A Precedence-Driven Approach for Concurrent Model Synchronization Scenarios using Triple Graph Grammars

Lars Fritsche[1], Jens Kosiol[2], Adrian Möller[3], Andy Schürr[4], Gabriele Taentzer[5]

Abstract: We summarize our paper *A Precedence-Driven Approach for Concurrent Model Synchronization Scenarios using Triple Graph Grammars* that has been published in the proceedings of the *13th ACM SIGPLAN International Conference on Software Language Engineering* (SLE 2020).

Keywords: bidirectional transformation; concurrent model synchronization; triple graph grammars

1 Summary

Model-driven engineering has proven to be an effective means to tackle the challenges that accompany the development of increasingly complex modern software systems. Often more than one model is needed to describe the developed system from different but overlapping perspectives. Keeping these models in a consistent state is a challenging task, often called *model synchronization*. Model synchronization becomes especially challenging when correlated models are changed concurrently. In such cases, not all changes can always be propagated between models as some may contradict each other and thus, are in conflict. This is the case, e. g., when a change in one model leads to the deletion of elements in the other whose existence is the prerequisite for changes performed in that second model. For a modern concurrent synchronization approach, it is therefore of paramount importance to identify synchronization conflicts reliably and give modelers the ability to orchestrate model synchronization processes for guiding the process in accordance with their goals.

Some approaches to concurrent synchronization provide solely one hard-wired solution of a conflict-detection and -resolution strategy (from a universe of many different options), others come without any formal guarantees for their synchronization results or have an exponential runtime behavior w.r.t. the size of the processed models. In [Fr20], we develop a framework that simplifies the implementation (orchestration of a family) of concurrent synchronization algorithms with the following properties:

- These algorithms are derived from a declarative rule-based formal specification of a model consistency relation in the form of so-called Triple Graph Grammars (TGGs).

[1] Technical University Darmstadt, Darmstadt, Germany lars.fritsche@es.tu-darmstadt.de
[2] Philipps-Universität Marburg, Marburg, Germany kosiolje@mathematik.uni-marburg.de
[3] Technical University Darmstadt, Darmstadt, Germany adrian.moeller@stud.tu-darmstadt.de
[4] Technical University Darmstadt, Darmstadt, Germany andy.schuerr@es.tu-darmstadt.de
[5] Philipps-Universität Marburg, Marburg, Germany taentzer@mathematik.uni-marburg.de

- They come with a number of predefined but extensible strategies for conflict detection as well as consistency restoration.
- Formal properties can be shown using state-of-the-art category-theory- and graph-transformation-based proof techniques (e. g., [Fr21; He15; OPN20]).
- We provide a reference implementation of our framework based on the state-of-the-art graph transformation tool *eMoflon*. A first evaluation shows that in our approach, the runtime of the synchronization algorithm depends polynomially on the size of processed model changes and not on the size of the whole models. This is achieved by limiting the effects of model updates to causally dependent areas in the regarded models and relying on incremental graph pattern matching techniques.

2 Data Availability

In the ACM Digital Library, we provide an artifact that contains the evaluation of our paper in the form of a virtual machine (https://dl.acm.org/do/10.1145/3410252/full/). An accompanying step-by-step guide explains how to configure the evaluation and how to access our source code.

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