

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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- 1) Motivational Example
 Proactive vs. Retroactive Tool
 Integration
- 2) Roles in Metalanguages
- 3) Role-Based Composition of
 Metamodels
- 4) Grounding



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Position

- 3
 - ▶ 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

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Obligatory Literature

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- ▶ 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>

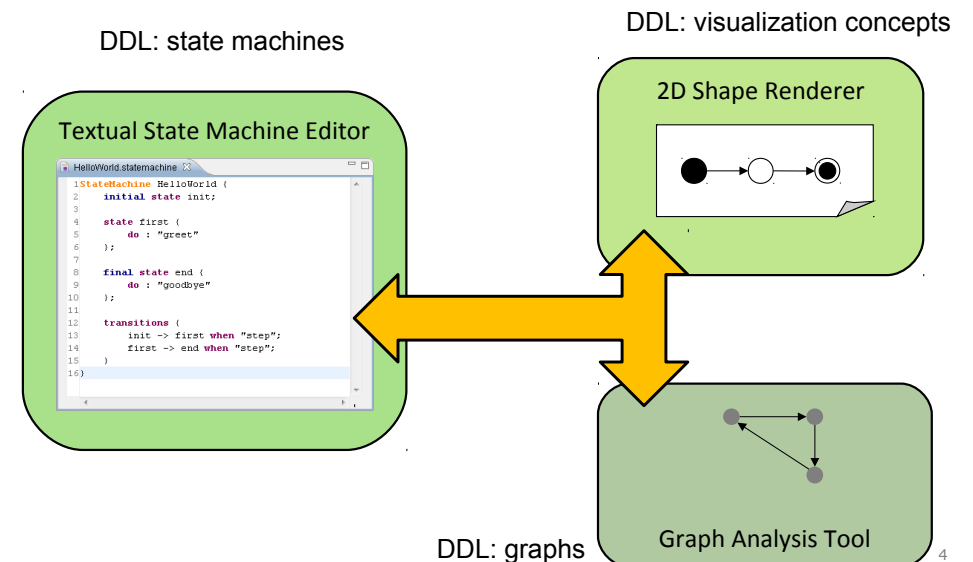
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34.1 Motivational Example for Data Sharing in Tool Integration

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- 4
 - ▶ Tools may rely on different DDL, which represent *similar concepts*



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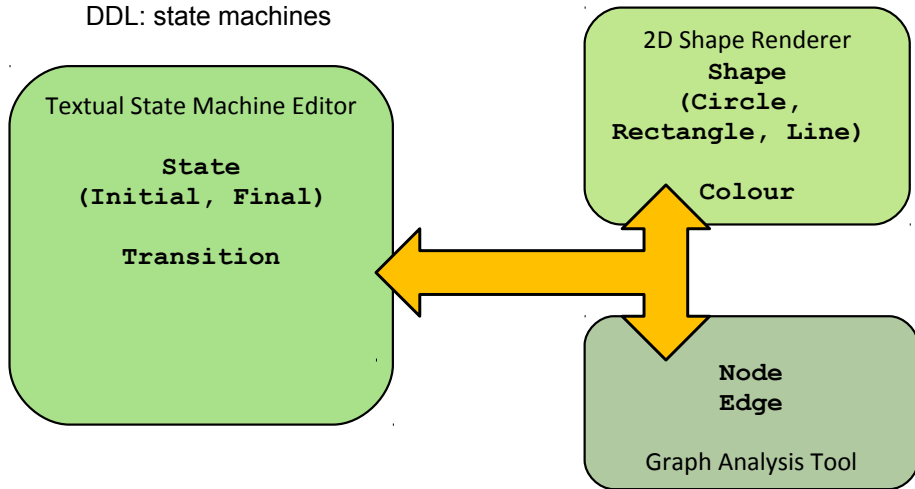
Example – Language Concepts in Metamodels of the Involved Tools

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

DDL: visualization concepts

DDL: state machines

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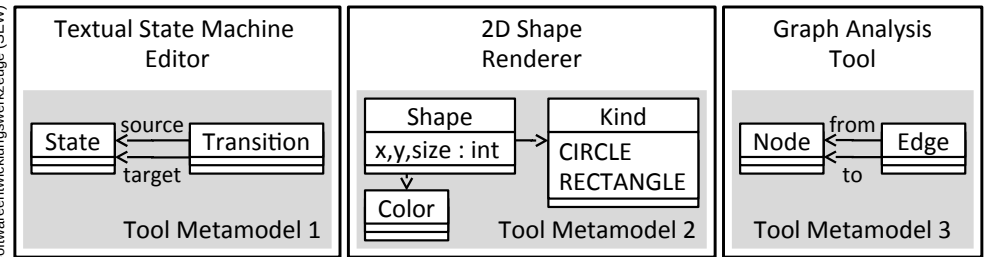
DDL: graphs

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How Can these Metamodels be Integrated?

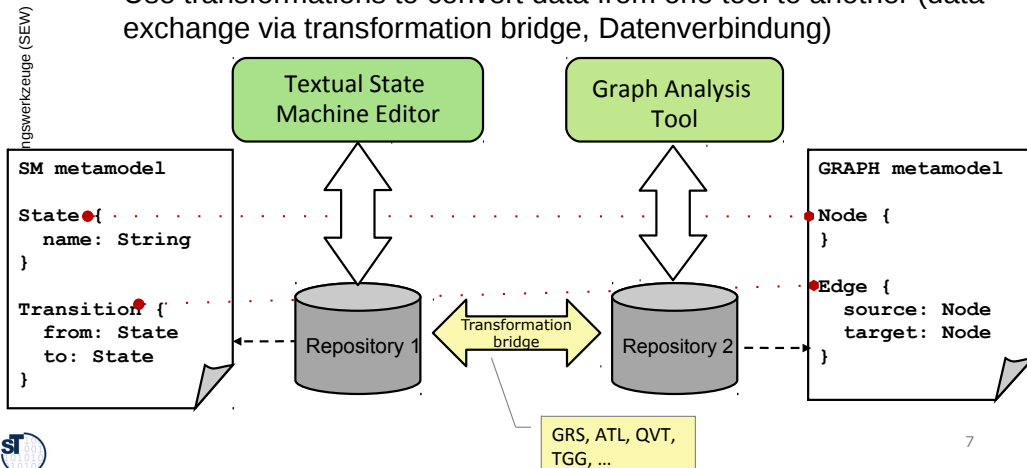
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Retroactive Tool Integration on Repositories by Data Connection

- 7 ▶ 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)



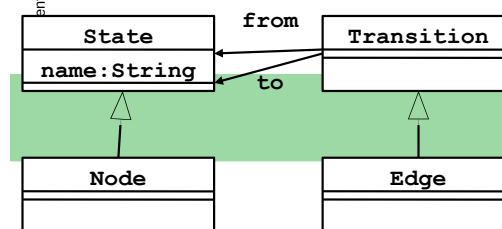
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Proactive Tool Integration (Classical)

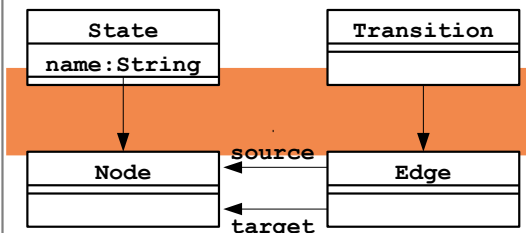
- 8 ▶ Sometimes, tool, metamodels, and repositories are not fixed yet
- ▶ Use **metamodel extension (integration)** to make data from one tool accessible to another
- **Extension by inheritance (“white-box”):** Submetaclasses are formed; language concepts are integrated, but no extension of supermetaclasses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

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a) Inheritance











b) Delegation



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Proactive vs. Retroactive Tool Integration

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	Proactive	Retroactive
Technique	Inheritance Delegation	Transformation
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 

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33.2 Roles in Metalanguages

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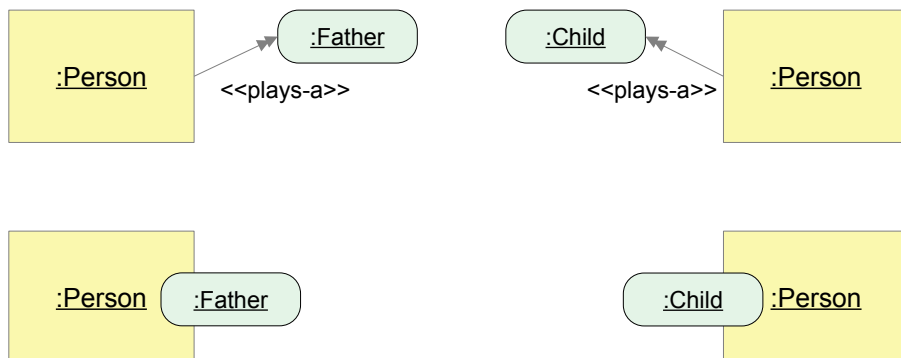
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Collaboration-Based Modeling (Role Modeling) (Rpt.)

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

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



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What are Roles? (Rpt.)

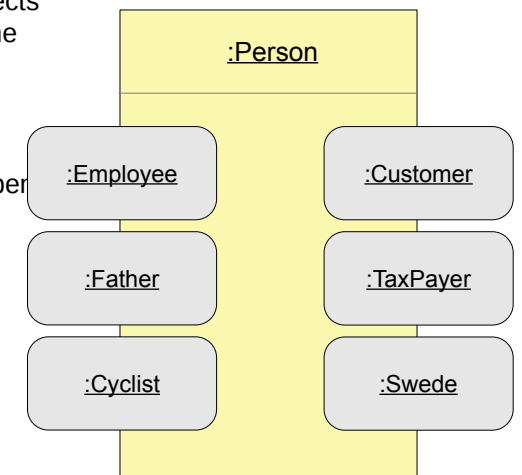
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A role is a *dynamic view* onto an object

- 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, depend on a partner



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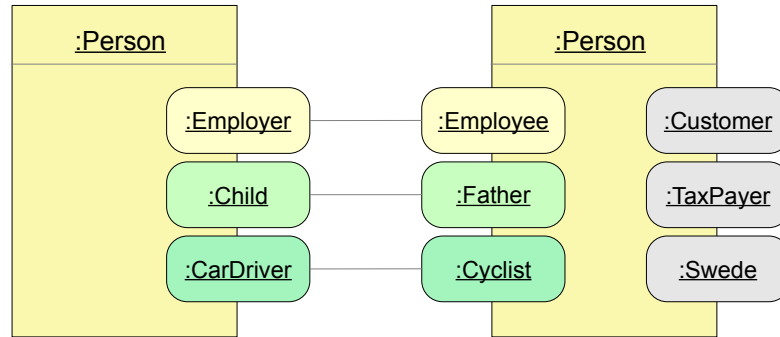
What are Roles? (Rpt.)

13 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*



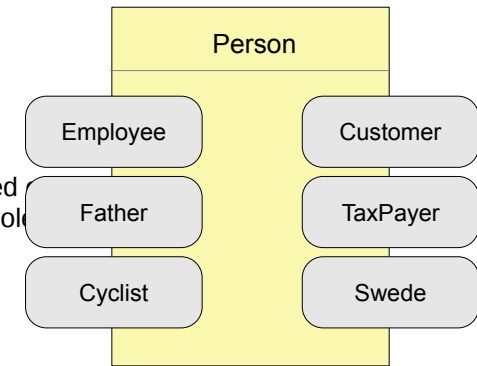
What are Role Types? (Rpt.)

14 Role types (*abilities*) are

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

Problem:

- The word "role" is also used at the class level, i.e., for a "role type"

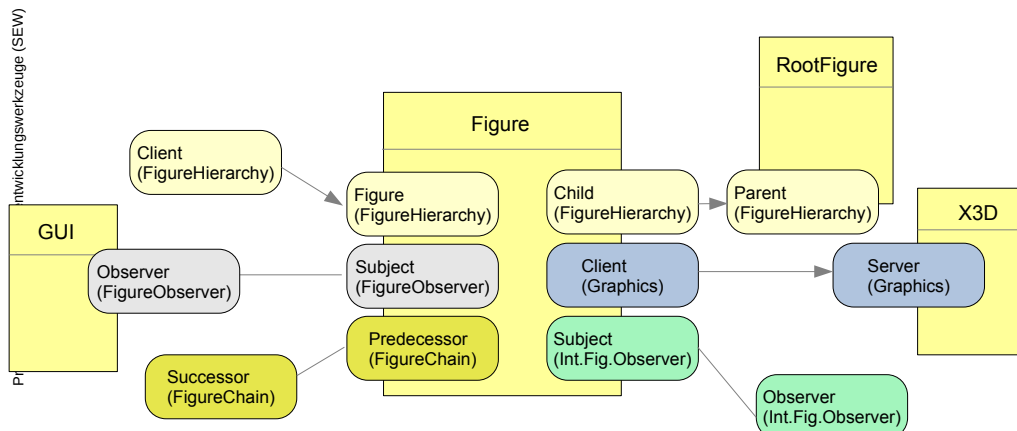


Collaboration Schemas (Role-Type Model) (Rpt.)

15 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

16 Views

- Hyperspace (MDSOC)

Collaborative Aspects

- ObjectTeams www.objectteams.org
- CaesarJ

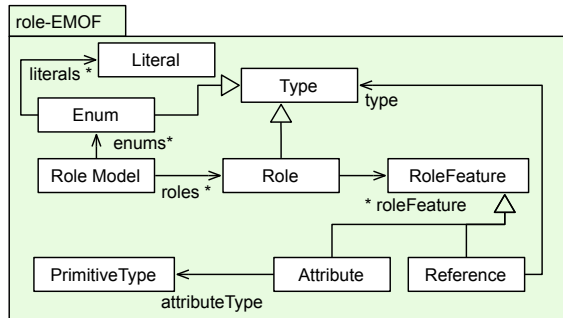
Template-based languages

- BETA with the metaprogramming environment Mjølner
- Invasive Software Composition

Roles in a Metalanguage (Metametamodel)

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

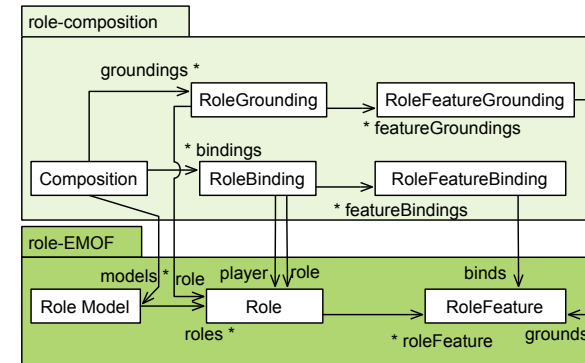


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A Metamodel for Deep Role Composition

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- ▶ **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

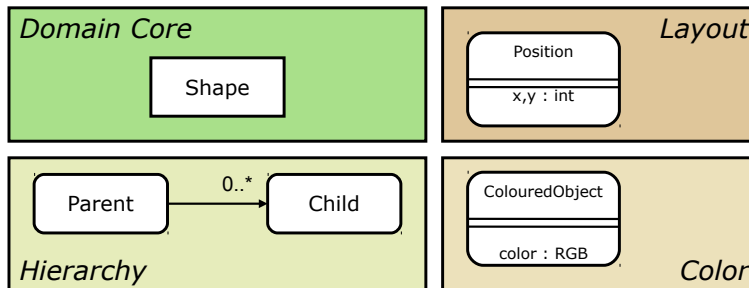


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Example: ShapeRenderer's Metamodel with Roles

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

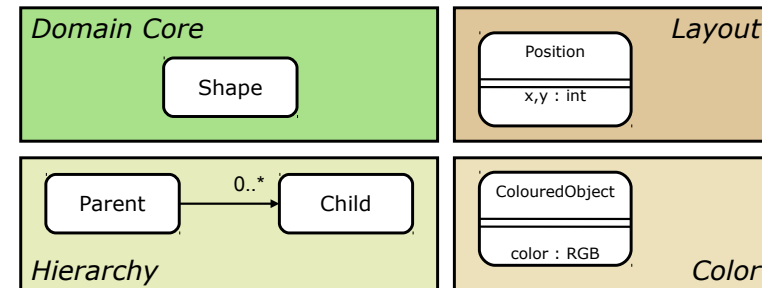


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Example: ShapeRenderer's Metamodel with Deep Roles

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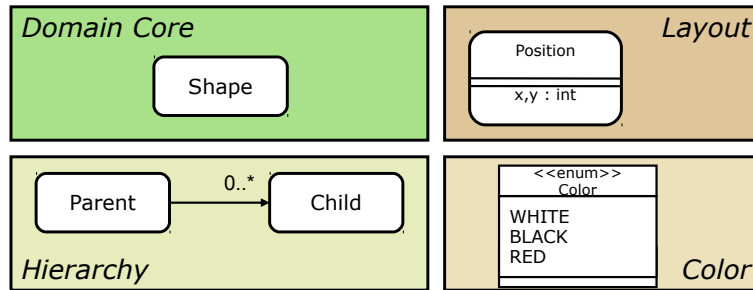
- ▶ Because other tools' metamodels might provide the natural types, we first specify all metamodels with deep roles
 - Then, they can be played by the naturals of other tools



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Example: ShapeRenderer's Metamodel with Deep Roles and Enums

- 21
- Some roles can be represented as enums; then they will become natural classes in the implementation

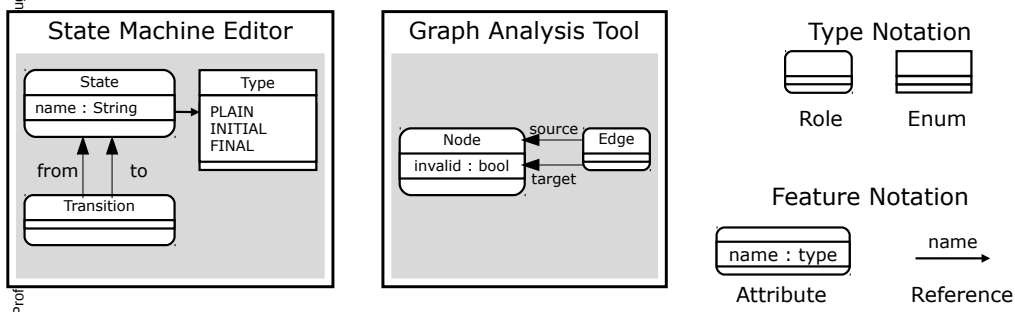


33.3 Proactive Tool Integration with Deep Roles

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

- 23
- 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

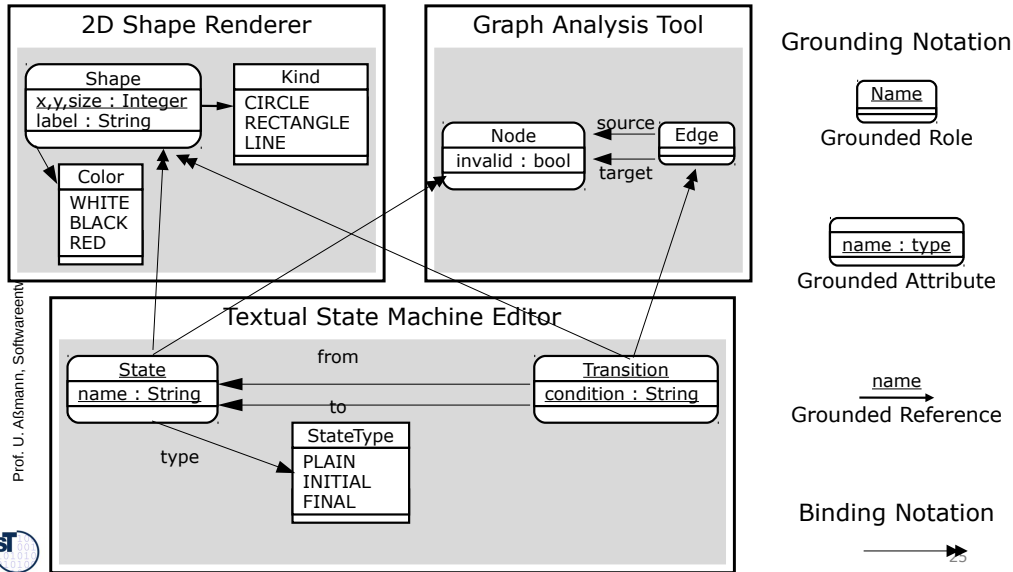


Tool Integration using Role Bindings (Role Grounding)

- 24
- 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

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



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A DSL for Integration (EMFText RoleCore Language)

- 28 ▶ 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 }
    
```



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33.4 Grounding: Mapping to Programming Language

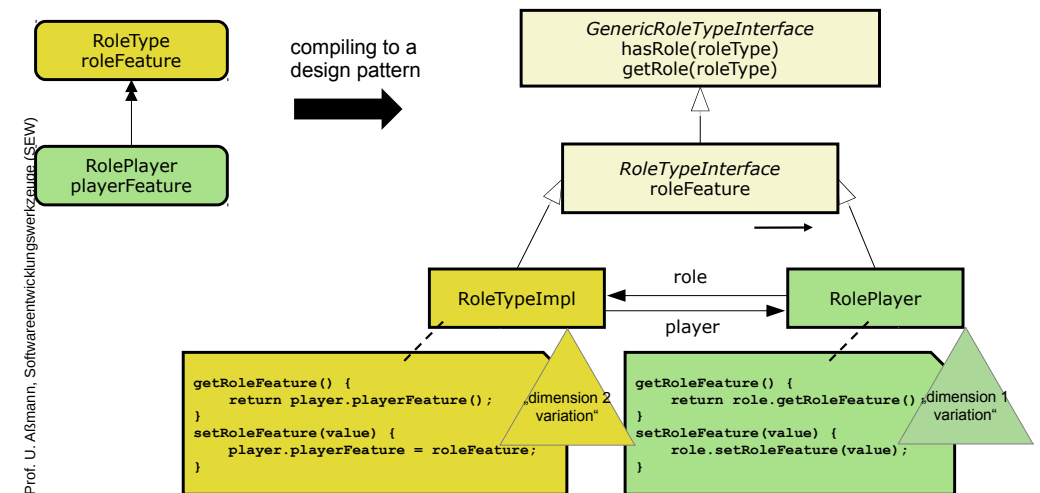
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Role Binding Realisation by e.g., Delegation (Design Pattern Bridge)

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



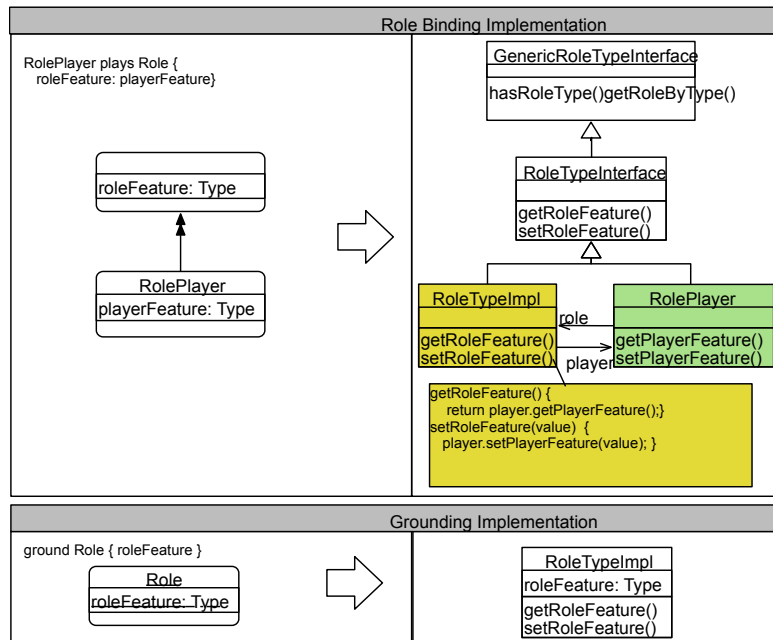
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Grounding is straightforward with many design patterns for role implementations

Role Binding Implementation with Role Object Pattern (ROP)

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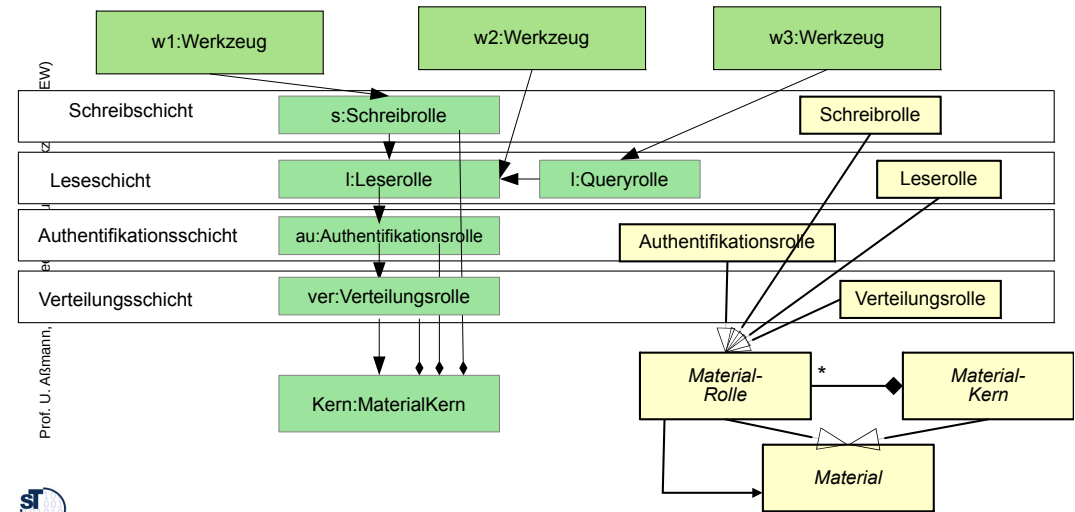
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Final Architecture of the Composed Repository

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



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What Did We Learn?

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- ▶ 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!

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