Transformation as Search

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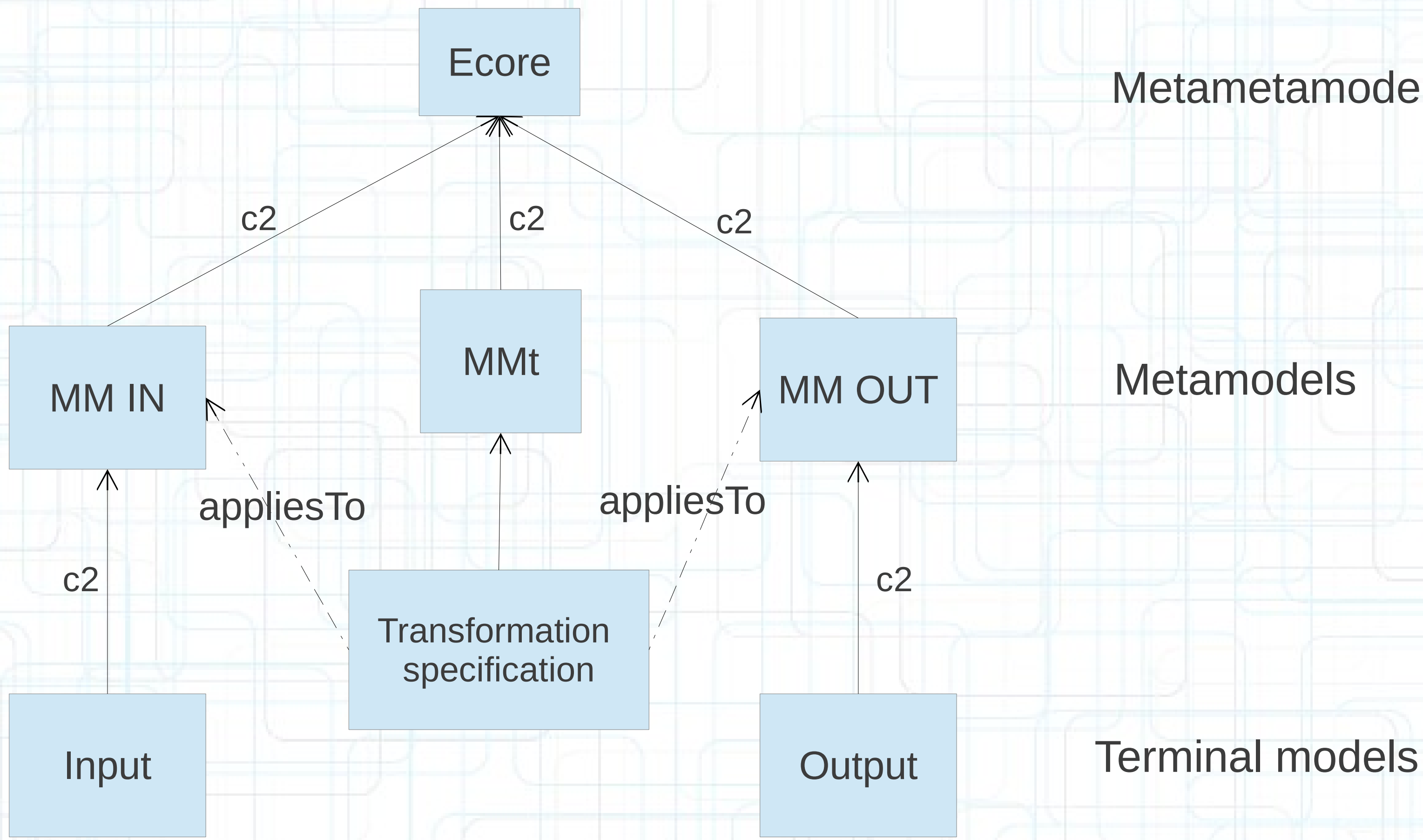
ECMFA 2013. July 3rd, 2013. Montpellier, France

- *Partially funded by CNPq Universal and FA/INRIA call

Outline

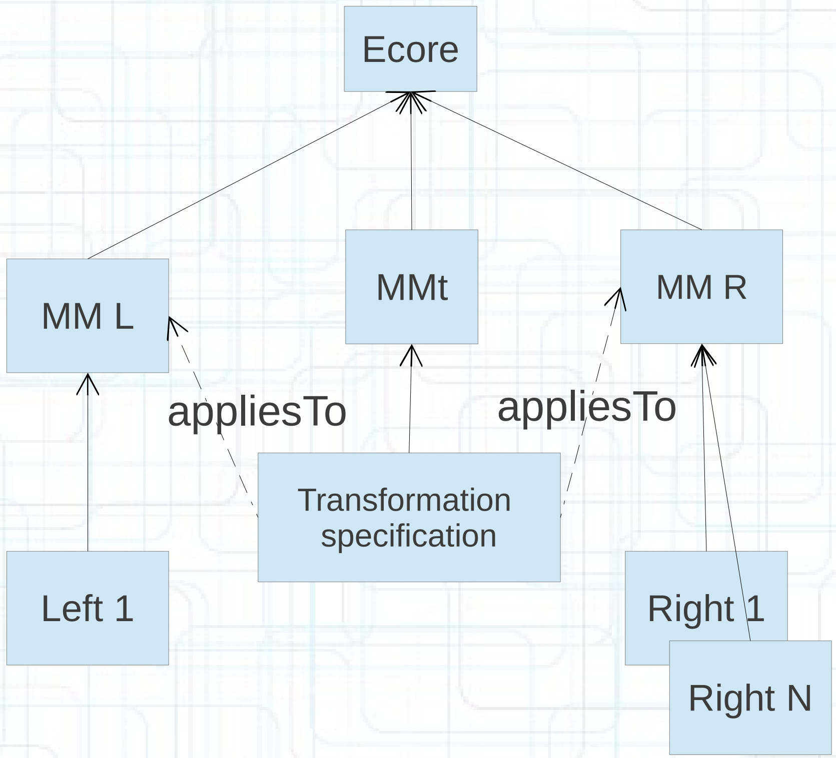
- Context
  - Model transformations
  - Model search
- Transformation as search
  - Transformation by unification
  - Use case
- Conclusions

Source-to-target Model Transformation (MT)



c2 : conformsTo

Several other aspects in MT



- First classification of approaches in [Czarnechi et. al. 2003]
- We stress two aspects
  - Directionality
    - Forward, Backward, Incremental, M:N, etc.
  - Execution semantics
    - 1 unique result
    - 1+ result(s)
- Solutions
  - TGG, JTL, QVT-R, ATL, Epsilon, QVT-M, Viatra, Moflon, etc.

Problem

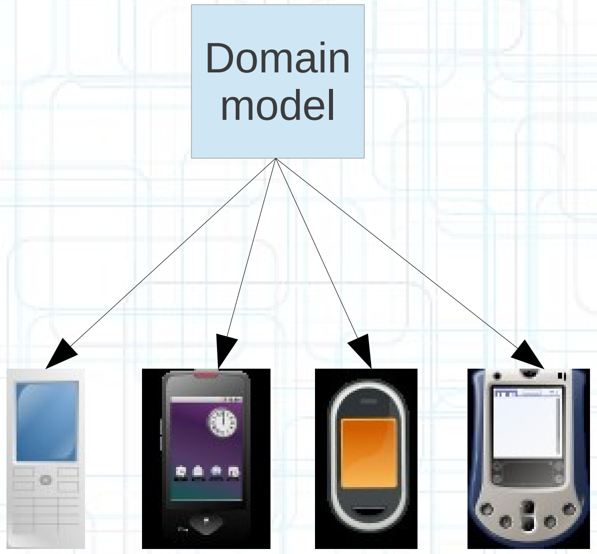
- Define a model transformation that:
  - Performs *Forward*, *Backward*, and *Incremental* transformations
  - From one input model, produces 1+ output models

Solution: Constraint Programming

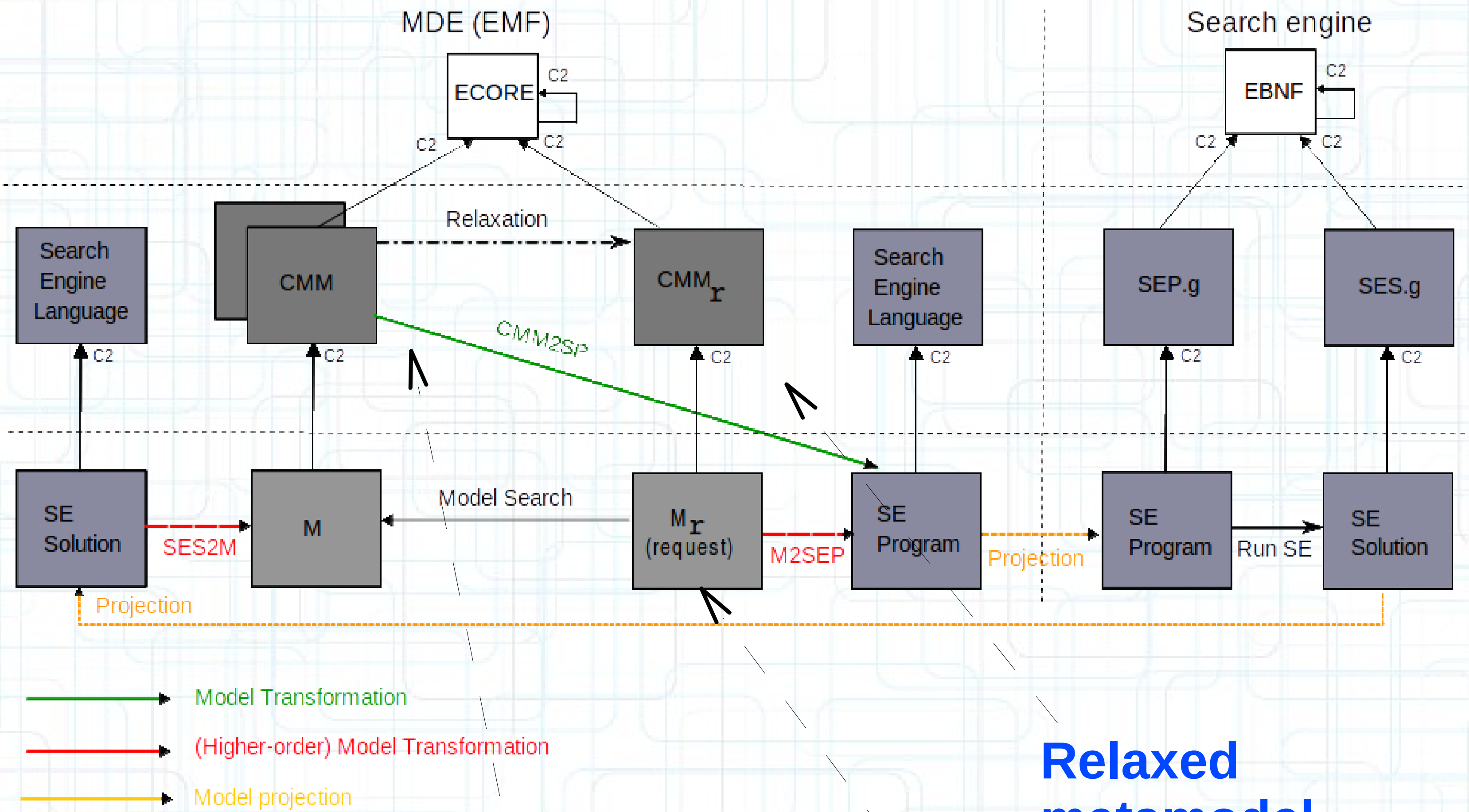
- Constraint Programming
  - *Constraint programming (CP) is a declarative programming technique to solve combinatorial (usually NP-hard) problems*
- One CP scenario
  - Find the best allocation of graduate course sections
    - From
      - C : Classrooms, capability of S : Students
      - Allocate W courses, with 1 professor
- Approaches
  - CSP : Constraint Satisfaction Programming (OPL, Choco, Eclipse), SAT : Boolean solvers (Alloy) ASP : Answer Set Programming (DLW), Configuration (class-based representation)

CP + MDE : Model Search

- Constrained Search as first class operation
- One typical scenario
  - SPL (Product Lines) : find the best/all product given a configuration
- Solutions
  - UmlToCSP, USE, JTL, SPL
  - Model Search : MDE + CP : formalization and implementation of a chain of operations



Model Search Chain



Relaxed metamodel

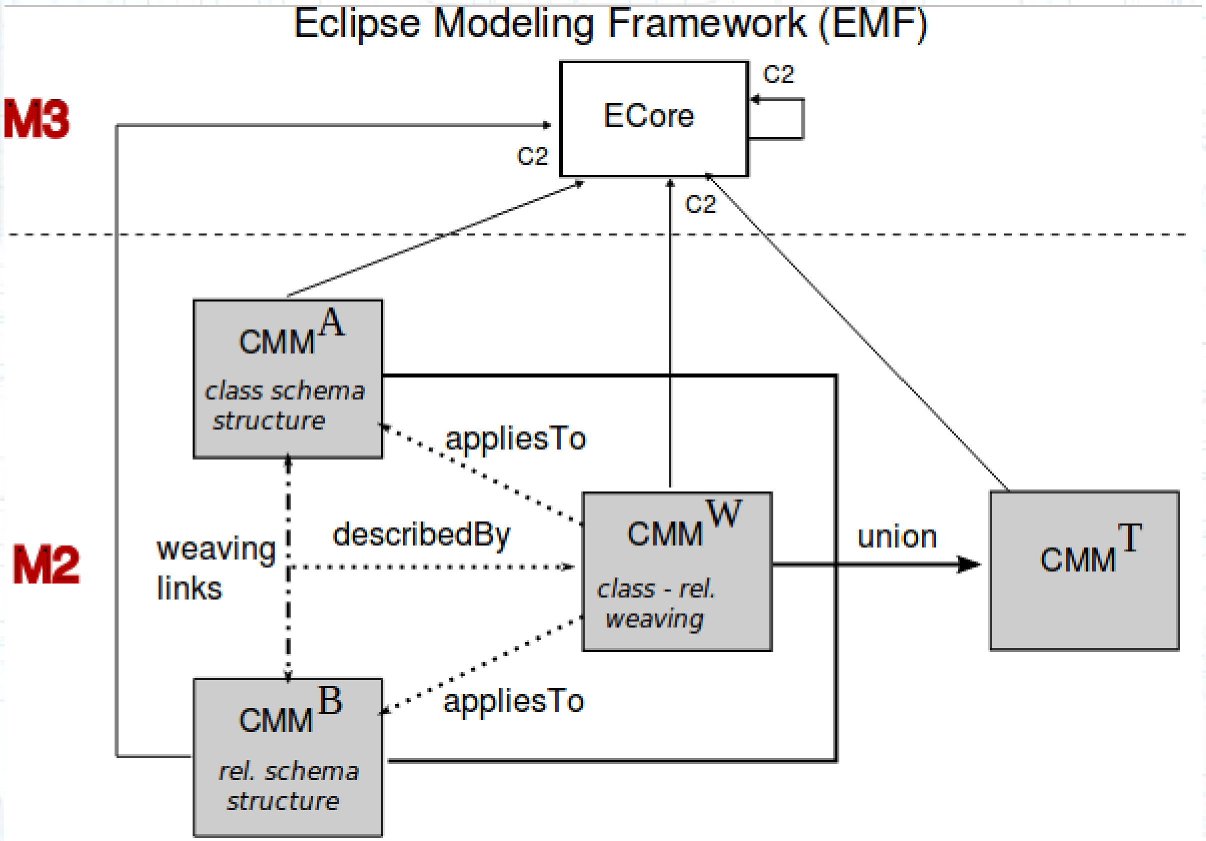
Partial model

Constrained metamodel

MAS → TAS

- Model search (MAS)
  - Input and output models conform (almost) to the same metamodel
  - Intra model constraints
- Transformation as search (TAS)
  - **Left** and **Right** metamodels and models
  - Intra and **inter model constraints**
    - Weaving metamodel

Transformation as Search: Transformation by unification



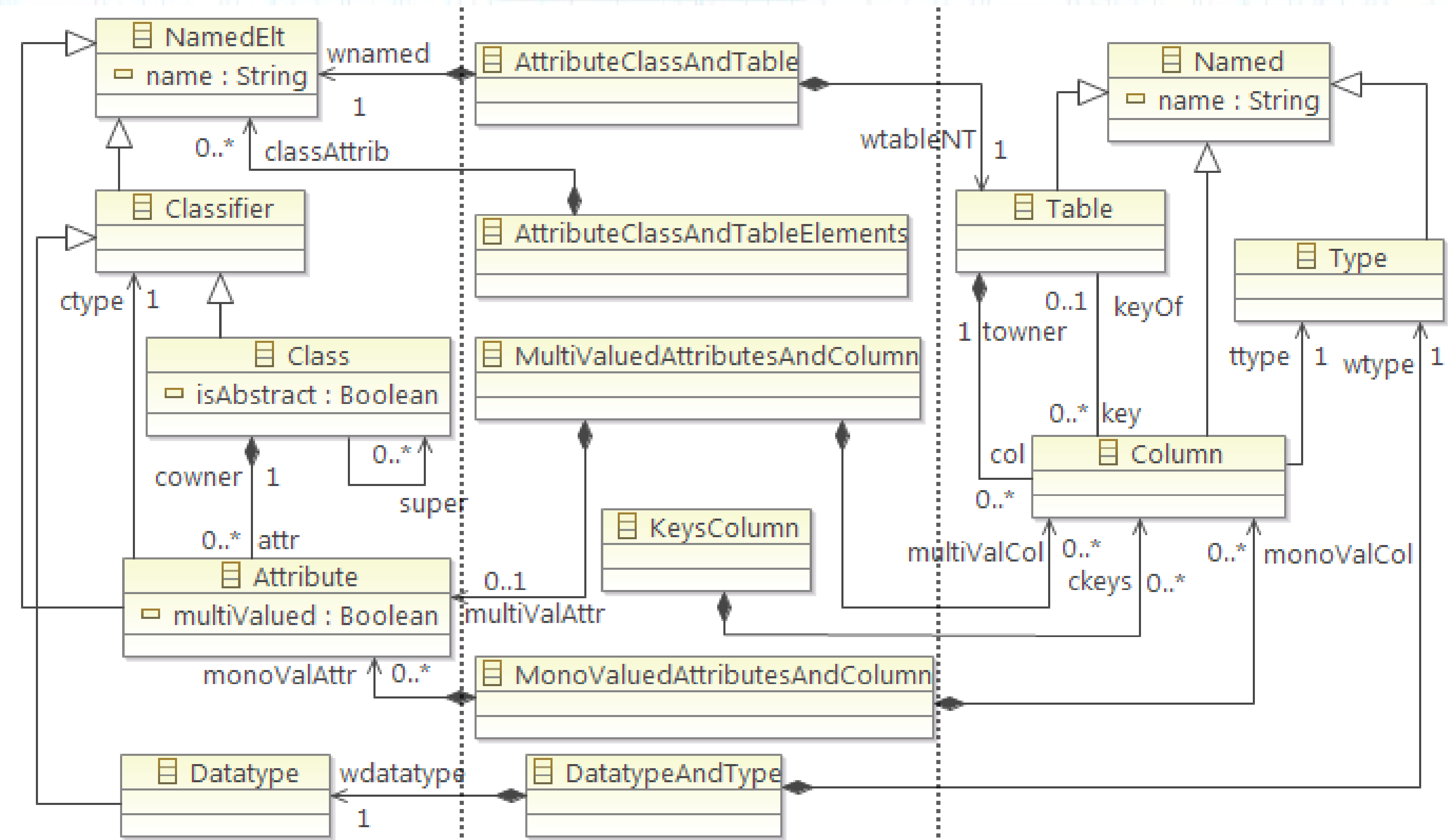
Two central definitions

- ***Weaving metamodel.*** We call weaving metamodel between metamodels CMM (A) and CMM(B), a constrained metamodel CMM(W) defined by CMM(W)=<MMW , C(W)>, where MM(W) and C(W) are respectively a set of metamodel elements and constraints that define the weaving relationships between the elements of CMM(A) and CMM(B).
- ***Transformation metamodel.*** We call transformation metamodel between metamodels CMM(A) =<MM(A), C(A)> and CMM(B)=<MM(B), C(B)>, using a weaving metamodel CMM(W), a constrained metamodel CMM(T) defined by CMM(T)=<MM(T), C(T)>, where MM(T)=MM(A) ∪ MM(B) ∪ MM(W) and C(T)=C(A) ∪ C(B) ∪ C(W).
- What actually the execution produces ?
  - Two constrained models
  - One weaving model → traceability information

Implementation : TAS chain

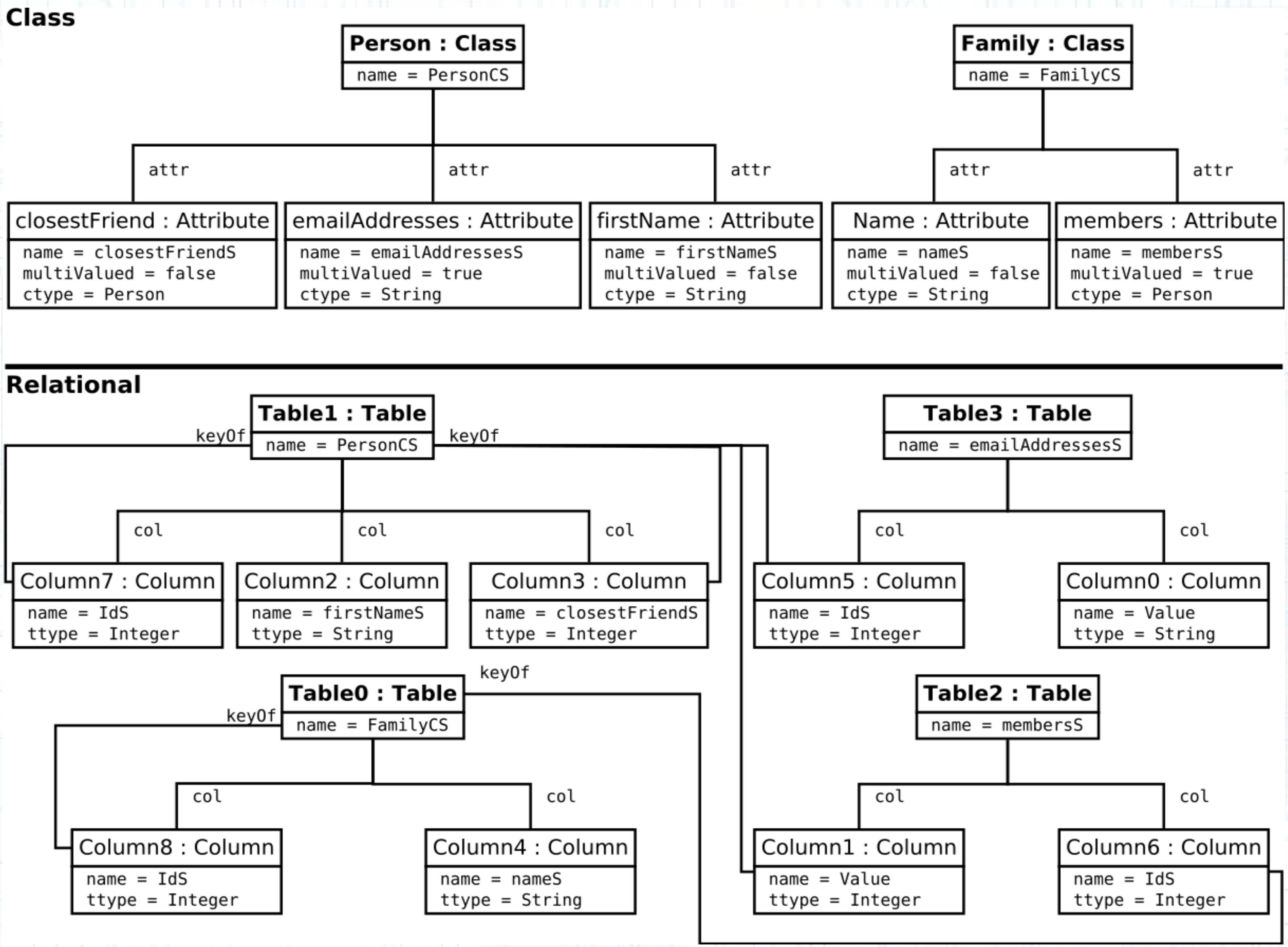
- Technologies
  - (Meta)Models implemented in Ecore
  - Constraints in OCL+
  - Translated into Alloy spec (SAT) [Jackson00]
- Use case
  - POC: Class ↔ Relational
    - Family model [ATLrepository] : 2 versions
    - Ongoing: graduate course model
- Scenarios
  - Forward, backward, synchronization, multiple output

Use case: transformation metamodel



+ 15 OCL constraints

Resulting instance



Results

- V1 x V2: changes on the constraints
- Constraints
  - One specification for the three scenarios
  - Multiple output : small relaxation of the weaving links

Scenario	#variables (solver format)	#constraints (solver format)	Exec. Time (s)
(1)-v1	9956	845357	3.432
(1)-v2	7179	866894	2.483
(2)-v1	10114	791167	5.529
(2)-v2	5725	866894	1.655
(3)-v1	6496	505227	0.324
(3)-v2	5448	1231787	0.666

Conclusions and Future Work

- Transformation as search
  - Chain of operations fitted to MDE
  - One specification, three scenarios
    - Synchronization is the faster
    - Multiple solutions need to be further investigated
- Improve the constraint language
  - OCL → Alloy → other...
- Future work
  - Generalization of the weaving links
  - Optimization (e.g., max() function)
  - Performance (generic transformation to Alloy is limited)

Questions ?