Design Patterns

Prof. Dr. Dirk Riehle

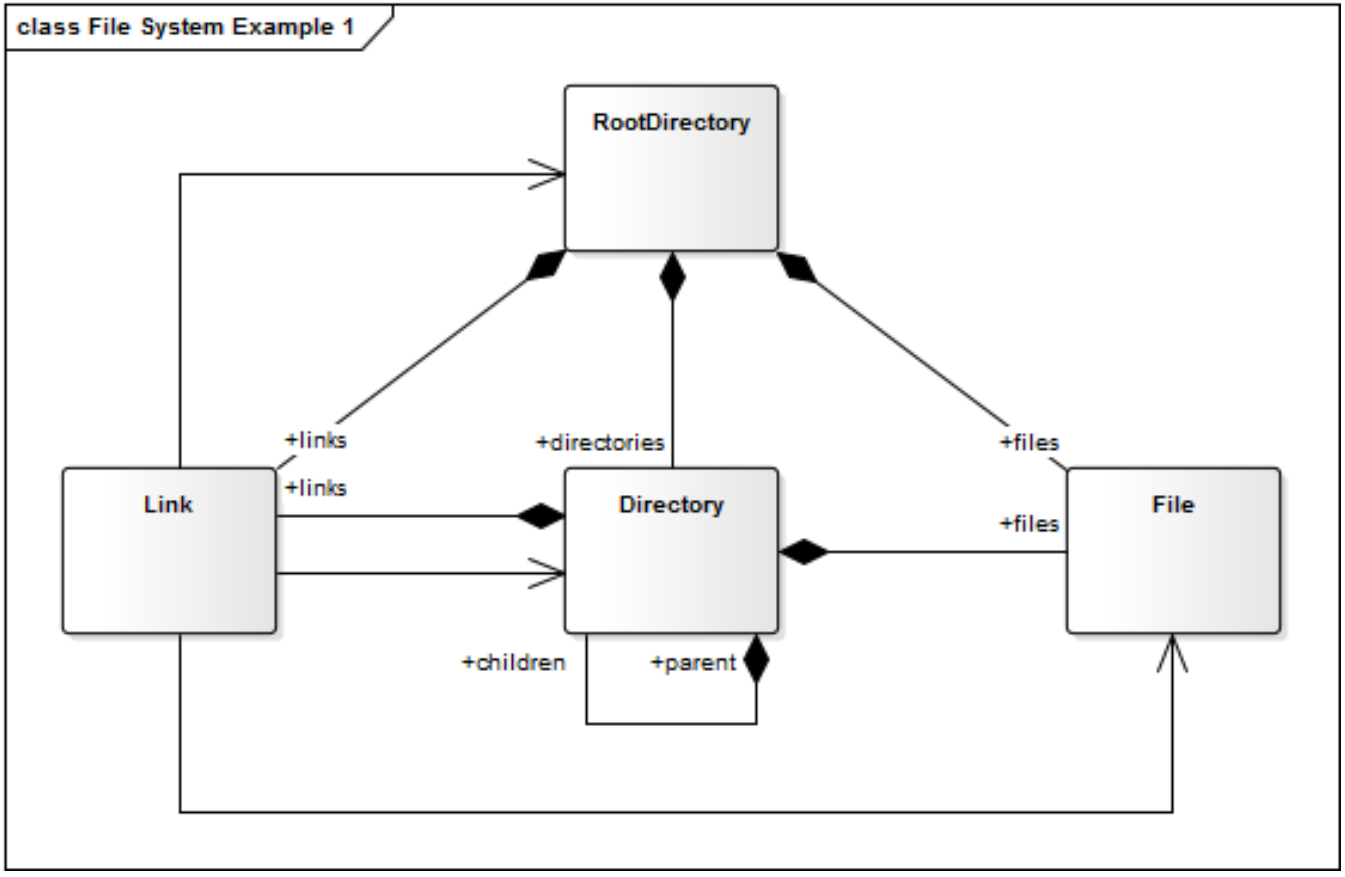
Friedrich-Alexander University Erlangen-Nürnberg

ADAP C08

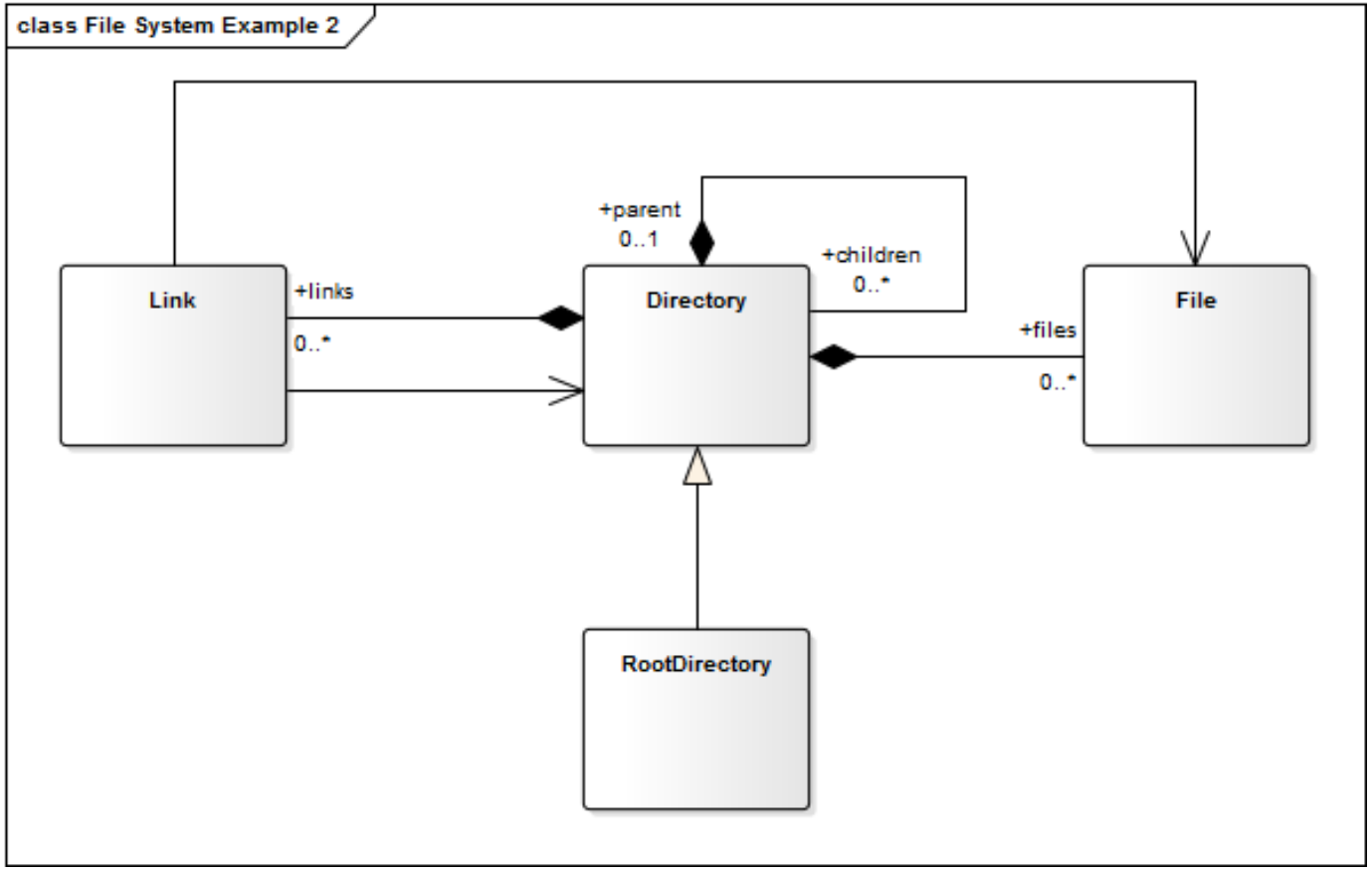
Three Examples

1. File / Directory
2. Position / Portfolio
3. TestCase / TestSuite

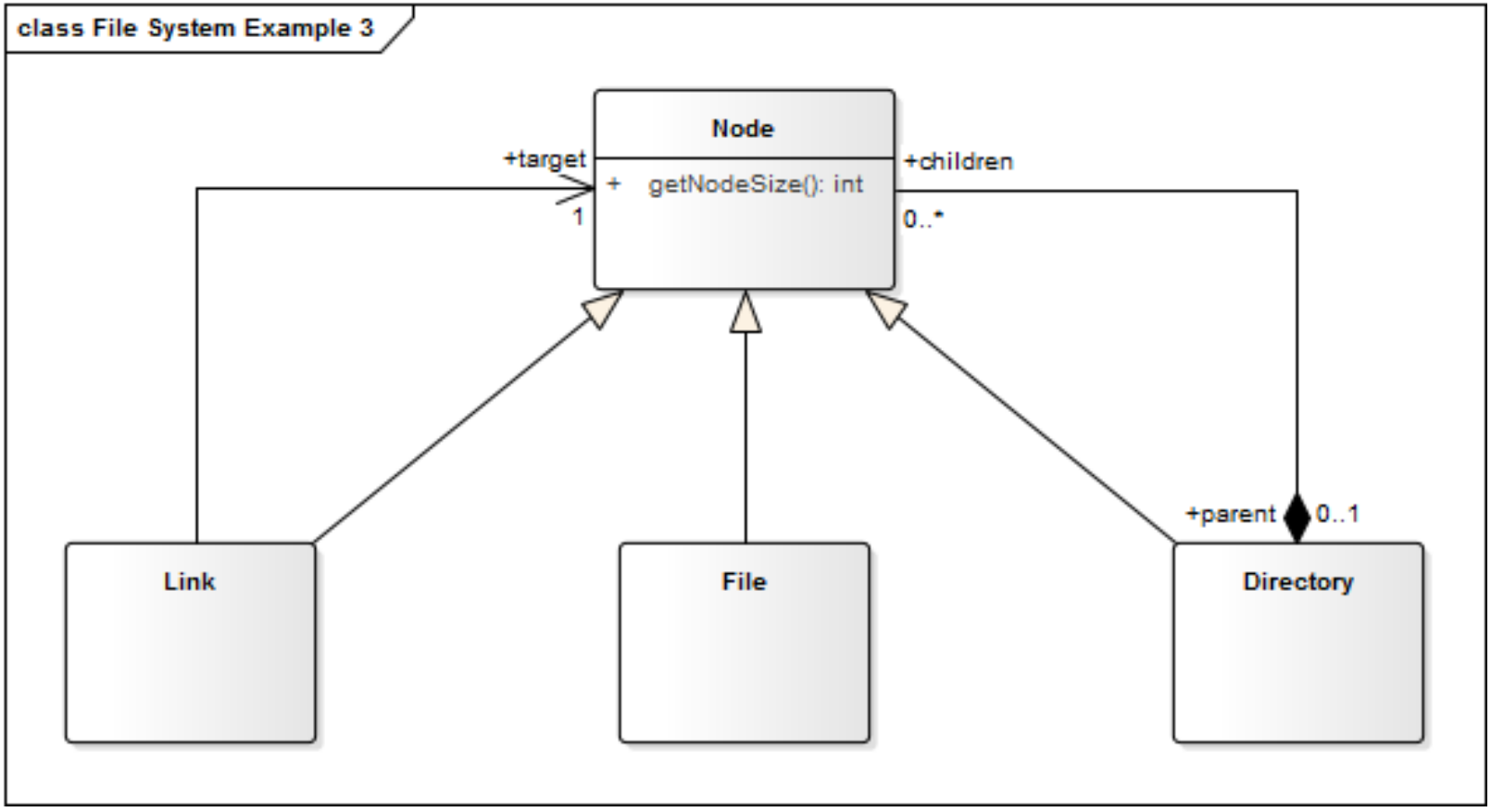
File / Directory Example 1 / 3



File / Directory Example 2 / 3



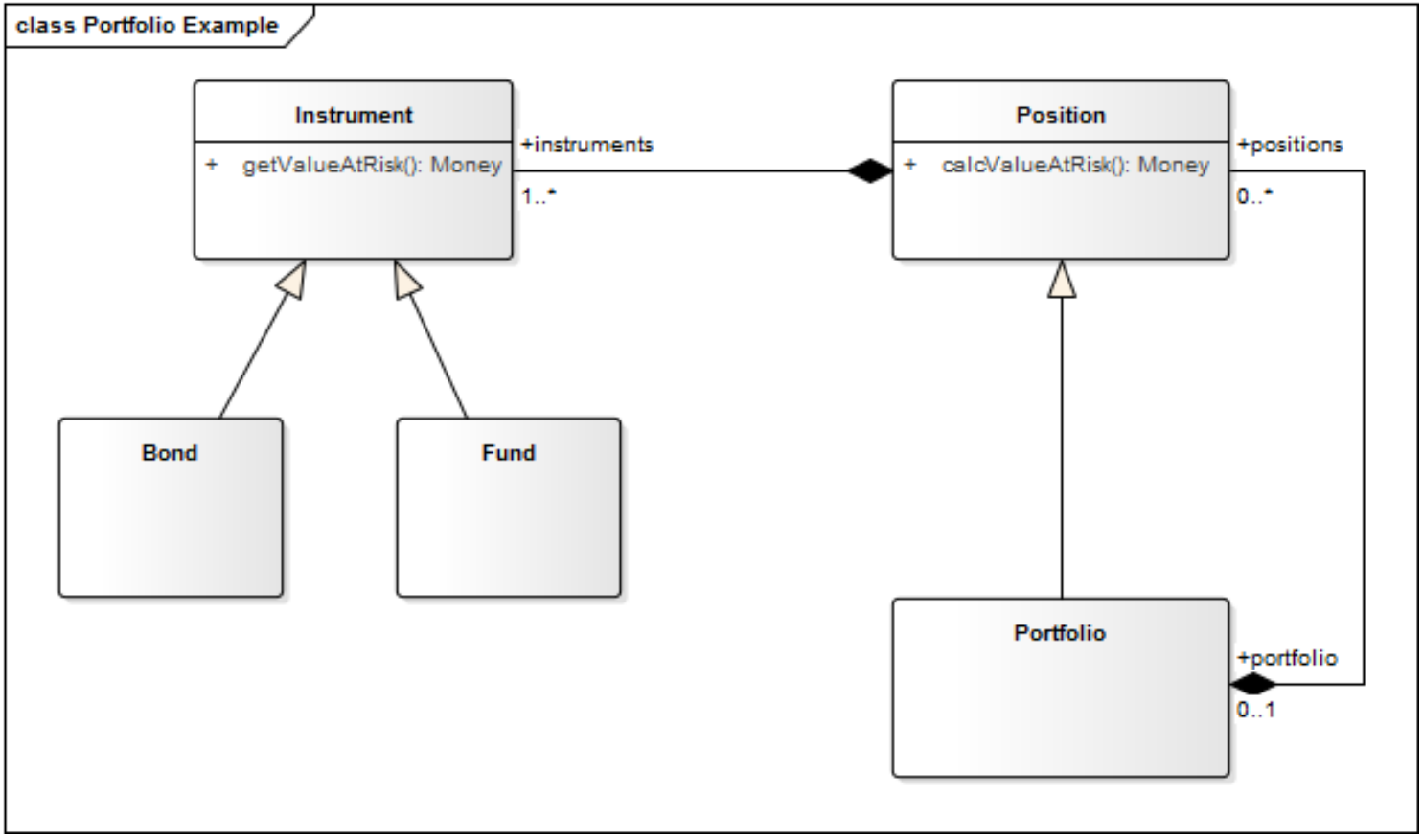
File / Directory Example 3 / 3



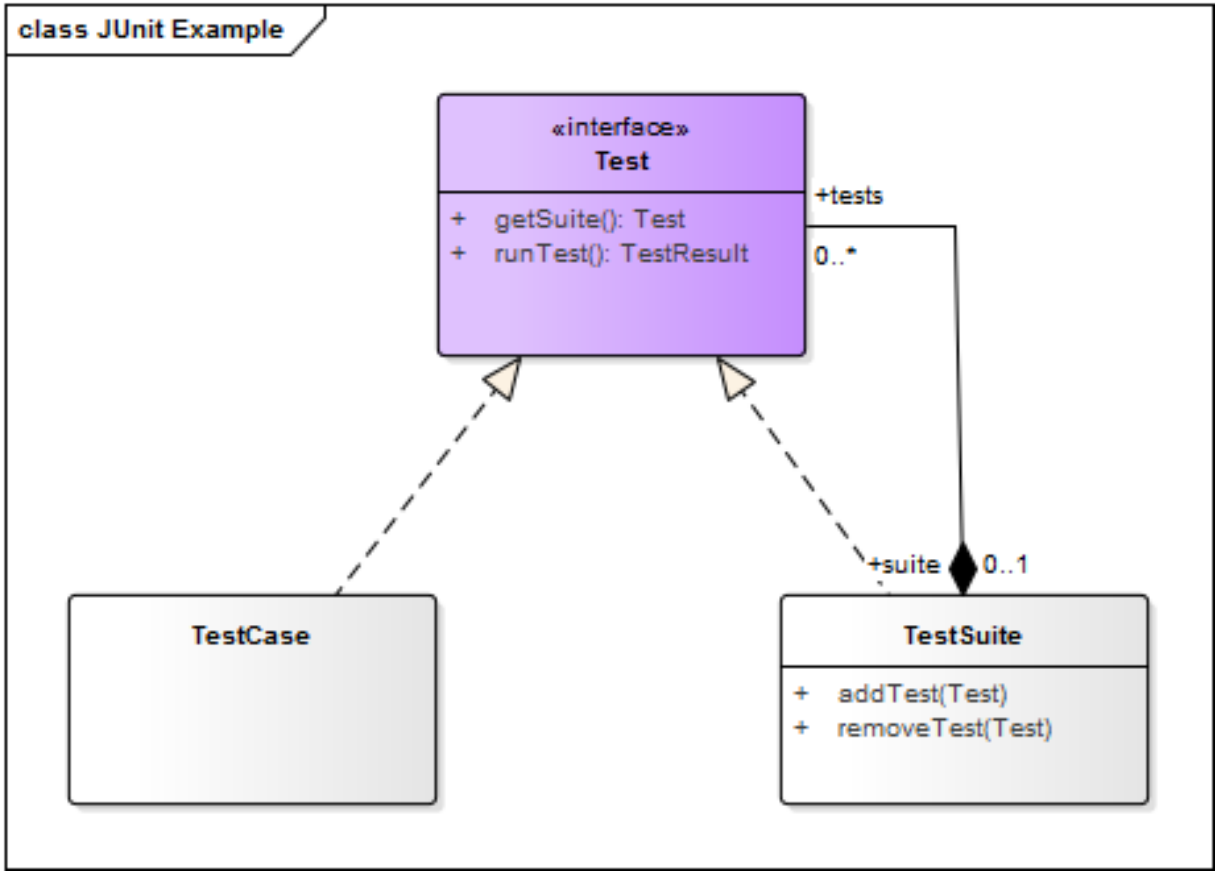
File / Directory Exercise

#	Size	Type	Path	Result
1	1	Directory	/	2484
2	1	Directory	bin/	9
3	4	File	ls	4
4	4	File	vi	4
5	1	Directory	usr/	1104
6	2	Directory	bin/	1103
7	357	File	gimp	357
8	743	File	eclipse	743
9	1	Link	Editor → /bin/vi	1
10	1	Directory	home/	1370
11	2	Directory	dirk/	134
12	12	File	doc1.doc	12
13	33	File	doc2.doc	33
14	87	File	image.gif	87
15	1	Directory	katja/	1235
16	1234	File	movie.mp4	1234

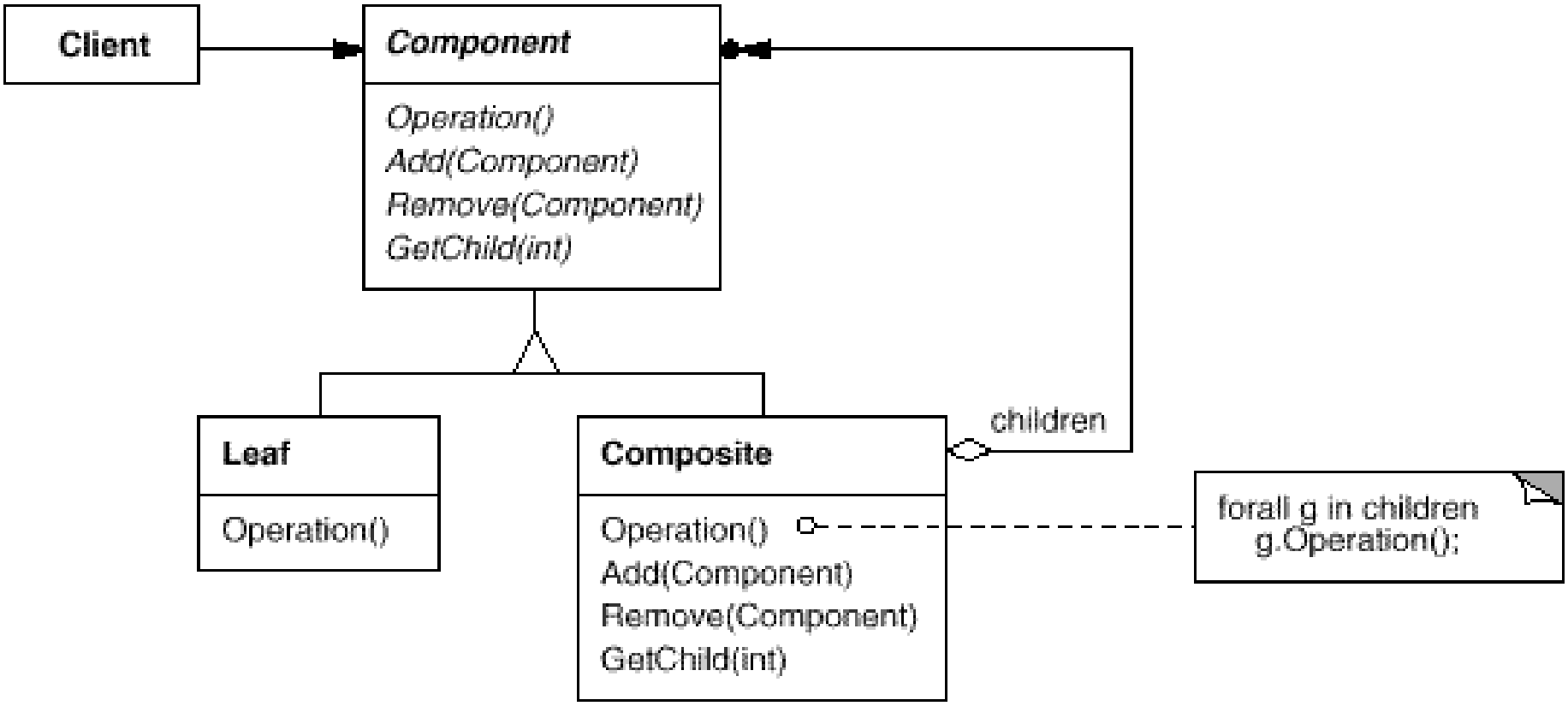
Position / Portfolio Example



TestCase / TestSuite Example



Composite Structure Diagram (Original)



Quiz: Configuring a Computer

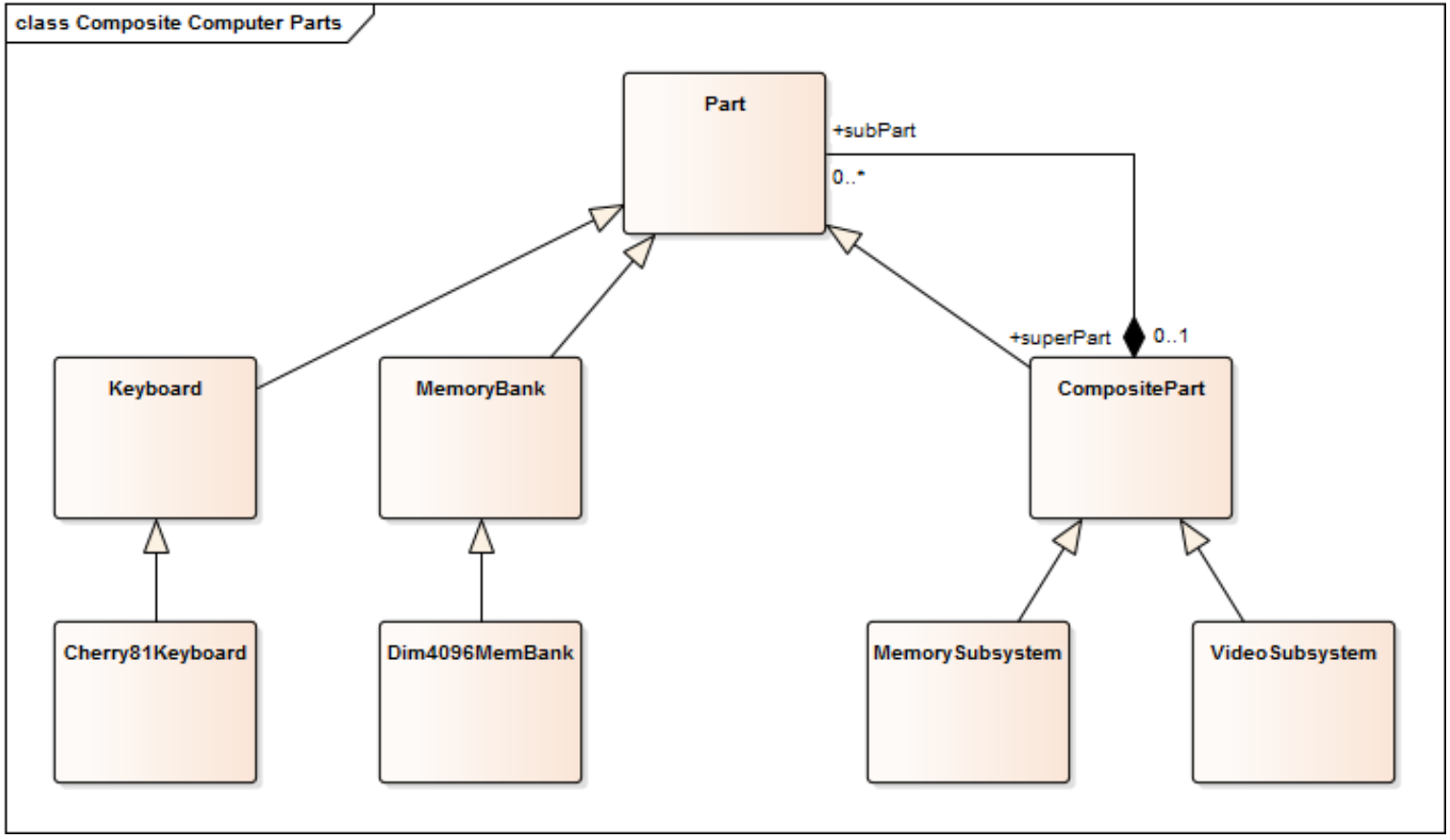
- You are configuring a computer. The computer consists of parts. Some parts are atomic (a keyboard, a memory bank, a hard disk), some are composite (memory subsystem, storage subsystem, video subsystem), meaning you can configure its parts.

  Using the Composite design pattern, how would you design a class hierarchy to represent a computer configuration?

  Select all correct statements.

  - Each type of atomic part is represented as its own class.
  - Each type of composite part is represented as its own class.
  - All part classes are direct subclasses of an abstract Part class.

Answer 1 / 2: Configuring a Computer



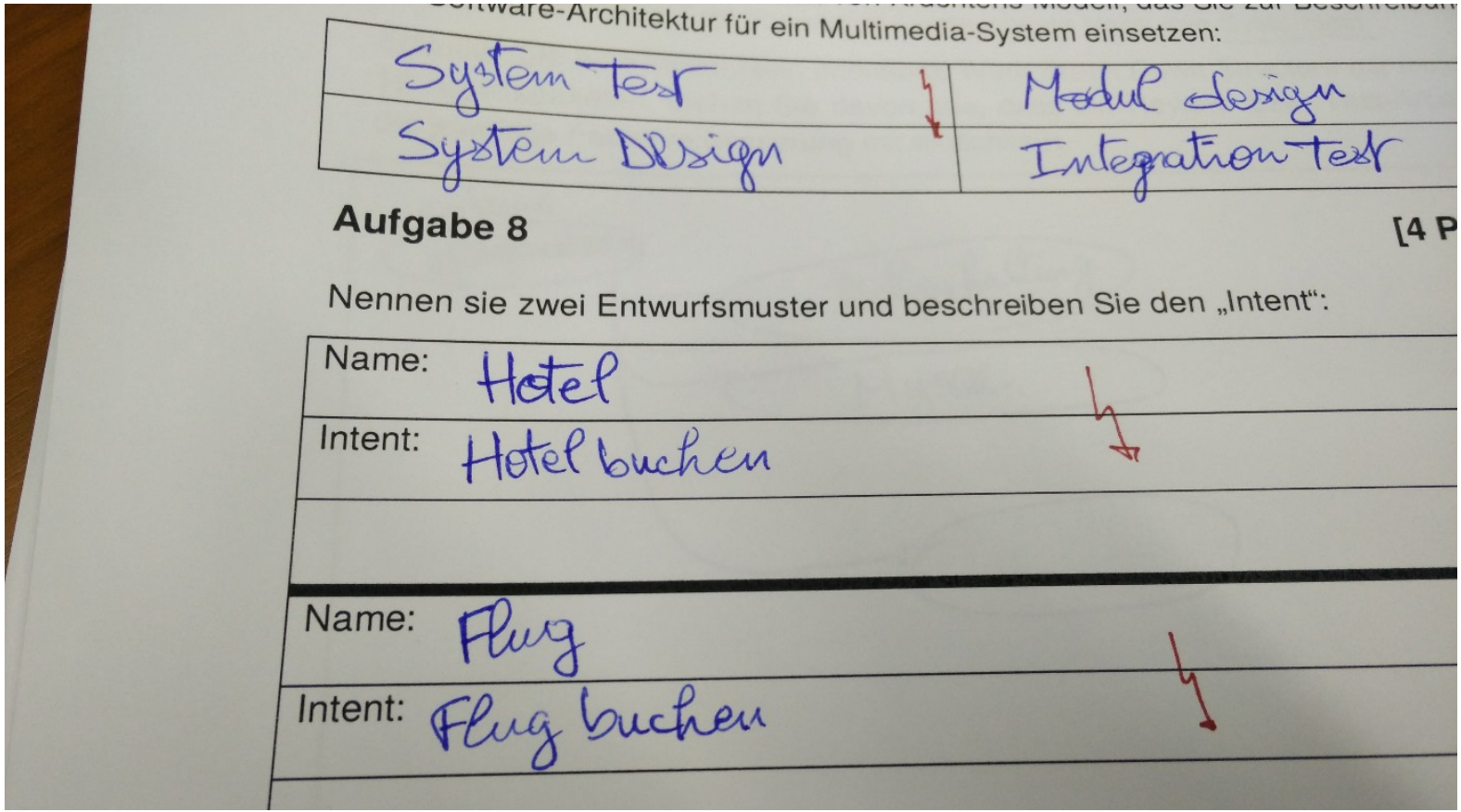
Answer 2 / 2: Configuring a Computer

- **How would you design a class hierarchy to represent a computer configuration?**
  - Each type of atomic part is represented as its own class.
    - **Yes. Different types of objects should be represented as different classes.**
  - Each type of composite part is represented as its own class.
    - **Yes. Different types of objects should be represented as different classes.**
  - All part classes are direct subclasses of an abstract Part class.
    - **No. Having a Part class makes sense, but there will be many part classes that will not be direct subclasses. An example are the classes for the specific types of subsystems.**

Definition of Design Pattern

The **abstraction** of a common **solution** to a recurring **problem** for a given **context**. [DR]

From a Written Exam



ware-Architektur für ein Multimedia-System einsetzen:

System Test	Modul design
System Design	Integration Test

Aufgabe 8 [4 P

Nennen sie zwei Entwurfsmuster und beschreiben Sie den „Intent“:

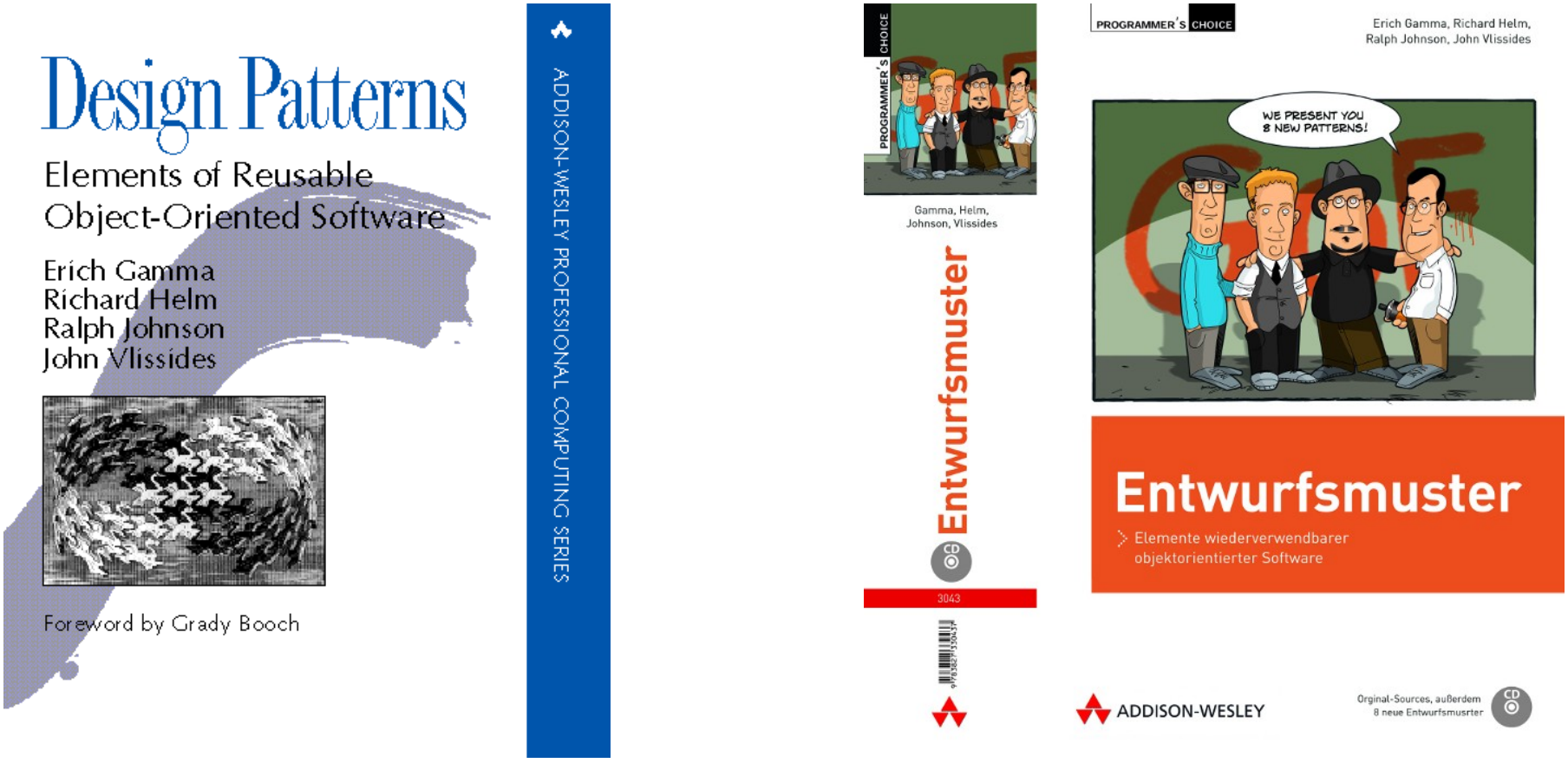
Name:	Hotel
Intent:	Hotel buchen
Name:	Flug
Intent:	Flug buchen

Benefits of Using Design Patterns

Faster, better, cheaper …

1. **designing of software**
2. **documenting software**
3. **communicating designs**

The Design Patterns (“Gang-of-Four”) Book



Highly Abridged History of Design Patterns

1. A Pattern Language
2. “No Object is an Island”
3. ET++ and Interviews
4. Design Pattern Catalog
5. A System of Pattern

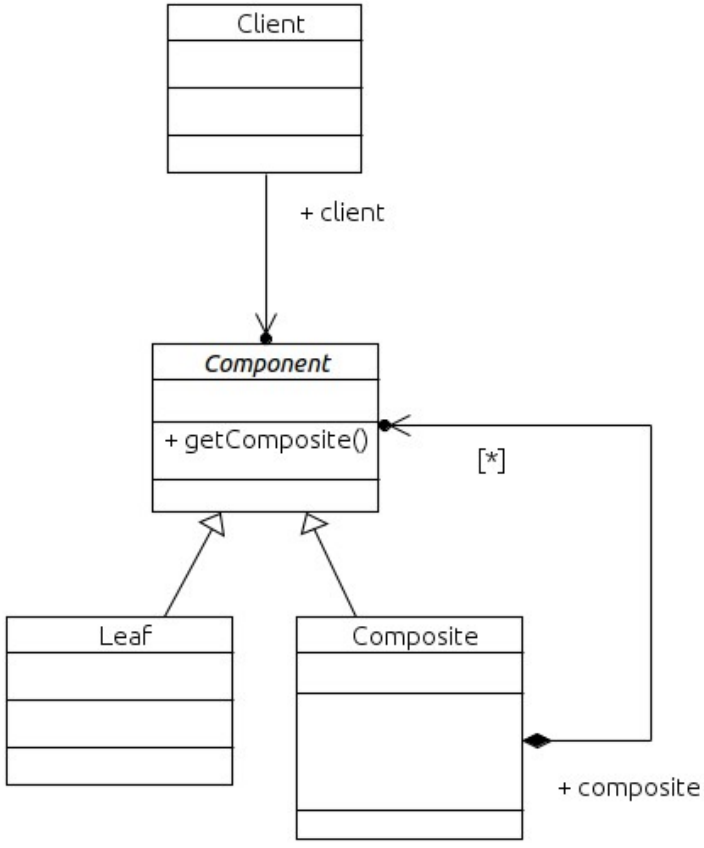
1. Descriptions
2. Collections
3. Applications

Describing Design Patterns 1 / 2

Problem: How to design a uniform yet flexible object hierarchy?

Context: You need an object hierarchy that you want to handle in a uniform way yet extend it dynamically. Frequently, algorithms need to run over the hierarchy.

Solution: Separate container functionality from domain behavior. Create a container class that can manage, at runtime, components of a generic type. Create all domain-specific classes separately. Make all classes implement the generic component protocol.



Design Pattern Description Formats 2 / 2

SEARCH

Help | Intro | Case Study | Pattern Catalog | Conclusion

Composite

Object Structural

Contents | Guide to Readers | Glossary | Notation | Foundation | Bibliography | Index | Pattern Map

Intent
Motivation
Applicability
Structure
Participants
Collaborations
Consequences
Implementation
Sample Code
Known Uses
Related Patterns

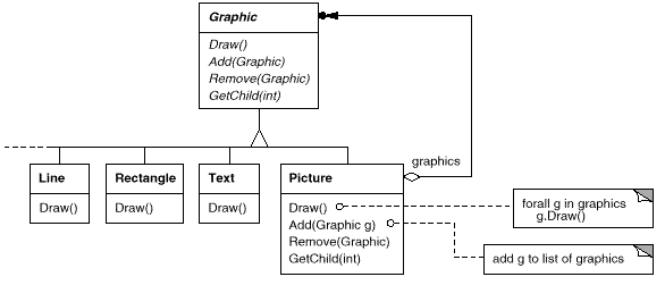
Intent

Compose objects into tree structures to represent part-whole hierarchies. Composite lets clients treat individual objects and compositions of objects uniformly.

Motivation

Graphics applications like drawing editors and schematic capture systems let users build complex diagrams out of simple components. The user can group components to form larger components, which in turn can be grouped to form still larger components. A simple implementation could define classes for graphical primitives such as Text and Lines plus other classes that act as containers for these primitives.

But there's a problem with this approach: Code that uses these classes must treat primitive and container objects differently, even if most of the time the user treats them identically. Having to distinguish these objects makes the application more complex. The Composite pattern describes how to use recursive composition so that clients don't have to make this distinction.



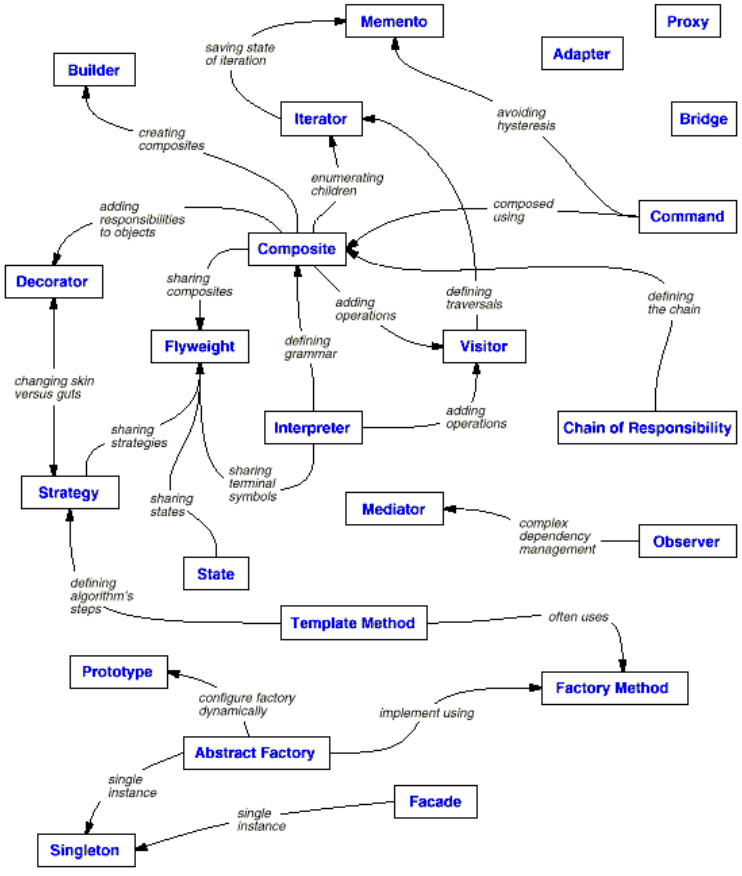
The key to the Composite pattern is an abstract class that represents *both* primitives and their containers. For the graphics system, this class is Graphic. Graphic declares operations like Draw that are specific to graphical objects. It also declares operations that all composite objects

Abstract Factory • Adapter • Bridge • Builder • Chain of Responsibility • Command • Composite •
Decorator • Facade • Factory Method • Flyweight • Interpreter • Iterator • Mediator • Memento •
Observer • Prototype • Proxy • Singleton • State • Strategy • Template Method • Visitor

Collections of Design Patterns

1. Pattern Collections
2. Pattern Handbooks
3. Pattern Languages

Design Pattern Map



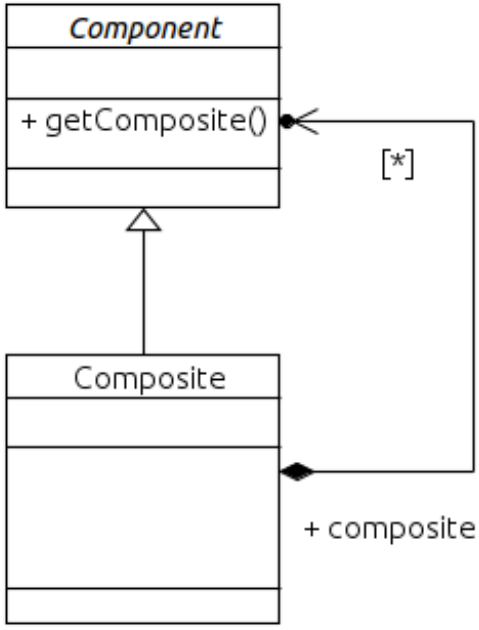
Applying Design Patterns

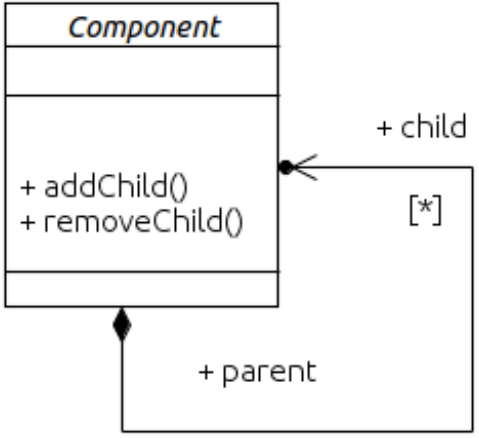
1. By-hand Instantiation
2. As a Design Template
3. As a Language Feature

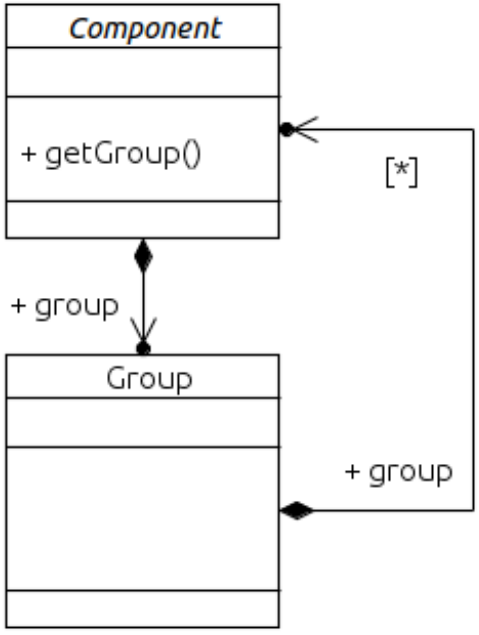
Design Pattern vs. Instance (Model)

- Pattern
  - Illustration, not a model
  - Generic terms, for example
    - Component, Composite, Leaf
    - getComponent, addComponent
- Instance
  - A specific model (UML, code)
  - Specific terms, for example
    - Test, TestCase, TestSuite
    - run, addTest, getTests

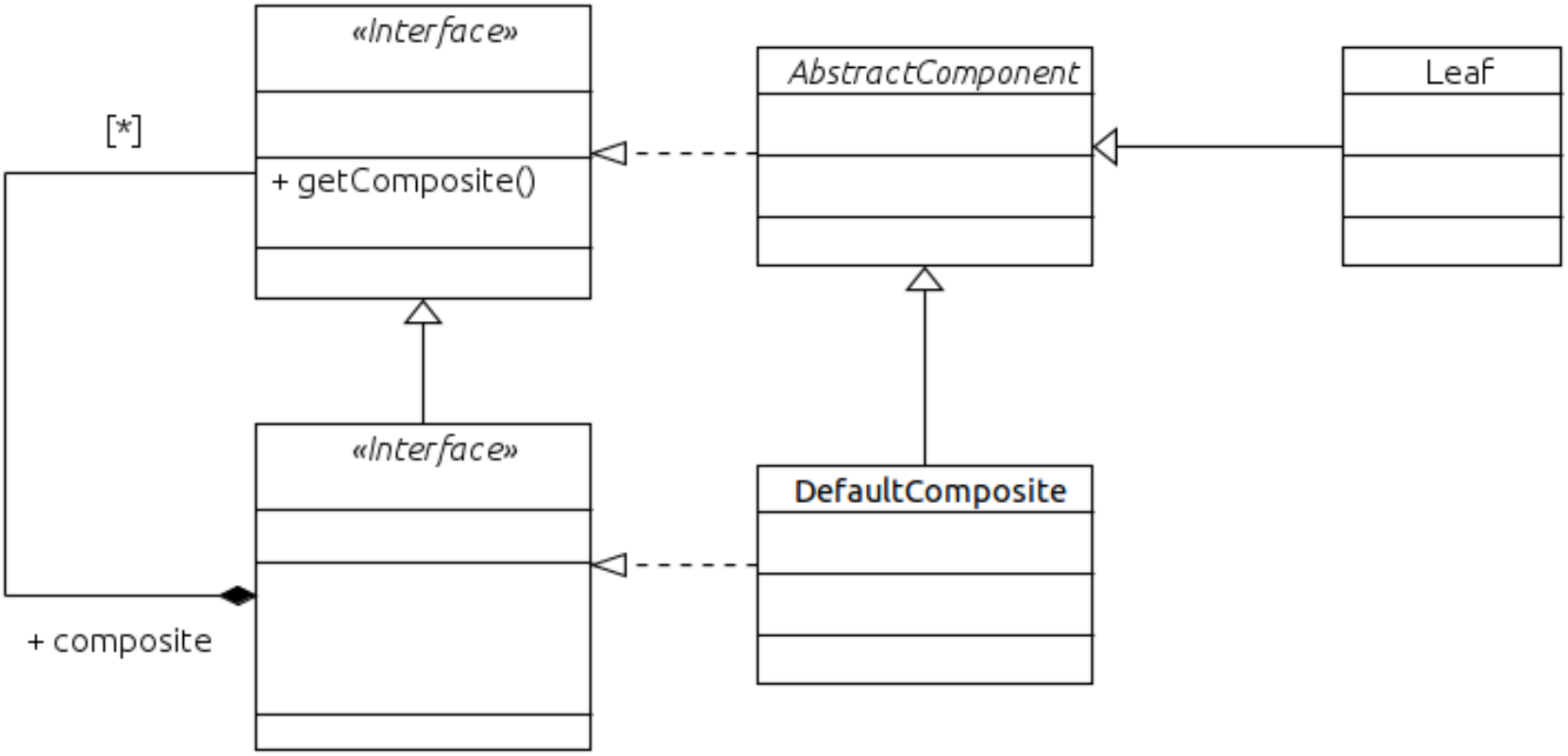
Design Pattern vs. Template







Design vs. Implementation



Quiz: Abstraction Levels

- You are looking at a class diagram with class names like KeyboardPart, MemorySubsystem, and GraphicsCard.

  The class diagram represents most likely what type of model?

  Select all that apply.

  - A design pattern
  - A design template
  - An implementation

Answer: Abstraction Levels

- **The class diagram represents most likely what type of model?**
  - A design pattern
    - **No. A design pattern (illustration of possible class models) should not contain application-specific class names.**
  - A design template
    - **No. A design template (class model for copying) should not contain application-specific class names.**
  - An implementation
    - **Yes. Application-specific class names indicate an implementation of a design pattern.**

Singleton Example 1 / 2

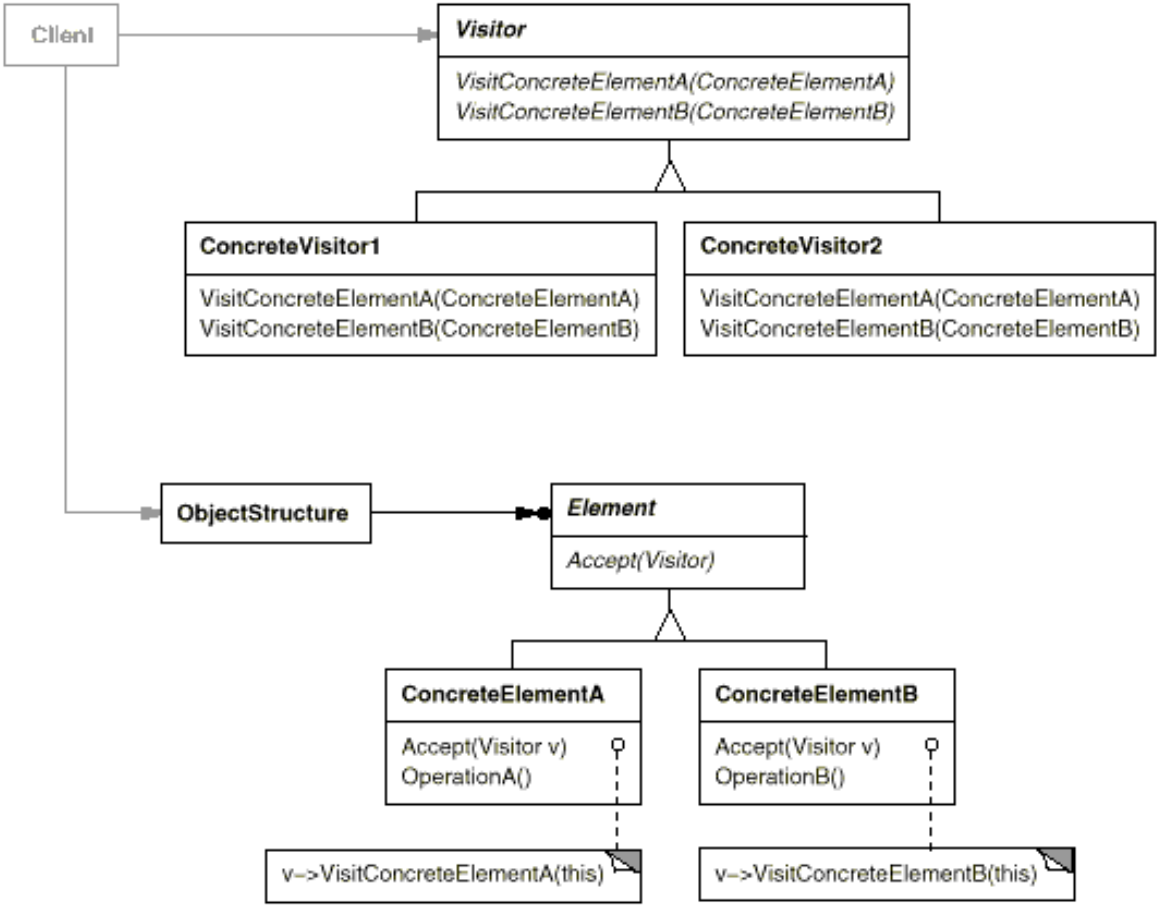
```
public class PhotoFactory {
  private static PhotoFactory instance = new PhotoFactory();

  public static PhotoFactory getInstance() {
    return instance;
  }

  protected PhotoFactory() {
    // do nothing
  }

  ...
}
```

Singleton Example 2 / 2

```
public class PhotoFactory {
  private static PhotoFactory instance = null;

  public static synchronized PhotoFactory getInstance() {
    if (instance == null) {
      setInstance(new PhotoFactory());
    }
    return instance;
  }

  protected static synchronized void setInstance(PhotoFactory pf) {
    assert instance == null;
    assert pf != null;
    instance = pf;
  }

  protected PhotoFactory() {
    // do nothing
  }
  ...
```

As a Programming Language Feature

- Double dispatch, for example: **`draw(device, figure);`**



Java Annotation Type for Design Patterns

```
@interface DesignPattern {
  String name();
  String[] participants();
}
```

Annotated File / Directory Example

```
@DesignPattern {
  name = "Composite",
  participants = { "Component" }
}
public class Node { ... }
```

```
@DesignPattern {
  name = "Composite",
  participants = { "Composite" }
}
public class Directory extends Node { ... }
```

```
@DesignPattern {
  name = "Composite",
  participants = { "Leaf" }
}
public class File extends Node { ... }
```

Levels of (Design) Patterns

1. **Architectural Patterns [1]**
2. **Design Patterns**
3. **Programming Patterns**

[1] A.k.a architectual style

Example of an Architectural Pattern

- Publish / Subscribe Architecture
  - Purpose
    - Create a system that can be
      - easily extended and
      - evolved at runtime
  - Components
    - Events: Data structures that capture a particular event
    - Publishers: Provide (and possibly create) events to the system
    - Subscribers: Receive events from publishers
    - Event Channels: Link subscribers to publishers
  - Examples
    - Linda (historic)
    - MQSeries (current)
    - ESB (whole category)

Example of a Programming Pattern (“Idiom”)

```
public class Counter {
  protected int count = 0;

  public synchronized int getNext() {
    return count++;
  }

  ...

}
```

Review / Summary of Session

- Design patterns
  - Definition, purpose, history
  - When compared with other patterns
  - Ways of implementing patterns
- Collections of patterns
  - Collections, handbooks, languages
  - Relationships between patterns

Thank you! Questions?

dirk.riehle@fau.de – http://osr.cs.fau.de

dirk@riehle.org – http://dirkriehle.com – @dirkriehle

Credits and License

- Original version
  - © 2012-2019 Dirk Riehle, some rights reserved
  - Licensed under Creative Commons Attribution 4.0 International License
- Contributions
  - ...