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GUEST EDITORIAL

Guest editorial for the special section on MODELS 2020

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1 Introduction

The MODELS conference series is the premier venue for model-based software and systems engineering covering all aspects of modeling, from languages and methods to tools and applications. MODELS 2020 took place online (originally in Montreal, Canada), from September 16 to October 23, 2020 as the ACM/IEEE 23rd International Conference on Model Driven Engineering Languages and Systems. A total of 127 papers were submitted to the conference. The Foundations track of MODELS 2020 received 106 submissions of which 26 were accepted, while the Practice and Innovation track received 21 submissions of which 9 were accepted. Together, both tracks had an acceptance rate of 27%.

It has become a much valued tradition that authors of the best papers at each MODELS conference edition are invited to submit revised and extended versions of their papers for publication in a special section in SoSyM. The selection of these papers is based on input from the Program Committee and on the reception of the papers at the conference.

This special section presents the nine articles that resulted from this invitation and review process. Each article was subject to the full SoSyM review cycle and authors received anonymous feedback in two rounds of reviewing from three reviewers who are experts in the field. As a result, each article has been thoroughly revised and substantially extended compared to its conference version.

2 Selected papers

We classify the nine papers included in this special section into two categories, corresponding to the two tracks of the conference: (1) foundations for model-driven engineering, and (2) domain and application-specific Model-Based software and system Engineering (MBE).

The six papers included in the first category provide insights on mechanisms and tools for model search, machine learning methods for model repair, synthetic model generation, incremental execution of temporal graph queries, model transformation specification using theorem provers, and methods for metamodel/model co-evolution. The three papers included in the category of domain and application specific model-based and system engineering describe solutions crossing various domains and applications: process modeling, fabrication machines and Internet-of-Things. Altogether, they are representative examples of the diversity, depth, and maturity of the current research in model-based software and systems engineering. A summary of each paper is described below.

2.1 Foundations for model-driven engineering

The paper *An efficient and scalable search engine for models* by José Antonio López and Jesús Sánchez Cuadrado presents MAR, a search engine for models. It features a crawler, analysis, and indexer. Queries can be formulated using keywords or examples. The results show that MAR is an efficient and precise search engine that is unique in the MDE ecosystem.

The paper *PARMOREL: a framework for customizable model repair* by Angela Barriga, Rogardt Heldal, Adrian Rutle, and Ludovico Iovino presents a customizable and extensible model repair framework called PARMOREL, which enables users to deal with different issues in different types of models. The framework leverages reinforcement learning to automatically find the best sequence of actions for repairing a model according to user preferences. Specifically, the paper describes the modular architecture of PARMOREL and demonstrates the extensibility of its modules through a series of implementations to deal with inter-model consistencies in UML models.

The paper *Automated generation of consistent models using qualitative abstractions and exploration strategies* by Aren Babikian,Oszkár Semeráth, Anqi Li, Kristóf Marussy,

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and Dániel Varró presents a model generation technique that can automatically derive consistent graph models that satisfy both structural and attribute constraints. The technique supports bidirectional interaction between a structural solver and two numeric solvers to handle int or double constraints. The paper also proposes a technique to define custom explorations for model generation to exploit domain-specific hints. The authors evaluated the scalability and diversity of their approach in four complex case studies.

The paper *Incremental execution of temporal graph queries over runtime models with history and its applications* by Lucas Sakizloglou, Sona Ghahremani, Matthias Barkowsky, and Holger Giese presents an approach to query runtime models (i.e., models that are used at execution time to monitor or adapt the software dynamically) with history. The paper introduces temporal logic operators in queries, and presents a mechanism for their incremental execution. The approach is implemented atop the Eclipse Modeling Framework in the InTempo tool, and was evaluated over two case studies in the smart healthcare and social networks domains.

The paper *Deep specification and proof preservation for the CoqTL transformation language* by Zheng Cheng and Massimo Tisi presents techniques to ensure that proofs about model transformations are preserved whenever the transformation engine evolves. The contribution is in the context of CoqTL, a transformation language based on the Coq theorem prover, which allows users to define model transformations, theorems on their behavior and machine-checked proofs of these theorems in Coq. The approach is based on an explicit deep specification of the transformation engine, and the authors present an evolution that introduces trace links in the specification, showing which user proofs are preserved through specification evolutions.

The paper *Semi-automated metamodel/model co-evolution: a multi-level interactive approach* by Wael Kessentini and Vahid Alizadeh deals with the problem of fixing models after their metamodels have evolved, which is a time-consuming activity if performed manually. Hence, the authors propose an interactive approach enabling designers to select their fixing preferences based on objectives like minimizing the number of remaining errors, the deviation with the initial model and the number of changes. The approach combines multi-objective search with clustering, where designer feedback is used to guide the search for the next iterations. The approach was evaluated on case studies and compared to existing fully automated and interactive co-evolution techniques.

2.2 Domain and application specific MBE

The paper *Live process modeling with the BPMN Sketch Miner* by Ana Ivanchik, Souhaila Serbout, and Cesare Pautasso describes an online tool for quickly creating Business Process Model and Notation (BPMN) models in real time based on notes taken in constrained natural language. The tool can be used in two contexts: (1) to facilitate communication and knowledge sharing between domain experts and business analysts when performing requirements gathering and (2) to facilitate learning BPMN and process modeling in classrooms. The main feature of BPMN Sketch Miner is its textual domain-specific language for entering a textual description of a process. The tool then transforms the textual description into a diagram (which is compliant with the BPMN visual syntax) while the user is typing/entering the information. The BPMN Sketch Miner tool is available at http://bit.ly/PD-2021-May-06.

The paper *Fabricatable Axis: an approach for modelling customized fabrication machines* by Frikk Fossdal, Rogardt Heldal, Jens Dyvik, and Adrian Rutle aims to develop a high-level modeling approach for machine builders with limited knowledge of machine design to implement and customize functional instances of computer controlled machines (e.g., 3D printers, laser cutters). In particular, the authors propose The Farbicatable Axis, a model that enables users to create customized linear actuators. The model takes high-level input parameters, such as length and gearing-parameters, and outputs a CAD model of a linear motion axis consisting of fabricatable parts. The authors then present how instances of the Fabricatable Axis can be combined and used to design and implement fabricatable machines.

The paper *Model-based fleet deployment in the IoT-edge-cloud continuum* by Hui Song, Rustem Dautov, Nicolas Ferry, Arnor Solberg, and Franck Fleurey describes an approach that leverages model-based engineering and constraint-solving techniques to automatically deploy multiple software variants on many edge computing devices in an accurate and efficient way. The approach was implemented, integrated into a DevOps toolchain, and tested in a real-world environment for a healthcare company, using state-of-the-art Microsoft technologies (Azure Internet of Things Edge and Z3 solver). The results of the industrial case study show that the approach is able to generate correct deployment assignments, automate key DevOps activities, and increase development productivity. While the approach is specific to the deployment problem faced by the health-care company, the authors are generalizing it to be used across multiple edge application providers.

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Eugene Syriani is an Associate Professor at the department of computer science and operations research at University of Montreal. He received his Ph.D. in Computer Science in 2011 from McGill University. His main research interests fall in software design based on the model-driven engineering approach, the engineering of domain-specific languages, model transformation and code generation, simulation-based design, collaborative modeling, and user experience. He has been general co-chair of the MODELS conference in 2020 and 2022, he has edited several special issues of several journals, including SoSyM and JOT, and has served on the program, steering and board committee of many MDE and simulation conferences.