"Model-Driven Development of Model Transformations"

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Overview

- Model Everything
  - Extend (Transformation) Modeling Language when desirable
- Modeling languages:
  - Do not re-invent the wheel
  - Applies especially to Transformation Modeling!
- **Copying** problem tackled
  - Transformation **Modeling** (not Programming)
  - *Challenge Me!*
- **Higher Order** Transformations
  - Extensible Transformation Languages
  - Tool-Independent Results
- **Success** Criteria
  - OUT: Evangelize Story Diagrams, Copy Operator
  - IN: Practical Experience with
    - » DEVS, Alloy
    - » MDE work for SoC

Model Everything

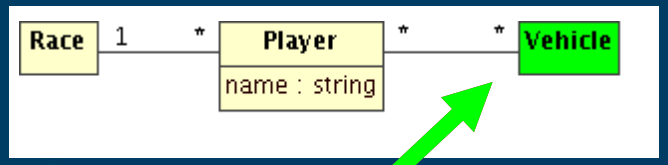
- Why?

I. Keep it Stable

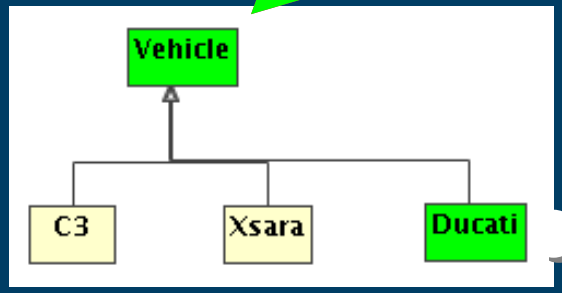
II. Make it Human-Friendly

Modeling Languages & Tools: Human Friendly

- Example: Decompose complex models into **Views**
  - **Association View**



  - **Inheritance View**



models

  - **Automatic Consistency Maintenance**
    - **Mainstream: several industrial tools**

Model-Driven Development of Model Transformations

- ***Model*** the **Model Transformations**
  - Evaluate the UML
  - State-of-the-art
    - Start
      - » Taxonomy: compare existing approaches, identify weaknesses
      - » Graph Transformation Languages: Story Diagrams
    - Standardize
    - Improve
      - » BUT: Maintain UML's interoperability
  - General Applicability

- **Transform** the **Transformation Models**

Part 1

Evaluating the UML for

Transformation Modeling

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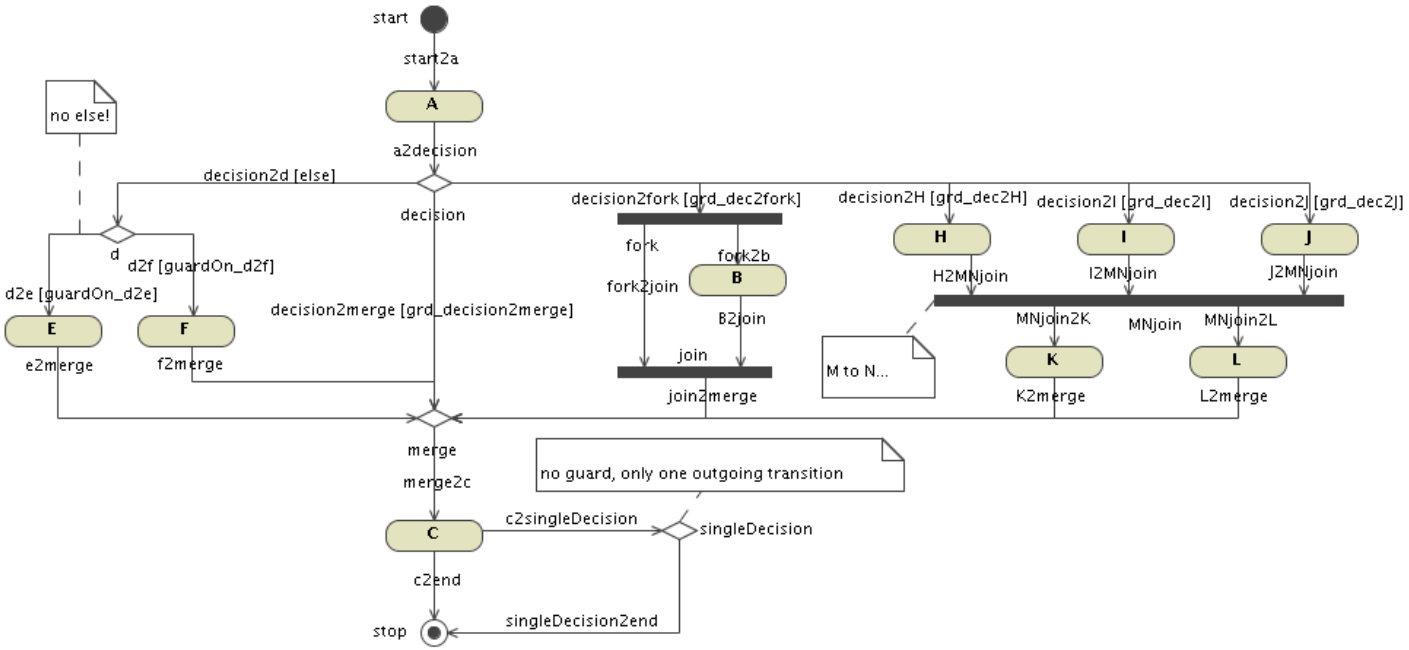


```
1  start2a = A → a2decision
2  a2decision = (
3   decision2J ⟨ grd_dec2J ⟩ (
4    decision2I ⟨ grd_dec2I ⟩ (
5     decision2H ⟨ grd_dec2H ⟩ (
6      decision2merge ⟨ grd_decision2merge ⟩ (
7        decision2fork ⟨ grd_dec2fork ⟩
8         decision2d
9      )
10    )
11   )
12  )
13 )
14 decision2fork = ( fork2join || fork2b )
15 c2end = SKIP
16 merge2c = C → c2end
17 fork2b = B → B2join
18 d2e = E → e2merge
19 d2f = F → f2merge
20 decision2d = (
21  d2f ⟨ guardOn_d2f ⟩ (
22   d2e ⟨ guardOn_d2e ⟩ SKIP
23  )
24 )
```

```
25 c2singleDecision = SKIP
26 decision2H = H → H2MNjoin
27 decision2I = I → I2MNjoin
28 decision2J = J → J2MNjoin
29 MNjoin2K = K → K2merge
30 MNjoin2L = L → L2merge
31 TrMNjoin_to_MNjoin = (
32   MNjoin2L || MNjoin2K
33  )
34 decision2merge = merge2c
35 join2merge = merge2c
36 f2merge = merge2c
37 e2merge = merge2c
38 K2merge = merge2c
39 L2merge = merge2c
40 fork2join = processJoin → join2merge
41 B2join = processJoin → SKIP
42 H2MNjoin = processJoin →
43              TrMNjoin_to_MNjoin
44 I2MNjoin = processJoin → SKIP
45 J2MNjoin = processJoin → SKIP
```

Input:
UML
Activity Diagram

Output:
CSP Program

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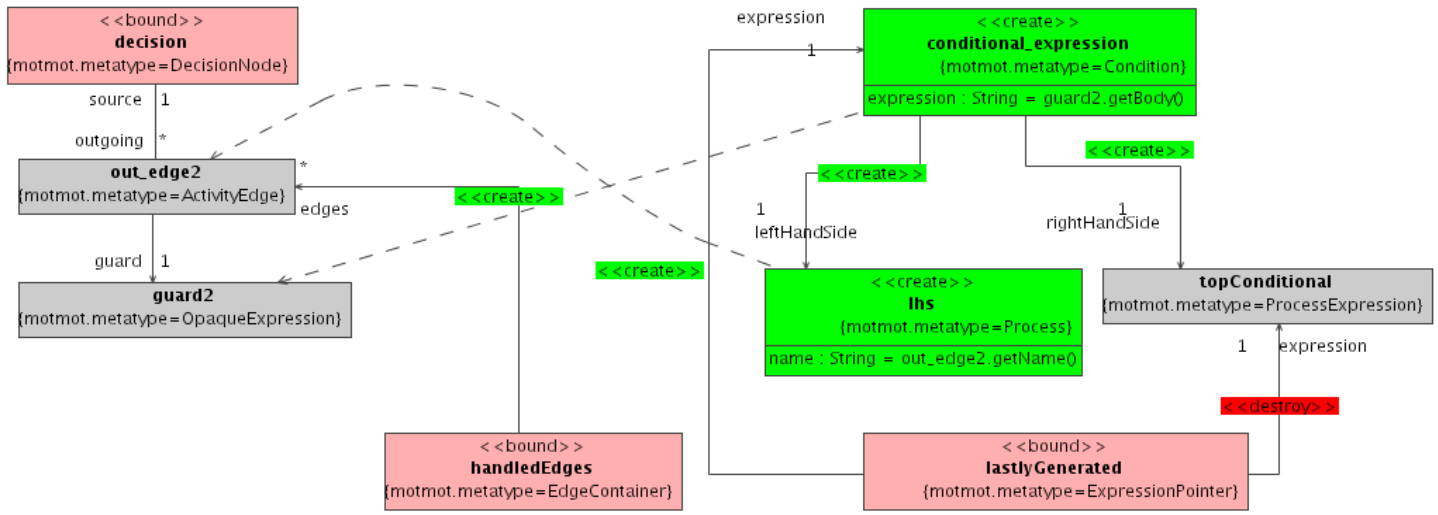
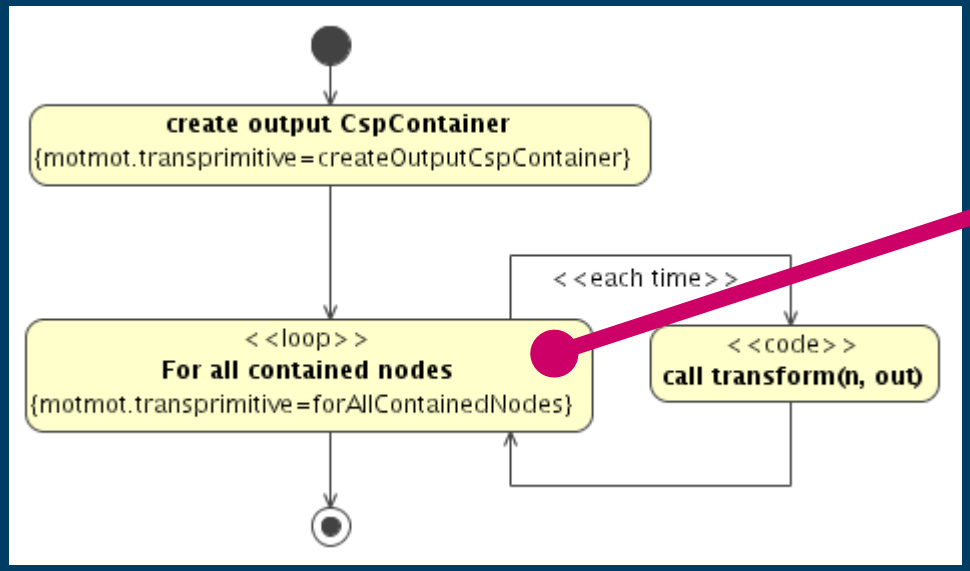
UML2CSP: *MoTMoT as state-of-the-art GT tool*

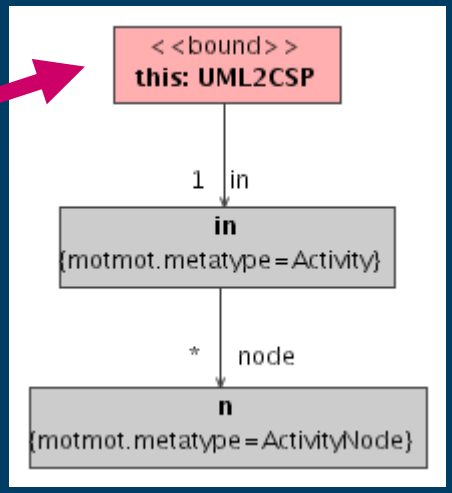
- *"industrial"* UML 2.0 input: MagicDraw 10 → standard with "variations" ☺
- Transformation defined **strictly** on UML 2.0 standard
- In-place normalization of input
  - Violating *Decision* node → Standard-Compliant *Merge* node
  - Violating *Fork* node → Standard-Compliant *Join* node
- Views: "for free" from application modeling tool (MagicDraw 9)



MoTMoT: *UML Profile for Story Diagrams*

– Explicit Control Flow modeling: branch, iterative loop (*forEach*), calls, ...





– Reasoning about termination (typical GG verification example)
= not an issue (yet?) in our case studies

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Cognitive Evaluation

(of Transformation Modeling Language)

+	-
Closeness of Mapping (syntax ~ metamodeling)	Juxtaposition (embedding… native Fujaba)
Role-Expressiveness (edges: relation to whole)	Progressive Evaluation (tool issue?)
Secondary Notation (2D layout, color, …)	Diffuseness (however: issue of input/output metamodels!)
Consistency (able to infer <<onCopy>> <<destroy>>)	

T. R. G. Green. **Cognitive dimensions of notations**. In Alistair Sutcliffe and Linda Macaulay, editors, People and Computers V, pages 443–460, New York, NY, USA,1989. Cambridge University Press.

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Generality

(of Transformation Modeling Language)

Synthesis

UML2CSP
CM2RM
Copy2GT

Refactoring

Pull Up Method
Extract Interface
Push Down Method

Normalization

UML2CSP

Chaining

UML2CSP

Model Synchronization

Operational
Declarative, Hybrid:
>> outline for future work

Part 2

Improving the state-of-the-art in

Transformation Modeling

(Progres, Story Diagrams, QVT)

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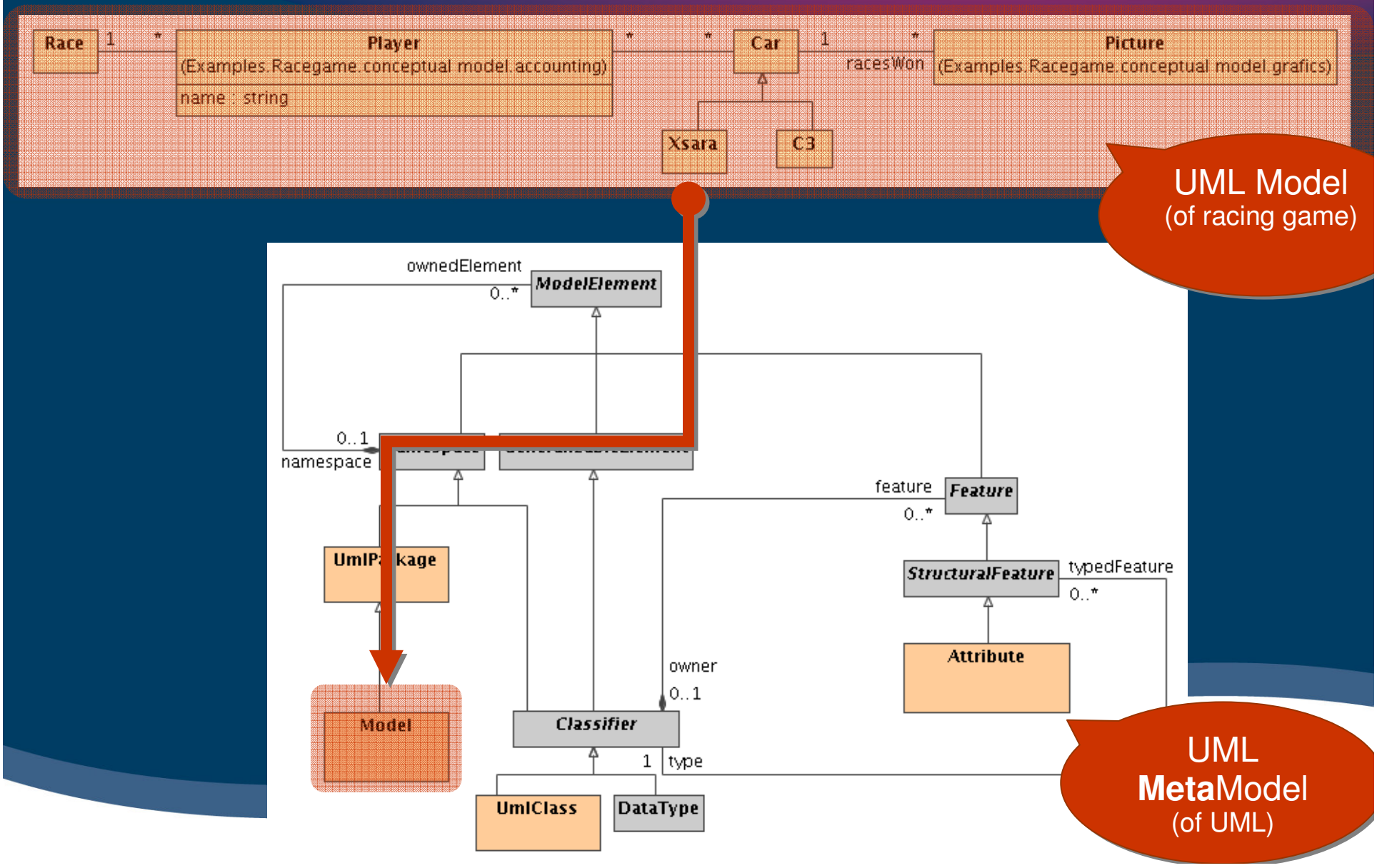
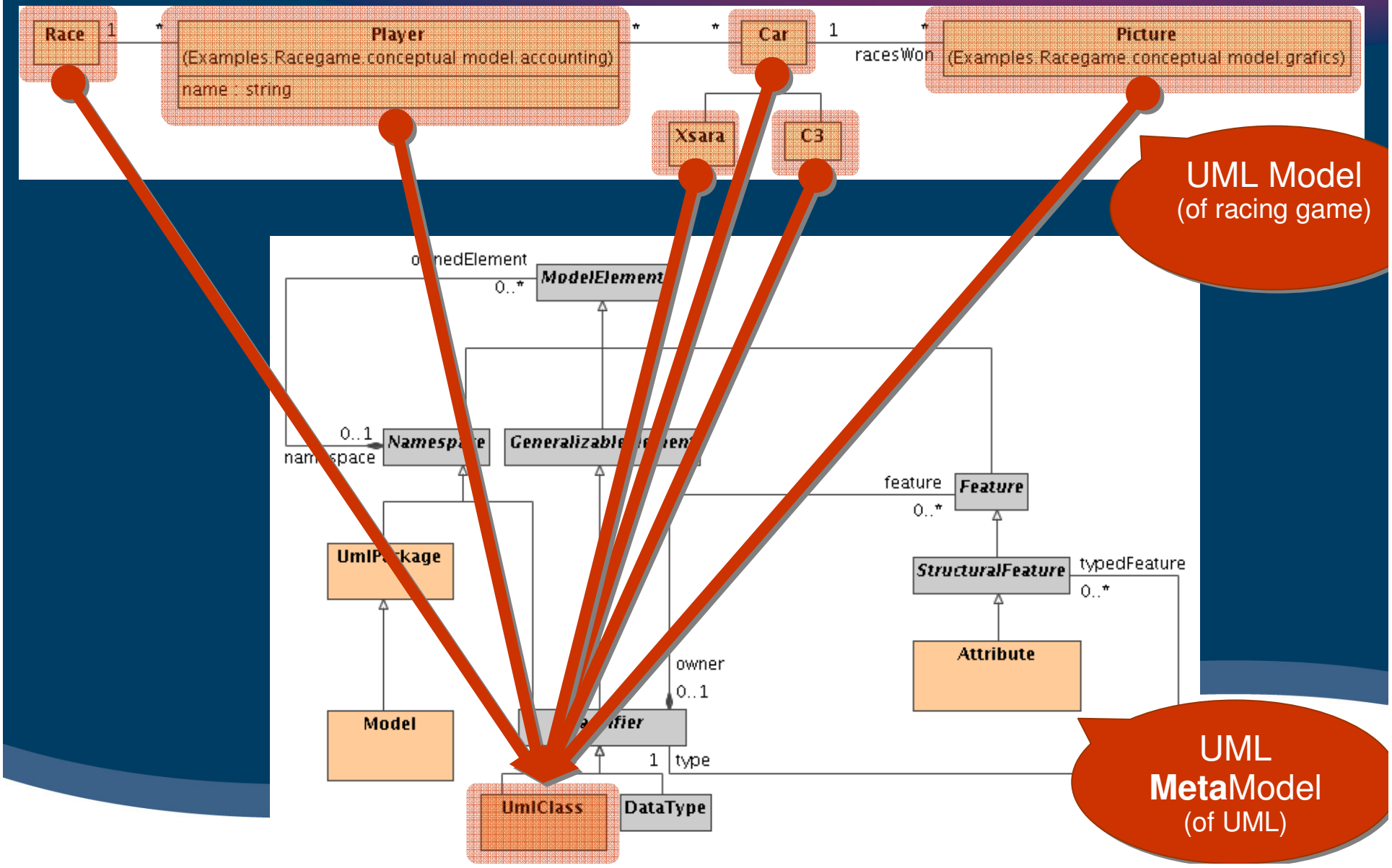
Back to Basics: the UML metamodel



Standard Syntax for Metamodeling

Example: UML Metamodel



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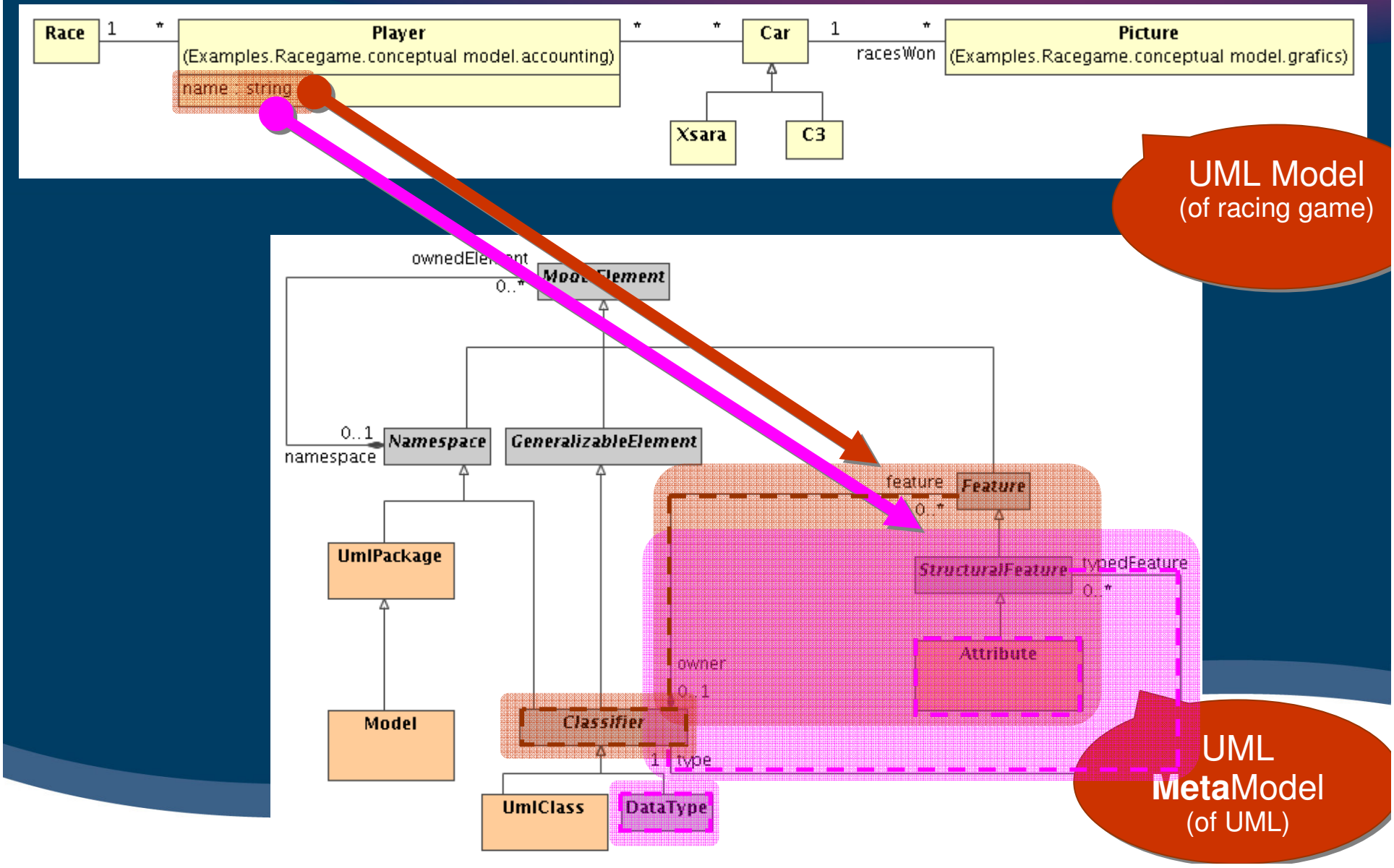
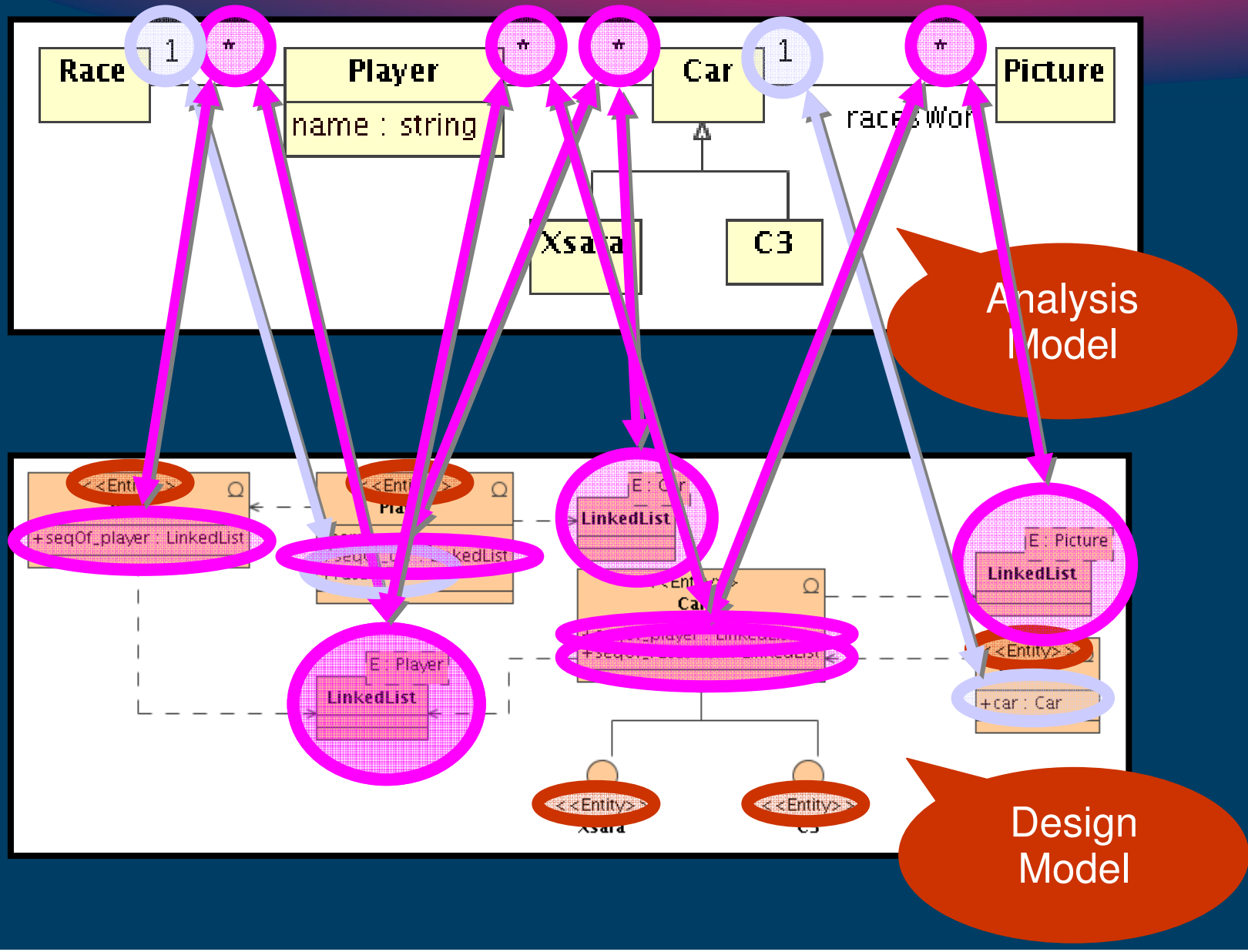


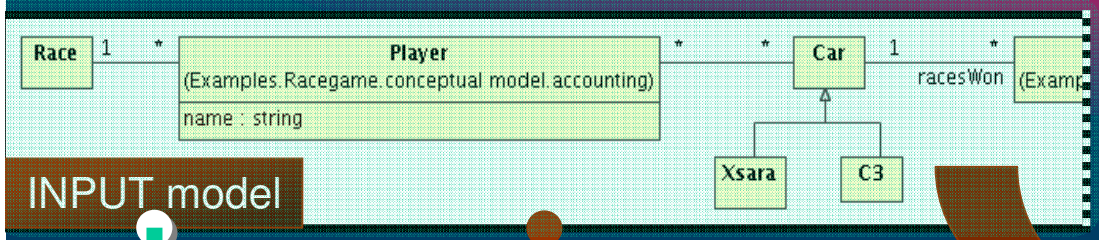
Related Software Models:

Correspondences in Detail

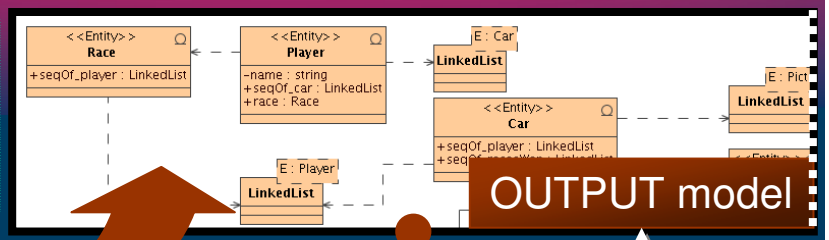


Modeling a **Copy** Operation

Derivation



INPUT model



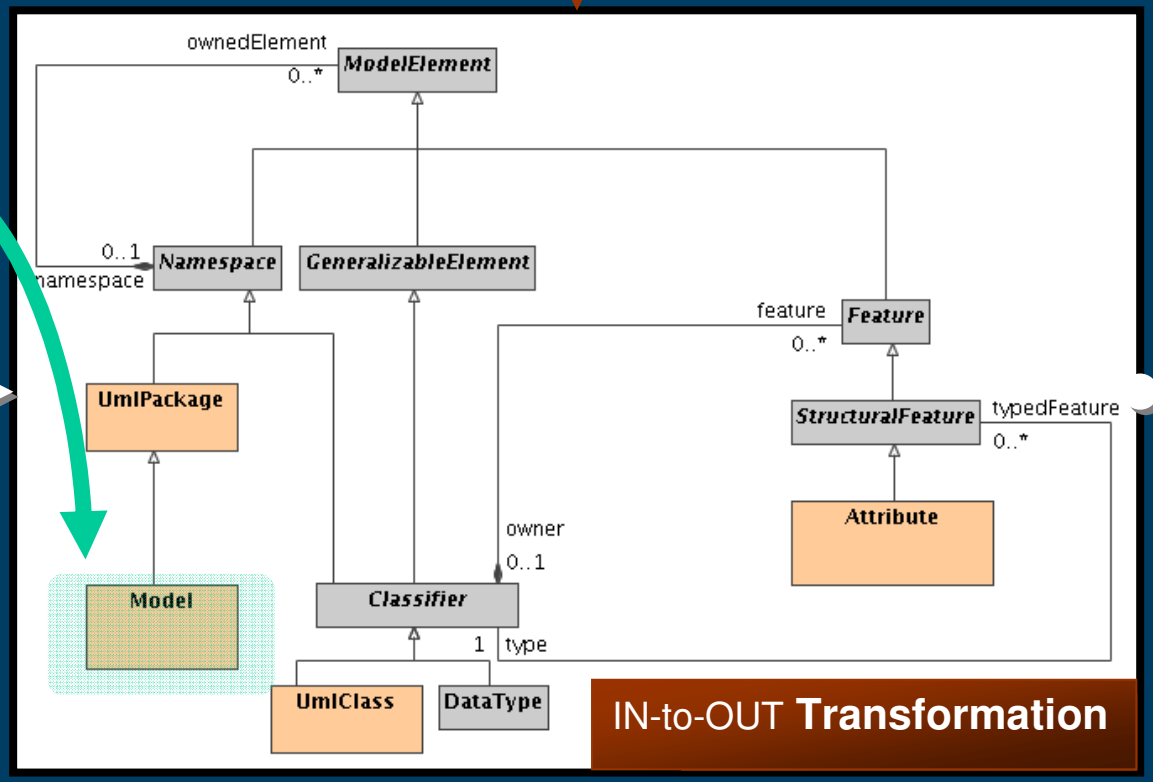
OUTPUT model

conforms to

processed by

conforms to

processed by



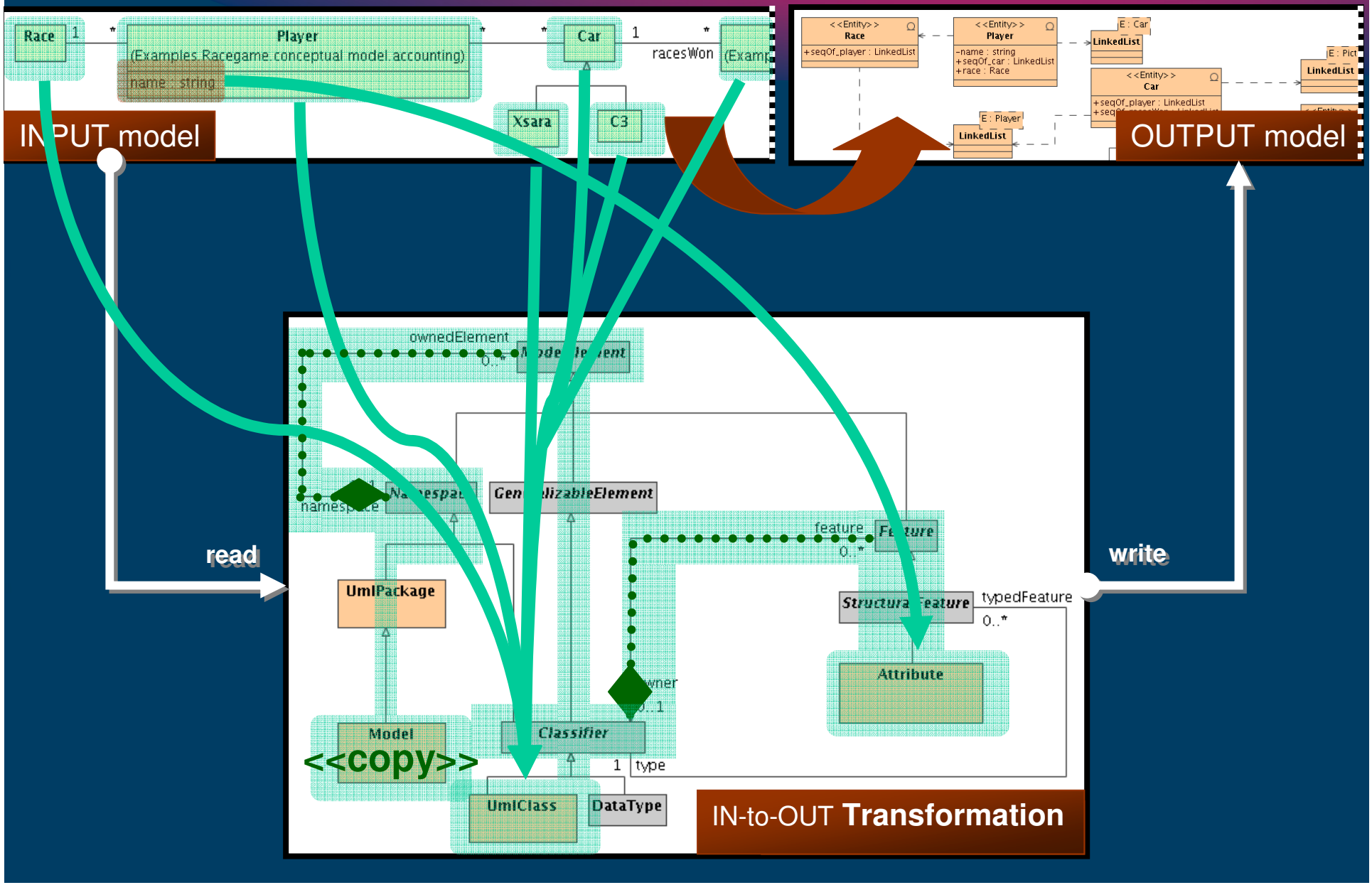
IN-to-OUT **Transformation**

read

write

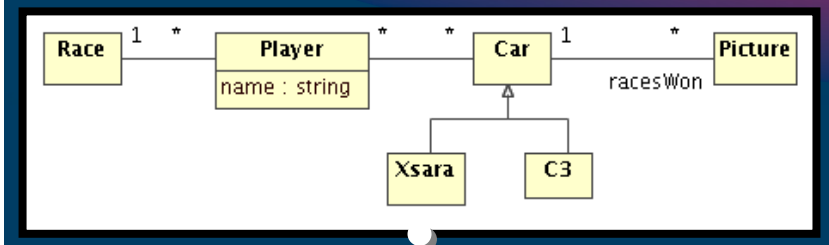
Modeling a **Copy** Operation

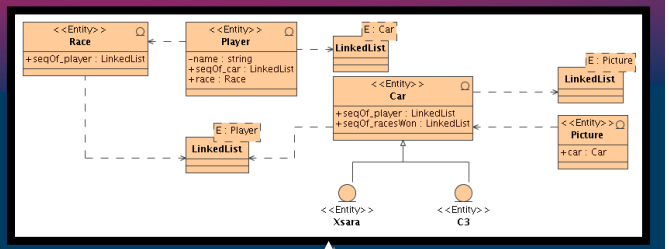
Derivation



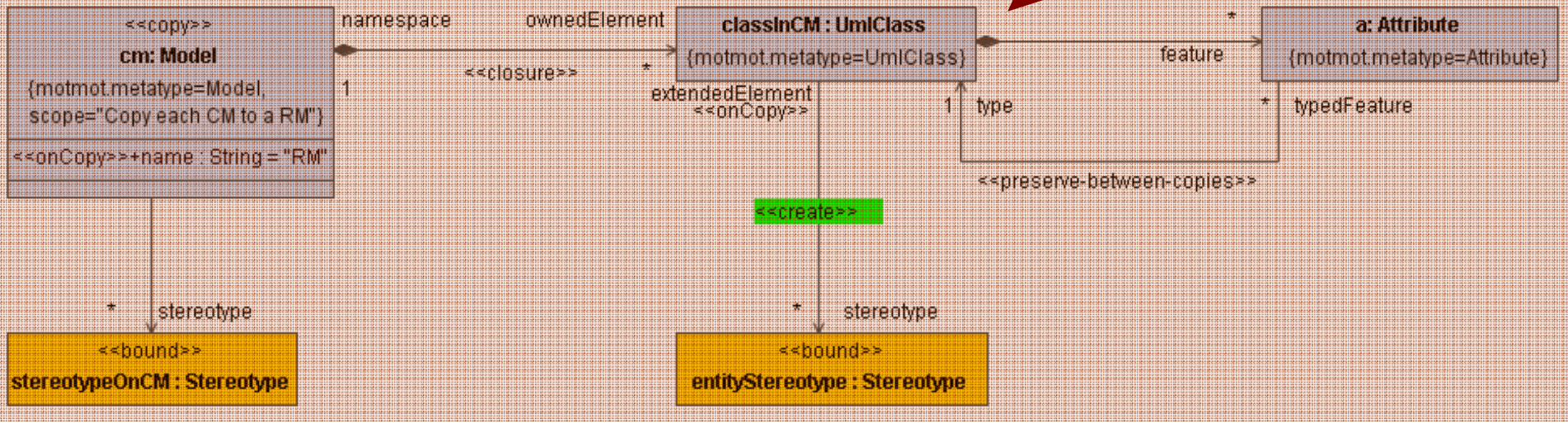
Modeling a **Copy** Operation

Summary



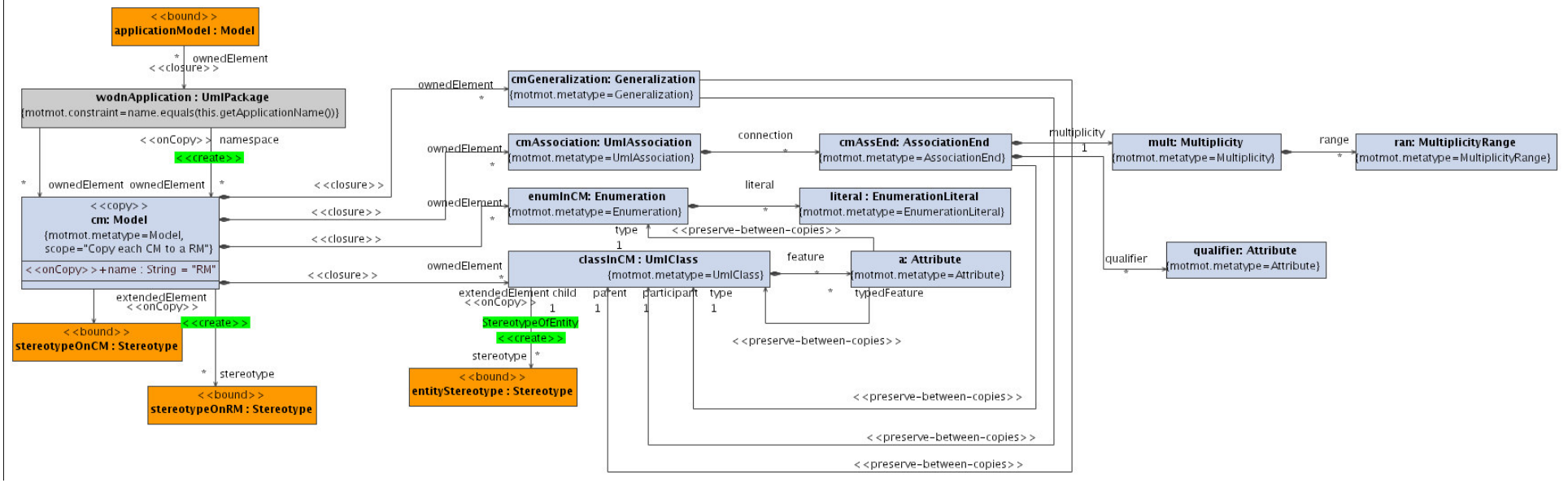


Transformation Modeling Language:
(extension of) so-called **"Story Diagrams"**, in **Standard UML** syntax



Copying: Example IN CONTEXT

- *Complete copy operation in **ONE rewrite rule***
- *Enables one to assess **overall effect***
- *Complexity can be managed using **views** (!)*
- *Only specify WHAT is copied, **don't bother about***
  - » ***Traceability***
  - » ***Properties of metaclasses***
  - » ***…***



Part 3

Higher Order Transformations

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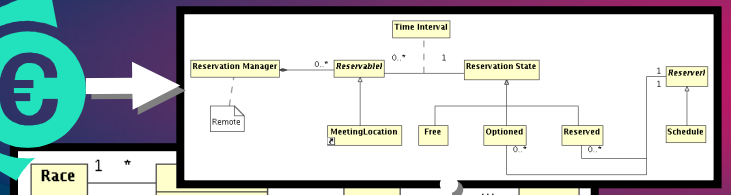
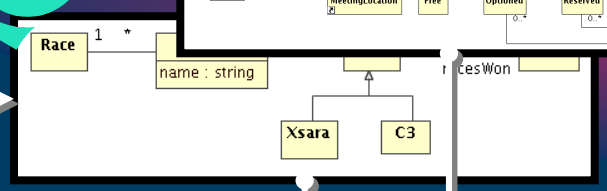
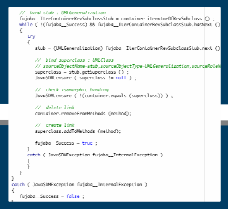
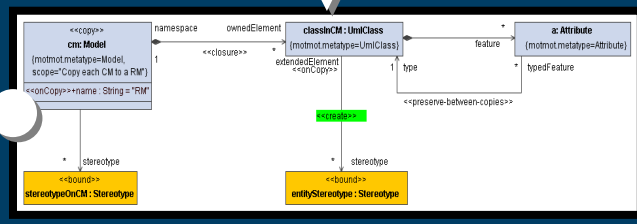
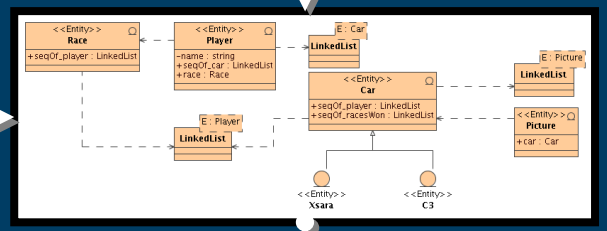
Towards Transformation Code…

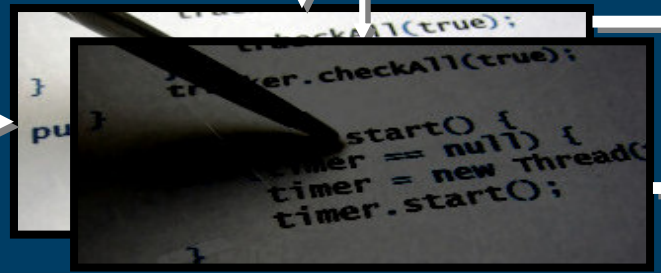












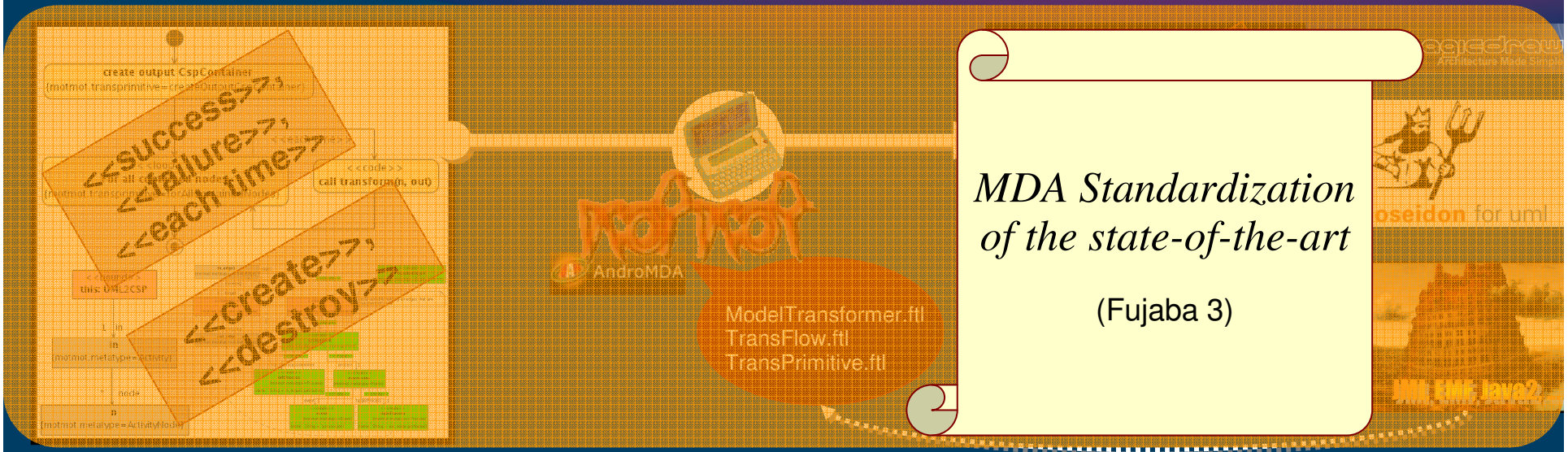
Higher Order Transformations

Case Studies:

1. Story Diagrams
2. **Copying**

Higher Order Transformations

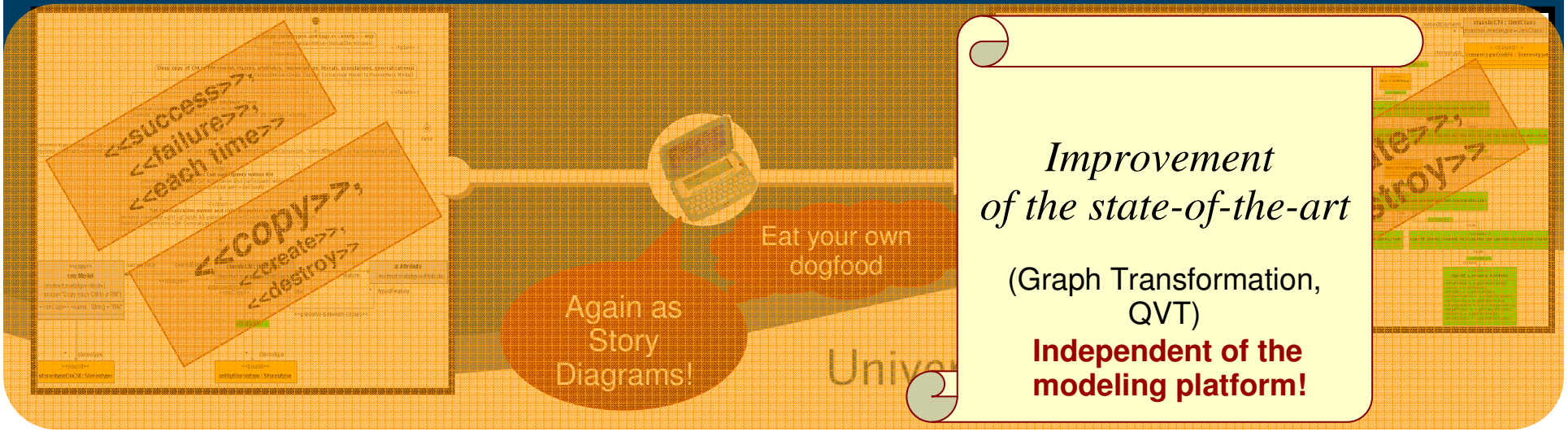
1. From Story Diagrams to JMI Transformation Code



MDA Standardization of the state-of-the-art

(Fujaba 3)

2. From the Copy language to plain Story Diagrams



Improvement of the state-of-the-art

(Graph Transformation, QVT)

Independent of the modeling platform!

Part 4

Current Focus

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Hybrid Transformation Modeling

- Combine Implicit and Explicit Rule Scheduling
- Combine TGGs (bidirectional, incremental) with Story Diagrams (control flow)
- …

Summary

- Modeling languages:
  - Do not re-invent the wheel
  - Applies especially to Transformation Modeling!
    - **Views** for **free**!
- **Copying** problem tackled
  - Transformation **Modeling** (not Programming)
- **Higher Order** Transformations
  - Extensible implementation of <<copy>>
  - Easy to integrate with other modeling platforms
- **Challenge Me!**
  - Copy Operator
- **Success** Criteria
  - OUT: Evangelize Story Diagrams, Copy Operator
  - IN: Practical Experience with
    - » DEVS, Alloy
    - » MDE work for SoC