Towards Systematic Mutations for and with ATL Model Transformations*

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Abstract. This abstract summarizes the content of this paper in about 70 to 150 words. ...

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1 Introduction

The broader goal of this work is to create an introduction to a specific field of software testing. Software testing is a process, or a series processes engineered to check if a program does what it is designed to do and that id does not do anything unintended. [**?**] Model based testing (MBT) is a variant of testing. Test cases are not written by the programmer directly. The programmer creates a model of the requirements and in a second step the test cases are generated on base of the model. [**?**]

Mutation testing is a fault-based testing technique. It applys changes to the input and creates a mutant. A mutant represents a faulty program. In the best case these changes, which are applied by the mutator, represent mistakes a programmer would make. [**?**]

The basic idea is of mutation testing is not to test the resulting software itself but the test cases. Good test cases should be able to identify mutants. Identifying means recognizing differing results of the original system under test (SUT) or mutants. [**?**]

The process of mutation testing consists of these components:

- *Test data* as input for the original programm P and its mutants.
- The original program P
- The *mutants* of P.
- An *oracle* which is able to decides if results differ and which is therefore able to identify mutants.

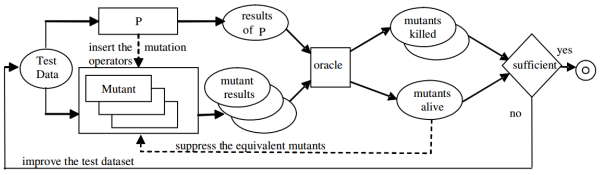

Fig. 1. The mutation testing workflow contains a feedback loop. [**?**]

The goal of the process1 is to *kill* or identify faulty versions of P. If a mutant outputs the same data as the P for the same input data it's called *equivalent*. In this case this mutant has to removed from the set of mutants under test.

The last step is to assess how good the tests are and check if they should be improved. Assume KM as the set of the killed mutants, M is the set of all mutants and EM is the set of all identified, equivalent mutants. Then the mutation score MS is calculated like this: [**?**]

$$MS = \frac{|KM|}{|M| - |EM|} \tag{1}$$

If this value is to small the tests have to be improved.

The success of this method depends on the set of mutants used in the process. Manual creation of mutants is a tedious and time consuming task. Therefore a quick, reliable and efficent creation of mutants is proposed in [**?**].

Troya et. al. build upon ATL and higher order transformations (HOT) to create transformations to automatically generate mutants.

This report show what additional transformation have been developed and what their goal is. The scope of this work is only on the mutation generation in the whole process.

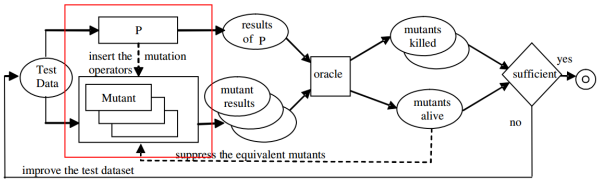

Fig. 2. The mutation testing workflow contains a feedback loop. [**?**]

2 General

Model transformations play an important role in the Model Driven Engineering (MDE) approach. Developing model transformation definitions is expected to become a common task in model driven software development. [**?**] In this part of the paper we want to explain the basics of the requirements we needed for Mutations for and with ATL Model Transformations.

2.1 Model transformation in MDE

Model transformation is an important technique in software development, espacially in Model-Driven Software Development (MDSD) and Model-Driven Software Development (MDA). There exists different types of model transformations like Model-To-Model Transformation and Model-To-Text Transformation.

2.2 ATL

ATL is a model transformation language containing a mixture of declarative and imperative constructs. ATL is applied in the context of the transformation pattern shown in . In this pattern a source model Ma is transformed into a target model Mb according to a transformation definition mma2mmb.atl written in the ATL language. The transformation definition is a model conforming to the ATL

metamodel. All metamodels conform to the MOF. ATL is a hybrid transformation language. It contains a mixture of declarative and imperative constructs. We encourage a declarative style of specifying transformations. The declarative style of transformation specification has a number of advantages. It is usually based on specifying relations between source and target patterns and thus tends to be closer to the way the developers intuitively perceive a transformation. This style stresses on encoding these relations and hides the details related to selection of source elements, rule triggering and ordering, dealing with traceability, etc. Therefore, it can hide complex transformation algorithms behind a simple syntax. [?]

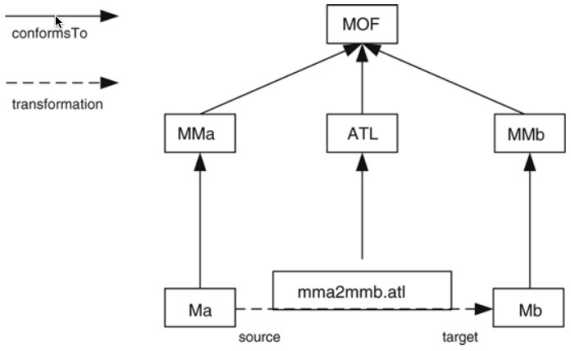

Fig. 3. Overview of the ATL transformational approach

[?]
[?]
[?]

In the following you can see a short example of a ATL transformation:

```
//Start Program
module Entities2Forms;
create OUT : Forms from IN : Forms;

rule EntityModel2FormModel {
from
em : Forms!EntityModel
to
fm : Forms!FormModel (
)
}
//End Program
```

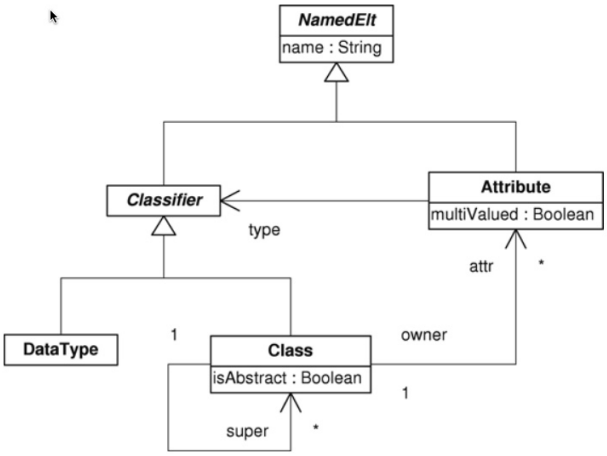

Fig. 4. Class metamodel

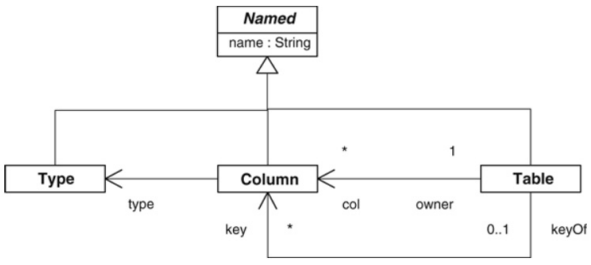

Fig. 5. Relational metamodel

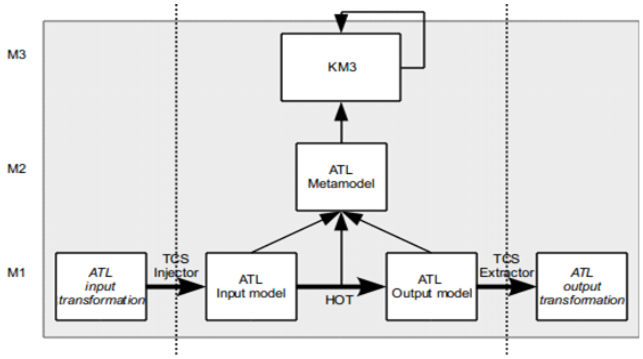

Fig. 6. Sample schema of a HOT for transformation modification in ATL

This ATL file shows a tranformation Entities2Form. The source model is the 'IN' model and the target model is 'OUT'. The rule mapped the elements EntityModel to FormModel.

2.3 High Order Transformations

High Order Transformations are defined in some special languages of model transformations. That means that the model transformation is itself a model. The input and output models are also themselves transformation models.

2.4 Mutations in Model Transformations

[?]

3 Implementation

3.1 Transformations

Binding Addition
Implementation
Discussion
Deletion
Implementation
Discussion
Change
Implementation
Discussion

Out Pattern Element Addition
Implementation
Discussion
Class change
Implementation
Discussion

In Pattern Element Deletion
Implementation
Discussion
Class change
Implementation
Discussion
Explain what we did and why.

3.2 Related transformation

Explain what other transformations would make sense.

4 Conclusion

5 Bibliographic Issues

5.1 Literature Search

Information on online libraries and literature search, e.g., interesting magazines, journals, conferences, and organizations may be found at `http://www.big.tuwien.ac.at/teaching/info.html`.

5.2 BibTeX

BibTeX should be used for referencing.

The LaTeX source document of this pdf document provides you with different samples for references to journals [**?**], conference papers [**?**], books [**?**], book chapters [**?**], electronic standards [**?**], dissertations [**?**], masters' theses [**?**], and web sites [**?**]. The respective BibTeX entries may be found in the file `references.bib`. For administration of the BibTeX references we recommend `http://www.citeulike.org` or JabRef for offline administration, respectively.

References

1. Business Informatics Group. http://www.big.tuwien.ac.at. Accessed: 2010-11-09.
2. Frédéric Jouault, Freddy Allilaire, J. B., and Kurtev, I. Atl: A model transformation tool. *Software Engineering Group 37*, 5 (Aug 2007), 31–39.

3. Hitz, M., Kappel, G., Kapsammer, E., and Retschitzegger, W. *UML @ Work, Objektorientierte Modellierung mit UML 2*, 3. ed. dpunkt.verlag, 2005 (in German).
4. Huemer, C., Liegl, P., Schuster, R., and Zapletal, M. B2B Services: Worksheet-Driven Development of Modeling Artifacts and Code. *Computer Journal 52*, 2 (2009), 28–67.
5. Jia, Y., and Harman, M. An analysis and survey of the development of mutation testing. *Software Engineering, IEEE Transactions on 37*, 5 (Sept 2011), 649–678.
6. Jordi Cabot. http://modeling-languages.com/introducing-higher-order-transformations-hots/. Accessed: 2015-04-15.
7. Langer, P. Konflikterkennung in der Modellversionierung. Master's thesis, Vienna University of Technology, 2009.
8. Mottu, J.-M., Baudry, B., and Le Traon, Y. Mutation analysis testing for model transformations. In *Proceedings of the Second European Conference on Model Driven Architecture: Foundations and Applications* (Berlin, Heidelberg, 2006), ECMDA-FA'06, Springer-Verlag, pp. 376–390.
9. Myers, G. J., and Sandler, C. *The Art of Software Testing.* John Wiley & Sons, 2004.
10. OASIS. *Business Process Execution Language 2.0 (WS-BPEL 2.0)*, 2007.
11. Schauerhuber, A., Wimmer, M., Schwinger, W., Kapsammer, E., and Retschitzegger, W. Aspect-Oriented Modeling of Ubiquitous Web Applications: The aspectWebML Approach. In *Proceedings of the 14th Annual IEEE International Conference and Workshops on the Engineering of Computer-Based Systems (ECBS '07), March 26-29, Tucson, Arizona, USA* (2007), IEEE CS Press, pp. 569–576.
12. Schwinger, W., and Koch, N. Modeling Web Applications. In *Web Engineering*, G. Kappel, B. Pröll, S. Reich, and W. Retschitzegger, Eds. John Wiley & Sons, Ltd, 2006, pp. 39–64.
13. Troya, J., Bergmayr, A., Burgueo, L., and Wimmer, M. Towards systematic mutations for and with atl. In *Proc. of the Eighth IEEE International Conference on Software Testing, Verification and Validation Workshops (ICSTW); 10th International Workshop on Mutation Analysis (Mutation 2015)* (2015).
14. Utting, M., Pretschner, A., and Legeard, B. A taxonomy of model-based testing approaches. *Softw. Test. Verif. Reliab. 22*, 5 (Aug. 2012), 297–312.
15. Wimmer, M. *From Mining to Mapping and Roundtrip Transformations - A Systematic Approach to Model-based Tool Integration.* PhD thesis, Vienna University of Technology, 2008.