32. Data Sharing of Tools by Role-Based Integration of DDL (Role-Based Metamodel Composition on M2)

for Tool Interoperability on M1-Models and M0-Repositories

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Version 12-0.3, 07.12.12

1) Motivational Example

Proactive vs. Retroactive Tool Integration

2) Roles in Metalanguages
3) Role-Based Composition of Metamodels
4) Grounding

Obligatory Literature

- Mirko Seifert, Christian Wende and Uwe Aßmann. Anticipating Unanticipated Tool Interoperability using Role Models. In Proceedings of the 1st Workshop on Model Driven Interoperability (MDI'2010) (co-located with MODELS 2010), 5th October 2010, Oslo, Norway
- Course “Design Patterns and Frameworks” (chapter about role modeling)
- http://www.langems.org

- http://www.emftext.org/language/rolecore

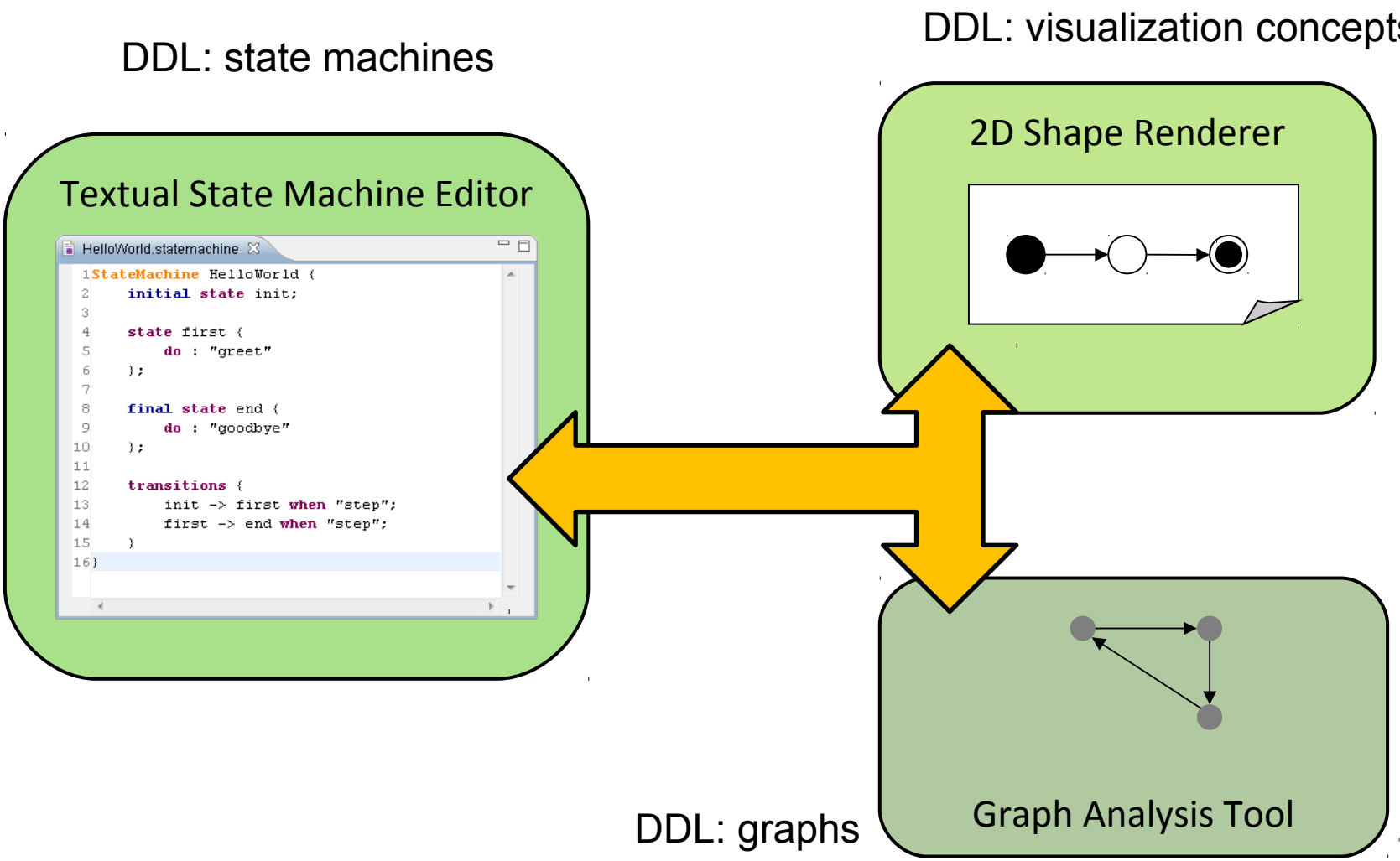
emftext

Position

- We have learned in chapter “Tool Architecture” that metamodels can be composed so that metamodel-driven repositories can be generated
- So far, the integration was based on union of metamodel packages, i.e., the metaclasses stayed as they are during composition
- In this chapter, we will merge metaclasses during composition
- This achieves a much tighter integration

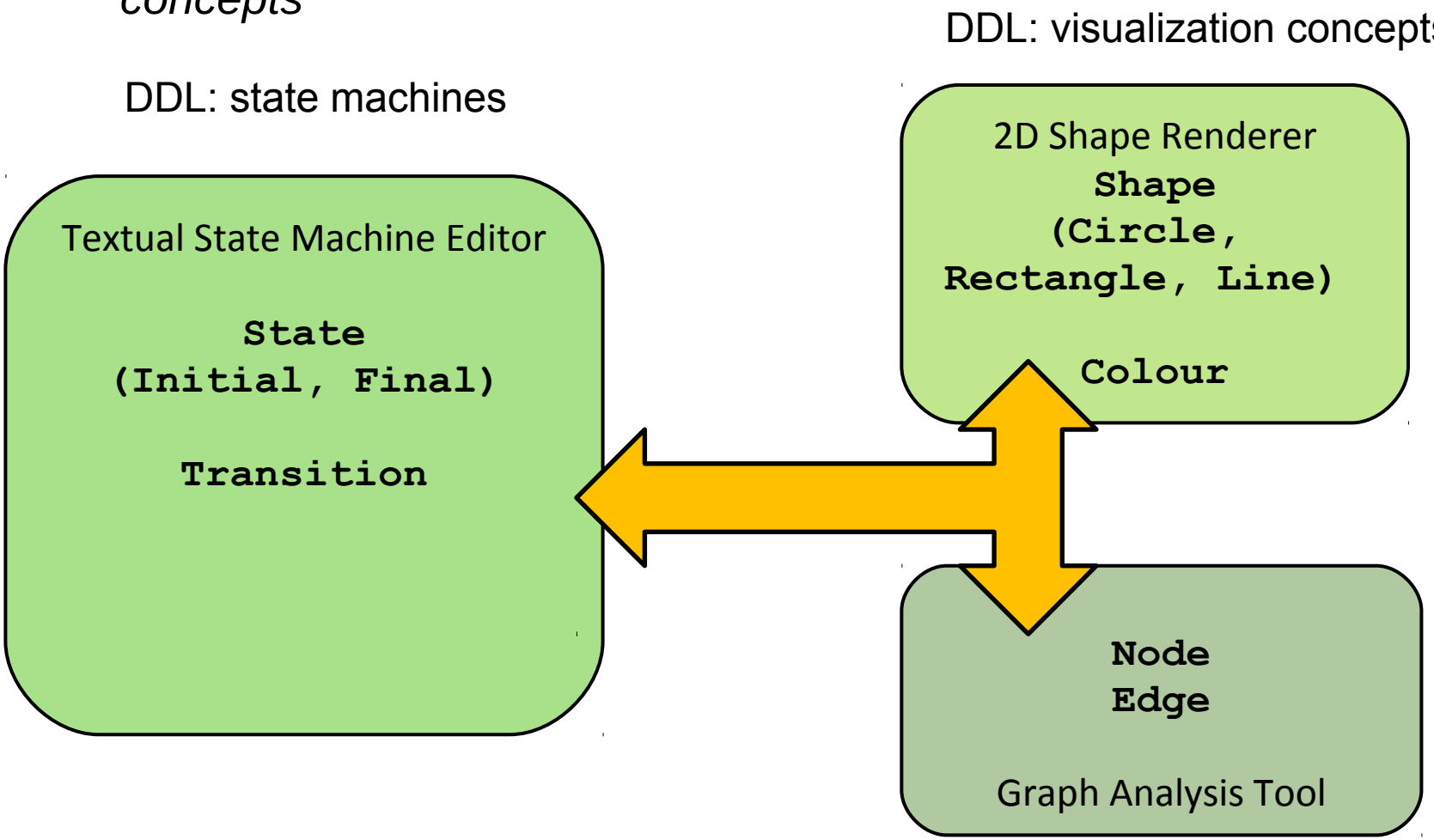
34.1 Motivational Example for Data Sharing in Tool Integration

- Tools may rely on different DDL, which represent *similar concepts*

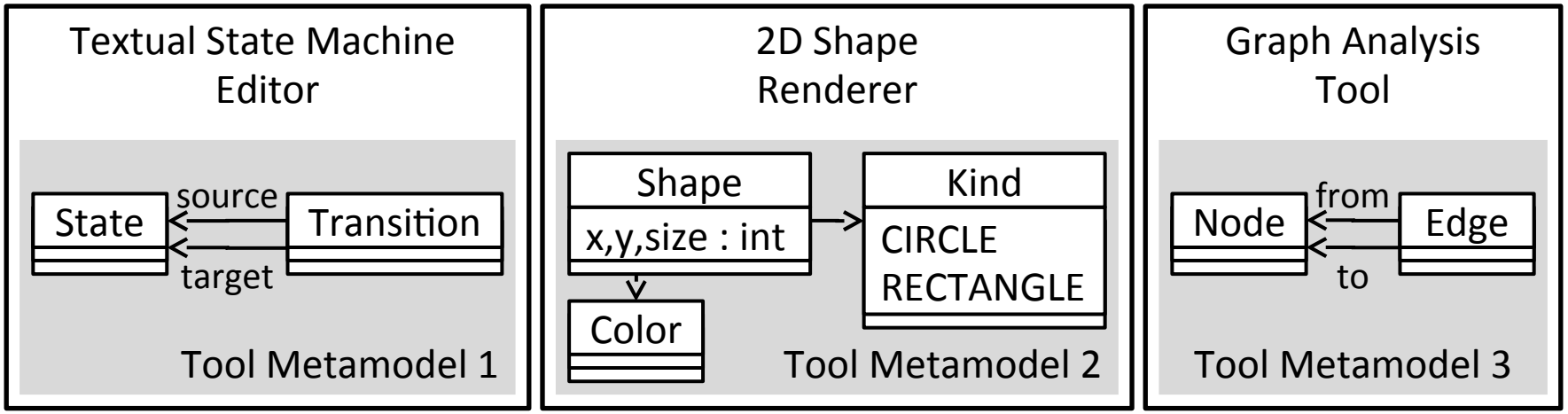


Example – Language Concepts in Metamodels of the Involved Tools

- Then, tools rely on different DDL metamodels with *overlapping concepts*

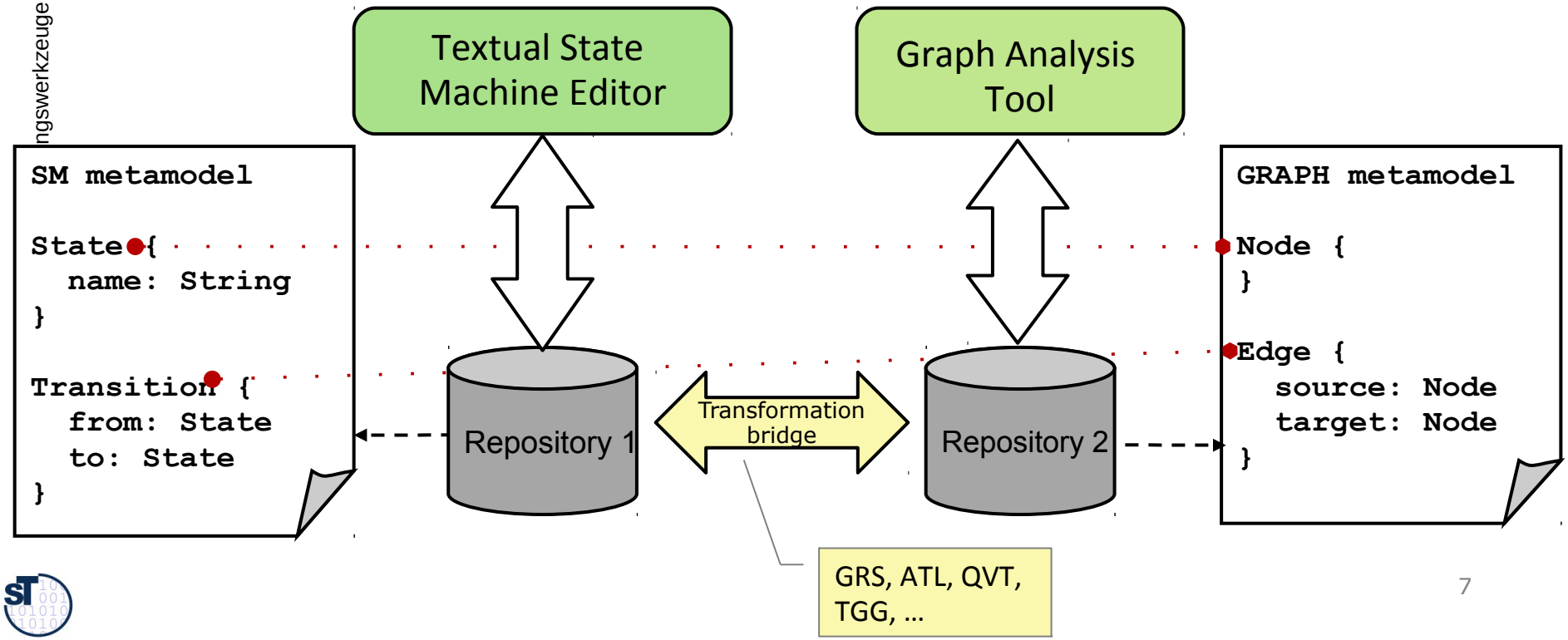


How Can these Metamodels be Integrated?



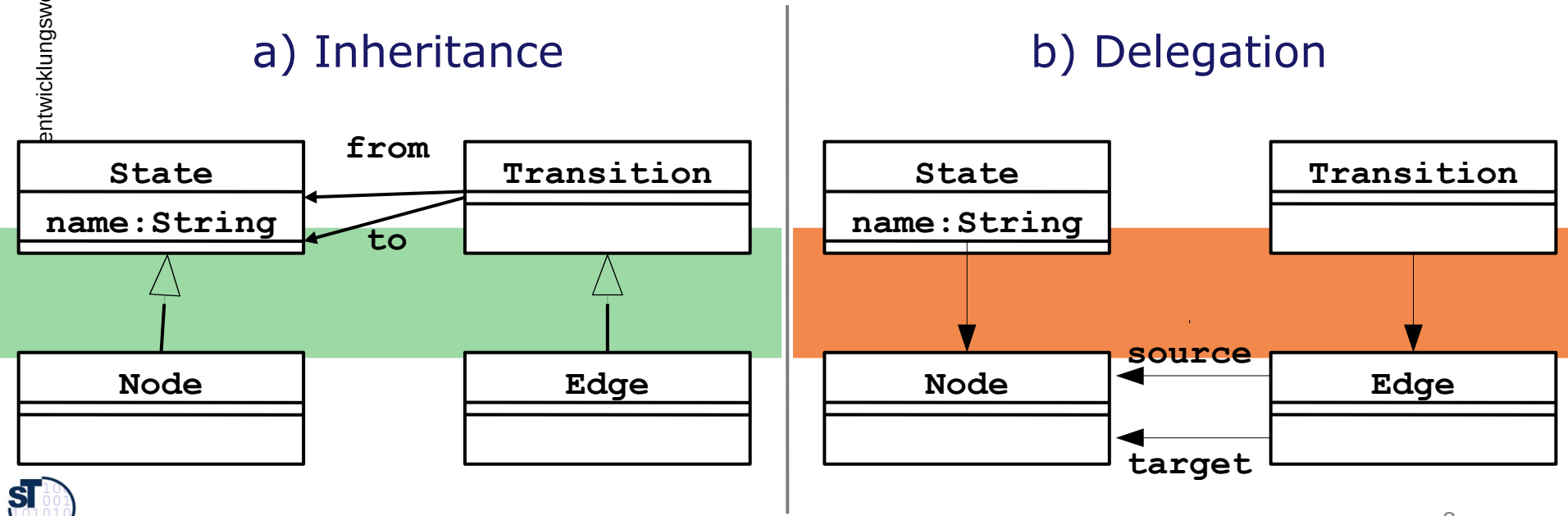
Retroactive Tool Integration on Repositories by Data Connection

- Often, tools, their metamodels, and the metamodel-driven repositories already exist
- **Metamodel mapping (language mapping):** map the concepts of one DDL to the other
- Use transformations to convert data from one tool to another (data exchange via transformation bridge, Datenverbindung)



Proactive Tool Integration (Classical)

- Sometimes, tool, metamodels, and repositories are not fixed yet
- Use **metamodel extension (integration)** to make data from one tool accessible to another
  - **Extension by inheritance (“white-box”):** Submetaclasses are formed; language concepts are integrated, but no extension of supermetaclasses possible
  - **Extension by delegation (“black-box”):** Language concepts stay separate, but are connected; no real integration



Proactive vs. Retroactive Tool Integration

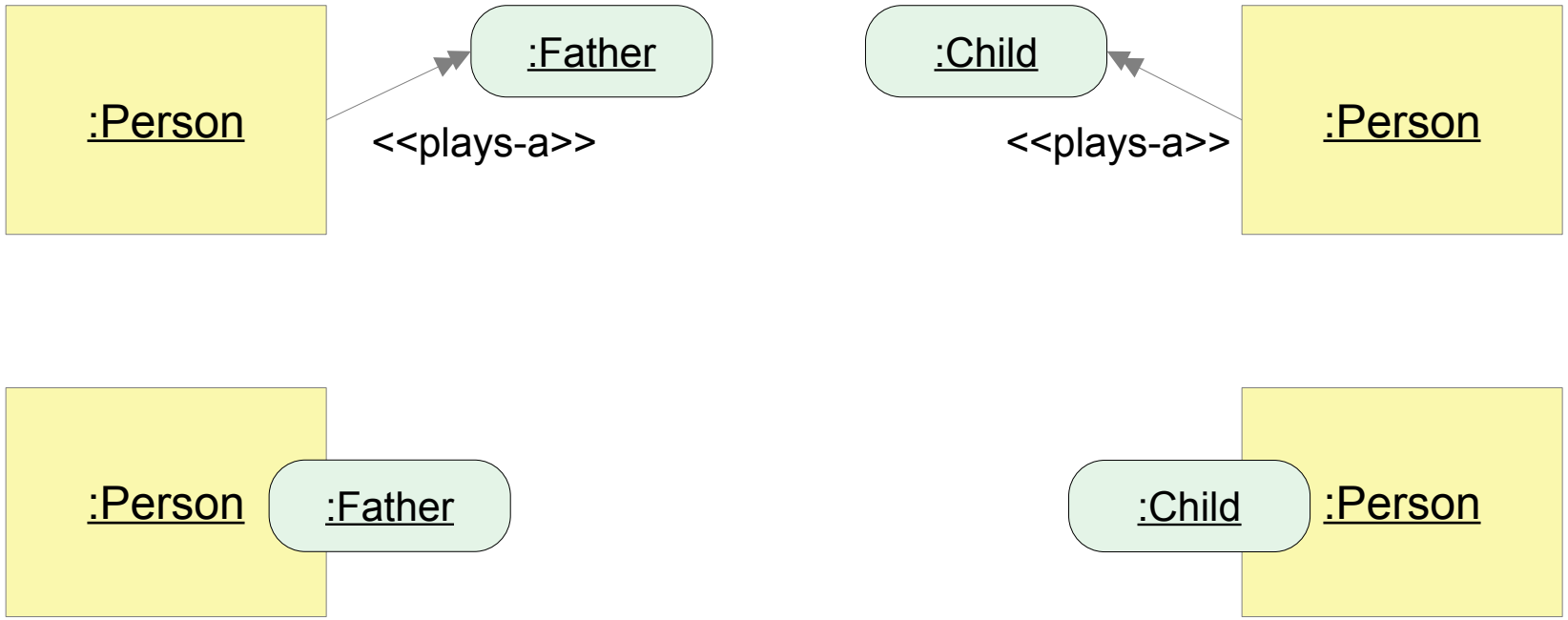
	Proactive	Retroactive
Technique	Inheritance	Transformation
	Delegation	
Appropriate Abstraction	Metamodels need to be adapted (−)	Metamodels unaffected (+)
Tool Independence	Strong coupling (−)	No coupling (+)
Shared Data	Sharing among all integrated tools (+)	Replicated Data, Synchronization needed (−)
Tool Interaction	Support for anticipated interaction only (±)	Transformations hinder interaction (−)

33.2 Roles in Metalanguages

Collaboration-Based Modeling (Role Modeling) (Rpt.)

Roles are first-class modeling concepts in modern object-oriented languag

- Databases [Bachmann], Object-Role Modeling [Halpin]
- Factorization [Steimann]
- Research in Design Patterns [Reenskaug, Riehle/Gross]



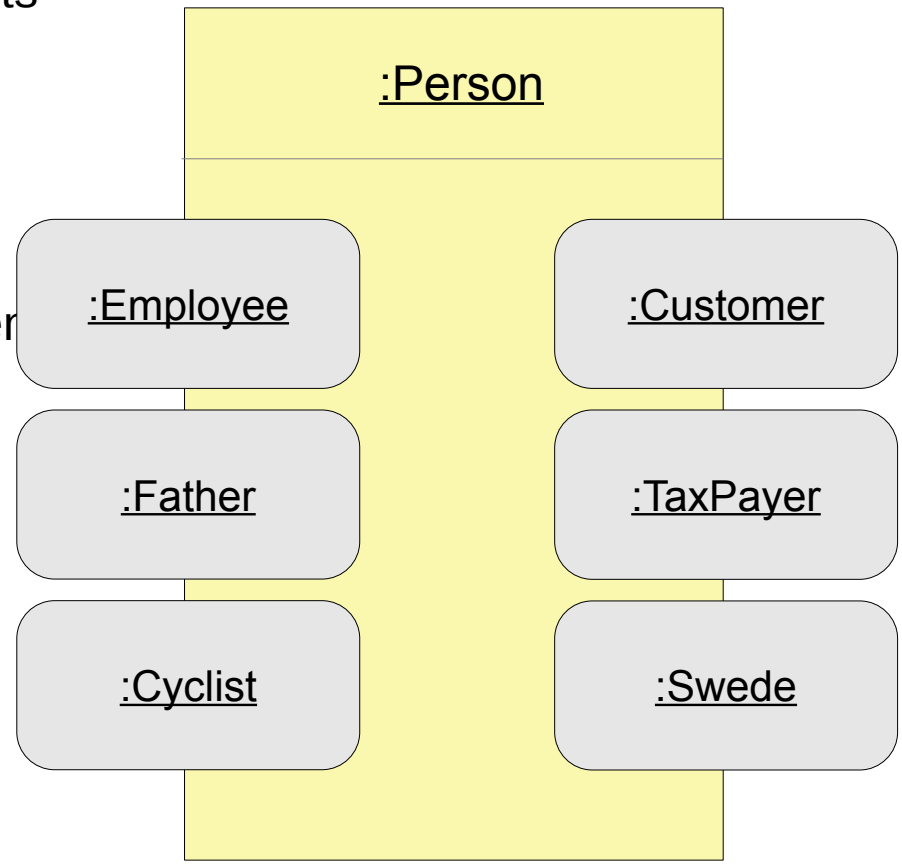
What are Roles? *(Rpt.)*

A *role* is a *dynamic view* onto an object

- Roles are *played* by the objects (the object is the *player* of the role)
- A *partial object*

Roles are tied to *collaborations*

- Do not exist standalone, deper on a partner



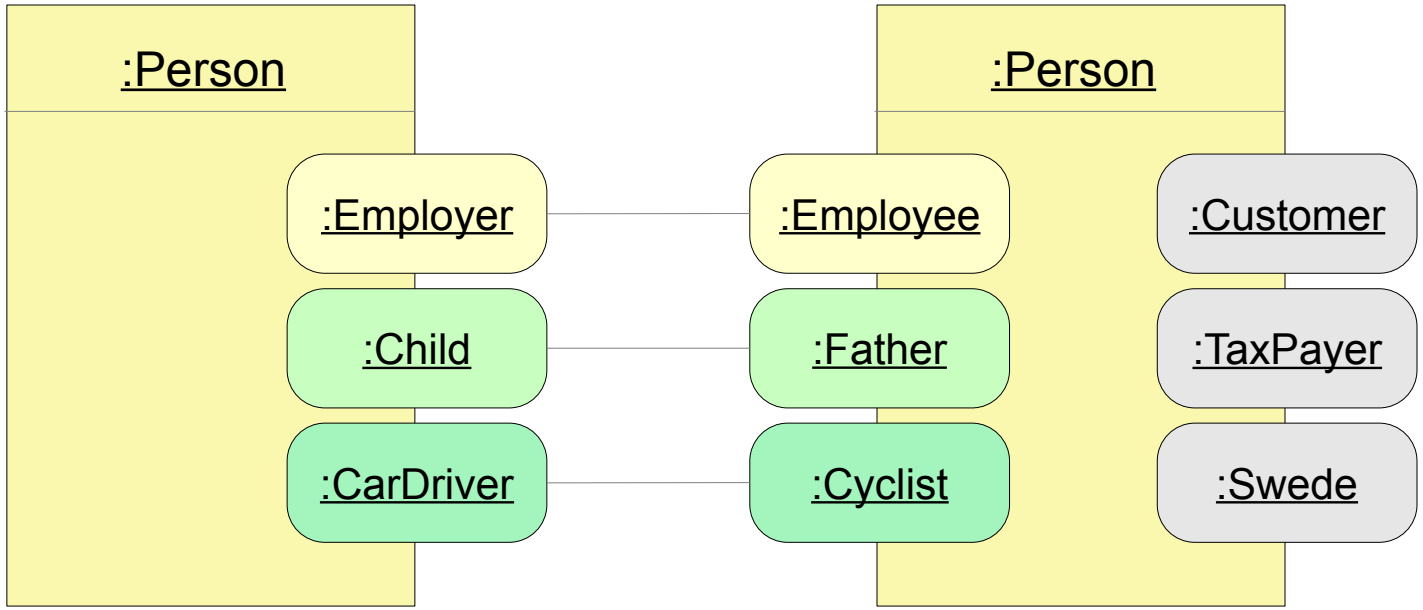
What are Roles? *(Rpt.)*

Roles are *services* of an object in a context

- Roles can be connected to each other
- A role has an *interface*

Roles form *role models,* capturing an area of *concern* [Reenskaug]

- Role models are *collaborative aspects*



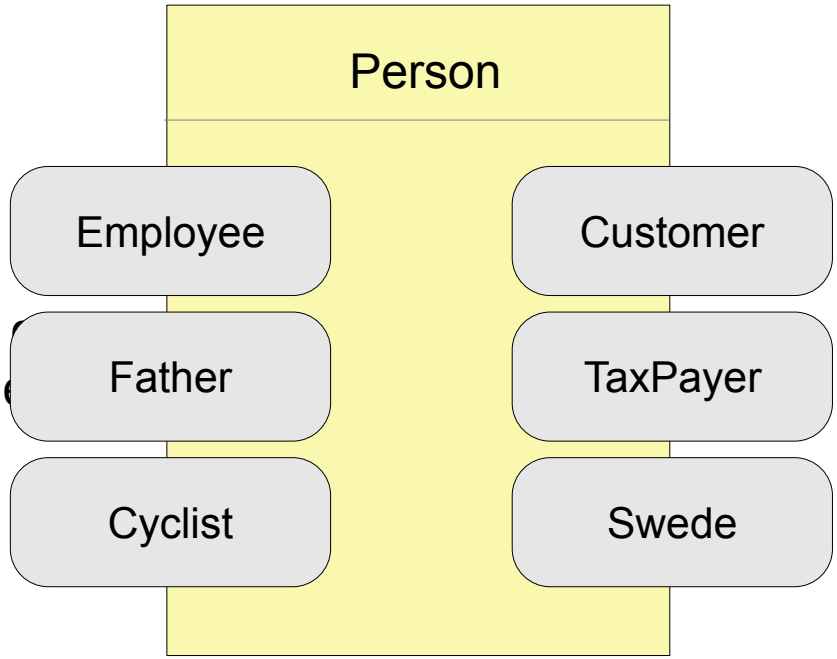
What are Role Types? *(Rpt.)*

Role types (abilities) are

- *service types*
- *dynamic types*
- *collaborative types*

Problem:

- The word “role” is also used on the class level, i.e., for a “role type”

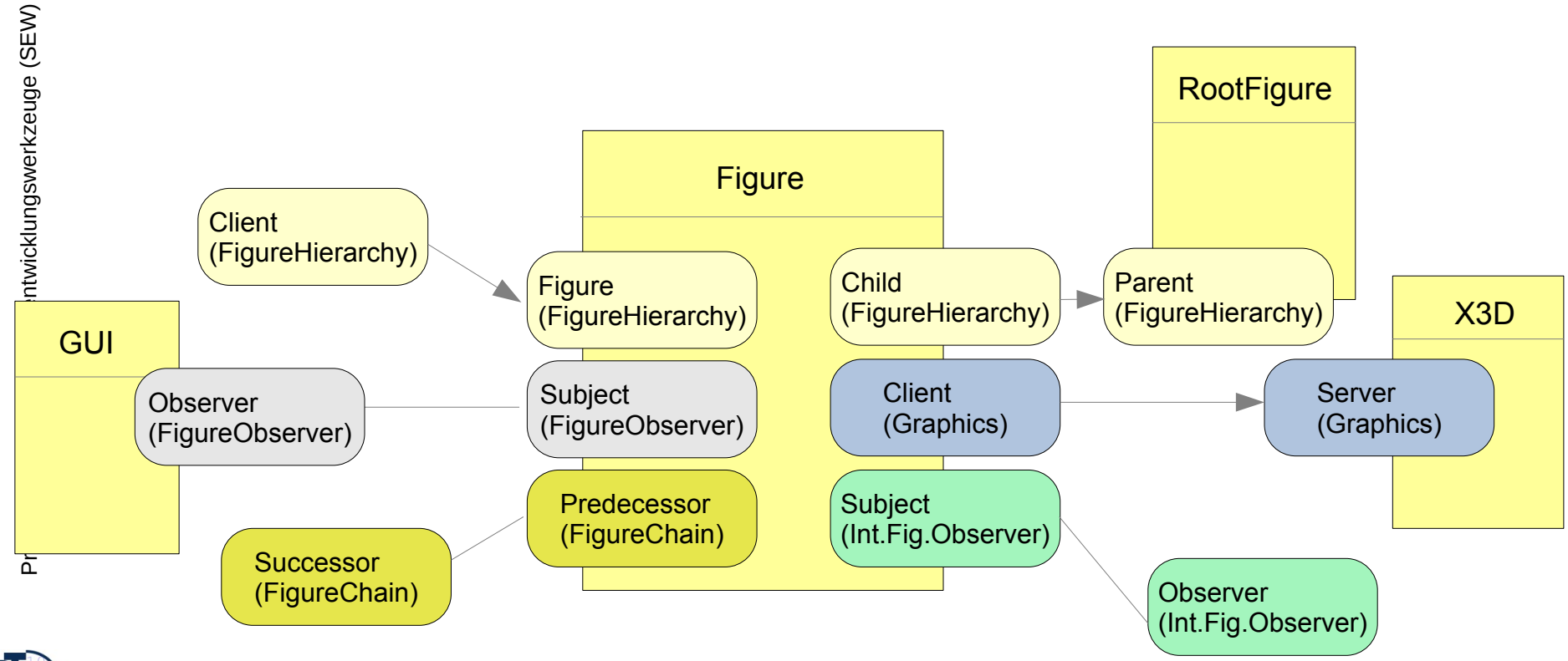


Collaboration Schemas (Role-Type Model) *(Rpt.)*

Collaboration schema (role type model, ability model):

- Set of object collaborations abstracted by a set of role types
- A constraint specification for classes and object collaborations

Ex: A figure can play many roles in different *collaboration schemas*



Role- and Role-Type Models Underly Many Gray-Box Component Models

Views

- Hyperspace (MDSOC)

Collaborative Aspects

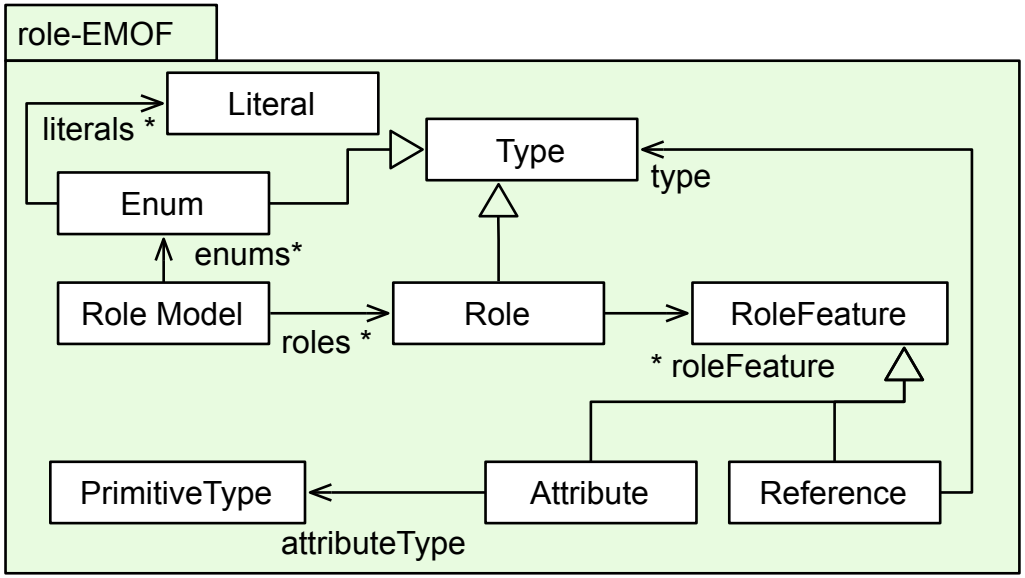
- ObjectTeams www.objectteams.org
- CaesarJ

Template-based languages

- BETA with the metaprogramming environment Mjölner
- Invasive Software Composition

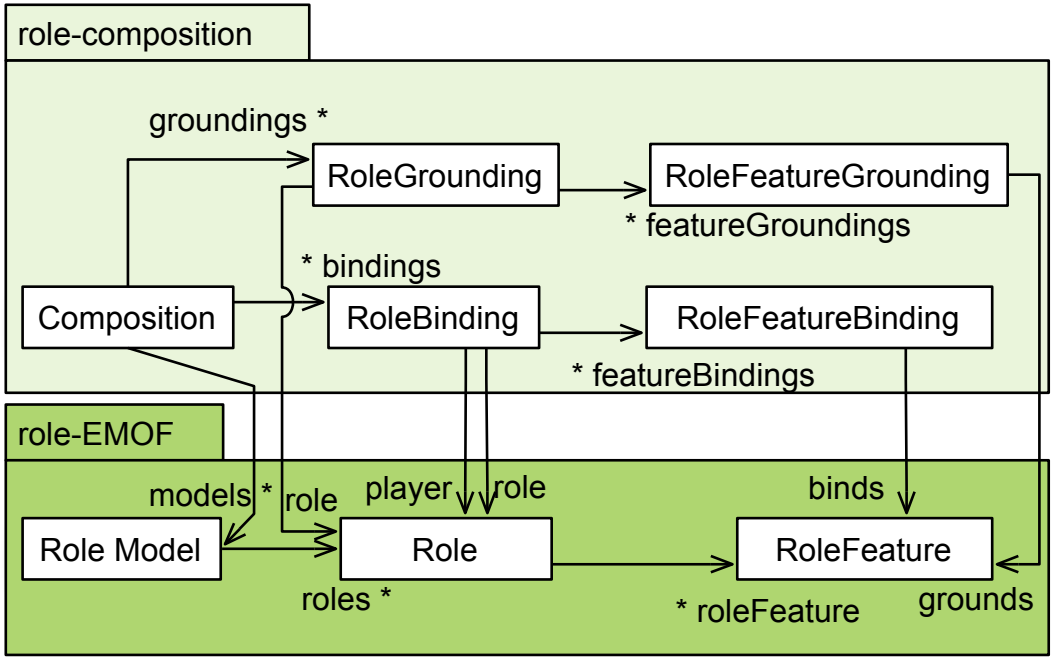
Roles in a Metalanguage (Metametamodel)

- Roles can be introduced as modeling concept.
- Here, an extension of EMOF with roles:



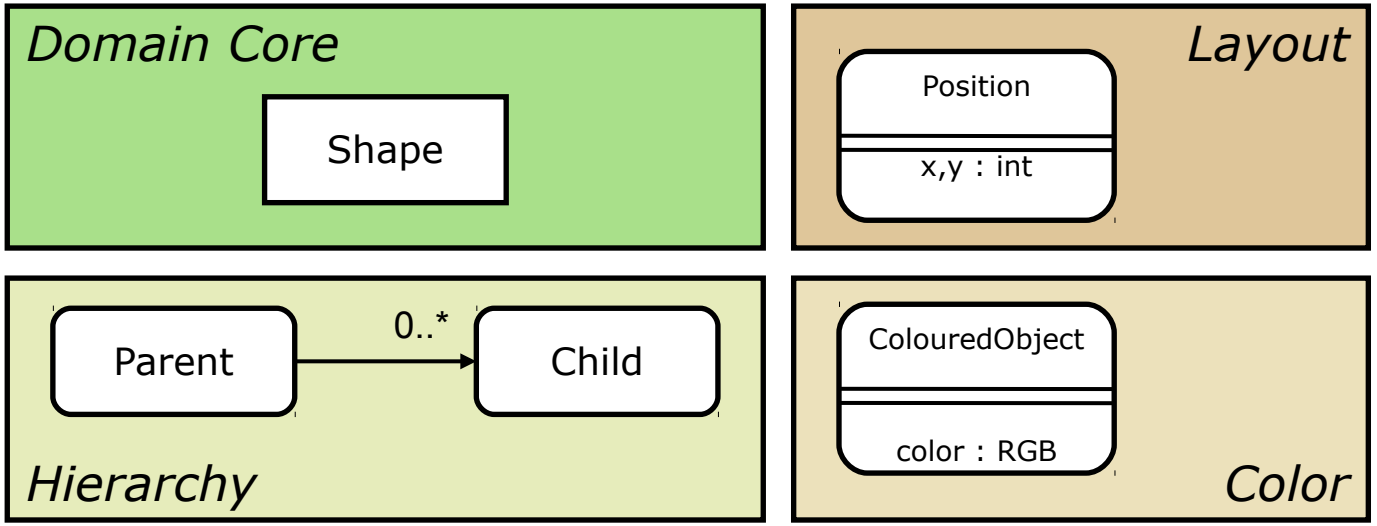
A Metamodel for Deep Role Composition

- **Deep roles** are roles playing roles
- **Flat roles** do not play roles
- This role composition technique (specified by a role-composition metamodel) allows for deep roles



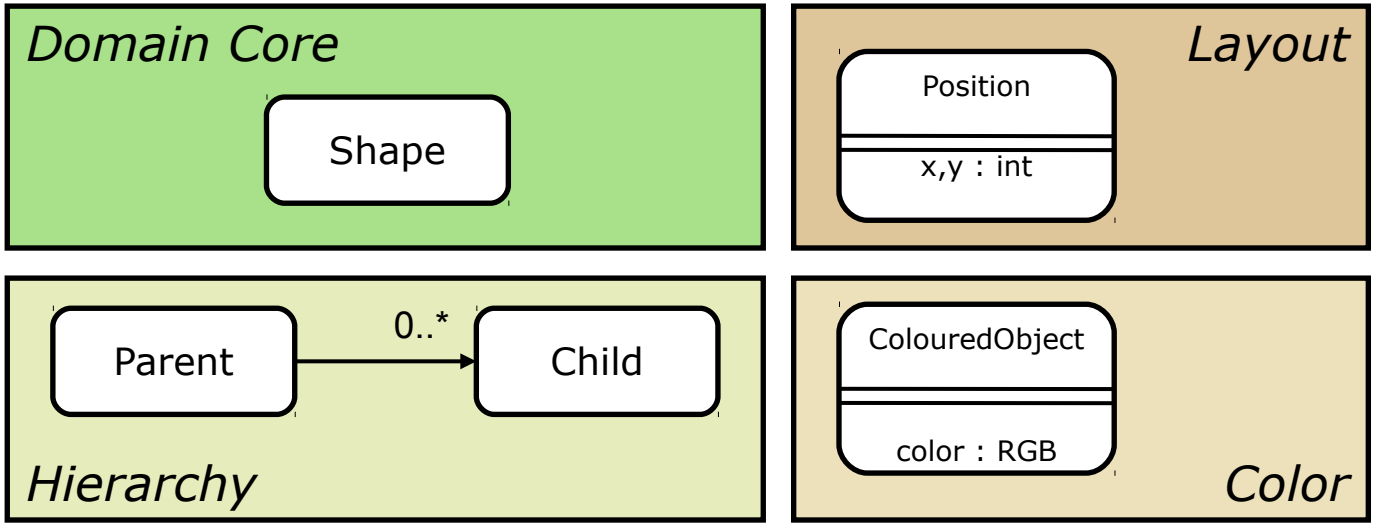
Example: ShapeRenderer's Metamodel with Roles

- Roles adhere to a context
- A context is a specific *concern* (here: colors)
- Only one natural type, many roles



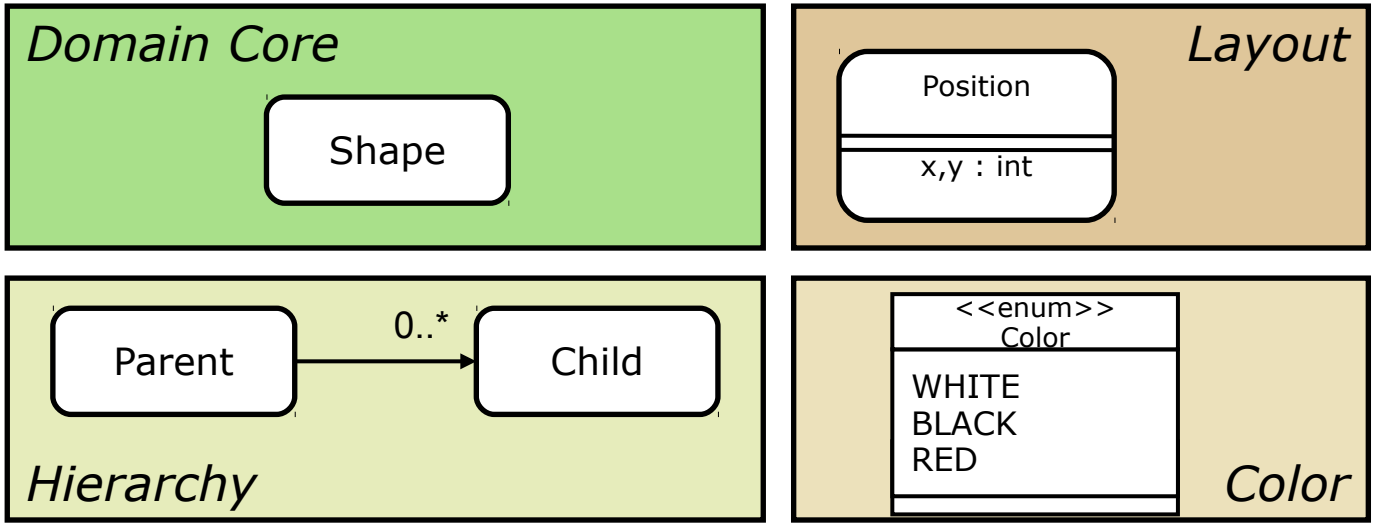
Example: ShapeRenderer's Metamodel with Deep Roles

- Because other tools' metamodels might provide the natural types, we first specify all metamodels with deep roles
  - Then, they can be played by the naturals of other tools



Example: ShapeRenderer's Metamodel with Deep Roles and Enums

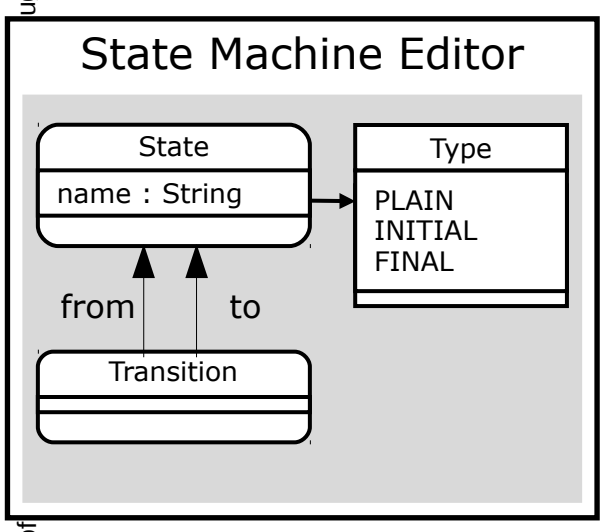
- Some roles can be represented as enums; then they will become natural classes in the implementation

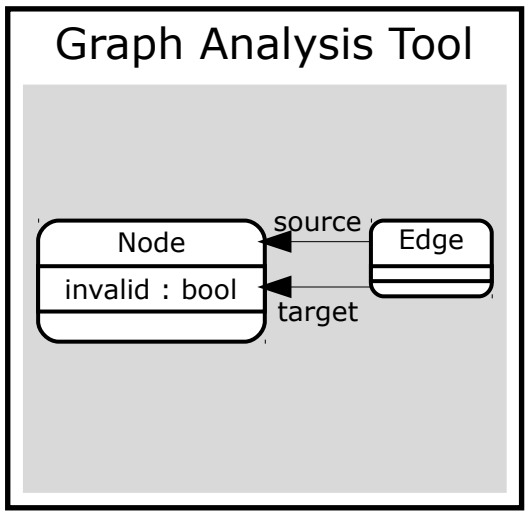


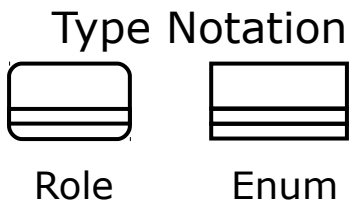
33.3 Proactive Tool Integration with Deep Roles

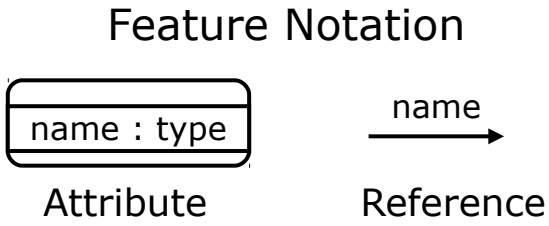
Tool Integration using Deep-Role-Model Based Integration of Metamodels on M2

- Specify M2-metamodels also with role types (abilities) not only classes
- At first sight not much different from object-oriented metamodels
- Difference to classical role modeling: Naturals are selected later; first specify everything as deep role; some roles become enums







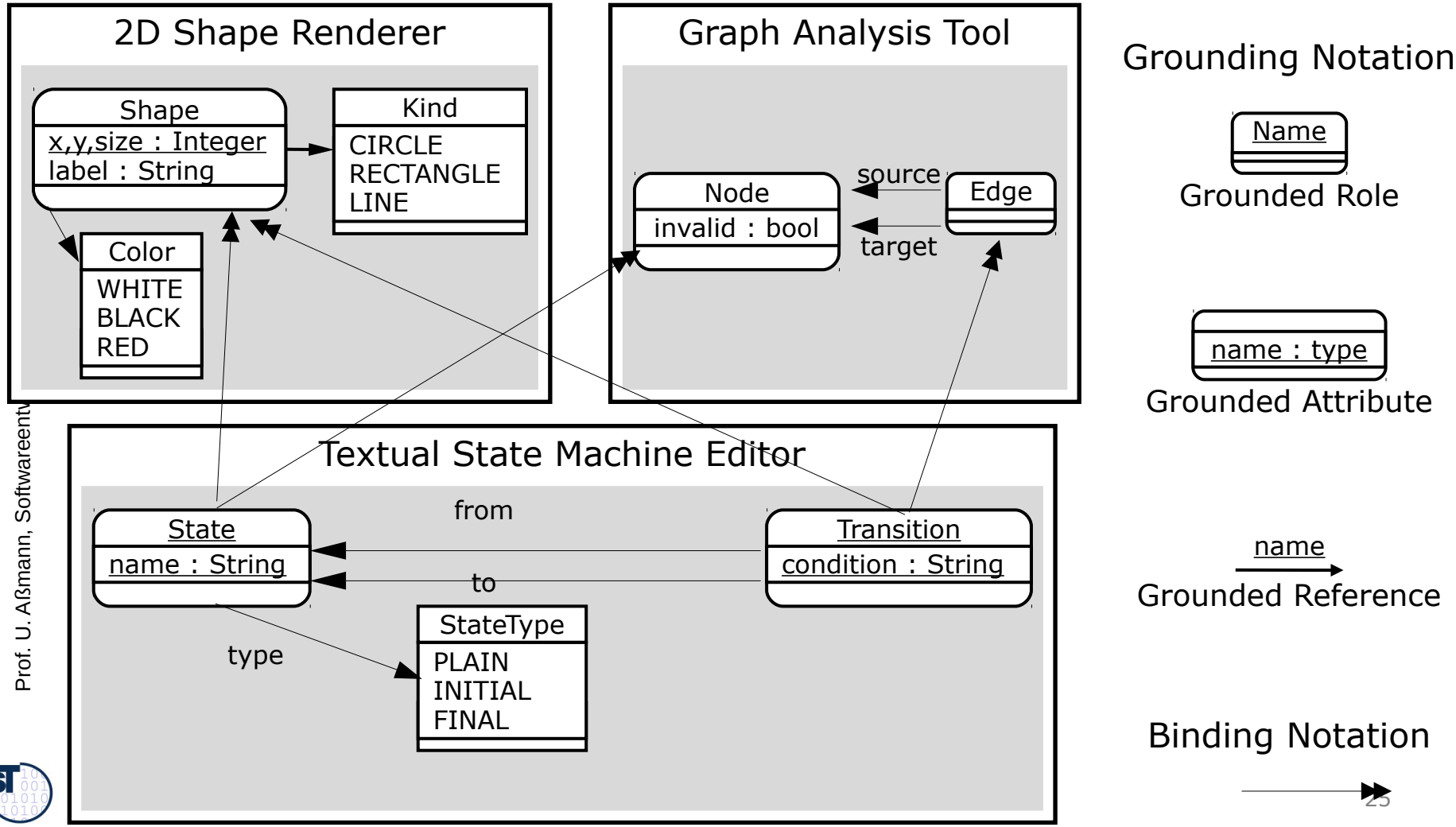


Tool Integration using Role Bindings (Role Grounding)

- Role Bindings on the logical level with relationship “plays-a”
  - Connect roles and role players, producing deep roles
  - Define how to obtain value of attribute or reference
  - Allow to create views on other classes 
- Grounding on the physical level
  - Defines which attributes/classes are represented physically
  - Select natural types
  - Ground to implementation by design patterns or other role-implementations (see course Design Patterns and Frameworks)
- The decision (about which data is derived and which is not) is done at tool integration time!

Metamodel Composition based on Deep Role Type Binding

- Composition by deep role binding and role grounding
- We defer the decision “what is a natural”



33.4 Grounding: Mapping to Programming Language

A DSL for Integration (EMFText RoleCore Language)

- Role binding can be described by a DSL.

```
integrate statemachine, 2dShapes, graph {
    State plays Shape {
     label: name
     kind: if (player.type == PLAIN) return RECTANGLE
           else return CIRCLE
     colour: if (player.type == INITIAL) return WHITE
           else return BLACK
    }
    Transition plays Shape {
     label: condition
     kind: return LINE
     colour: return BLACK
    }
    State plays Node {}
    Transition plays Edge {
     source: from
     target: to
    }

    ground State { name, type }
    ground Transition { condition, from, to }
}
```

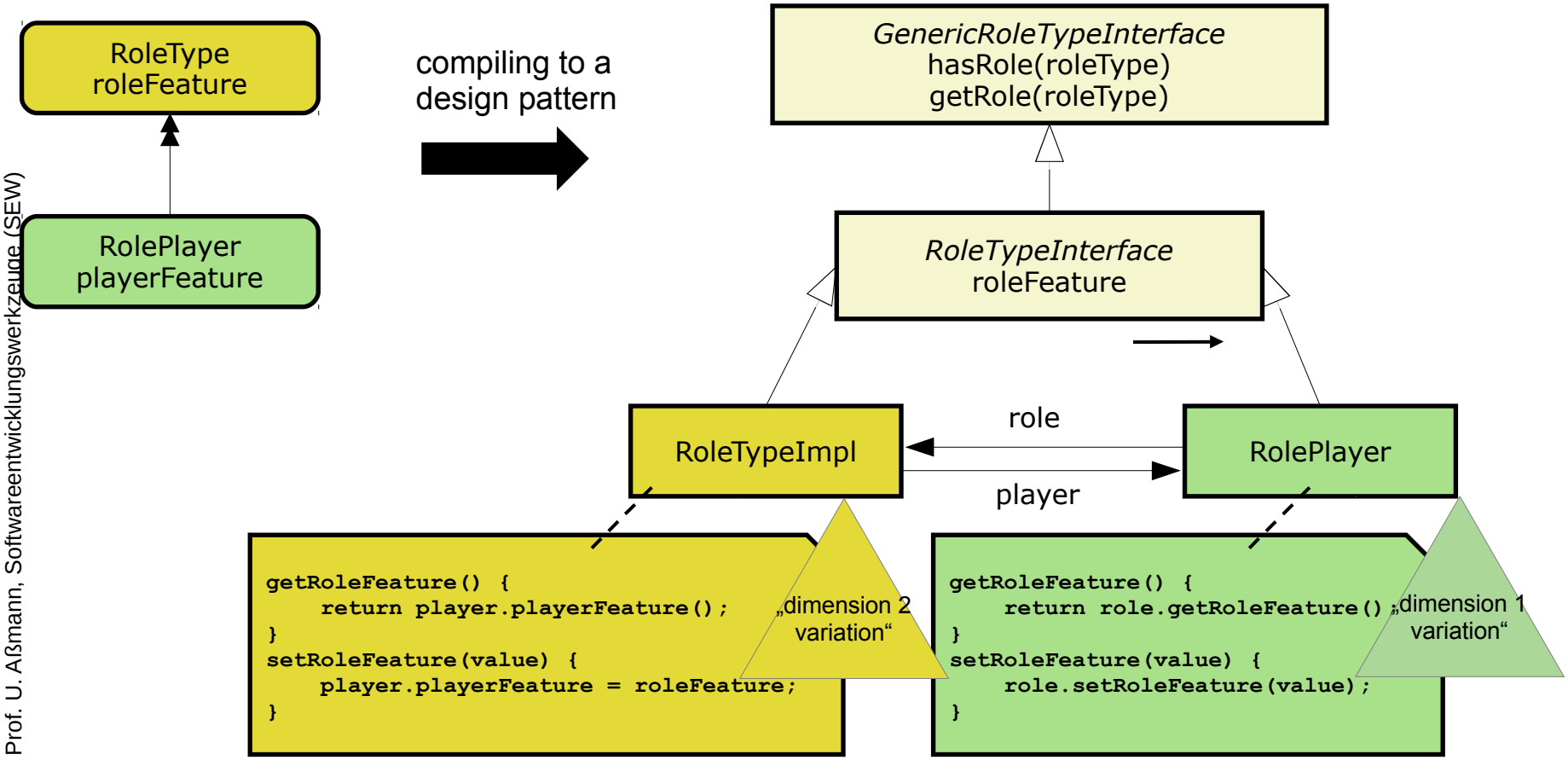
Role Binding Specification

Grounding Specification

http://www.reuseware.org/index.php/EMFText_Concrete_Syntax_Zoo_Rolecore

Role Binding Realisation by e.g., Delegation (Design Pattern Bridge)

- The constructs of RoleCore can be easily expanded to design patterns (code generation), e.g., MultiBridge or Role-Object Pattern



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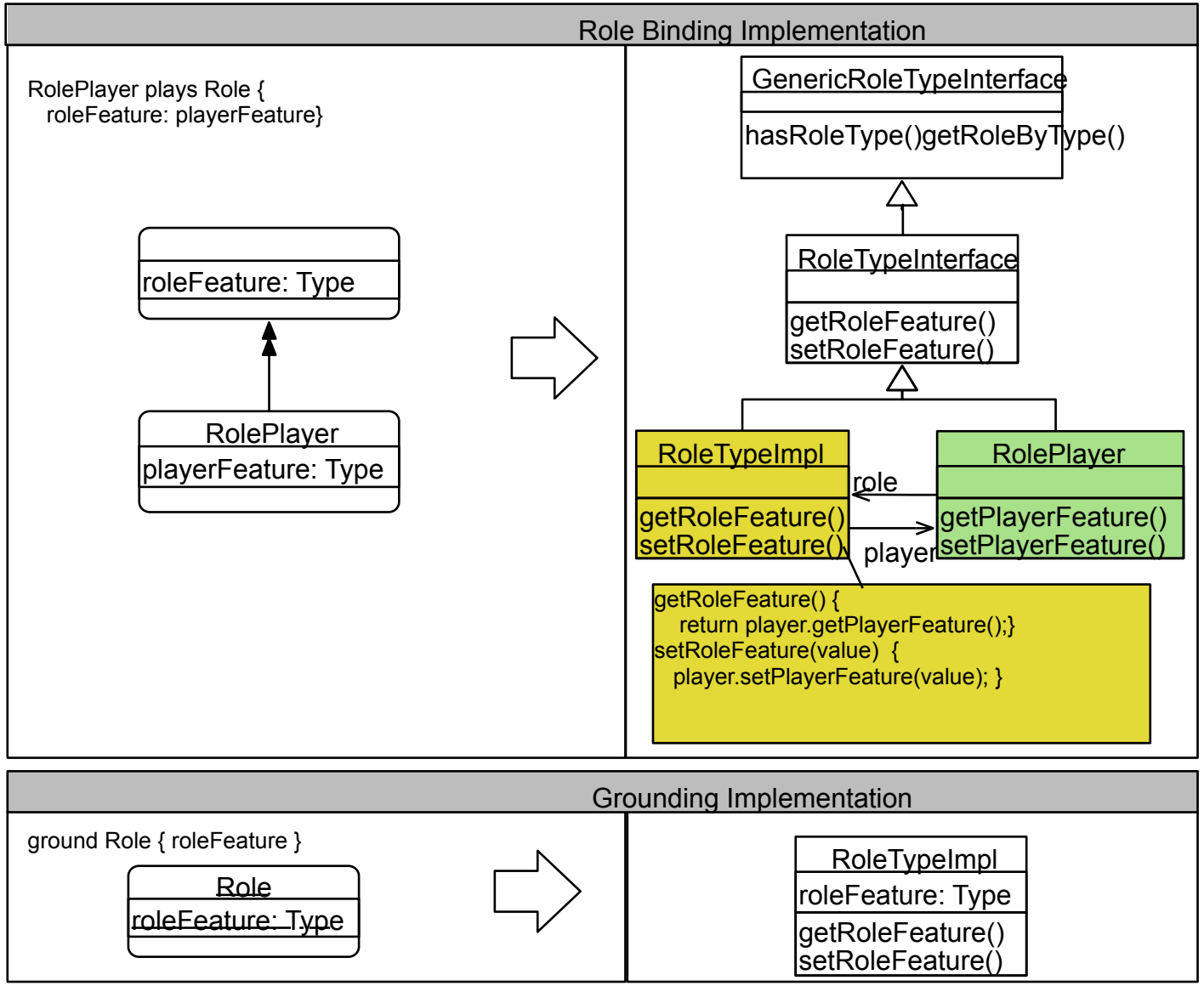
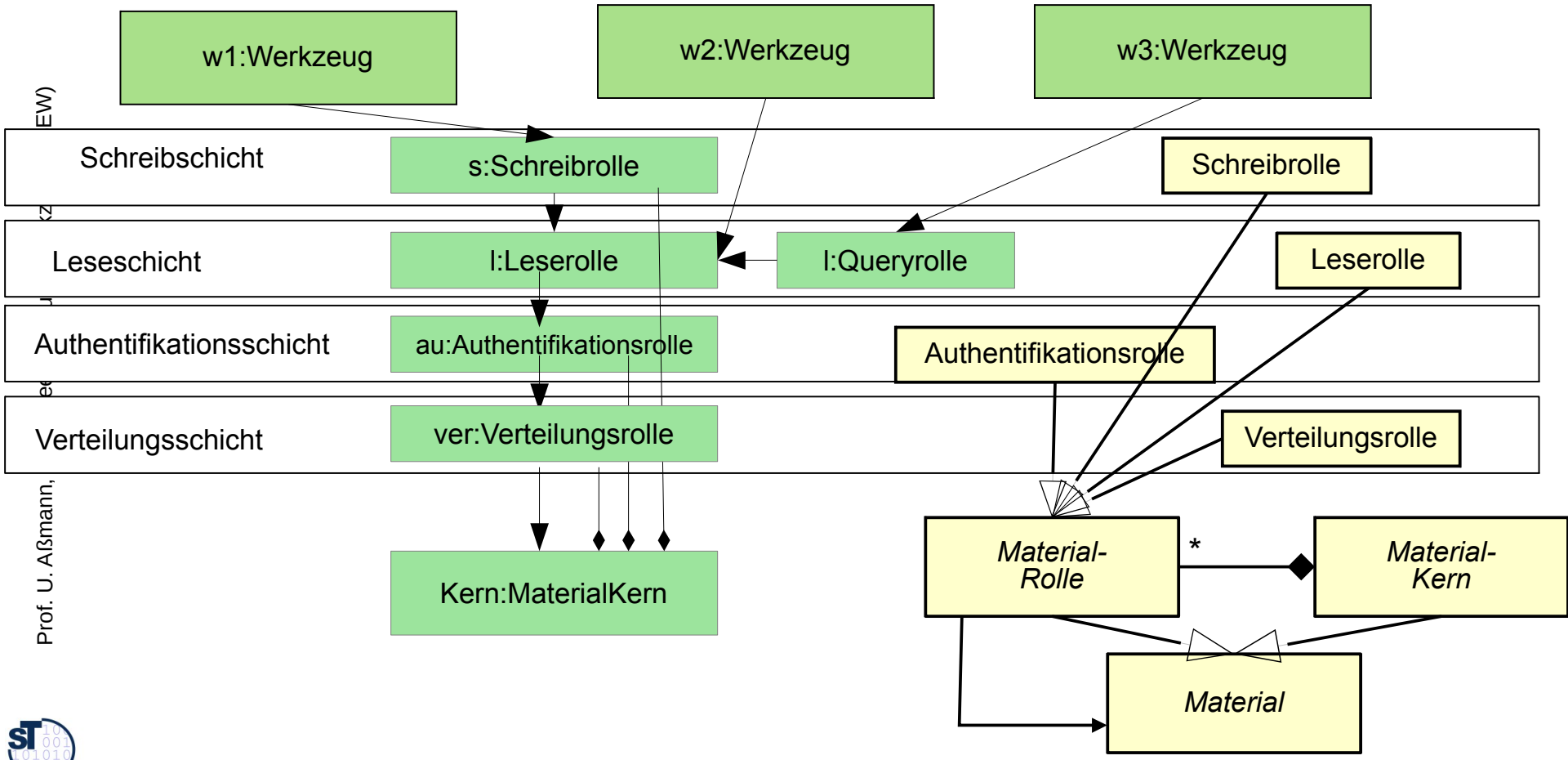
Grounding is straightforward with many design patterns for role implementations

Role Binding Implementation with Role Object Pattern (ROP)



Final Architecture of the Composed Repository

- When using ROP for binding, the role-access layer architecture for repositories results naturally:



What Did We Learn?

- Deep Role Modelling allows for unanticipated tool integration, but needs to be applied at tool design time
- Clean separation of required interface (to access tool-specific data) and realization of this interface (to obtain data)
- Physical representation define at integration time by design patterns for role implementation
- If ROP is used, a role-based access layering of the repository results naturally.
- Open Issues
  - Data migration (if grounding evolves)
  - Practical validation required
- Looking for students!