11. Design Patterns as Role Models

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Version 13-1.1 12/2/13

Literature (To Be Read)

- D. Riehle, T. Gross. Role Model Based Framework Design and Integration. Proc. 1998 Conf. On Object-oriented Programing Systems, Languages, and Applications (OOPSLA 98) ACM Press, 1998. http://citeseer.ist.psu.edu/riehle98role.html
- Dirk Riehle. Bureaucracy. In Robert Martin, Dirk Riehle, and Frank Buschmann, editors, Pattern Languages of Program Design 3, pages 163-185. Addison Wesley, 1998.
  - http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.33.2034

Other Literature

- Walter Zimmer. Relationships Between Design Patterns. Pattern Languages of Program Design 1 (PLOP), Addison-Wesley 1994
- T. Reenskaug, P. Wold, O. A. Lehne. Working with objects. Manning publishers.
  - 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
  - Same age as Gamma, but much farer..
- H. Allert, P. Dolog, W. Nejdl, W. Siberski, F. Steimann. *Role-Oriented Models for Hypermedia Construction – Conceptual Modelling for the Semantic Web.* citeseer.org.

Other Literature

- B. Woolf. The Object Recursion Pattern. In N. Harrison, B. Foote, H. Rohnert (ed.), Pattern Languages of Program Design 4 (PLOP), Addison-Wesley 1998.
- Walter Zimmer. Relationships Between Design Patterns. Pattern Languages of Program Design 1 (PLOP), Addison-Wesley 1994

Goal

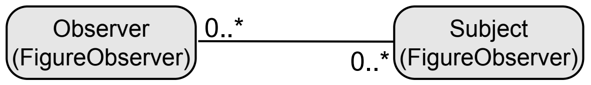
- Understand design patterns as role models, merged into class models
- Understand composite design patterns
  - Understand how to mine composite design patterns
- Understand role types as semantically non-rigid founded types
- Understand layered frameworks as role models
- Understand how to optimize layered frameworks and design patterns

11.1 Design Patterns as Role Diagrams

... more info...

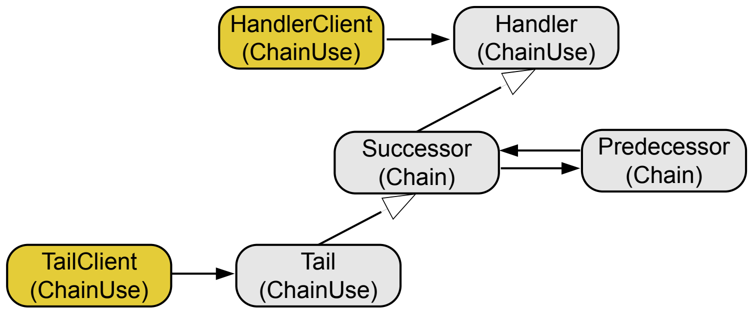
Design Patterns have Role Models

- Observer role model



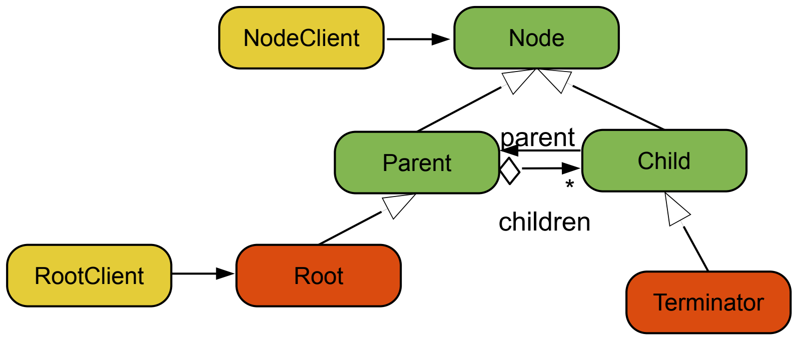
Structure Diagrams of DP are Role Diagrams

- The “participant” section of a GOF pattern is a *role model*
- Roles of Chain of Responsibility:
  - Chain: (successor, predecessor)
  - ChainUse: (Handler, HandlerClient, Tail, TailClient)



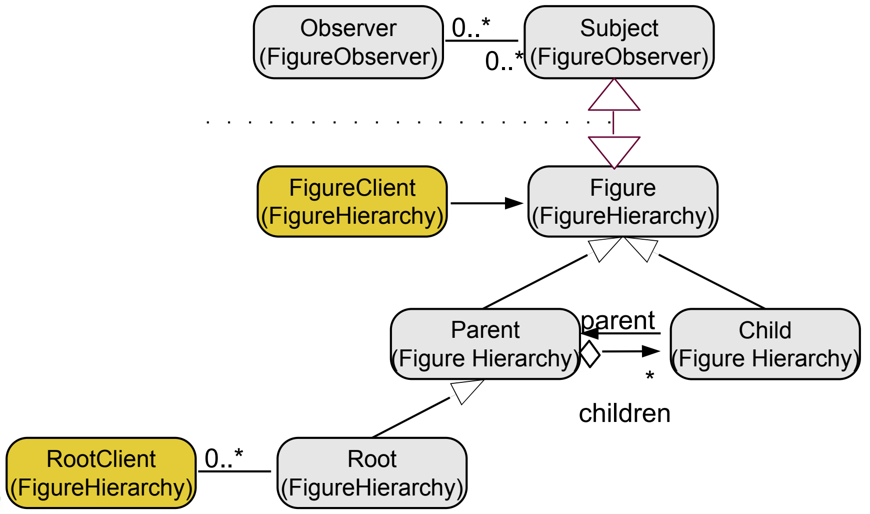
Role Diagram of Composite

- Root role is not in the standard pattern description
- Attention: role models are not standardized – it depends on the designer what she wants to model! (many variants of a role model for a design pattern may exist). Here: Root, Terminator, clients optional



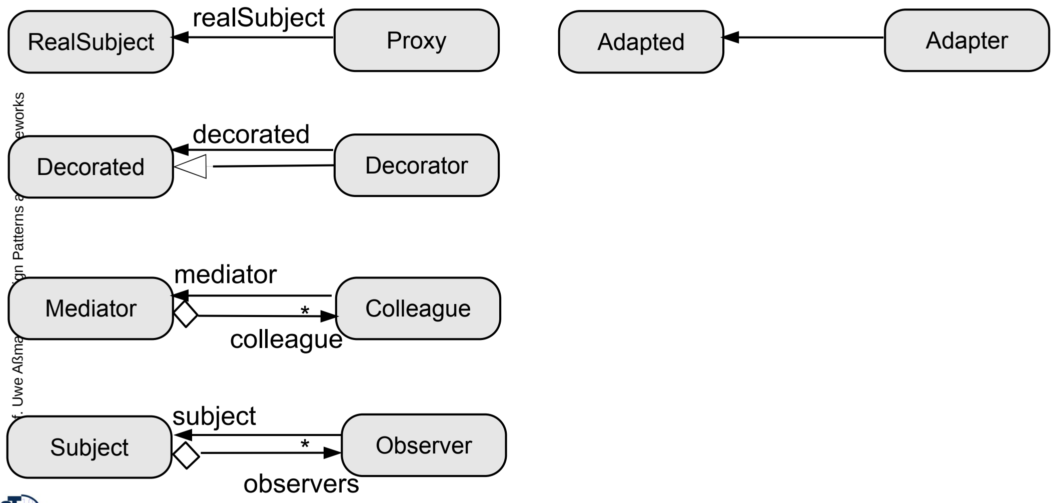
Composing (Overlaying) Role Models

- Overlaying the FigureHierarchy with the FigureObserver role model by role biimplication



Core Role Diagrams of Several Patterns

- Many of them are quite similar



What does Role-Type Merging Mean?

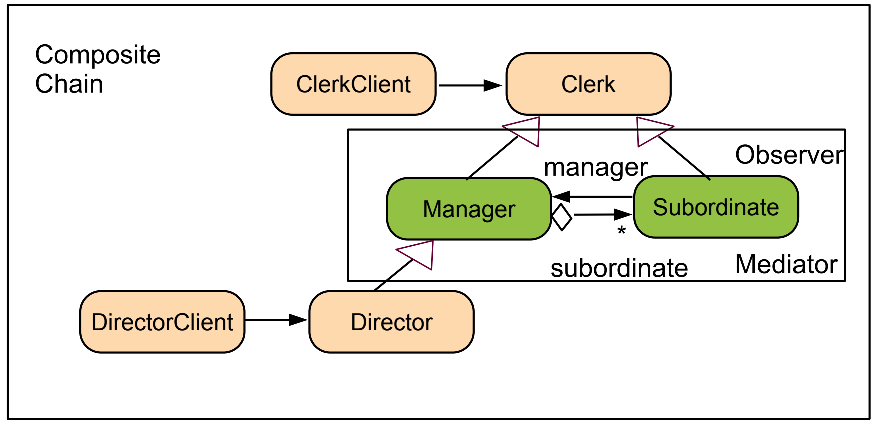
- Merging of attribute set
- Merging of method set

11.2 Composite Design Patterns with Role Model Composition

.. how to create bigger design patterns as composed role models..

11.2.1 Example: Bureaucracy

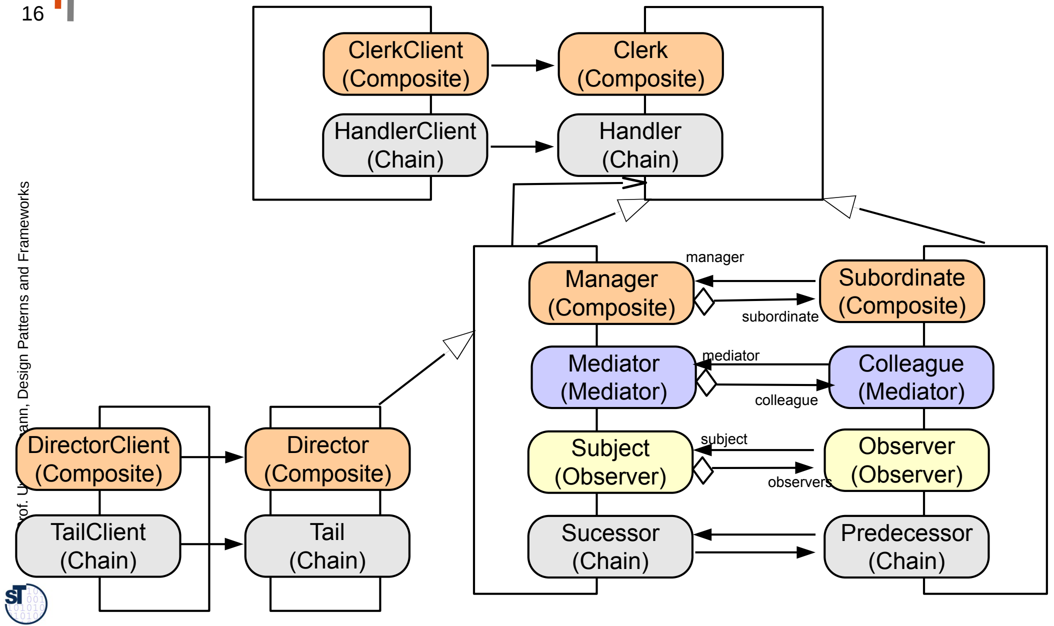
- A pattern to model organizations that have a tree-like structure (as opposed to matrix organizations)
  - composed of the role models of Composite, Mediator, Chain, Observer



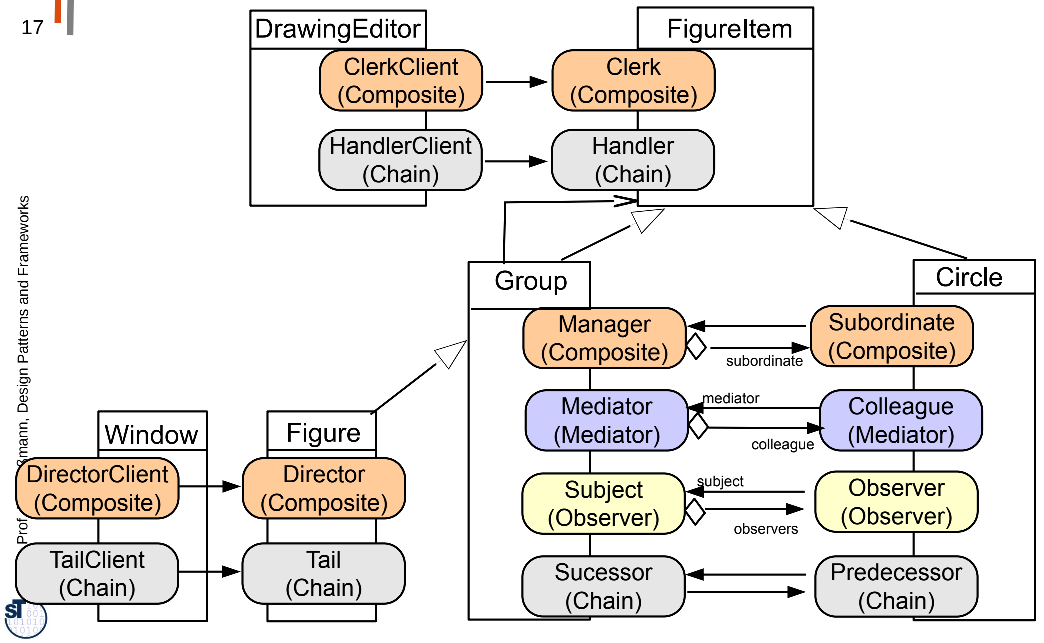
Example: Bureaucracy

- The *Composite* defines the organizational hierarchy of managers
- The *Mediator* is used to let talk children talk to their siblings (colleague roles) via a parent (mediator role)
- The *Chain* handles requests of clients
  - Every node may handle requests
  - If a node cannot handle a request, it is passed up in the hierarchy (on the path to the root)
- The *Observer* is used to listen to actions of a parent node
  - If a parent node (subject) changes something, its child (observer) listens and distributes the information accordingly

Class-Ability Model of Bureaucracy



Bureaucracy
Class-Ability Model of Figures



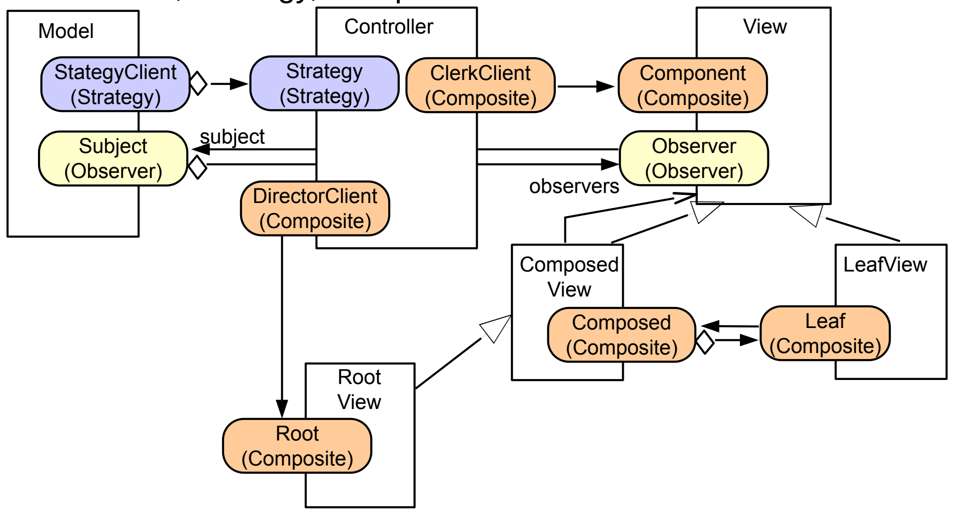
Application of Bureaucracy

- For all hierarchies
  - Figures in graphic and interactive applications
  - Widgets in GUIs
  - Documents in office systems
  - Piece lists in production management and CAD systems
  - Hierarchical tools in TAM (see later)
  - Modelling organizations in domain models: companies, governments, clubs

11.2.2 Model-View-Controller (MVC)

Class-Ability Model of MVC

- From Tyngre Reenskaug and Adele Goldberg
- MVC role model can be composed from the role models of Observer, Strategy, Composite



This Closes a Big Loop

- Remember, Reenskaug developed MVC 1978 with Goldberg, while working on Smalltalk-78 port for Norway
- Starting from his MVC pattern, Reenskaug has invented role-based design
- 1998, Riehle/Gross transferred role-based models to design patterns
- Today, MVC can be explained as composed role models of other design patterns

Riehle-Gross Law On Composite Design Patterns

The role model of a composite design patterns is composed of the role models of their component design patterns

- Concequences
  - Complex patterns can be easily split into simpler ones (decomposition)
  - Variants of patterns can more easily be related to each other (variability of patterns)
    - e.g., ClassAdapter and ObjectAdapter
  - Template&Hook conceptual pattern can be explained as role model (see next chapter)

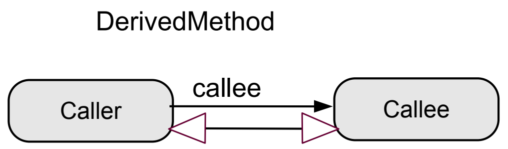
11.2.3 Composition of Simple Variability Patterns

Warning

- The following is an attempt to build up the basic GOF patterns from simple role models
- The compositions of patterns depend on the concrete form of their role models
- It explains why Strategy is different from Bridge and TemplateClass, etc.

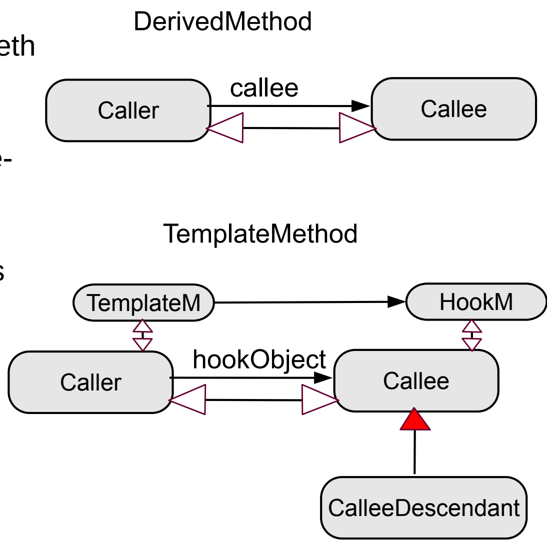
Derived Method

- In a class,
  - A *kernel method* implements the feature directly on the attributes of the class, calling no other method
  - A *derived method* is implemented by calling only kernel methods



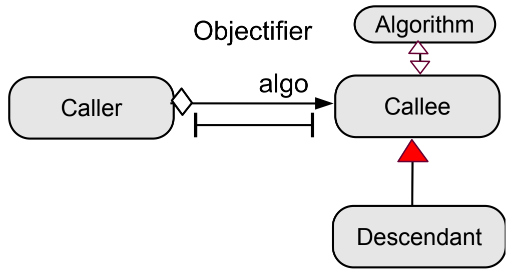
Derived Method and TemplateMethod

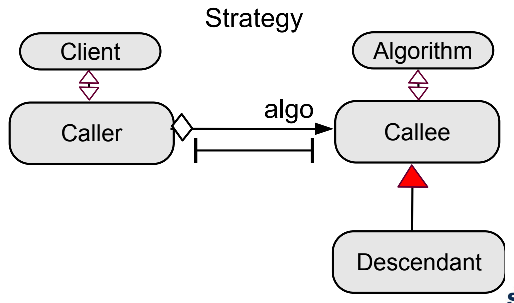
- TemplateMethod is a DerivedMethod that has
  - an additional TemplateMethod/HookMethod role model
  - Inheritance hierarchy on right side (implied by role-class inheritance constraint)
  - The template role implies no hierarchy on left side



Objectifier and Strategy

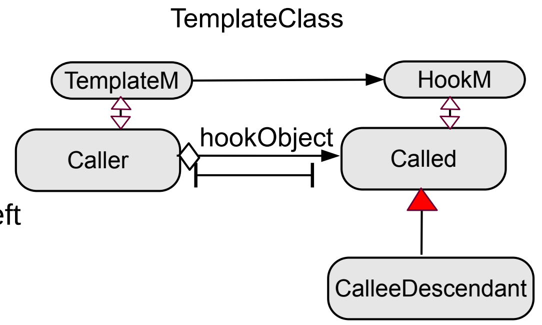
- Objectifier has
  - An additional exclusion constraint on Caller and Callee
  - An aggregation
  - An algorithm role
  - A subclassing constraint (right hierarchy)
  - No template role
- Strategy is an Objectifier with
  - Client role
  - Algorithm role
  - Hierarchy on right side
  - No template role





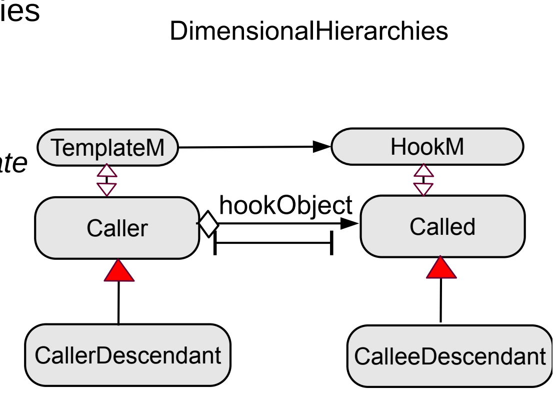
TemplateClass

- TemplateClass is an Objectifier with
  - An additional TemplateMethod/ HookMethod role model
  - TemplateMethod role implies no hierarchy on left side
  - HookMethod role implies inheritance hierarchy on right side
  - *No client or algorithm role,* otherwise like Strategy



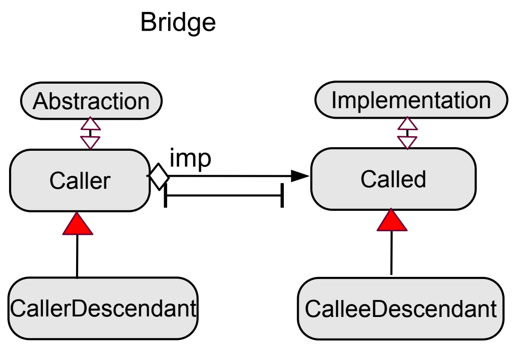
DimensionalClassHierarchies

- DimensionalClassHierarchies is a TemplateClass
  - *Without template-hook constraint, but still TemplateMethod/Template Hook constraint*
  - With left hierarchy constraint



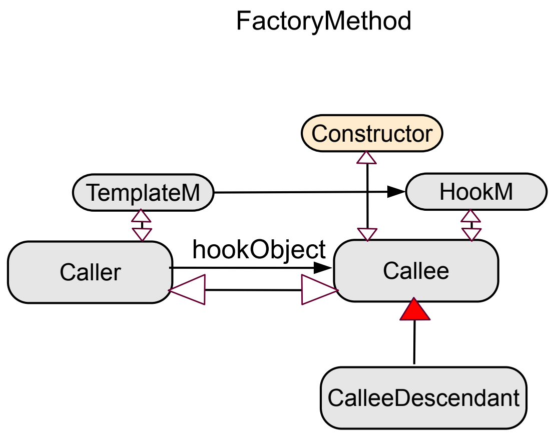
Bridge

- Bridge is a DimensionalHierarchies with
  - An additional abstraction/implementation role model
  - *No template/hook role*



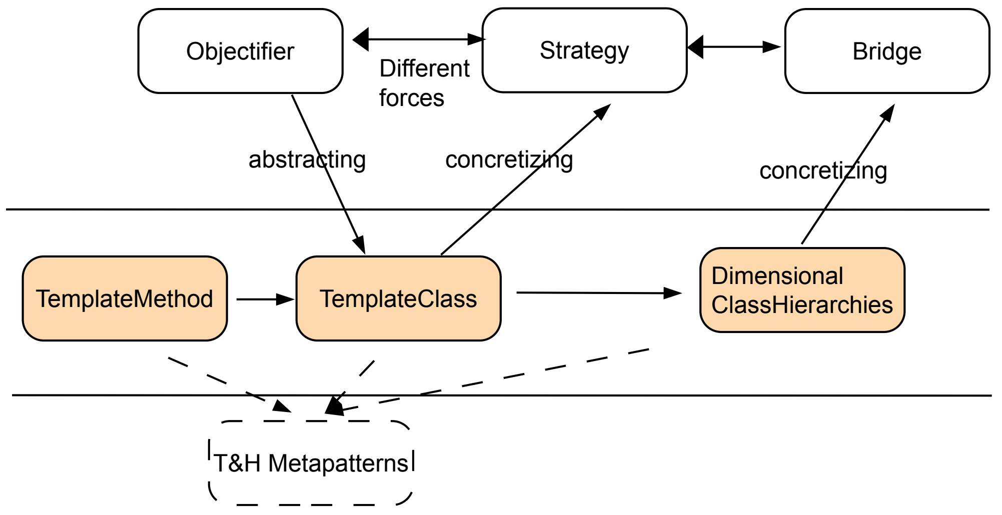
Creational Patterns

- Add more roles with semantics about creation
- E.g., FactoryMethod is a TemplateMethod with a creational role model



Remember: Relation TemplateMethod, TemplateClass, Strategy, Observer

More specific patterns (with more intent, more pragmatics, specific role denotations)

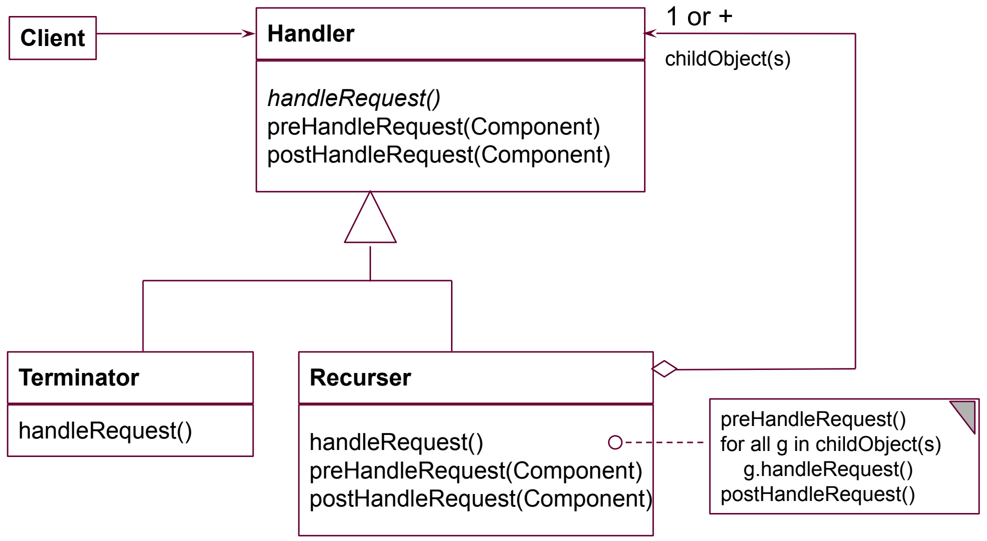


Framework Patterns (with TemplateM/HookM role model)

11.2.4 Composition of Simple Extensibility Patterns

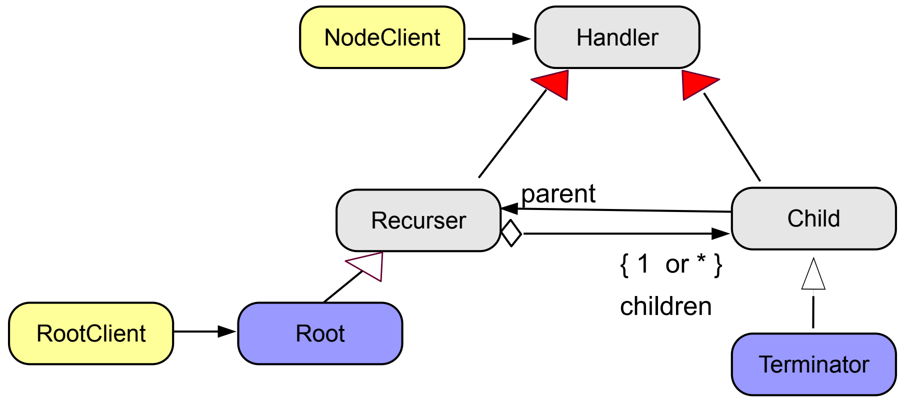
Object Recursion

- The aggregation can be 1:1 or 1:n (1-Recursion, n-Recursion)



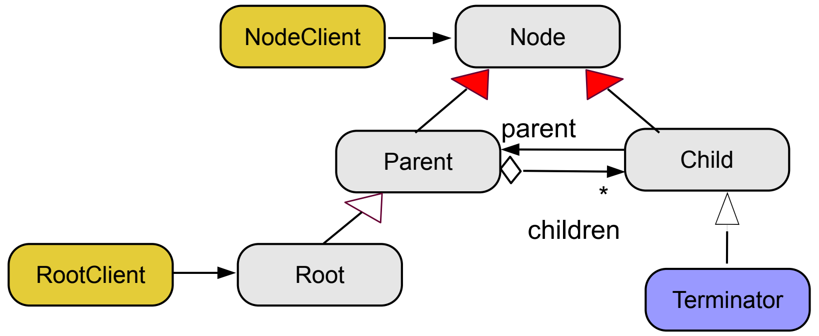
ObjectRecursion

- Essential roles are Handler, Recurser, Child
- Root, Terminator can, but need not be modeled
- Clients are optional, parent is optional



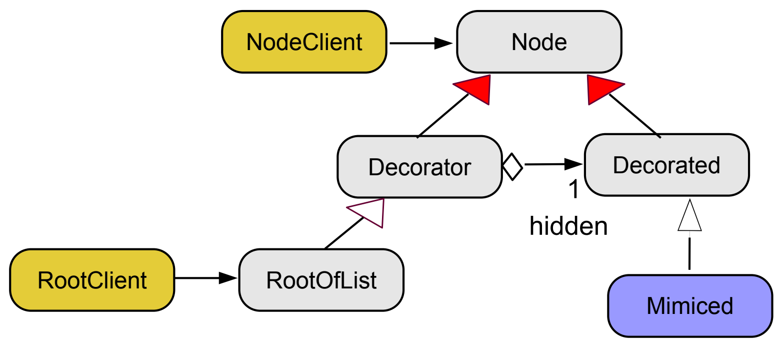
Composite

- n-ObjectRecursion
- Other role pragmatics, similar pattern
- Perhaps with additional parent relation



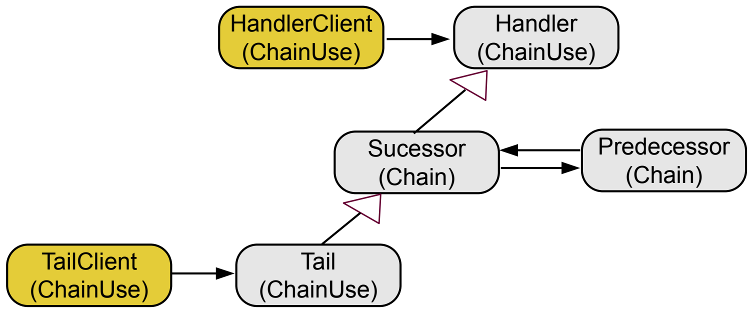
Decorator

- 1-ObjectRecursion
- other role pragmatics, similar pattern

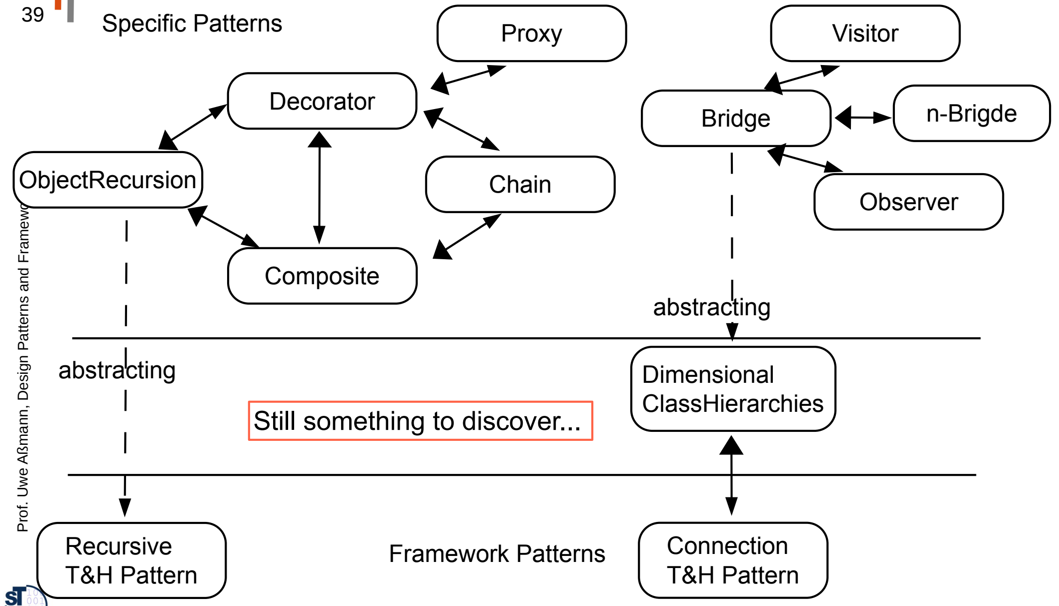


Chain of Responsibility

- No real ObjectRecursion



Remember: Relations Extensibility Patterns

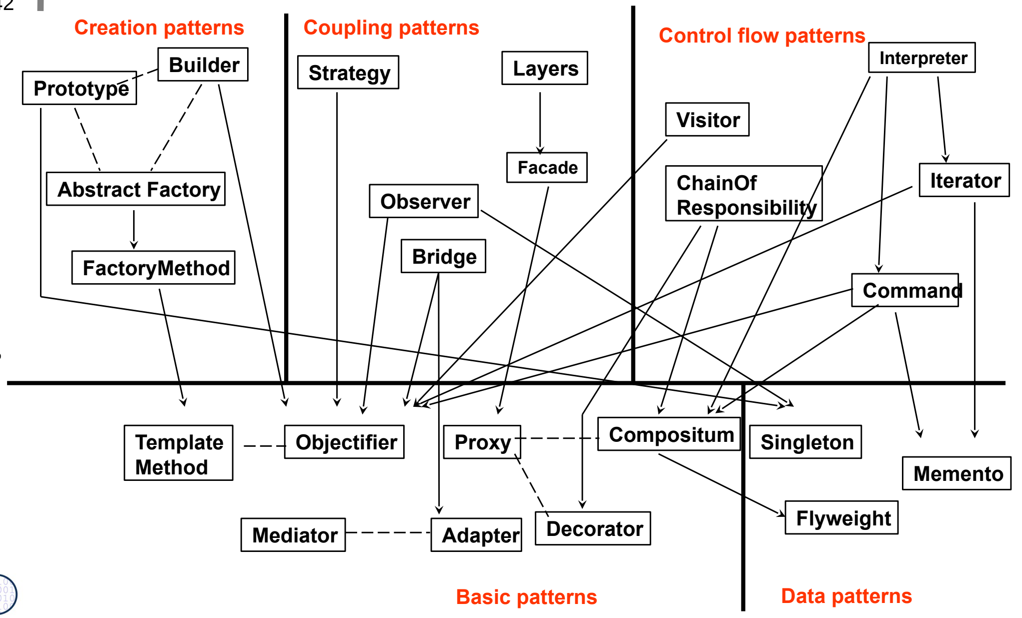


11.2.5 Consequences of the Riehle/Gross Law

Zimmer's Classification and the Riehle-Gross Law

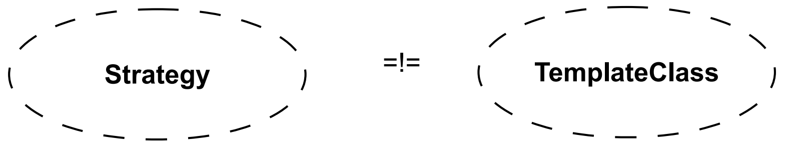
- Zimmer's hierarchy [Zimmer, PLOP 1] lists use-relationships between design patterns
  - But actually, he means composition of role models of design patterns
  - but Zimmer could not express it conceptually

Relations between Patterns [Zimmer, PLOP 1]



Consequence for Pattern-Based Design

- With different role models, the fine semantic differences between several patterns can be expressed syntactically
  - A role model can capture *intent (pragmatics)* of a pattern
  - While patterns can have the same structure, the intent may be different
  - It is possible to distinguish a Strategy, TemplateClass, a Bridge or DimensionalClassHierarchy
- This makes designs more explicit, precise, and formal



Consequence for Pattern Mining

- When you identify a pattern in the product of your company, use **pattern decomposition** and **composition**
  - Try to define a role model
  - Split the role model into those that you know already, i.e., decompose the complex pattern in well-known ones
- Advantage:
  - You know how to implement the well-known patterns
  - You can check whether an implementation of the composite, new pattern is correct
  - If all component patterns are implemented correctly, i.e., conform to their role models.
- Be Aware: These Role Models Are Not Stable
  - Role models provide freedom; so there may be several ones for one pattern

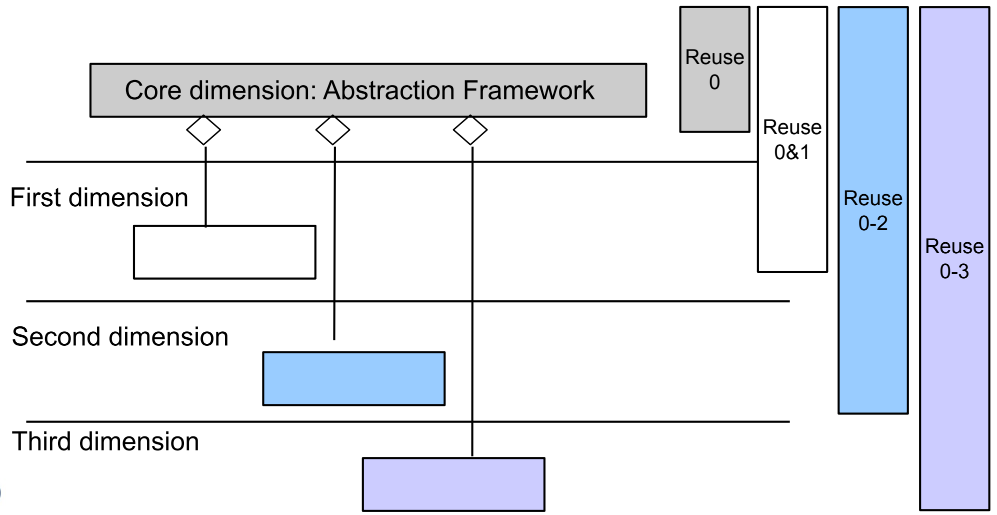
11.3 Effects of Role-Based Design Patterns on Frameworks and Applications

Effect of Role Models

- Role modelling allows for *scaling of delegation*
  - By default, all roles are overlaid by their class
  - But some can stay separate
  - Layered frameworks split all roles off to role objects

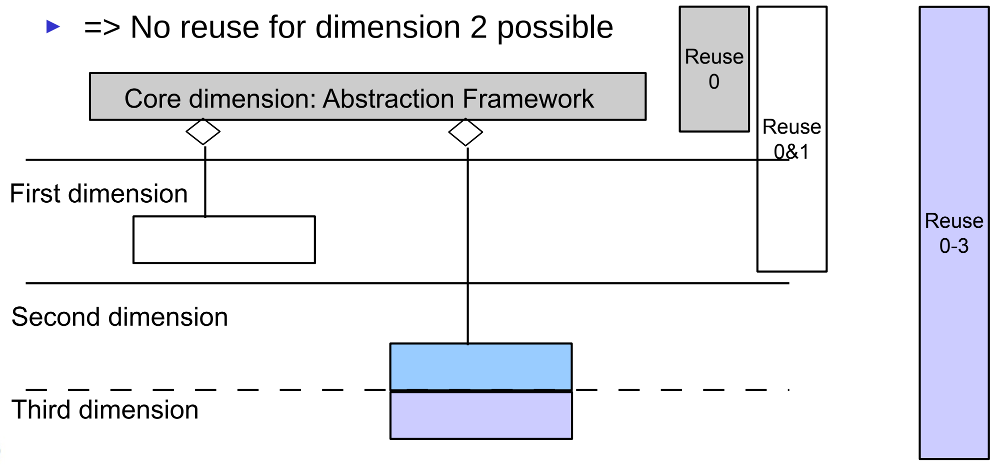
Role Models and Facet/Layered Frameworks

- Remember: An n-Bridge framework maintains roles (role models) in every facet (because a facet model is based on a class-role model)
- Similar for Chain-Bridges and layered frameworks



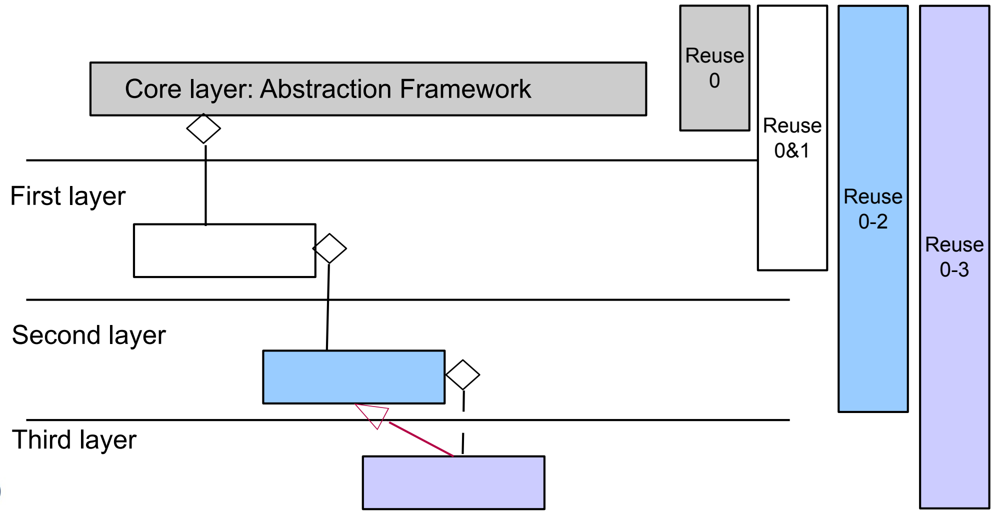
Merging dimensions of Facet/Layered Frameworks

- If the dimensions are seen as role models, it can be chosen to merge them, i.e., the role models
- Here: merge second and third dimension into one physical implementation (mixins)
- => No reuse for dimension 2 possible



Role Models and Layered Frameworks

- Similar for Chain-Bridges and layered frameworks

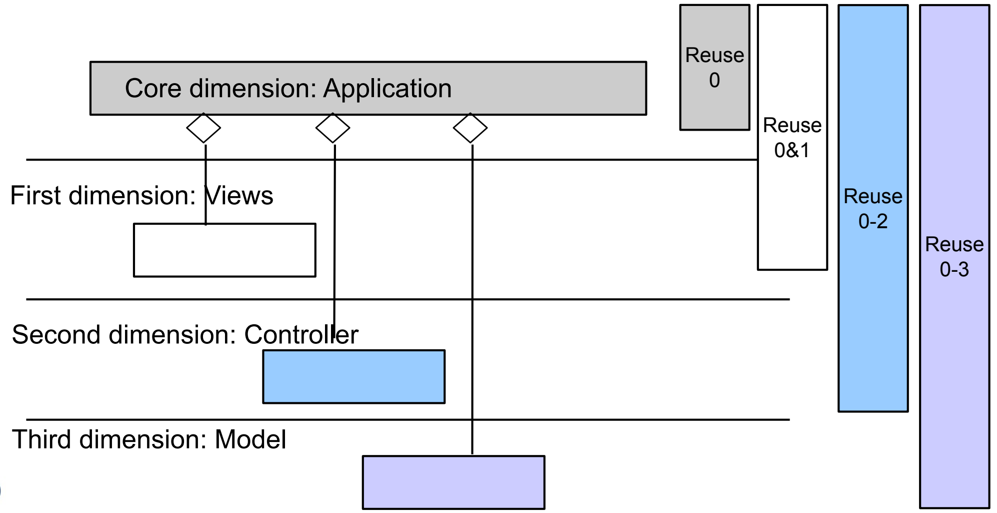


Merging Dimensions/Layers of Dimensional/Layered Frameworks

- When two layers are merged, the variability of a framework sinks
- But its applications are more efficient:
  - Less delegations (less bridges)
  - Less allocations (less physical objects)
  - Less runtime flexibility (less dynamic variation)

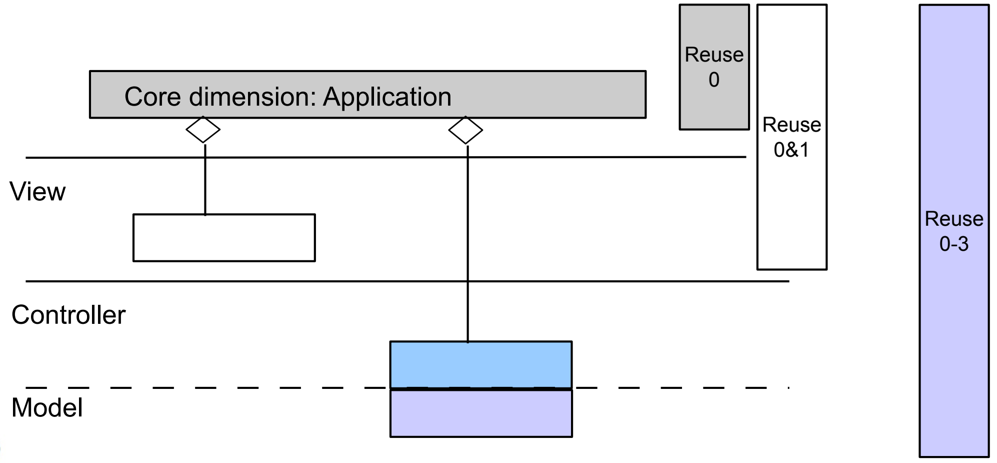
MVC as Multi-Bridge Framework

- The roles of MVC can be ordered in a n-Bridge framework



MVC as Optimized Multi-Bridge Framework

- Model and Controller layer can be merged
- Less variability, but also less runtime objects



11.4 Optimization of Design Patterns with Role Models

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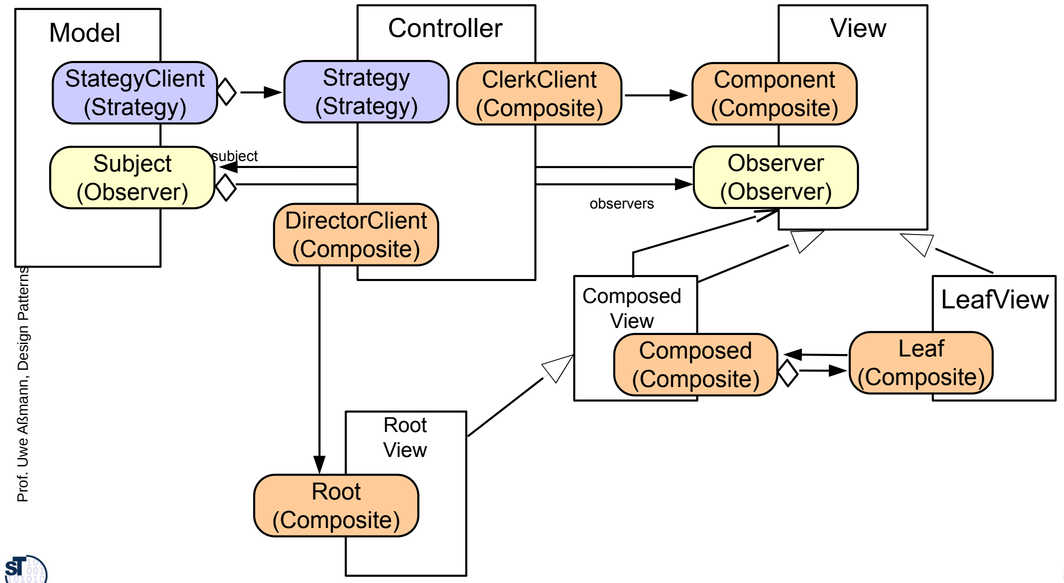
Law of Optimization for Design Patterns

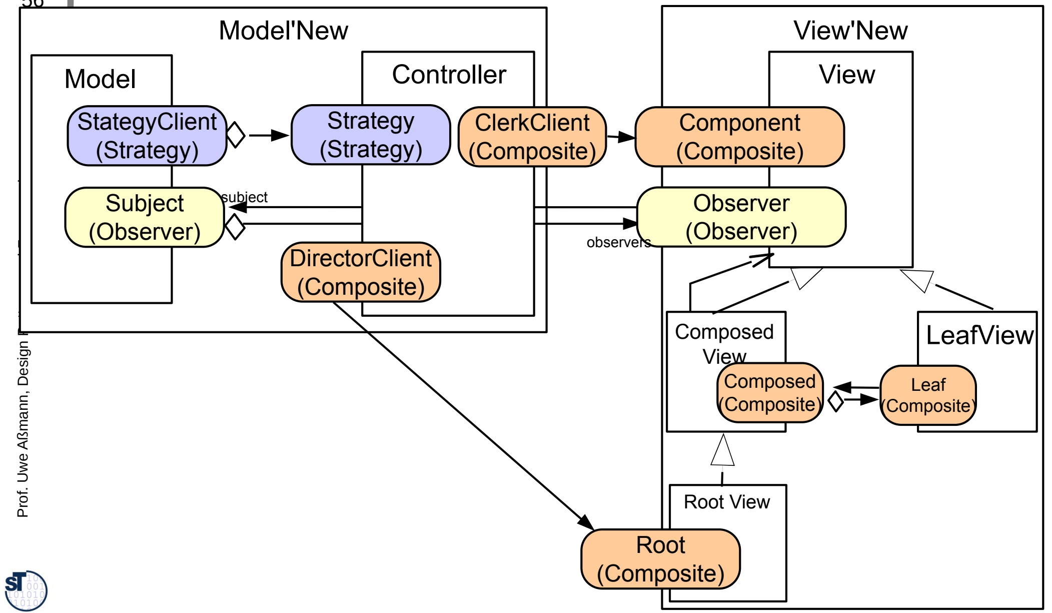
Whenever you need a variant of a design pattern that is more efficient, investigate its role model and try to merge the classes of the roles

- Effect:
  - Less variability
  - Less runtime objects
  - Less delegations

Original Role-Class Model of MVC



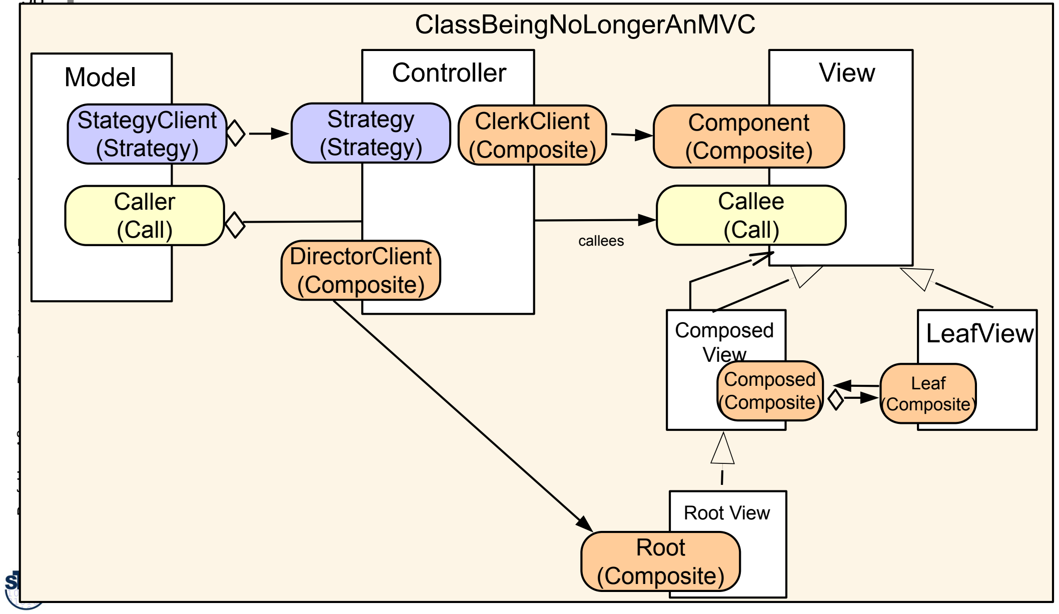
Optimized Role-Class Model of MVC



Optimized Role-Class Model of MVC

- The optimized model merges all roles into two classes
  - No strategy variation
  - No composite views
- Only 2 instead of 3+n objects at runtime
  - Faster construction
  - Essence of the pattern, the Observer, is still maintained
- However, restricted variability

Super-Optimized Role-Class Model of MVC (Monolithic)



- In this design, the ClassBeingNoLongerAnMVC merges all roles
  - It should be a superclass of all contained classes
- The Observer pattern is exchanged to a standard call
- No variability anymore
- But only one runtime object!

The End: Summary

- Roles are important for design patterns
  - If a design pattern occurs in an application, some class of the application plays the role of a class in the pattern
  - Roles are dynamic classes: they change over time
- Role-based modelling is more general and finer-grained than class-based modelling
- Role mapping is the process of allocating roles to concrete implementation classes
- Hence, role mapping decides how the classes of the design pattern are allocated to implementation classes (and this can be quite different)
- Composite design patterns are based on role model composition
- Layered frameworks and design patterns can be optimized by role merging