Embedding Domain-Specific Modelling Languages into Maude Specifications

Vlad Rusu

INRIA & Laboratoire d'Informatique Fondamentale de Lille, France

Outline

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Domain Specific Modelling Languages (DSML)

- What are they:
  - DSML are language for modelling specific domains
  - some DSML are *executable*
- Why are they needed:
  - the Unified Modelling Language (UML) is "too large"
  - people prefer smaller languages adapted to their *domain*
- How to define them:
  - based on *metamodels, models, and model transformations*.

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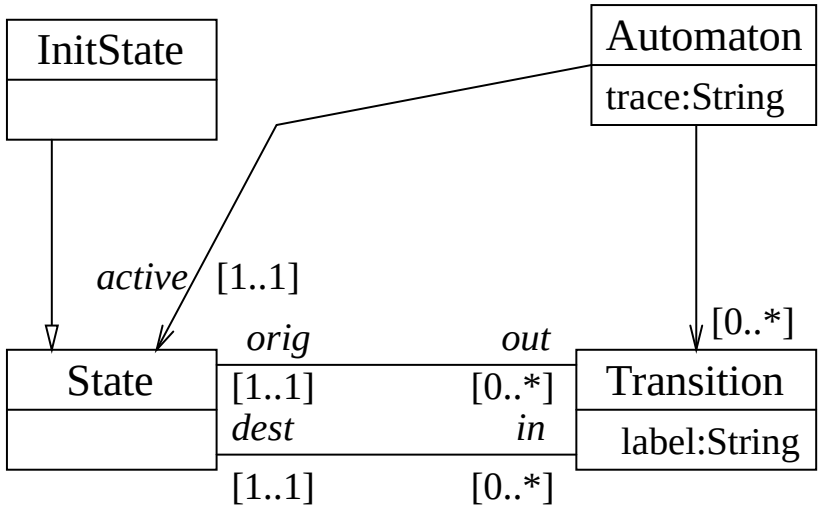
Syntax of Finite Automata = Metamodel

= UML Class Diagram + (optionally) OCL constraints



Context *State* : $self.out \rightarrow forAll(t_1, t_2 | t_1 \neq t_2 \text{ implies } t_1.label \neq t_2.label)$
Context *Transition* : $self.label \neq ""$

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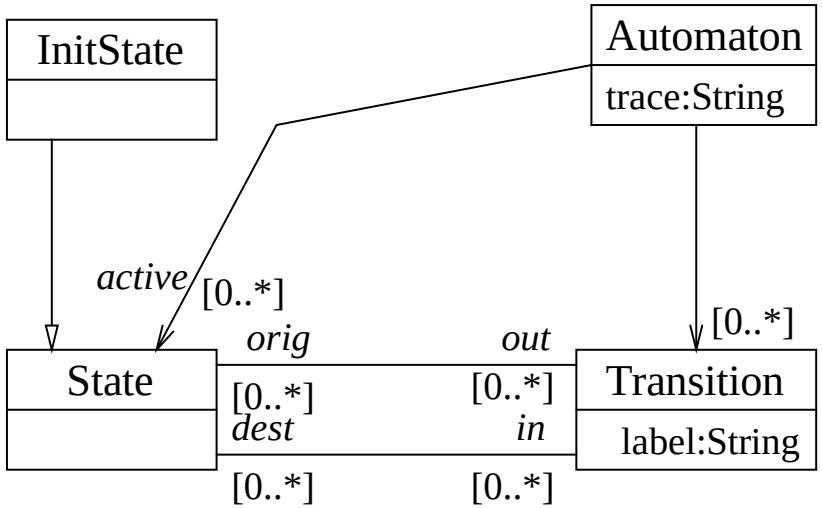

Context *Transition* : $self.dest.size() = 1$
Context *Automaton* : $self.active.size() = 1$
Context *Transition* : $self.orig.size() = 1$
Context *State* : $self.out \rightarrow forAll(t_1, t_2 | t_1 \neq t_2 \text{ implies } t_1.label \neq t_2.label)$
Context *Transition* : $self.label \neq ""$

Metamodel of Automata as Maude Specification

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fth AUTOMATA-META-MODEL is
pr NAT .
pr STRING .

sorts Automaton State InitialState Transition .
subsort InitialState < State .

op trace :  Automaton -> String .  --- attributes
op label :  Transition -> String .

op owned :  Automaton -> Set{Transition}.  --- associations
op orig :  Transition -> Set{State} .
op dest :  Transition -> Set{State} .
op incoming :  State -> Set{Transition} .
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op active :  Automaton -> Set{State} .

eq card(active(X:Automaton)) = 1 -- "implicit" OCL invariant for cardinality ...
eq length(label(W:Transition)) > 0 = true --- "explicit" OCL invariant
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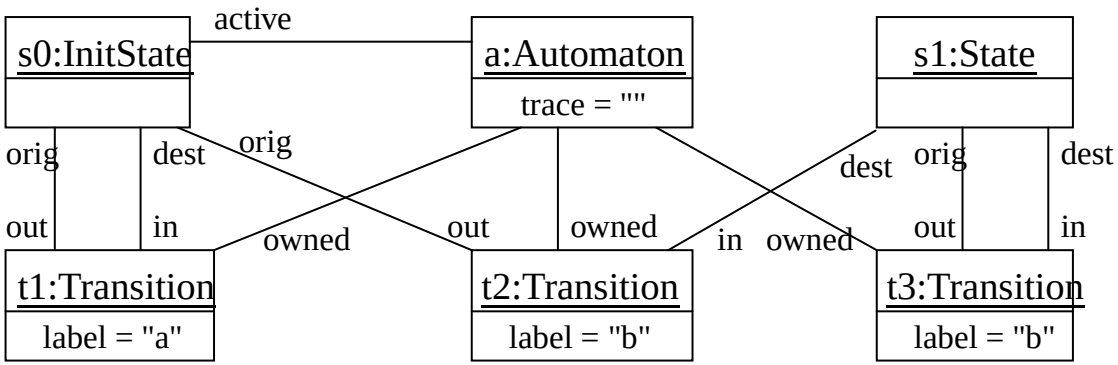
One Automaton = a Model (of the Metamodel)

= Object diagram of Class Diagram



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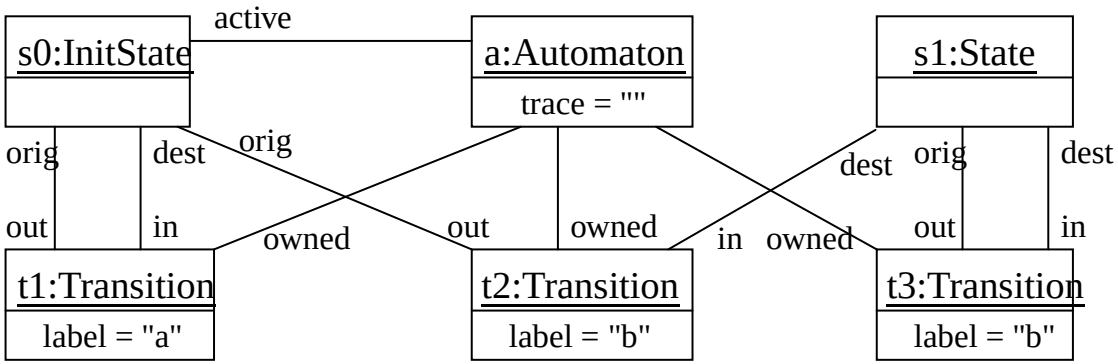

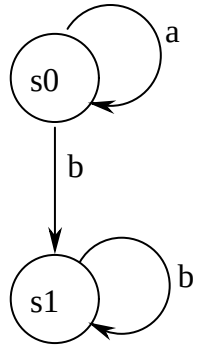

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...includes AUTOMATA-META-MODEL except equations for OCL invariants

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op s1 :  -> State .
ops t1 t2 t3 :  -> Transition .

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eq label(t2) = "b" .
eq label(t3) = "b" .
eq owned(a) = t1, t2, t3 .
eq active(a) = s0 .
eq orig(t1) = s0 .
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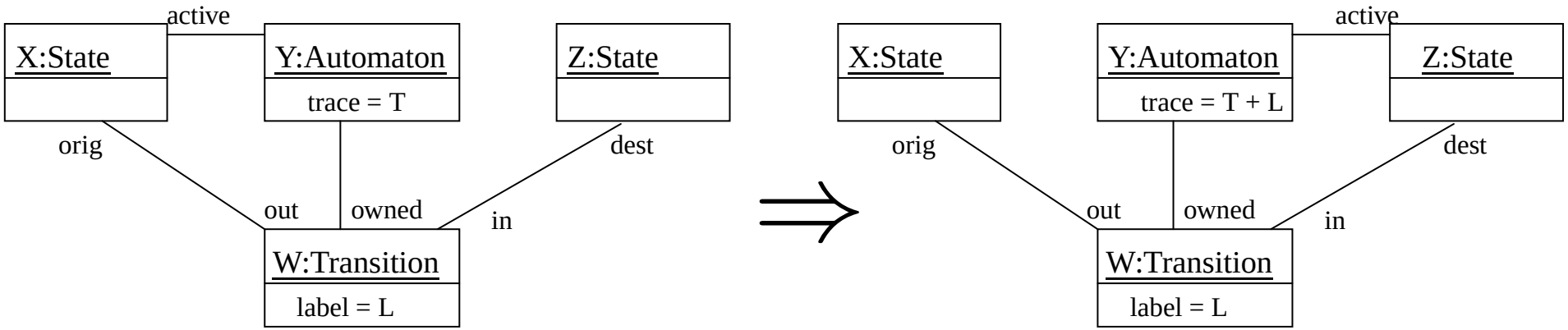
Operational Semantics = Model Transformation
= Graph Rewriting



Automata Semantics as Rewriting over Maude Specs

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getTrace(M) = '"aaabbb".String
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All DSML can be thus represented!

metamodel $MM \rightsquigarrow$ Maude theory $MM \rightsquigarrow [\![MM]\!]$.
model M of $MM \rightsquigarrow$ Maude module $M_{MM} \rightsquigarrow (\!|M_{MM}|\!)$.

- *conformance*: $(\!|M_{MM}|\!) \in [\![MM]\!]$
- *operational semantics*: rec. function $[\![MM]\!] \rightarrow \mathcal{P}([\![MM]\!])$

are *effectively decidable/computable* in Maude

Also in the paper: *semantics-preserving model transformations*.

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- Moment2 (Leicester) : metamodels as *Maude sorts*
- Maudeling (Málaga) : metamodels as *Full Maude specs*.

Other closely related approaches:

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