Integrated Simulation of Domain-Specific Modeling Languages with Petri Net-based Transformational Semantics

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Abstract: The development of domain specific models requires appropriate tool support for modeling and execution. Meta-modeling facilitates solutions for the generation of modeling tools from abstract language specifications. The RMT approach (RENEW Meta-Modeling and Transformation) applies transformational semantics using Petri net formalisms as target languages in order to produce quick results for the development of modeling techniques. The problem with transformational approaches is that the inspection of the system during execution is not possible in the original representation. We present a concept for providing simulation feedback for domain specific modeling languages (DSML) that are developed with the RMT approach on the basis of meta-models and transformational semantics using Petri nets. Details of the application of this new approach are illustrated by some well-known constructs of the Business Process Model and Notation (BPMN). The results summarized in this extended abstract have been published in [Mo19].

Keywords: Meta-Modeling; Petri Nets; Reference Nets; Simulation; Graphical Feedback

1 Challenge of DSMLs: Animation and Simulation

As Meta-Modeling is used to provide new domain-specific modeling languages (DSML) several tools provide tool support to build corresponding models. Bryant et al. identified "the mapping of execution results (e.g., error messages, debugging traces) back into the DSML in a meaningful manner, such that the domain expert using the modeling language understands the result" [Br11, p. 228] as one of the challenges for the translation semantics approach. Concerning the user experience, meaningful visual representation of the domain concepts is vital for the communication between different stakeholders, especially for the domain experts that are often non-software engineers [Ab17, p. 233]. The representation of DSML in execution is still considered a challenge in tool generation in general [MC18, p. 196].

2 The RMT-Approach

As solution we extend the RENEW Meta-Modeling and Transformation (RMT) framework with a direct simulation of the DSML's original representation and discuss the integration of the approach. The presented concept for simulation visualization is based on the highlighting

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of model constructs as graphical feedback. This is achieved by reflecting simulation events of the underlying executed Petri nets (target language) into the DSML (source language). As a special dialect of Petri nets we use reference nets (see [Ku02]) which can be executed by our tool RENEW. Several types of mappings are evaluated regarding their expressiveness and features for modeling. A major challenge for the provision of direct simulation support is the integration into model-driven approaches in the sense that the DSML developer can specify the desired representation of the executed models in a model-driven fashion. The concept presented includes tools that enable DSML developers to create the necessary artifacts and configurations to manage this task. We describe the current implementation that processes these artifacts and configurations to initialize a simulation of the DSML model with graphical feedback. Based on these implementations we discuss multiple alternatives to provide support for DSML developers to specify the desired representation of the executed models in the RMT approach. As a part of our contribution, a generic compiler is implemented in RENEW. This is used in the processing of artifacts and configurations. On this basis, the generated technique may be executed within RENEW's simulation engine in its original representation. The applicability is demonstrated by providing a solution of simulation / animation for a selected subset of BPMN concepts via our approach.

Based on our concept for providing simulation feedback for DSML that are developed with the RMT approach on the basis of meta-models and transformational semantics using Petri nets we plan to extend the transformation and variations of the target language in the direction of traditional Petri net formalisms for which analysis can be integrated into the RMT-approach.

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