

Design Patterns and Frameworks (DPF) Announcements

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Elements of the Course

- ▶ Lecturing
 - Do not miss one, they should give you a short and concise overview of the material
- ▶ Reading
- ▶ Exercise sheets
 - Handed out every 2nd week
 - You have one week to solve them on your own
 - After that, solutions will be explained in the exercise seminars (Große Übungen)
- ▶ <http://st.inf.tu-dresden.de> -> Teaching -> Design Patterns and Frameworks
- ▶ <http://st.inf.tu-dresden.de/teaching/dpf>

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Reading Along the Lectures

- ▶ Unfortunately, the course is not covered by any book
 - Only about 25-30% is covered by GOF
- ▶ You have to read several research papers, available on the internet
 - Marked by “Mandatory Literature (To Be Read)”
- ▶ Secondary Literature is non-mandatory, but interesting reading.
 - Can be done during the course
- ▶ Other Literature is not to be read, but also interesting.

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Literature (To Be Read)

- ▶ During the course, read the following papers, if possible, in sequential order. See also literature web page.
 - Every week, read about 1 paper (3-4h work)
- ▶ Start here:
 - A. Tesanovic. What is a pattern? Paper in Design Pattern seminar, IDA, 2001. Available at home page.
 - Brad Appleton. Patterns and Software: Essential Concepts and terminology.
<http://www.cmcrossroads.com/bradapp/docs/patterns-intro.html> Compact introduction into patterns.
- ▶ K. Beck, J. Coplien, R. Crocker, L. Dominick, G. Meszaros, F. Paulisch, J. Vlissides. Industrial Experience with Design Patterns Int. Conference on Software Engineering (ICSE) 1996.
<http://citeseer.ist.pst.edu/beck96industrial.html>

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Literature (To Be Read)

- ▶ [GOF, Gamma] E. Gamma, R. Helm, R. Johnson, J. Vlissides: Design Patterns. Addison-Wesley 1995. Standard book belonging to the shelf of every software engineer.
 - Chapters on Design Patterns in as far as they are handled in the lectures
 - The book is called GOF (Gang of Four), due to the 4 authors
- ▶ Alternatively to GOF can be read:
 - Head First Design Patterns. Eric Freeman & Elisabeth Freeman, mit Kathy Sierra & Bert Bates. O'Reilly, 2004, ISBN 978-0-596-00712-6
 - German Translation: Entwurfsmuster von Kopf bis Fuß. Eric Freeman & Elisabeth Freeman, mit Kathy Sierra & Bert Bates. O'Reilly, 2005, ISBN 978-3-89721-421-7
- ▶ Alternatively, available at home page. If you have already studied GOF, do not read these. These paper stem from a Design Pattern seminar at Linköpings Universitet, IDA, 2001:
 - A. Tesanovic. What is a pattern?
 - T. Panas. Design Patterns, A Quick Introduction. (on Composite, Visitor)
 - Veaceslav Caisin. Creational Patterns.
 - P. Pop. An overview of the automation of patterns.

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Literature (To Be Read)

- ▶ D. Riehle, T. Gross. Role Model Based Framework Design and Integration. Proc. 1998 Conf. On Object-oriented Programming Systems, Languages, and Applications (OOPSLA 98) ACM Press, 1998. <http://citeseer.ist.pst.edu/riehle98role.html>
- ▶ D. Bäumer, G. Gryczan, C. Lilienthal, D. Riehle, H. Züllighoven. Framework Development for Large Systems. Communications of the ACM 40(10), Oct. 1997. <http://citeseer.ist.pst.edu/bumer97framework.html>
- ▶ D. Bäumer, D. Riehle, W. Silberski, M. Wulf. Role Object. Conf. On Pattern Languages of Programming (PLOP) 97. <http://citeseer.ist.pst.edu/baumer97role.html>

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Literature (To Be Read)

- W. Pree. Framework Development and Reuse Support. In Visual Object-Oriented Programming, Manning Publishing Co., editors M. M. Burnett and A. Goldberg and T. G. Lewis, Pp, 253-268, 1995. www.softwareresearch.net/publications/J003.pdf
- Or: D. Karlsson. Metapatterns. Paper in Design Pattern seminar, IDA, 2001. Available at home page.
- ▶ D. Riehle, H. Züllighoven. A Pattern Language for Tool Construction and Integration Based on the Tools&Materials Metaphor. PLOP I, 1995, Addison-Wesley. <http://citeseer.ist.pst.edu/riehle95pattern.html>

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Secondary Literature

- ▶ M. Fowler. Refactoring. Addison-Wesley, 1999.
- ▶ D. Riehle, H. Züllighoven, Understanding and Using Patterns in Software Development. Theory and Practice of Object Systems, 1996 <http://citeseer.ist.pst.edu/riehle96understanding.html>
- ▶ D. Garlan, R. Allen, J. Ockerbloom. Architectural mismatch – or why it is so hard to build systems out of existing parts. Int. Conf. On Software Engineering (ICSE 95). <http://citeseer.ist.pst.edu/garland95architectural.html>
- ▶ A. Abel. Design Pattern Relationships and Classification. Paper in Design Pattern seminar, IDA, 2001. Available at home page.
- ▶ T. Pop. Multi-Paradigm Design. Paper in Design Pattern seminar, IDA, 2001. Available at home page.

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Other Literature

- ▶ T. Reenskaug, P. Wold, O. A. Lehne. Working with objects Manning.
 - The OOram Method, introducing role-based design, role models and many other things. A wisdom book for design. Out of print. Preversion available on the internet at <http://heim.ifi.uio.no/~trygver/documents/book11d.pdf>
- ▶ K. Beck. Extreme Programming. Addison-Wesley.
- ▶ H. Allert, P. Dolog, W. Nejdl, W. Siberski, F. Steimann. *Role-Oriented Models for Hypermedia Construction – Conceptual Modelling for the Semantic Web*. citeseer.org.



Please, Please Be Aware – There Will Be Pain!

- ▶ **This course is a research-oriented course**
- ▶ **It treats rather advanced material, the most recent sugar sweets of object-oriented software engineering**
- ▶ **No book exists on all of that at all**
 - GOF covers only about 25-30%
 - Please, collaborate! Read the articles, ask questions!
 - Do the exercise sheets
- ▶ **Warning: The oral exams can only be done if you have visited all lectures and solved all exercise sheets**
 - **The GOF Book alone is not sufficient**
- ▶ **Learn continuously!**
- ▶ **Be aware: you have not yet seen larger systems**
 - You will see one small system in the labs (< 100KLOC)
 - Middle-size systems start over 100KLOC



Learning Java with the Praktomat

- ▶ In our basic course on software technology, we have published a web-based self-learning system for Java
 - into which you can enter Java programs
 - which tests style and syntax of the programs
 - and runs a test suite against your program
- ▶ The praktomat gives you feedback about your programming abilities in Java
- ▶ The Praktomat is an opportunity for you, please use it!
- ▶ Students without FRZ-account, please register by emailing to Sebastian.Richly@tu-dresden.de



The Positive Side

- ▶ If you follow carefully, you will discover an exciting world of beauty in software
- ▶ If you know all the patterns of the course, you will be a much better software engineer than the standard programmer
 - Most of the work has been discovered in the last 8-10 years, and is unknown to the programmers
- ▶ You will also be a much better manager,
 - because patterns and frameworks teach you how to master large systems and product lines in your company
- ▶ Confession: If I myself had known all these patterns in 1998, my life would have been much easier
- ▶ The gain is worthwhile the pain!



<http://praktomat.inf.tu-dresden.de/>

Design Patterns and Frameworks

DPF

Goals

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Main Goals

- ▶ Know several different kinds of patterns
 - Basic kinds of incentives for design patterns
- ▶ Explain patterns for variability, extensibility of systems
- ▶ Understand frameworks and product lines better
- ▶ Explain systematic structures for systems with 100KLOC
 - Layered frameworks
 - Facets
- ▶ Understand a different way of object-oriented design
 - Role-based design



Standard Problems to Be Solved By Design Patterns

- ▶ Variability
 - Exchanging parts easily
 - Variation, complex parameterization
 - Static and dynamic
 - For product lines, framework-based development
- ▶ Extensibility
 - Software must change
- ▶ Glueing (bridging, adapting, connecting)
 - Overcoming architectural mismatches
 - Coupling software that was not built for each other
- ▶ Others:
 - Optimization: making things more efficient
 - Antagonistic to flexibility
 - Structuring of interactive applications
 - Grasping common patterns of flow in software systems



Goal: Variability Patterns

- ▶ Variability (Variation, Exchange, Parameterization)
 - Expressing commonality and variability
 - We fix a common part (a *framework*) and parameterize it at *variation points (variability)*
 - *Framework instantiation patterns* describe variation of frameworks
- ▶ Understanding Templates and Hooks
 - Template Method vs Template Class
 - Dimensional Class Hierarchy, Bridge
- ▶ Understanding creational patterns
 - Factory Method, Factory Class, Builder
- ▶ Variability design patterns for frameworks
- ▶ Variability concerns
 - Exchange of communication
 - Dynamic call (e.g., ChainOfResponsibility)
 - Exchange of policy
 - Exchange of material in data-based applications



Goal: Extensibility Patterns

- ▶ Extensibility
 - For new, unforeseen product variants
 - For evolution
 - For dynamic change
- ▶ Understanding extensibility patterns
 - ObjectRecursion vs TemplateMethod, Objectifier (and Strategy)
 - Decorator vs Proxy vs Composite vs ChainOfResponsibility
 - Visitor, Observer (EventBridge)
- ▶ Parallel class hierarchies as implementation of facets
 - Understand facets as non-partitioned subset hierarchies
 - Layered frameworks as a means to structure large systems, based on facets
- ▶ Template/Hook Extension:
 - Code skeletons are *extended at hooks*
 - Frameworks can have hooks that can be extended (beyond variation)
- ▶ Framework extension patterns

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Goal: Glueing Patterns for Overcoming Architectural Mismatches

- ▶ Glue patterns
 - Understand architectural mismatch
 - Understand patterns that bridge architectural mismatch
- ▶ Adaptation, bridging, connections
 - Of communication protocols
 - Between heterogeneous components (different representations, different locations, different control flow structure)
- ▶ Anonymous communication
 - For exchange of communicators
- ▶ Scalable communication
 - At runtime, in distributed systems

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Goal: A Basic Tool: Role Modelling

- ▶ For all of that, a basic tool set is role modelling
 - Which roles does an object play in the application?
- ▶ It tells how design patterns occur in applications
 - Invented by Reenskaug. Summarized in the book "Working with Objects", 1995
- ▶ Role-model based design
 - Why design patterns are role models of class diagrams
 - Understand the difference between roles and objects, role types and classes
 - Understand role mapping to classes
 - How roles can be implemented
 - Understand role model composition
 - Understand composite design patterns as composition of role models

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Goal: Frameworks Pattern

- ▶ Understand variabilities in frameworks
 - Introducing different types of hooks for frameworks and components (TH patterns)
 - Understanding framework variability patterns
- ▶ Studying extensible framework hook patterns
 - Role Object pattern
 - Layered frameworks, implemented by Role Object
- ▶ Patterns document frameworks
 - Patterns play an important role on how a framework is instantiated
 - Whitebox, blackbox, layered, T&H framework

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Goal: Structuring Interactive Applications with Tools&Materials

- Understand the central metaphors of the Tools-and-Materials architectural style for the construction of interactive applications
 - Know an example of a pattern language
- ▶ Interactive applications can be pretty complex
- ▶ TAM (tools-and-materials, Werkzeug-Automat-Material, WAM) is a *pattern language for interactive applications*
- ▶ Nice metaphors that help thinking, constructing, maintaining interactive applications



Overview of the Course



Refactoring Framework Backward Compatibility Variability-Based Design **Part III: Refactoring and Symmetries**

Contracts Documentation Frameworks with components/models

Eclipse San Francisco SAP **Part II: Frameworking**

Tools & Materials Layered Frameworks **Part I: Patterns and Frameworks**

Metapatterns and Framework patterns Role Models Composite Patterns

Part 0: Basic Patterns

Variability Patterns Extensibility Patterns Connection Patterns

Intro Employment and Usage

The End

