22b Role-Based Metamodel Composition on M2 for Tool Interoperability on M1-Models and M0-Repositories

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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

LanGems

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

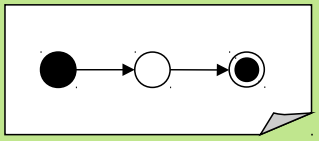
emftext

22b.1 Motivational Example

DDL: visualization concepts

DDL: state machines

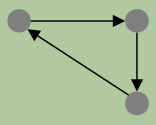
2D Shape Renderer



Textual State Machine Editor

HelloWorld.statemachine

```
1 StateMachine HelloWorld {
2     initial state init;
3
4     state first {
5         do : "greet"
6     };
7
8     final state end {
9         do : "goodbye"
10    };
11
12    transitions {
13        init -> first when "step";
14        first -> end when "step";
15    }
16 }
```



Graph Analysis Tool

DDL: graphs

Motivational Example – Language Concepts in Metamodels of the Involved Tools

DDL: visualization concepts

DDL: state machines

2D Shape Renderer

Shape
(Circle, Rectangle, Line)

Colour

Textual State Machine Editor

State
(Initial, Final)

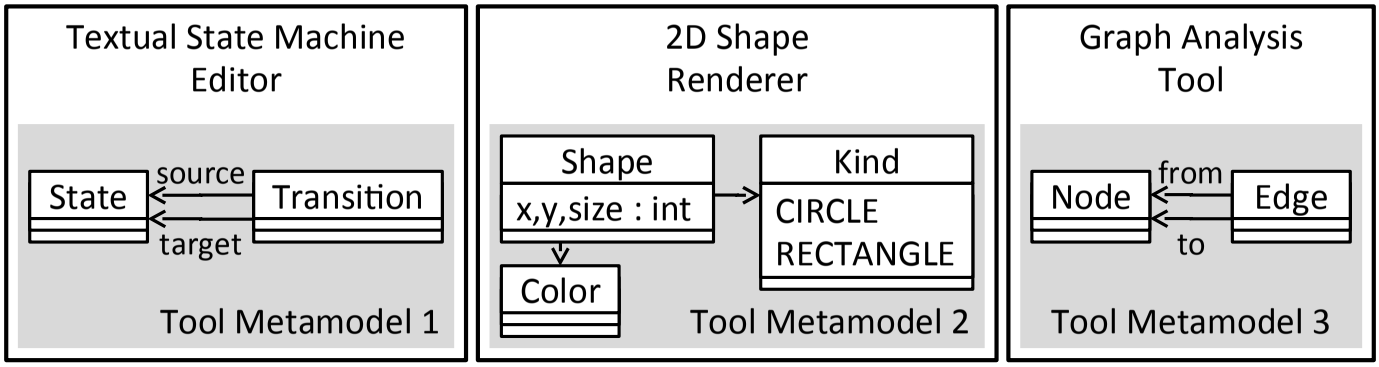
Transition

Node

Edge

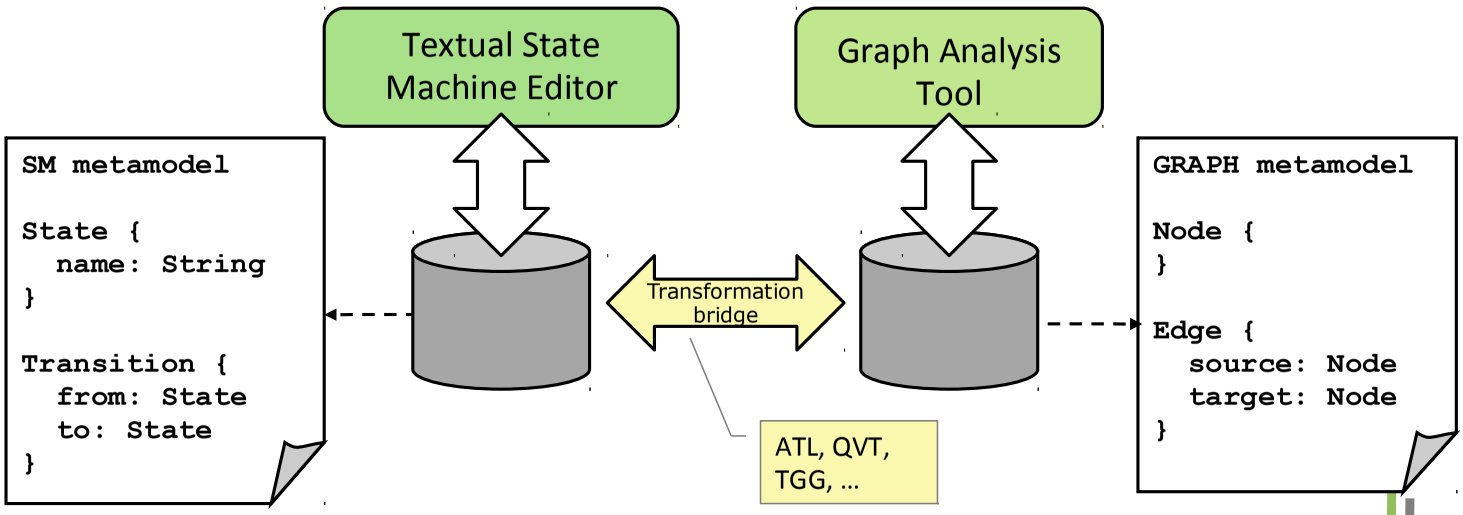
Graph Analysis Tool

DDL: graphs



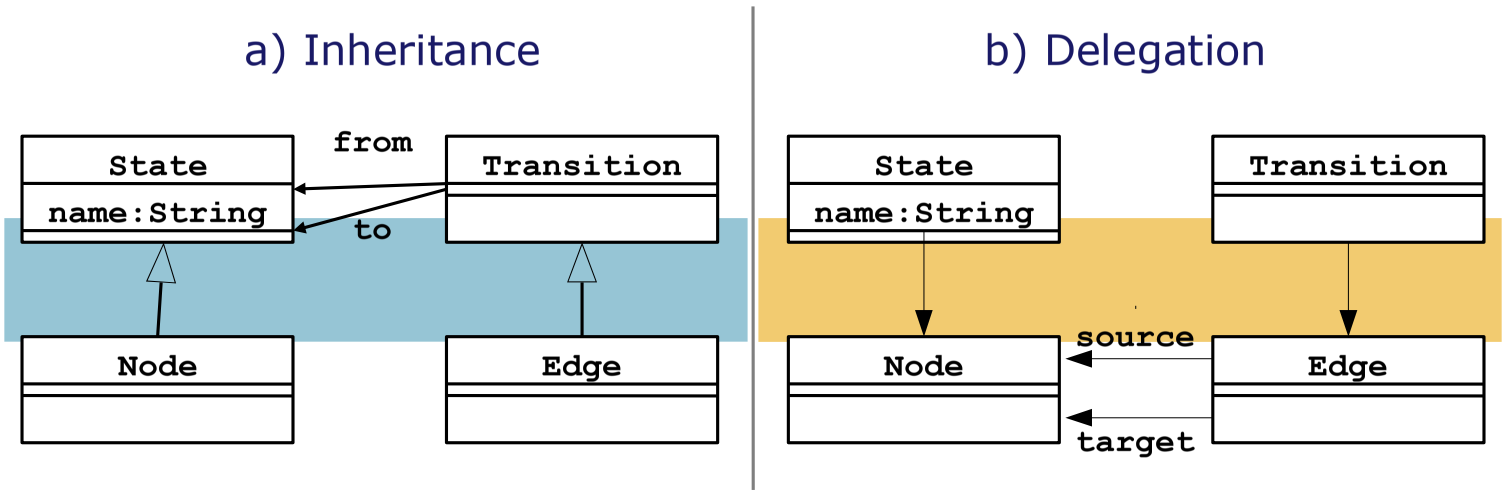
Retroactive Tool Integration on Repositories

- Tools, metamodels, and repositories already exist
- Use transformations to convert data from one tool to another (transformation bridge, data exchange, Datenverbindung)



Proactive Tool Integration (Classical)

- Tool, metamodels, and repositories are not fixed yet
- Use metamodel integration to make data from one tool accessible to another (usually by inheritance or delegation)



Proactive vs. Retroactive Tool Integration

	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

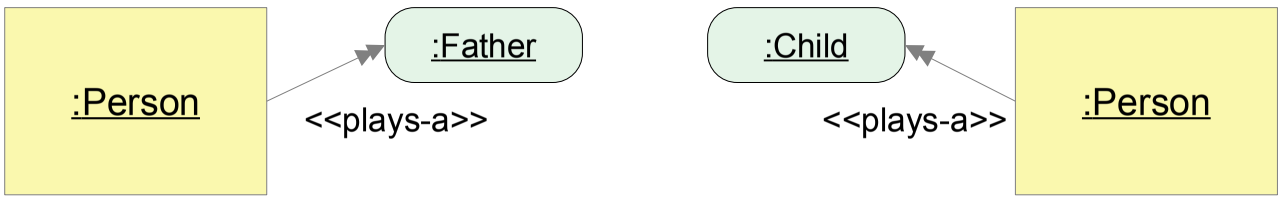
22b.2 Roles in Metalanguages

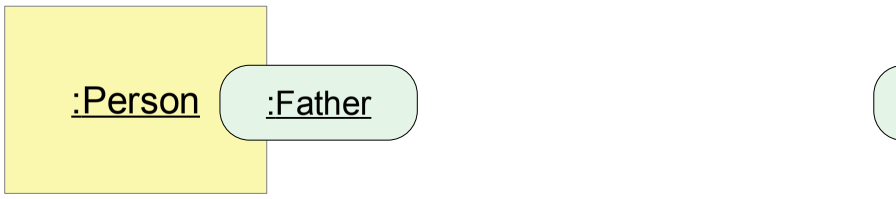
Collaboration-Based Modeling (Role Modeling) (Rpt.)

Databases [Bachmann]

Factorization [Steimann]

Research in Design Patterns [Reenskaug, Riehle/Gross]





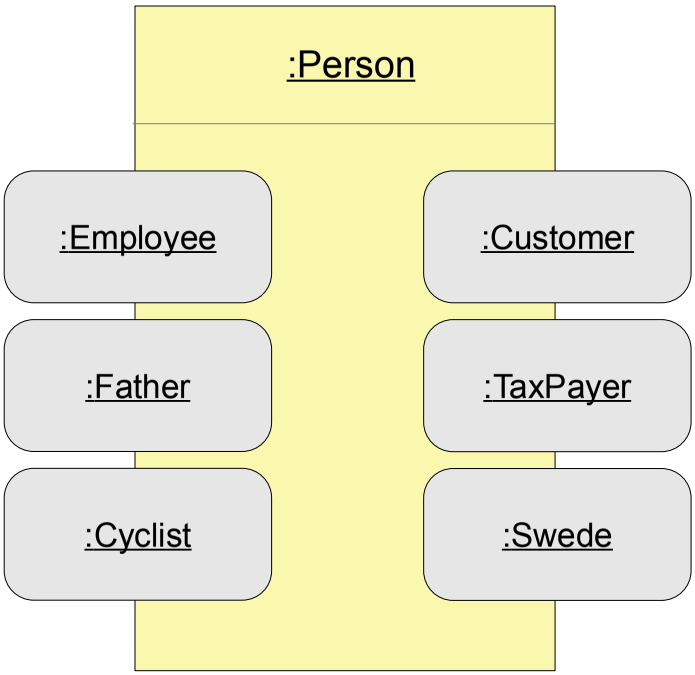
What are Roles? (Rpt.)

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, depend on a partner



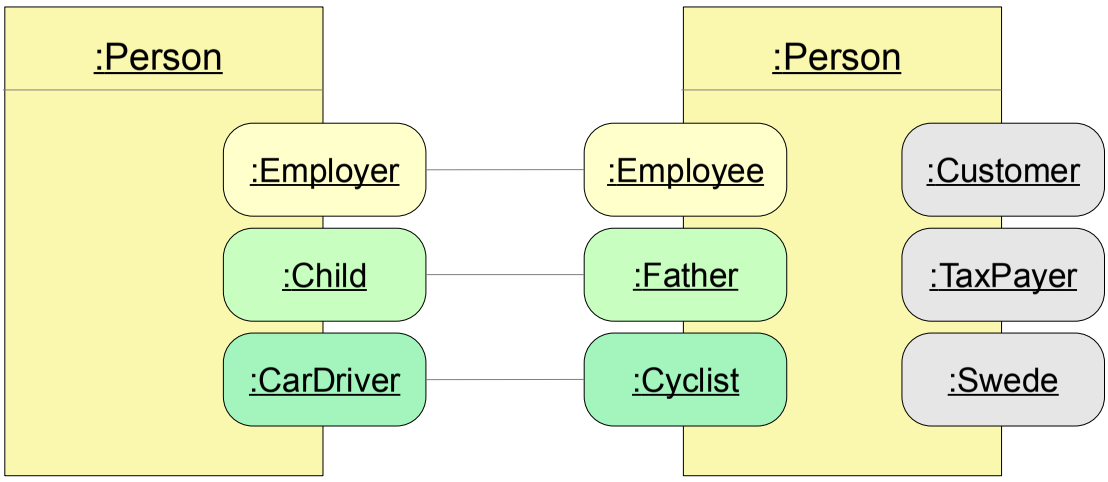
What are Roles? (Rpt.)

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*



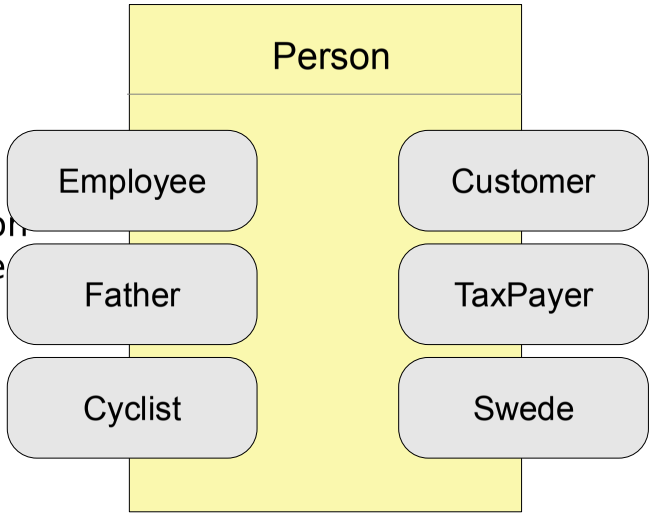
What are Role Types? (Rpt.)

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”

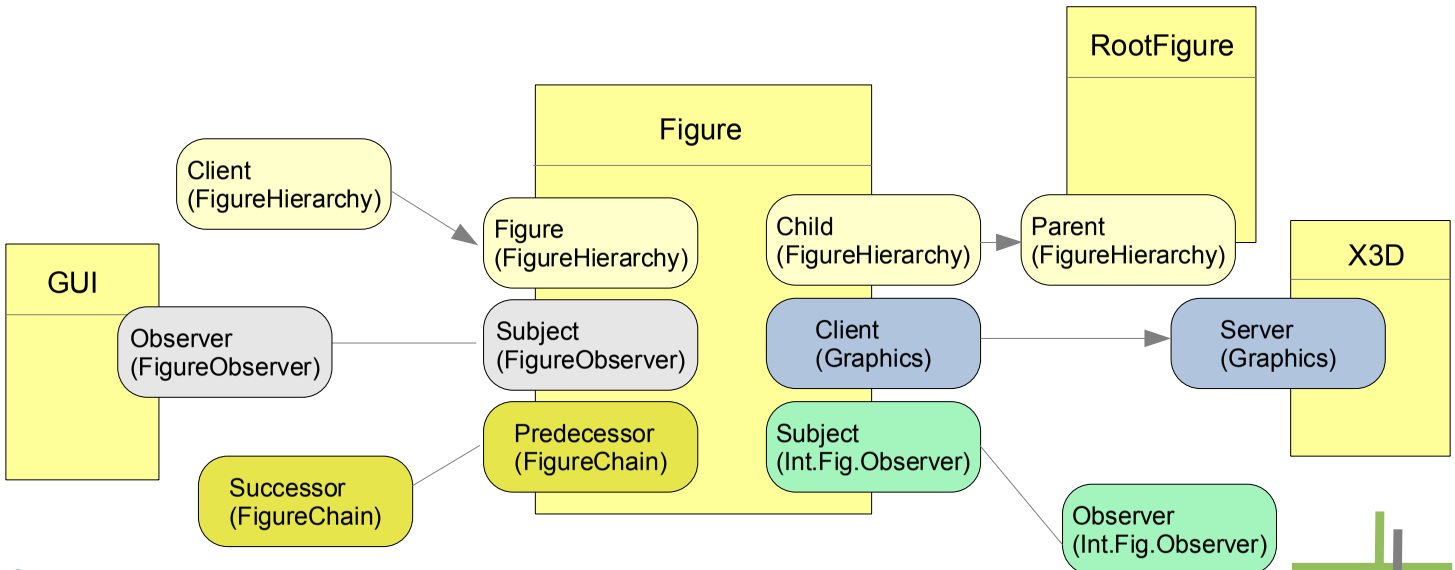


Collaboration Schemas (Role-Type Model) (Rpt.)

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

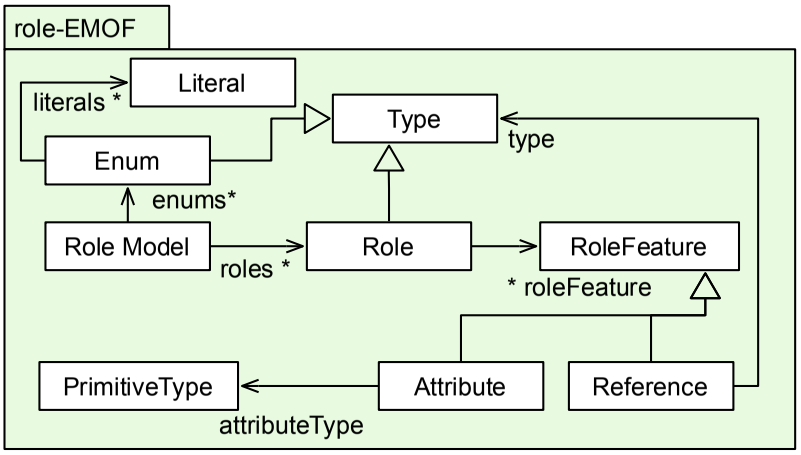
- ObjectTeams www.objectteams.org
- CaesarJ

Template-based languages

- BETA with the metaprogramming environment Mjölner
- Invasive Software Composition

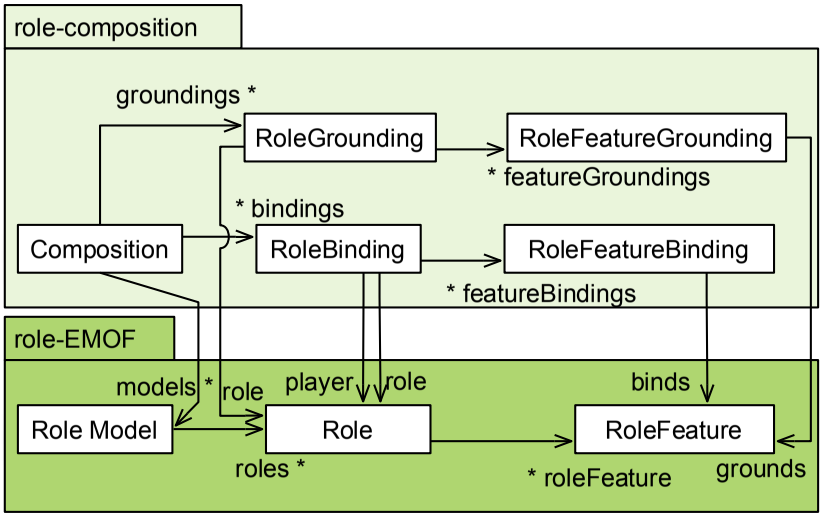
Roles in a Metalanguage (Metametamodel)

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



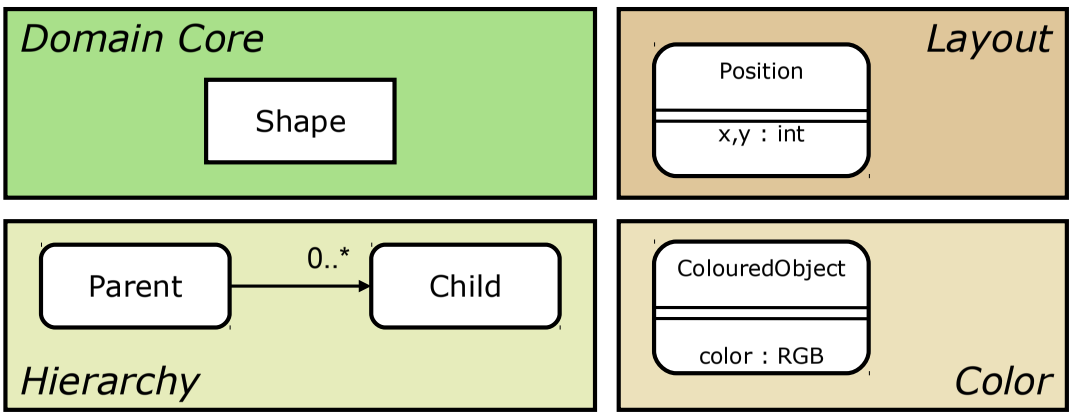
A Metamodel for Deep Role Composition

- **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



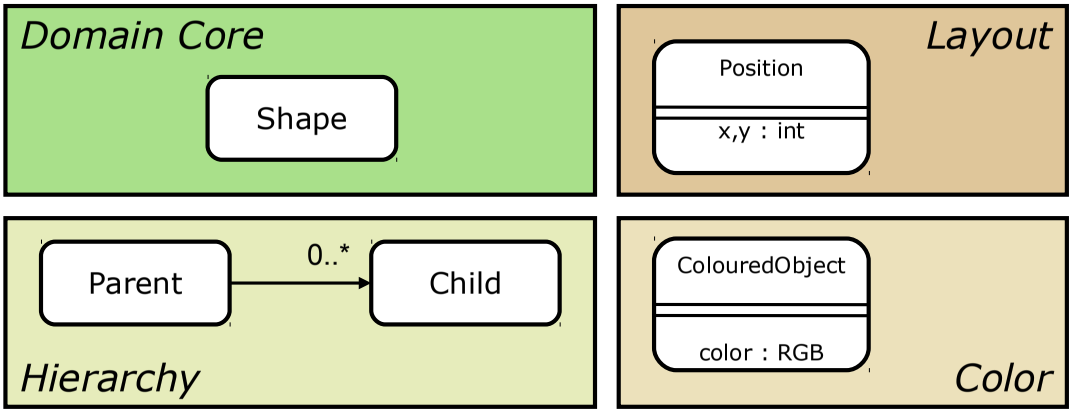
Example: ShapeRenderer's Metamodel with Roles

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



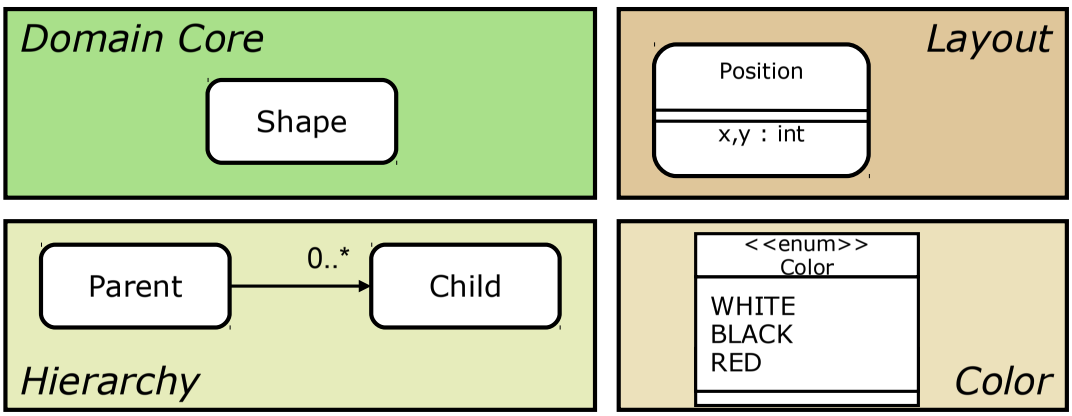
Example: ShapeRenderer's Metamodel with Deep Roles

- 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

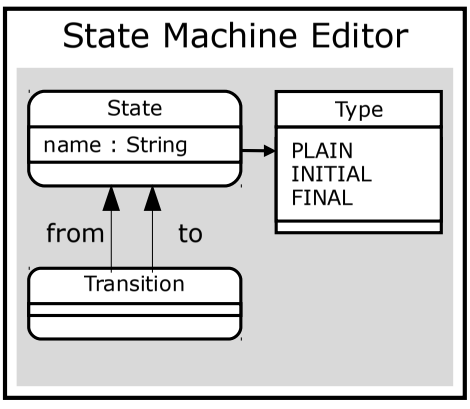
- Some roles can be represented as enums; then they will become naturals in the implementation

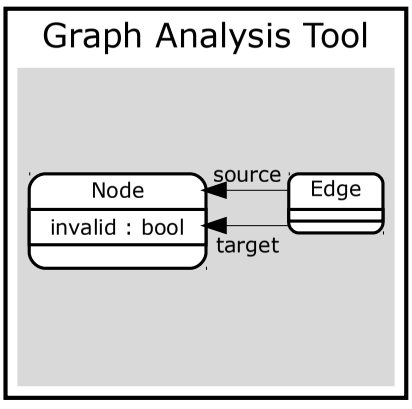


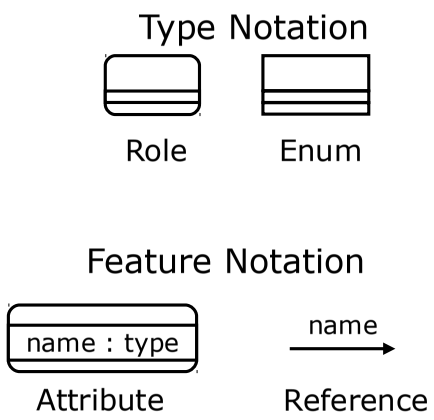
22b.3 Proactive Tool Integration with Deep Roles

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







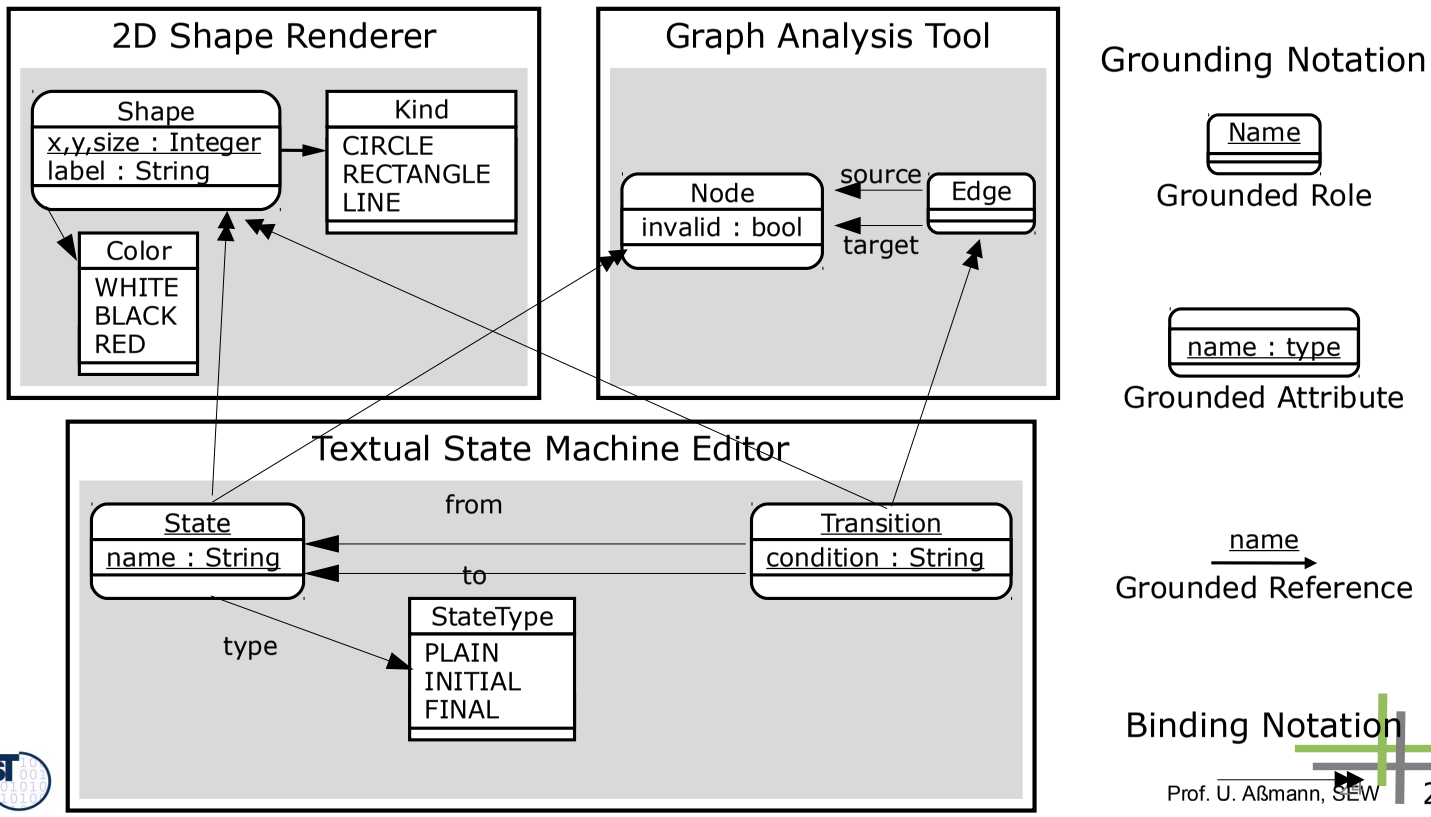
Tool Integration using Role Bindings (Role Grounding)

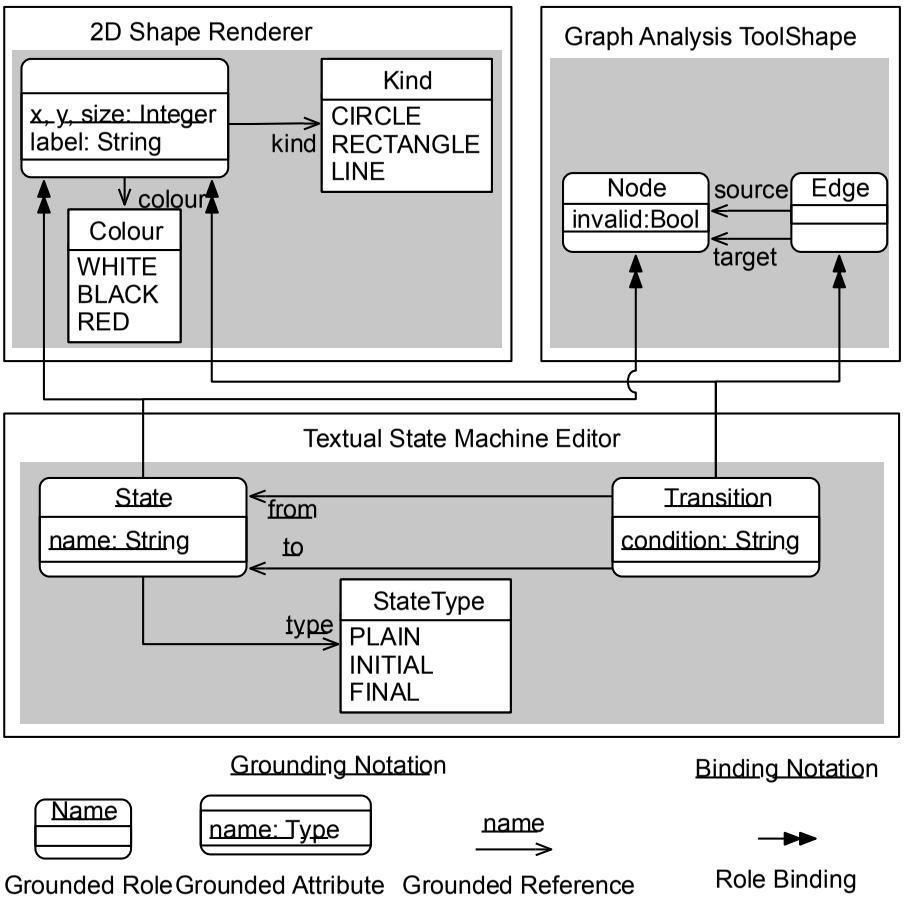
- Role Bindings on the logical level with relationship “plays-a”
  - Connect roles and role players, producing *deep roles*
  - Define how to obtain value of attribute or reference
  - Allow to create views on other classes

- 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”





A DSL for Integration (EMFText RoleCore Language)

- Role binding can be described by a DSL.

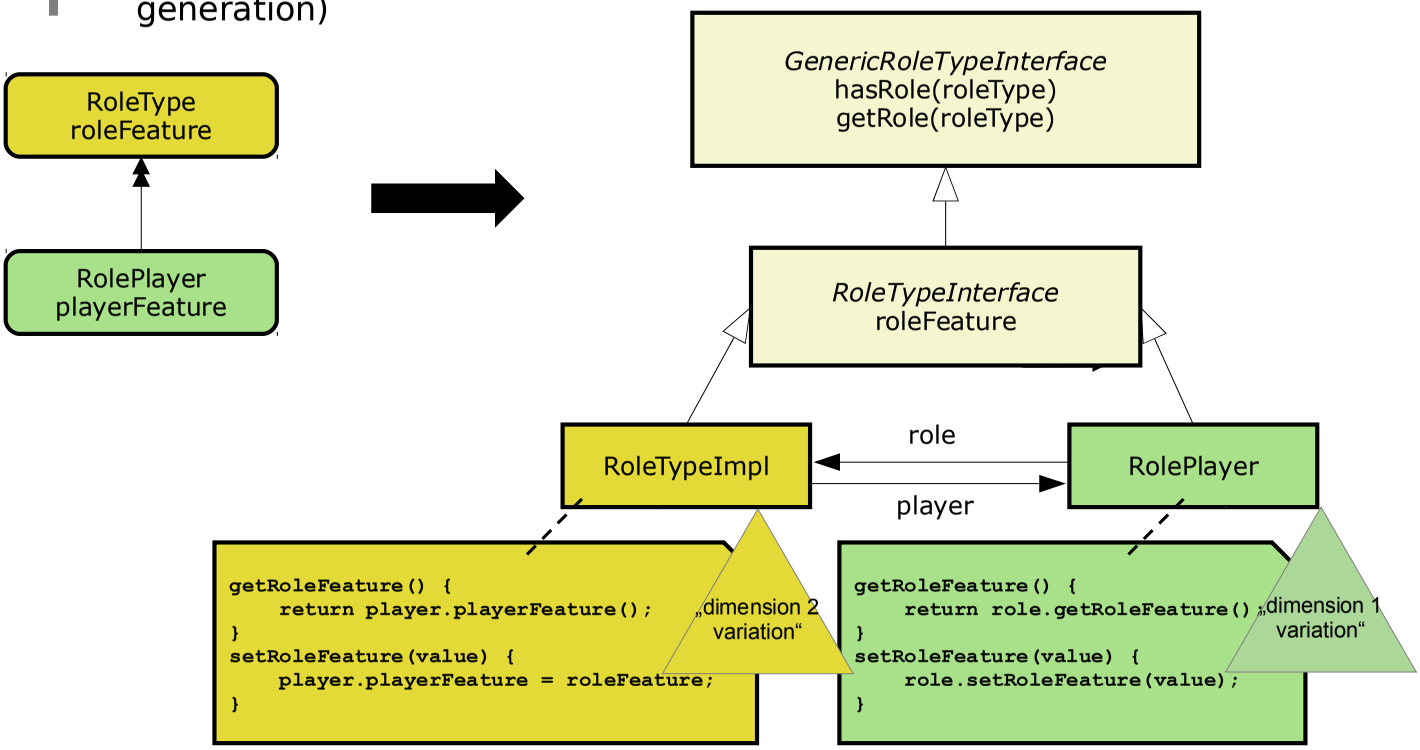
```
integrate statemachine, 2dShapes, graph {
    State plays Shape {
     label: name
     kind: if (player.type == PLAIN) return RECTANGLE
           else return CIRCLE
     colour: if (player.type == INITIAL) return WHITE
           else return BLACK
    }
    Transition plays Shape {
     label: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

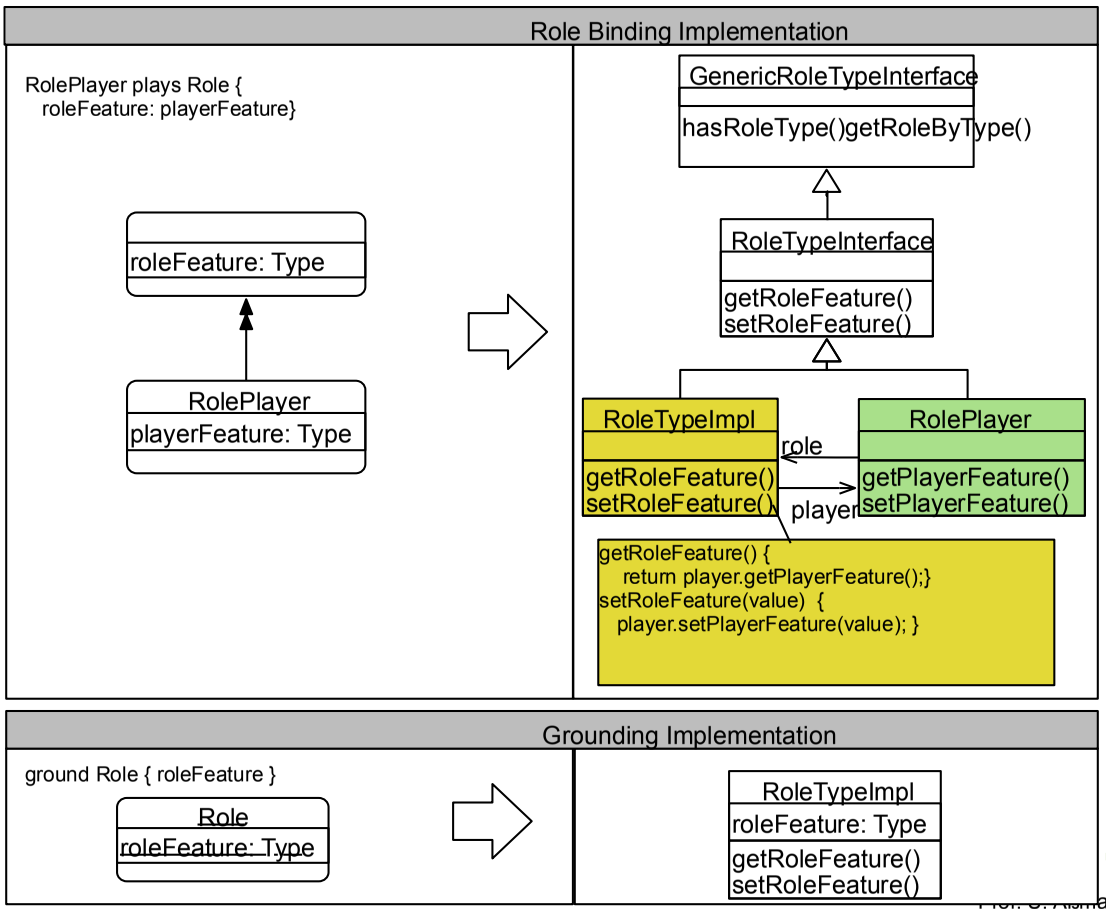
Role Binding Realisation by e.g., Delegation (Design Pattern Bridge)

- The constructs of RoleCore can be easily expanded to design patterns (code generation)



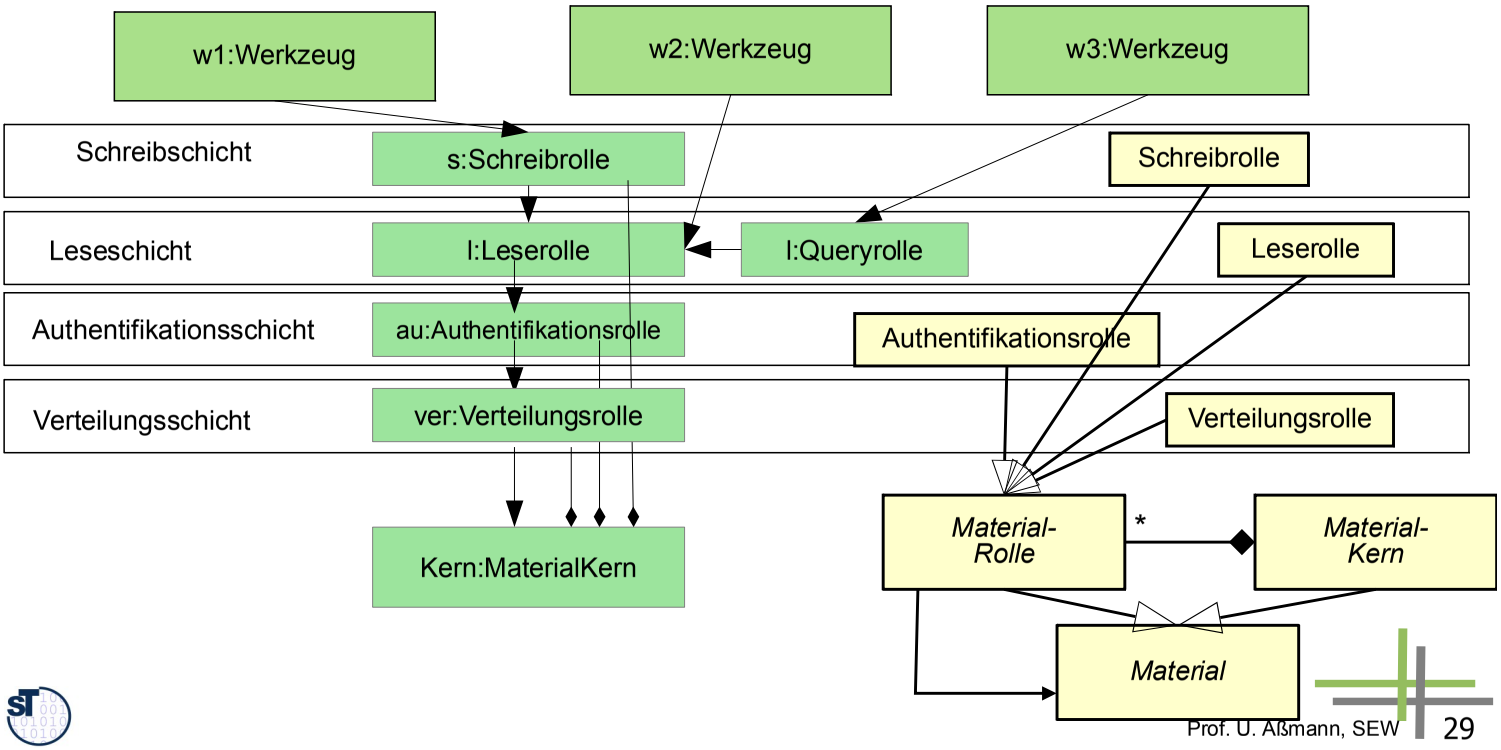
Grounding is straight forward with many design patterns for role implementations

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!