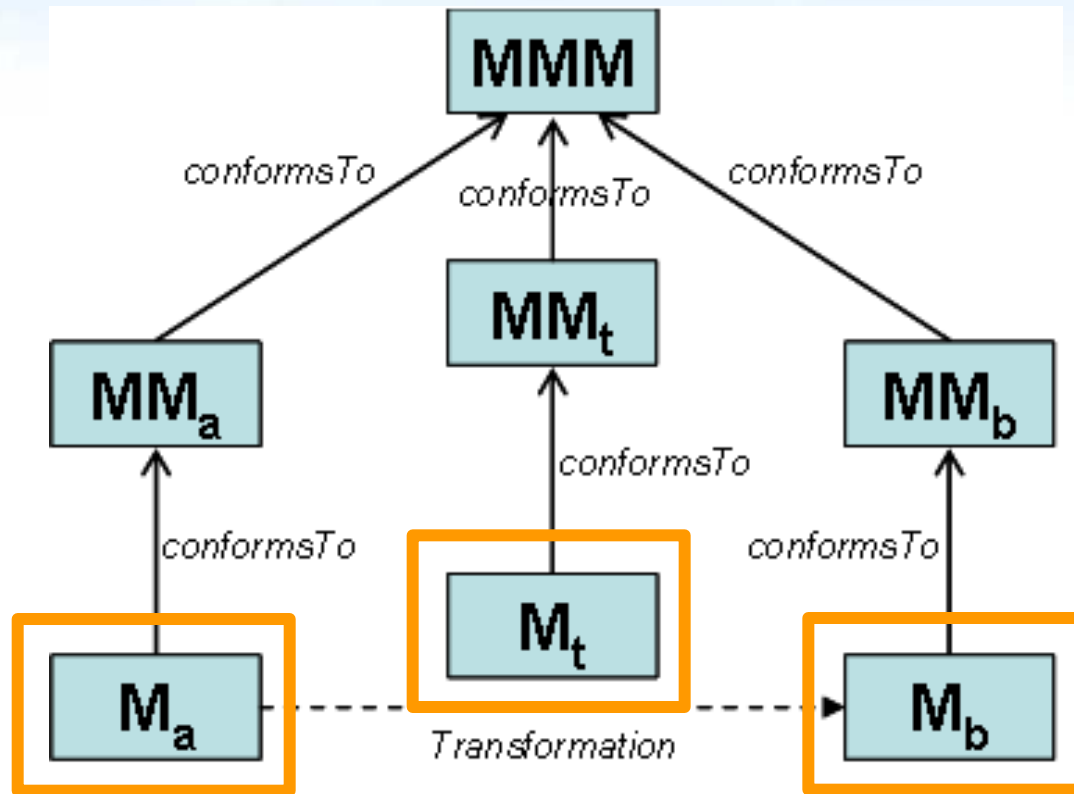


On the Realization of TractsTool

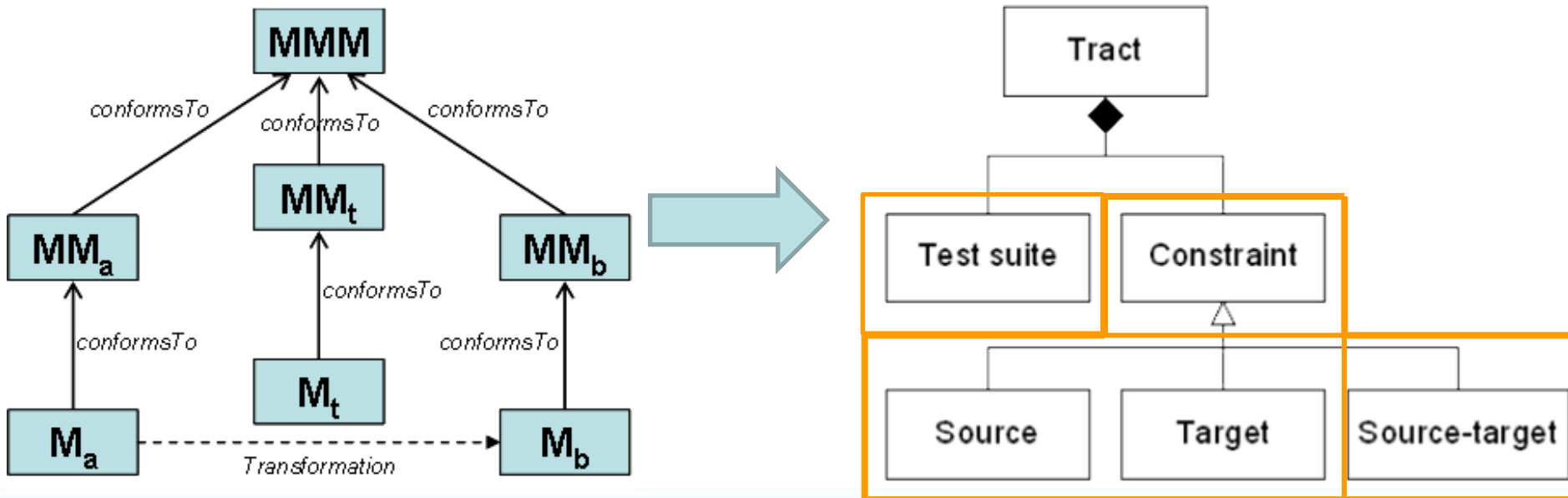
**Loli Burgueño, Manuel Wimmer,
Javier Troya, and Antonio Vallecillo**

University of Málaga & Vienna University of Technology














Testing Model Transformations



- ❏ A **Tract** defines
 - ❏ a set of **constraints on the source and target metamodels**,
 - ❏ a set of **source-target constraints**, and
 - ❏ a **tract test suite** (a collection of source models satisfying the source constraints)



Principles

-  Reuse existing languages and techniques of MDE
 -  Contract specification
 -  Test model generation
-  Light-weight, black-box testing approach
 -  Partial specification
 -  Transformation language & implementation independent
-  Support for various transformation kinds
 -  Model-to-model
 -  Model-to-text
 -  Text-to-model
-  Open design
 -  Several testing scenarios
 -  Integration with different transformation tools

TractsTool's Ecosystem

- EMF (Eclipse Modeling Framework)
 - Metamodeling (Ecore-based) & modeling support

- USE Tool (UML-based Specification Environment)
 - Analyzes model structure (with respect to its metamodel & OCL constraints)

- OCL (Object Constraint Language)
 - Allows to define model constraints

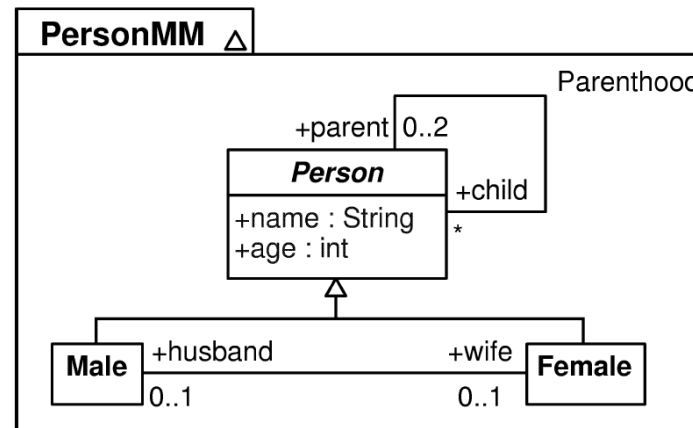
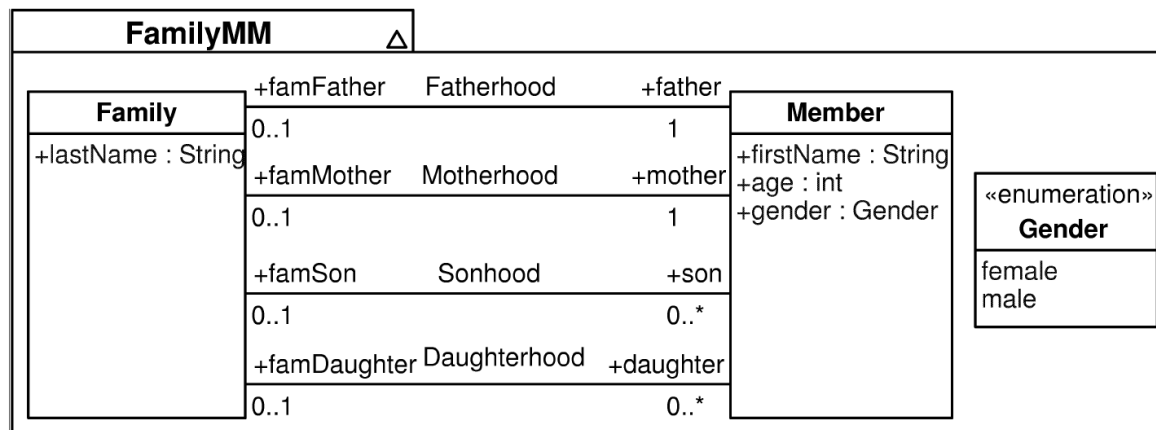
- ASSL (A Snapshot Sequence Language)
 - Imperative programming language with features for randomly choosing attribute values or association ends
 - Allows to automatically generate models
 - ASSL supports backtracking for finding models with particular properties

- ATL (ATLAS Transformation Language)
 - Hybrid language to define model transformations

Tracts for the Families2Persons MT

 **Source Metamodel: Family**

 **Target Metamodel: Person**



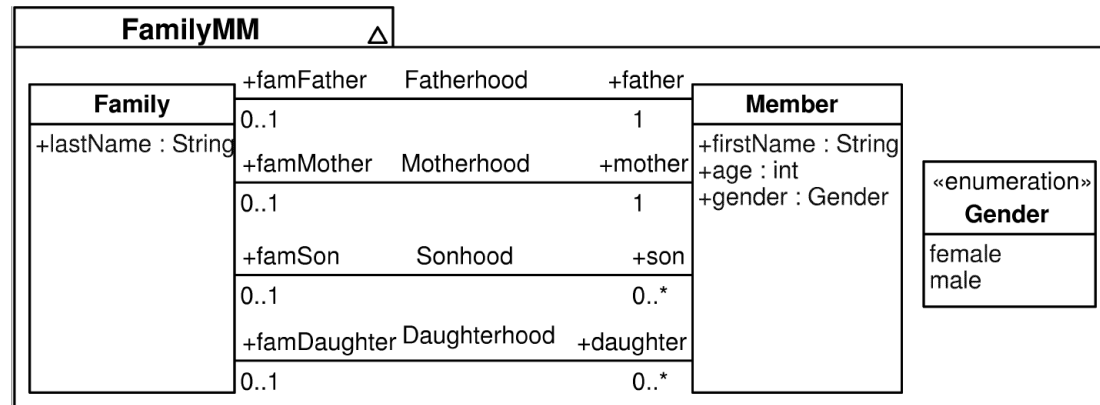
Example of *Tract*: "Members only"

Tract: Members only

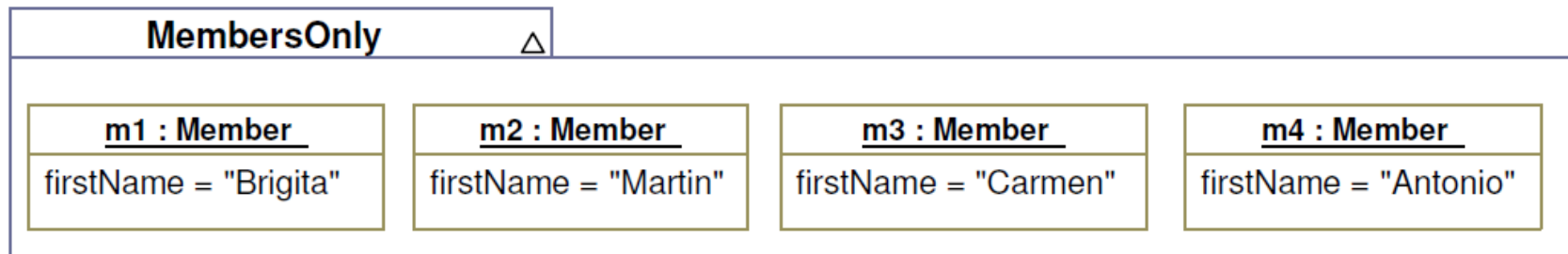
Interested in families consisting only of members

Precondition

```
inv SCR_MembersOnly:  
src_Member.allInstances -> forAll (m |  
  m.famFather->size() +  
  m.famMother->size() +  
  m.famSon->size() +  
  m.famDaughter->size() = 0)
```



Test Source Model



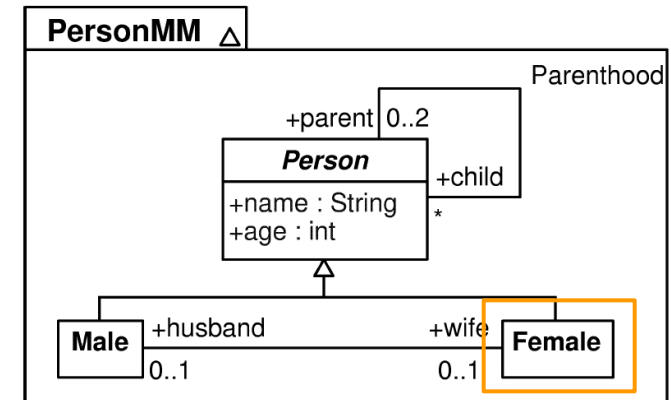
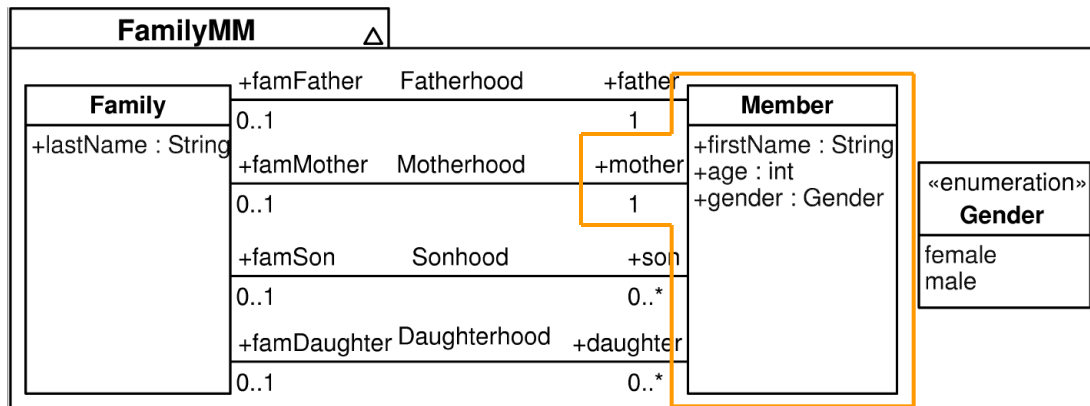
Example of *Tract*: “Mother2Female”

Tract: Mother2Female – a female has to be created from each mother

Constraint on the **source-target relationship**

inv SRC_TRG_Mother2Female:

```
src_Family.allInstances -> forAll (fam|trg_Female.allInstances-> exists(m|  
fam.mother.firstName.concat(' ').concat(fam.lastName) = m.name))
```



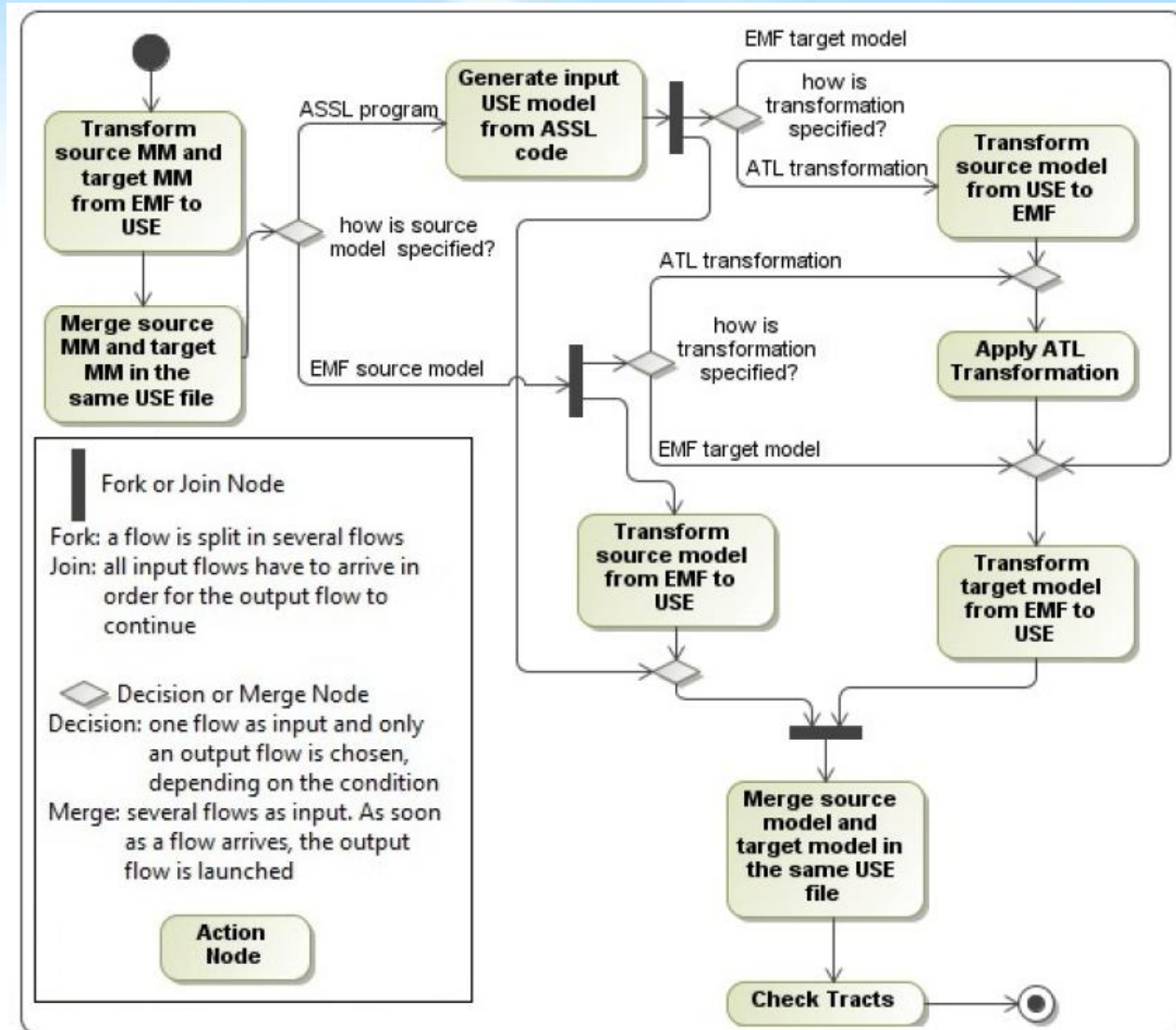
Internal Model Transformation Chain (M2M transformations)

Input Models

- Intensional
 - ASSL program
- Extensional
 - EMF models
 - Text artefacts

Transformation

- Intensional
 - ATL transformation
- Extensional
 - EMF models
 - Text artefacts



TractsTool

The screenshot shows the TractsTool application window. It has two tabs: "M2M testing" and "T2M injector". The "T2M injector" tab is active. The interface consists of several input fields and a "Check" button. Annotations with orange arrows point from text labels to specific fields:

- Input and Output Metamodels**: Points to the "Source metamodel (.ecore or URI)" and "Target metamodel (.ecore or URI)" fields.
- OCCL Constraints**: Points to the "Tracts file" field.
- Input (or ASSL code) and Output (or ATL trans) Models**: Points to the "ASSL or src model file (.xmi or .ecore)" and "ATL transfo (.atl) or trg model file (.xmi or .ecore)" fields.
- Temporal and auxiliary folder**: Points to the "Temporal folder" field.

The "Result:" area is currently empty. A "Check" button is located at the bottom left of the interface.

http://atenea.lcc.uma.es/index.php/Main_Page/Resources/Tracts

TractsTool

The screenshot shows the TractsTool application window with the 'T2M injector' tab selected. The interface is divided into two main sections: input fields on the left and a result pane on the right.

Input Fields:

- Source metamodel (.ecore or URI):** C:\TractsTool_v5.0\org.tracts.tool\F2P\Families.ecore
- Target metamodel (.ecore or URI):** C:\TractsTool_v5.0\org.tracts.tool\F2P\Persons.ecore
- Tracts file:** tsTool_v5.0\org.tracts.tool\F2P\FamiliesToPersons.ocl
- ASSL or src model file (.xmi or .ecore):** C:\TractsTool_v5.0\org.tracts.tool\F2P\familyModel.xmi
- Signature of the invocation to ASSL file:** (Empty text box)
- ATL transfo (.atl) or trg model file (.xmi or .ecore):** tsTool_v5.0\org.tracts.tool\F2P\FamiliesToPersons.atl
- Temporal folder:** C:\TractsTool_v5.0\org.tracts.tool\F2P\temp

Result Pane:

Result:

```
checking structure...
checking invariants...
checking invariant (1) `src_Family::SRC_TRG_FatherSon2Male': OK.
checking invariant (2) `src_Family::SRC_TRG_Female2MotherDaughter': OK.
checking invariant (3) `src_Family::SRC_TRG_MemberSize_EQ_PersonSize': OK.
checking invariant (4) `src_Family::SRC_TRG_MotherDaughter2Female': OK.
checking invariant (5) `src_Family::SRC_TRG_MotherDaughter2Female2': OK.
checking invariant (6) `trg_Male::SRC_TRG_Male2FatherSon': FAILED.
-> false : Boolean
Instances of trg_Male violating the invariant:
-> Set{@Male_13,@Male_14,@Male_17,@Male_18,@Male_19} : Set(trg_Male)
checked 6 invariants in 0.030s, 1 failure.
```

A 'Check' button is highlighted with an orange border at the bottom of the input section.

http://atenea.lcc.uma.es/index.php/Main_Page/Resources/Tracts

TractsTool

The screenshot shows the TractsTool application window with the 'T2M injector' tab selected. The interface is divided into two main sections: input fields on the left and a 'Result' pane on the right.

Input Fields (Left):

- Source metamodel (.ecore or URI):** C:\TractsTool_v5.0\org.tracts.tool\F2P\Families.ecore
- Target metamodel (.ecore or URI):** C:\TractsTool_v5.0\org.tracts.tool\F2P\Persons.ecore
- Tracts file:** tsTool_v5.0\org.tracts.tool\F2P\FamiliesToPersons.ocl
- ASSL or src model file (.xmi or .ecore):** C:\TractsTool_v5.0\org.tracts.tool\F2P\familyModel.xmi
- Signature of the invocation to ASSL file:** (Empty text box)
- ATL transfo (.atl) or trg model file (.xmi or .ecore):** tsTool_v5.0\org.tracts.tool\F2P\FamiliesToPersons.atl
- Temporal folder:** C:\TractsTool_v5.0\org.tracts.tool\F2P\temp

Result (Right):

```
checking structure...
checking invariants...
checking invariant (1) `src_Family::SRC_TRG_FatherSon2Male': OK
checking invariant (2) `src_Family::SRC_TRG_Female2MotherDaughter': OK
checking invariant (3) `src_Family::SRC_TRG_MemberSize_EQ_PersonSize': OK
checking invariant (4) `src_Family::SRC_TRG_MotherDaughter2Female': OK
checking invariant (5) `src_Family::SRC_TRG_MotherDaughter2Female2': OK
checking invariant (6) `trg_Male::SRC_TRG_Male2FatherSon': FAILED.
-> false : Boolean
Instances of trg_Male violating the invariant:
-> Set{@Male_13,@Male_14,@Male_17,@Male_18,@Male_19} Set(trg_Male)
checked 6 invariants in 0.030s, 1 failure.
```

A red box highlights the text: `Instances of trg_Male violating the invariant: -> Set{@Male_13,@Male_14,@Male_17,@Male_18,@Male_19} Set(trg_Male)`. A red arrow points from the 'FAILED' status in the invariant list to this box. A yellow box highlights the 'Check' button at the bottom of the input section.

http://atenea.lcc.uma.es/index.php/Main_Page/Resources/Tracts

```

context trg_Male inv SRC_TRG_Male2FatherSon:
trg_Male.allInstances->forAll(m|src_Family.allInstances->exists(fam |
fam.father.firstName.concat('').concat(fam.lastName)=m.name
or fam.sons->any(true).firstName.concat('').
concat(fam.lastName)=m.name))
    
```

For all trg_Male, it has to exists (at least) a father or a son whose first name concatenated with '-' and with his family name is like the name of the male

The screenshot shows the TractsTool interface. On the left, there are several input fields for configuration: 'Tracts file' (C:\TractsTool_v5.0\org.tracts.tool\F2P\Persons.ecore), 'ASL or src model file (.xmi or .ecore)' (C:\TractsTool_v5.0\org.tracts.tool\F2P\FamiliesToPersons.ocl), 'Signature of the invocation to ASL file:' (empty), 'ATL transfo (.atl) or trg model file (.xmi or .ecore)' (C:\TractsTool_v5.0\org.tracts.tool\F2P\FamiliesToPersons.atl), and 'Temporal folder' (C:\TractsTool_v5.0\org.tracts.tool\F2P\temp). A 'Check' button is highlighted with an orange box. On the right, the execution log shows the following output:

```

checking invariant (2) `src_Family::SRC_TRG_Female2MotherDaughter': OK.
checking invariant (3) `src_Family::SRC_TRG_MemberSize_EQ_PersonSize': OK.
checking invariant (4) `src_Family::SRC_TRG_MotherDaughter2Female': OK.
checking invariant (5) `src_Family::SRC_TRG_MotherDaughter2Female2': OK.
checking invariant (6) `trg_Male::SRC_TRG_Male2FatherSon': FAILED.
-> false : Boolean
Instances of trg_Male violating the invariant:
-> Set{@Male_13,@Male_14,@Male_17,@Male_18,@Male_19} Set(trg_Male)
checked 6 invariants in 0.030s, 1 failure.
    
```

An orange arrow points from the failed invariant line to the 'Instances of trg_Male violating the invariant' line. A red box highlights the set of instances, and a red arrow points from the 'FAILED' status to this box.

http://atenea.lcc.uma.es/index.php/Main_Page/Resources/Tracts

```

context trg_Male inv SRC_TRG_Male2FatherSon:
trg_Male.allInstances->forAll(m|src_Family.allInstances->exists(fam |
fam.father.firstName.concat('-').concat(fam.lastName)=m.name
or fam.sons->any(true).firstName.concat('-').
concat(fam.lastName)=m.name))
    
```

For all trg_Male, it has to exist (at least) a father or a son whose first name concatenated with '-' and with his family name is like the name of the male

checking invariant (2) `src_Family::SRC_TRG_Female2MotherDaughter': OK
 checking invariant (3) `src_Family::SRC_TRG_MemberSize_EQ_PersonSize': OK
 checking invariant (4) `src_Family::SRC_TRG_MotherDaughter2Female': OK
 checking invariant (5) `src_Family::SRC_TRG_MotherDaughter2Female2': OK
 checking invariant (6) `trg_Male::SRC_TRG_Male2FatherSon': **FAILED**.
 -> false : Boolean

Instances of trg_Male violating the invariant:
 -> Set{@Male_13,@Male_14,@Male_17,@Male_18,@Male_19} Set(trg_Male)

ed 6 invariants in 0.030s, 1 failure.

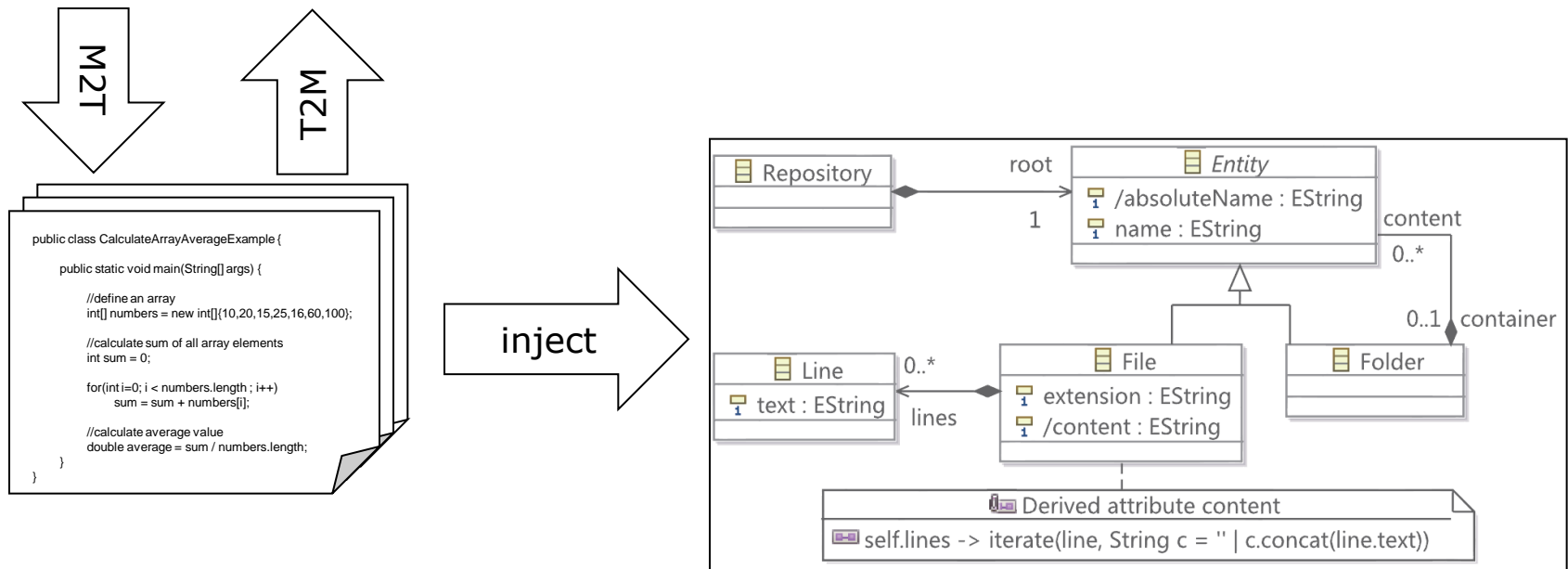
```

@Male_13.fullName := 'Jim March'
@Male_14.fullName := 'Peter Sailor'
@Female_15.fullName := 'Cindy March'
@Female_16.fullName := 'Jackie Sailor'
@Male_17.fullName := 'Brandon March'
@Male_18.fullName := 'David Sailor'
@Male_19.fullName := 'Dylan Sailor'
    
```

http://atenea.lcc.uma.es/index.php/Main_Page/Resources/Tracts

Dealing with M2T and T2M Transformations

- Testing problem is transformed to M2M testing problem
 - Text artefacts are represented as models
 - Then TractsTool can be simply reused



Next steps

- ❏ Generate ASSL code automatically
 - ❏ Metamodel Coverage/Transformation Coverage
- ❏ Enhance output of TractsTool
 - ❏ Text report → diagnostic model
- ❏ Allow transformation written in other languages to be tested



Thanks!

The Tracts Team:

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Antonio Vallecillo, Manuel Wimmer, and Javier Troya
Universidad de Málaga/Universität Bremen/Technische Universität Wien

The TractsTool:

http://atenea.lcc.uma.es/index.php/Main_Page/Resources/Tracts

More information on Tracts:

- Loli Burgueño, Manuel Wimmer, Antonio Vallecillo. "Towards Tracking Guilty Transformation Rules". In AMT@MODELS 2012: 27-32
- Antonio Vallecillo, Martin Gogolla, Loli Burgueño, Manuel Wimmer, Lars Hamann: Formal Specification and Testing of Model Transformations. In SFM 2012: 399-437
- Antonio Vallecillo, Martin Gogolla: Typing Model Transformations Using Tracts. In ICMT 2012: 56-71
- Martin Gogolla, Antonio Vallecillo: *Tractable* Model Transformation Testing. In ECMFA 2011: 221-235

Acknowledgements:

This work has been supported by Universidad de Málaga, Campus de Excelencia Internacional Andalucía Tech