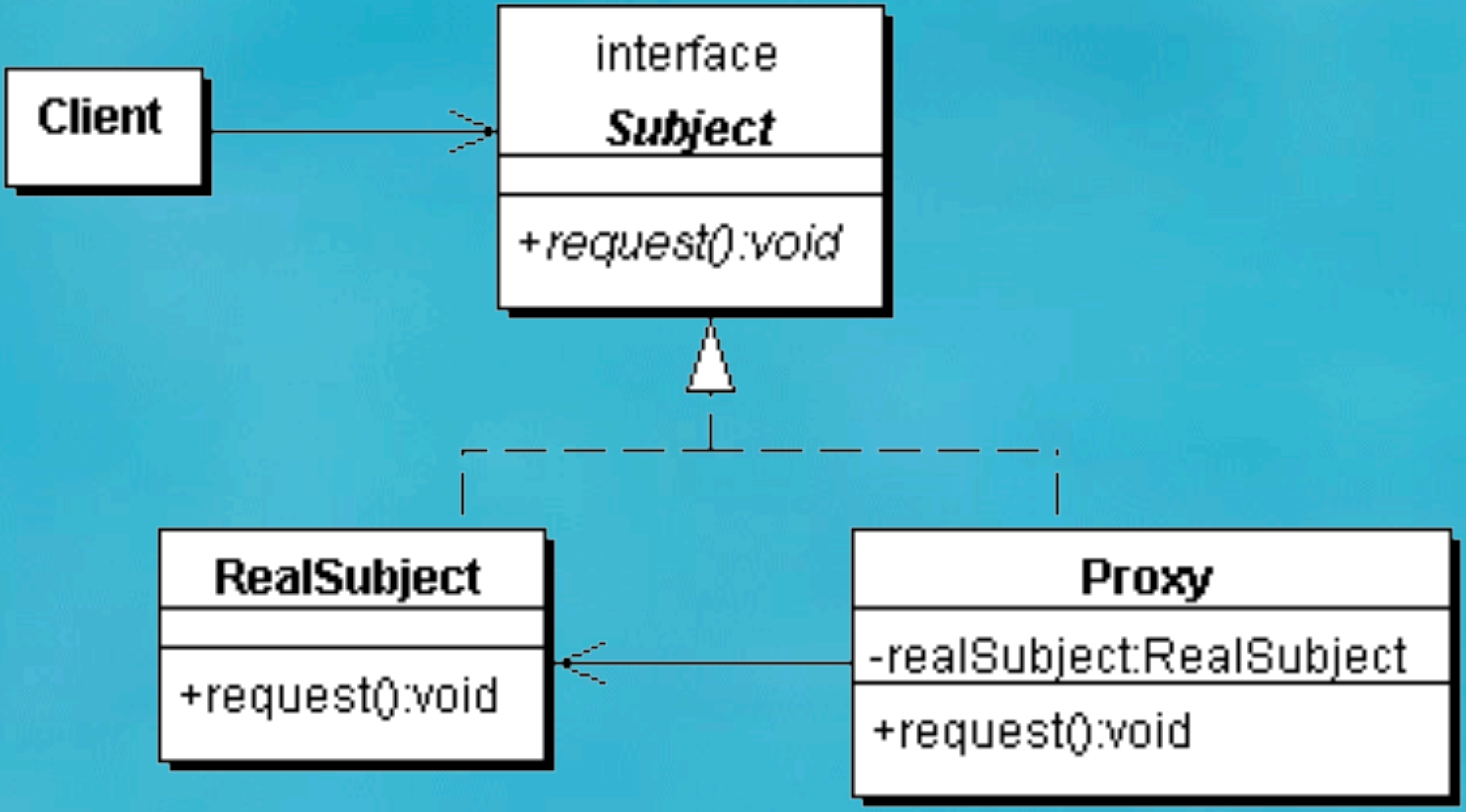
- There should be a facility for deleting older files
- Partial reads should be resumed
- Can’t handle simultaneous connections for some URL
- Versions of URLs
- Code was kept “simple”



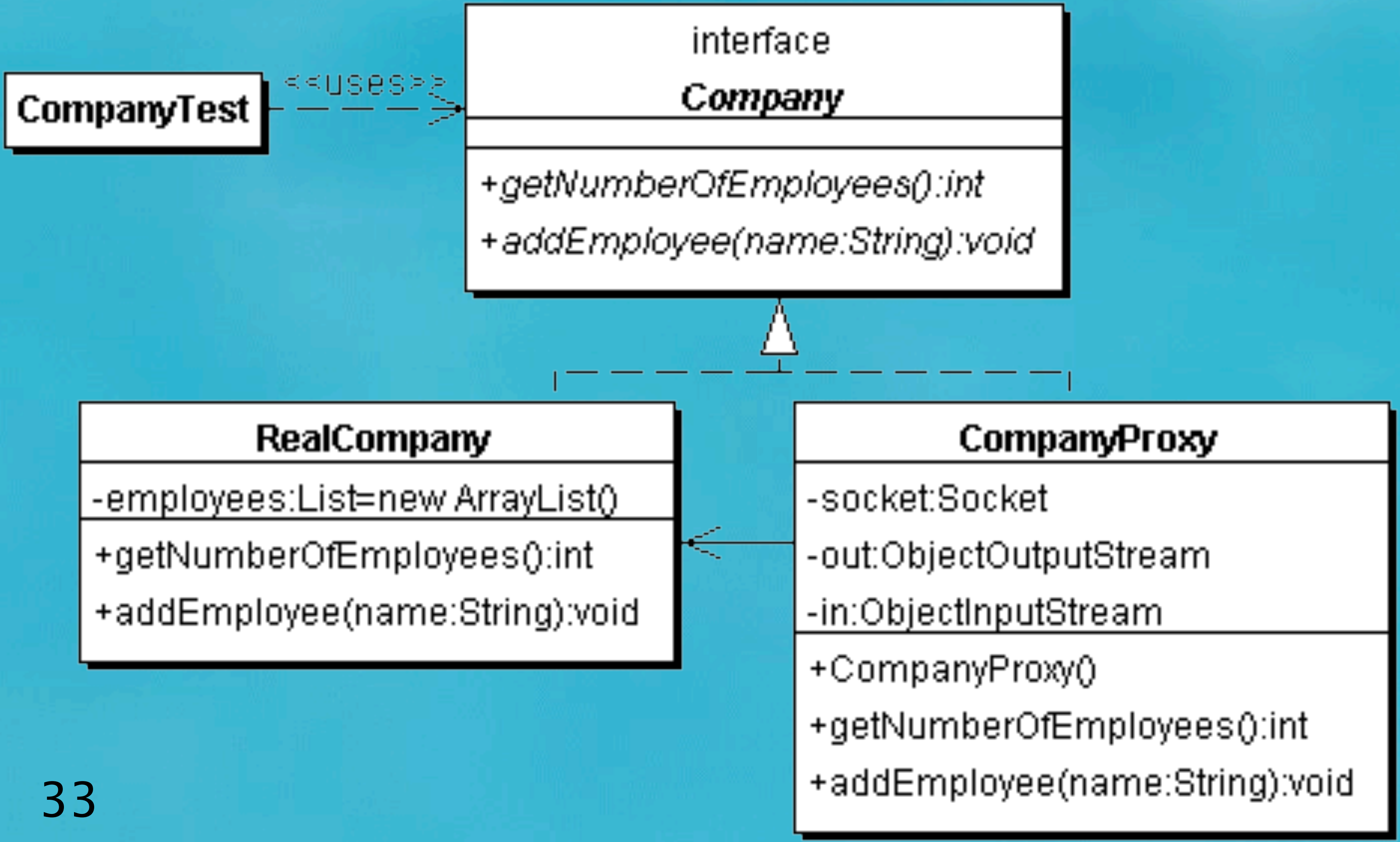
Applicability: Proxy

- Virtual Proxy
  - creates expensive objects on demand
- Remote Proxy
  - provides a local representation for an object in a different address space
- Protection Proxy
  - controls access to original object

Structure: Proxy



Remote Proxy


CompanyTest
<<uses>>
interface
Company
+getNumberOfEmployees():int
+addEmployee(name:String):void
RealCompany
-employees:List=new ArrayList()
+getNumberOfEmployees():int
+addEmployee(name:String):void
CompanyProxy
-socket:Socket
-out:ObjectOutputStream
-in:ObjectInputStream
+CompanyProxy()
+getNumberOfEmployees():int
+addEmployee(name:String):void

```
public interface Company {
  int getNumberOfEmployees();
  void addEmployee(String name);
}

// The “RealCompany” would typically be an object
// contained by an EJB container or RMI server
import java.util.*;
public class RealCompany implements Company {
  private List employees = new ArrayList();
  public int getNumberOfEmployees() {
    return employees.size();
  }
  public void addEmployee(String name) {
    employees.add(name);
  }
}
```

```java
public class CompanyProxy implements Company {
  // various data members for network comms
  public int getNumberOfEmployees() {
    // send a message over the network to fetch
    // the value from the RealCompany class
    // sitting on the server
  }
  public void addEmployee(String name) {
    // send a message over the network to create
    // an employee in the remote company
  }
  // etc.
}
```

```
public class CompanyTest {
  public static void main(String[] args)
      throws java.io.IOException {
    Company company = new CompanyProxy();
    company.addEmployee("John Smith");
    System.out.println("Now there are " +
      company.getNumberOfEmployees() +
      " employees");
  }
}
```

Our client code can talk to the **Company** as if it were a local object

Consequences: Proxy

- Introduces level of indirection when accessing an object
  - A remote proxy can hide the fact that an object resides in a different address space
  - A virtual proxy can perform optimizations such as creating an object on demand
- The proxy and the real subject are objects of different types
  - Make sure equals(Object) caters for this!
- Another optimization is copy-on-write
  - e.g. `java.lang.StringBuffer`

Known Uses in Java: Proxy

- Remote proxies created transparently by **rmic** tool for Remote Method Invocation (RMI) mechanism
- EJB deployment tools call **rmic** transparently
- JDK 1.3 has support for dynamic proxies
  - Can add a proxy to a live object
  - Covered in “The Java™ Specialists’ Newsletter”

Questions: Proxy

- You have designed a Java server that connects to a database. If several clients connect to your server at once, how could Proxies be of help?
- If a Proxy is used to control access to another object, does the Proxy simplify code?

Exercises: Proxy

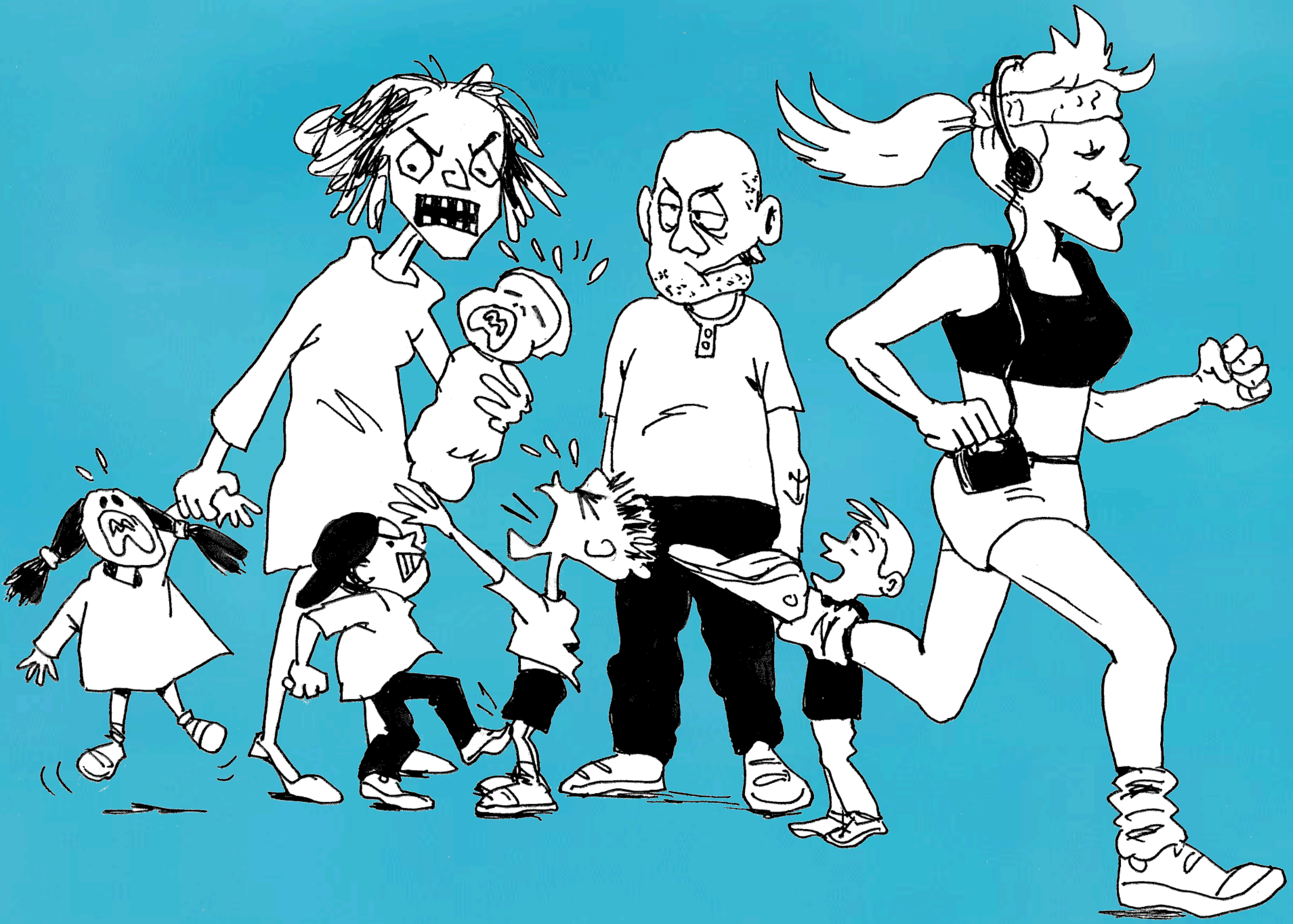
- Consider the following Employee classes. Write a SecureEmployee class which implements the Employee interface, but checks that the SecurityManager allows access to salaries. Test it against the EmployeeTest class.

```
public interface Employee { // the Subject
  /**@throws SecurityException if access denied */
  double getSalary();
}
public class RealEmployee implements Employee {
  public double getSalary() {
    return 321444.22;
  }
}
```

Exercises: Proxy

```
public class SecurityManager {
  private static boolean salary;
  public static void setSalaryPermission(
    boolean val) {salary = val;}
  public static void checkSalaryPermission() {
    if (!salary) throw new SecurityException();
  }
}
public class EmployeeTest {
  public static void main(String[] args) {
    Employee maxi = new SecureEmployee(
      new RealEmployee());
    SecurityManager.setSalaryPermission(true);
    System.out.println(maxi.getSalary());
    SecurityManager.setSalaryPermission(false);
    System.out.println(maxi.getSalary());
  }
}
```

4. Singleton

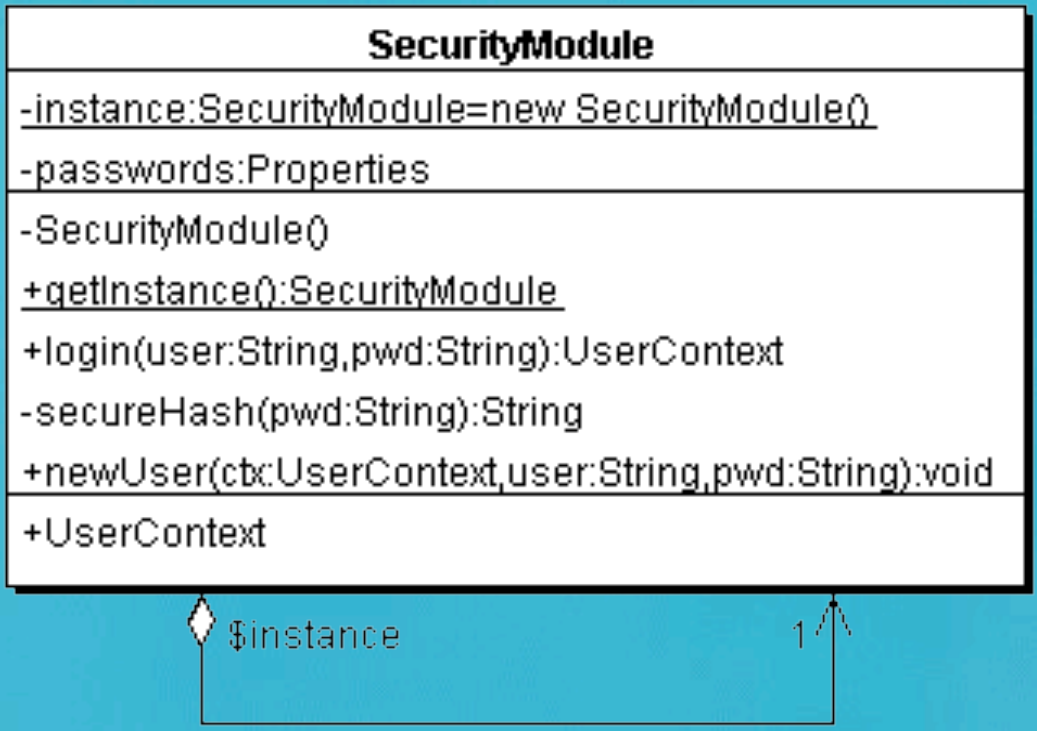


Singleton

- Intent
  - Ensure a class only has one instance, and provide a global point of access to it.

Motivation: Singleton

- It’s important for some classes to have exactly **one** instance, e.g. SecurityModule



SecurityModule

-instance:SecurityModule=new SecurityModule()

-passwords:Properties

-SecurityModule()

+getInstance():SecurityModule

+login(user:String,pwd:String):UserContext

-secureHash(pwd:String):String

+newUser(ctx:UserContext,user:String,pwd:String):void

+UserContext

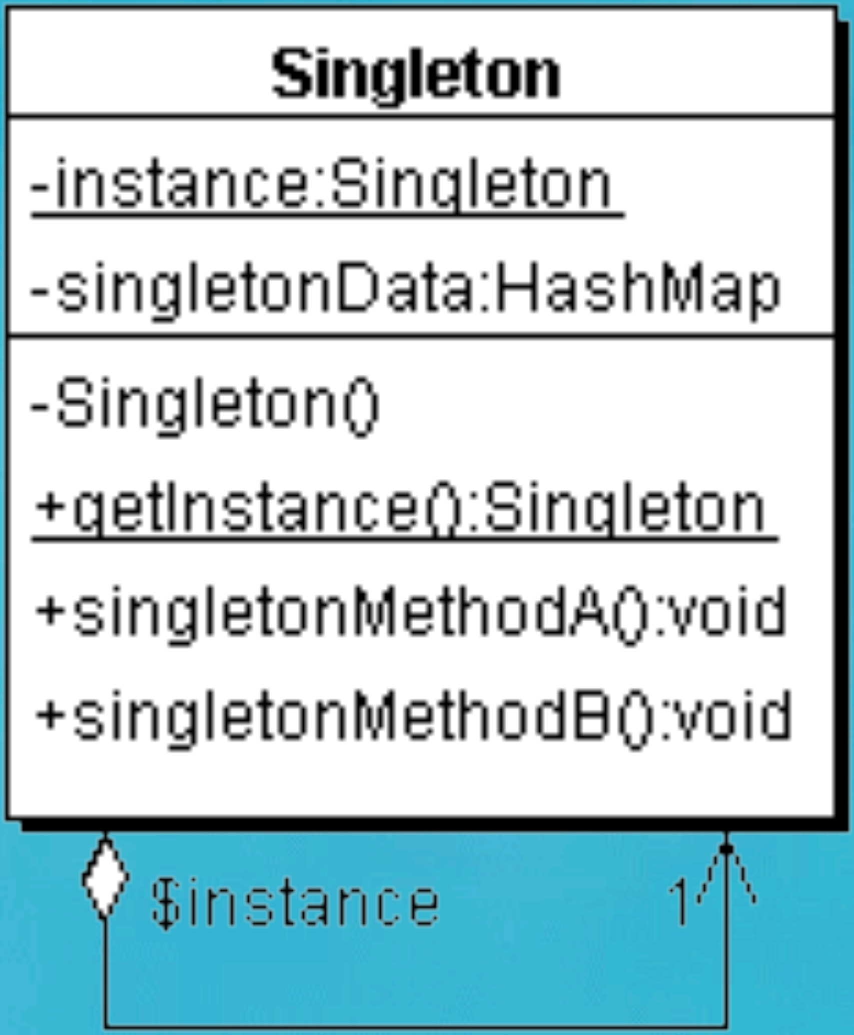
Sample Code: Singleton

```
public class SecurityModule {
  private static SecurityModule instance =
    new SecurityModule();

  public static SecurityModule getInstance() {
    return instance;
  }

  private SecurityModule() {
    loadPasswords();
  }

  public UserContext login(String username,
      String password) {
    return new UserContext(username, password);
  }

  // etc.
```

Applicability: Singleton

- Use the Singleton pattern when
  - there must be exactly one instance of a class, and it must be accessible to clients from a well-known access point.
  - when the sole instance should be extensible by subclassing, and clients should be able to use an extended instance without modifying their code.

Structure: Singleton



Singleton

-instance:Singleton

-singletonData:HashMap

-Singleton()

+getInstance():Singleton

+singletonMethodA():void

+singletonMethodB():void

Consequences: Singleton

- Benefits
  - Controlled access to sole instance
  - Reduced name space
  - Permits refinement of operations and representation
  - Permits a variable number of instances
  - More flexible than class operations
- Drawbacks
  - Overuse can make a system less OO.

Known Uses in Java: Singleton

- java.lang.Runtime.getRuntime()
- java.awt.Toolkit.getDefaultToolkit()

Questions: Singleton

- The pattern for Singleton uses a private constructor, thus preventing extendability. What issues should you consider if you want to make the Singleton “polymorphic”?
- Sometimes a Singleton needs to be set up with certain data, such as filename, database URL, etc. How would you do this, and what are the issues involved?

Exercises: Singleton

- Turn the following class into a Singleton:

```
public class Earth {
  public static void spin() {}
  public static void warmUp() {}
}

public class EarthTest {
  public static void main(String[] args) {
    Earth.spin();
    Earth.warmUp();
  }
}
```

- Now change it to be extendible

5. Conclusion

- Software Engineering is essential for developing solid programs
- Architecture, Design, Performance all play a part

6. Some Thoughts

- Greece
  - Full member of the European Union
  - You can work in Germany, France, Netherlands, Belgium
- Entrepreneurship
  - Would you like to become a space tourist?
    - (Cost $ 20,000,000 for one flight)
  - Young means small expenses
  - Don’t work for someone – start your own companies!
    - Develop good products sold internationally

Body Shops

- Hundreds of underpaid programmers developing software for USA Germany UK
- Eastern Europe very cheap
  - $10 per hour
- India Wipro has 10,000 Java developers!
- Intel Science & Engineering Fair
  - Largest pre-university science competition
  - America: 65,000
  - China: 6,000,000
- **Greece cannot compete at that level!**

Innovation, Innovation

- Develop own ideas
- Start own companies
- Write the products, market them, sell them
- No one needs to know where software was produced
  - And no one cares either
- E.g. Thawte Consulting
  - Started in parent's garage, sold for $600,000,000
- E.g. The Java™ Specialists' Newsletter
  - Reaching over 100 countries!

Crete

- Crete is an excellent base from which to work
- Sunshine, beauty, friendly people
- Good quality of life
- Close to everywhere in Europe
- Access to internet
- Expenses low

Future

- We plan to move to Crete in the near future God willing

The Java™ Specialists' Newsletter

Produced on the beautiful island of Crete

- See you soon!

Design Patterns Cape Town

Design Patterns Germany

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