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„Co-Evolution of Metamodels and Model Transformations“

Abstract

With the continual increase in size and complexity of modern software systems, the evolution of software remains one of the big challenges of software engineering. Model Driven Engineering (MDE) is one approach to meet this challenge - by breaking down the description of software systems under development into manageable abstractions, each embodied by a suitable kind of artefact. Kinds of artefacts are models and metamodels, along with model transformations, (modelling) languages, generators and others. Yet the benefits expected from MDE can only be fully realised when the complexity of the MDE artefacts and their relationships remain manageable themselves.

The challenge addressed in this context by this thesis is the co-evolution of metamodels and model transformations; expressed as transformation descriptions in common, dedicated transformation languages. Transformations are used to produce output models conforming to a metamodel based on input models conforming to another (or the same) metamodel and are expressed in terms of the metamodels used. This enforces a tight coupling between metamodels and transformation descriptions. In consequence, any change made to one or more metamodel potentially invalidates existing transformations so that every change requires the validation and adaptation of all dependent transformations. This can lead to an exceeding amount of effort necessary to keep metamodels and transformations consistent as the number of transformations and metamodels increase.

This work presents an operator-based, stepwise approach to support software architects in the co-evolution of metamodels and transformations. To this end we propose a set of operators which, when applied to metamodels, perform an evolution step on the metamodel. The impacts of such a change in the form of an operator applied to a metamodel can be predicted for transformations that depend on the metamodel. The approach further allows the resolution of the impacts to restore consistency, either automatically or with minimal human input - depending on the type of change and the kind and complexity of the transformation. In the worst case, the use of operators at least indicates potentially invalid transformation parts that need further validation to fulfil their original intended purpose. Overall the approach reduces the effort needed for co-evolution.

The approach is implemented and integrated into MDE tooling commonly used for modelling and transformation creation to demonstrate its feasibility. The operators are formalised on the basis of the Essential MOF and the impact resolution is provided for the ATLAS Transformation Language.