# Preface to the JOT special issue on the 21st European Conference on Modelling Foundations and Applications (ECMFA 2025)

Robbert Jongeling\* and Sébastien Mosser<sup>†</sup> \*Mälardalen University, Västerås, Sweden <sup>†</sup>McSCert, McMaster University, Hamilton, Ontario, Canada

**ABSTRACT** In this preface, we present an overview of the topics and scope of the European Conference on Modelling Foundations and Applications (ECMFA) and describe the editorial and reviewing process for its 21st edition (ECMFA 2025). We also provide an overview of the papers selected for publication and presentation, and details about the keynote talks by Anne Koziolek and Matthias Volk. Finally, we acknowledge the work of the ECMFA committees.

KEYWORDS Model-Based Engineering, Modelling Foundations, Modelling Applications.

# 1. Introduction

The European Conference on Modelling Foundations and Applications (ECMFA) is the premier European forum dedicated to advancing the state of knowledge and fostering the application of all aspects of *Model-Based Engineering* (MBE) and related approaches. ECMFA 2025 was held in Koblenz (Germany) on June 10th and June 11th, as part of STAF 2025 (Software Technologies: Applications and Foundations).

Its focus is on engaging the key figures of research and industry in a dialog that will result in stronger and more effective practical application of MBE, hence producing more reliable software based on state-of-the-art research results. In the technical track, we invite high-quality submissions of technical research papers describing original and unpublished results related to MBE.

This preface provides an overview of the conference reviewing process, its accepted papers, and the two invited keynote talks.

#### JOT reference format:

# 2. Submission and review process

For its  $21^{st}$  edition, ECMFA solicited two kinds of research contributions from the modelling community:

- Foundation Papers, dealing with modelling foundations, such as metamodeling, model transformations, model validation, verification and testing, model engineering methods and tools, and related aspects.
- Application Papers, dealing with the application of modelling techniques, including experience reports on the use of MBE methods and tools, industrial case studies, or successful applications of MBE practices in industry or in public administration, with significant modelling lessons learned.

## 2.1. Topic of Interests

The topics of interest for ECMFA 2025 included, but were not limited to the following:

- Foundations of MBE, including model transformations, domain-specific languages, verification and validation approaches, etc.
- Novel paradigms, formalisms, applications, approaches, frameworks, or processes for model-based engineering such as low-code/no-code development, digital twins, etc.
- Interplay between MBE with and for AI-based systems.

Robbert Jongeling and Sébastien Mosser. *Preface to the JOT special issue on the 21st European Conference on Modelling Foundations and Applications (ECMFA 2025).* Journal of Object Technology. Vol. 24, No. 2, 2025. Licensed under Attribution 4.0 International (CC BY 4.0) http://dx.doi.org/10.5381/jot.2025.24.2.e1

- Application of MBE methods, tools, and techniques to specific domains, e.g., automotive, aerospace, cyber-physical systems, robotics, Artificial Intelligence or IoT.
- Successful use of MBE in connection with other disciplines and approaches, such as Artificial Intelligence, DevOps, Open Source, or Safety Assurance.
- Educational aspects of MBE.
- Tools and initiatives for the successful adoption of MBE in industry.

#### 2.2. Review Criteria and process

At least three members of the Program Committee have peerreviewed all submissions, assessing them for novelty, significance, technical quality, rigour, and suitability for the conference.

Contributions could be submitted to any of the two submission rounds in December 2024 and February 2025, respectively. In both rounds, each submitted paper could be recommended by the Program Committee to be accepted as is, accepted with minor revisions, to undergo major revisions or to be rejected. Papers accepted at any of the two rounds with major or minor revisions were given time to perform the revisions and resubmit. The same reviewers assessed how well the authors had addressed the revision requests and whether the final paper maintained or improved the level of contribution of the original submission. Revisions that significantly lessened the contribution of the work or that failed to address the reviewers' original concerns adequately resulted in the paper's rejection. The program chairs also used their right to desk reject a single paper that was not in the scope of the conference.

We used EasyChair to support the reviewing process. When exported to a single document, the reviews and comments made by the program committee members during the reviewing period represent 107 pages of discussions, for a total of 62, 058 words (representing two-thirds of the length of *The Hobbit* by J. R. R. Tolkien)

# 3. Accepted Papers

Overall, this edition of ECMFA attracted more contributors than the previous editions. Acceptance statistics can be found in TAB. 1. The program was organized around five major themes that emerged from the submissions<sup>1</sup>. Papers were presented in person during the conference, where authors had 20 minutes to present their contribution, followed by 10 minutes of Q&A from the audience.

## 3.1. Model Management

- A Model Management Framework for Next-Generation Web-based Modeling Tools by David Jaeger, Adam Lencses, Martin Fleck, Philip Langer and Dominik Bork describes a Typescript-only approach for generating Langium-based modeling language grammars and model management servers. Using this approach, developers can build next-generation web-based modelling tools with a

#### Table 1 Acceptance ratios

Straight rejection	23 %
Rejection after re-submission	23 %
Acceptance after major revisions	40 %
Acceptance after minor revisions	14 %
Straight acceptance	0 %

homogeneous technology stack, which can be executed as cloud applications or plain browser applications without any backend, if needed.

- Towards Modeling Inconsistencies in Production Workflows — An Experience Report by Thomas Weber, Niklas D. Kuder, Thomas A. Völk, Jonas Schneider, Sebastian Weber and Anne Koziolek describes a method to model inconsistencies using specific event types within BPMN 2.0 diagrams, to enhance the use of these potentially inconsistent models. The approach was applied and evaluated in the manufacturing industry, identifying 13 types of inconsistencies.
- Variability Exploration for Decision Making: Supporting Domain Experts in Configuring Business Processes by Haitam El Hayani, Benoit Combemale, Olivier Barais and Steffen Zschaler describes a tool-supported method for discovering and visualizing the variability space captured within feature models. This method allows experts to explore and evaluate different options against predefined objectives. By representing the variability space in a format conducive to decision-making, this method helps identify key choices that impact overall business processes, assess the implications of each option, and explore alternative configurations.

## 3.2. Testing

- Dynamic Role-Based Access Control Scenarios for Smart Contracts: Graph Rewriting for Testing Domain-specific Models by Issam Al-Azzoni, Reiko Heckel and Zobia Erum describes a model-based framework for testing and analysis based on operational semantics for DSLs expressed through graph rewriting. It was applied to a DSL for multiparty role-based access control policies, which is defined as an extension of the *iContractML* 2.0 metamodel.
- Introducing automated testing to video game development via Behaviour-Driven Development by Michael Mulder and Petra van den Bos describes a development process for applying Behaviour-Driven Development (BDD) in game development. Then, it provides an integration of BDD tooling in Unity 3D, a major platform for game development, and a framework for identifying and categorizing game behaviours, to cater for modelling game behaviours in BDD scenarios.
- Online Model-Based Testing Reusing Multiple Design Models in an Industrial Setting by Mathijs Schuts, Jozef Hooman, Ivan Kurtev, Issam Tlili and Erik Oerle-

<sup>&</sup>lt;sup>1</sup> Part of this section is written using material provided by the authors in their abstracts.

mans describes how Component Modelling and Analysis (ComMA) models can be reused for online Model-Based Testing (MBT). An innovative feature of ComMA is its ability to construct a test application based on existing component and interface models, which enables reuse and avoids clones. This avoids well-known problems with MBT, such as the validation and maintenance of large test models.

#### 3.3. Digital twins and data analysis

- Behavioral analysis of a digital twin using logging and model learning by Raghavendran Gunasekaran, Boudewijn Haverkort and Loes Kruger describes a new approach that helps to overcome classical issues when developing a Digital Twin: un(der)specification and real-time changes due to synchronization. The approach is applied to an autonomous case study driving truck.
- Navigating the trace of executable domain specific languages through a trace domain query language by Hiba Ajabri, Jean-Marie Mottu, Christian Attiogbé and Pascal Berruet describes an approach that allows domain experts to write domain-specific queries using domain terminology, without relying on developers or requiring an in-depth understanding of trace structures. This mechanism makes trace navigation transparent to domain experts, freeing them from the need to understand trace structures and simplifying the data extraction process.
- Support for Model-Based Data Sovereignty Analysis by Sanjeev Sun Shakya, Qusai Ramadan, Julian Flake and Alexander Peikert describes three main contributions: (i) a mapping from requirements of International Data Spaces Reference Architecture Mode (IDS-RAM) and Dataspace Protocol specifications to model-based analysis checks of UMLsec and existing extensions, (ii) two data sovereigntyoriented checks as extensions to UMLsec, namely Usage Control and Transfer Process Protocol, and (iii) an applicability evaluation based on a case study of the European Health Data Space (EHDS).

#### 3.4. Low-code and user-friendly modelling

- A Metascience Study of the Low-Code Scientific Field by Mauro Dalle Lucca Tosi, Javier Luis Cánovas Izquierdo and Jordi Cabot describes a metascience study of Low-Code. This study follows a two-fold approach: (1) to analyze the composition and growth (e.g., size, diversity, venues, and topics) of the emerging Low-Code community; and (2) to explore how these aspects differ from those of the "classical" model-driven community.
- An internal DSL for graphical modeling tools based on GLSP by Georg Hinkel and Bodo Igler describes a language server infrastructure that separates the generic model processing from the details of the model synchronization for specific graphical modelling languages. The languagespecific details are specified via a newly developed internal DSL. A generic server-side component based on the .NET Modelling Framework performs the actual model synchronization.

- User Modeling in Model-Driven Engineering: A Systematic Literature Review by Aaron Conrardy, Jordi Cabot and Alfredo Capozucca describes a systematic literature review to analyze existing proposals for user modelling in MDE and identify their limitations. The results showcase that there is a lack of a unified and complete user modelling perspective.

## 3.5. Maintenance

- Methodical and Formally Verified Model-Driven Architecture Refactoring by Lars Fischer, Hendrik Kausch, Bernhard Rumpe, Max Stachon, Sebastian Stüber and Lucas Wollenhaupt describes how refactoring patterns based on syntactic transformations of pipeline architectures were translated into Isabelle, an interactive theorem prover. Isabelle is employed to verify refactoring steps performed on component-and-connector architectures transformed from SysMLv2 models, supporting their development in an iterative way.
- On the Use of GPT-4 in the Reverse Engineering of Class Diagrams by Victor Campanello, Shariq Shahbaz, Vladislav Indykov and Daniel Strüber describes the use of large language models, specifically GPT-4, in generating class diagrams from code to emulate human abstraction. It uses an experimental methodology in which we applied GPT-4 to a dataset of five substantial projects, comprising 4452 code elements and their expert-created abstraction to 338 model elements.
- Using MDE to support sustainable re-engineering by Kevin Lano, Shekoufeh Rahimi and Zishan Rahman describes how energy-use analysis and improvement can be carried out within a model-driven re-engineering (MDRE) process.

# 4. Keynote Talks

ECMFA 2025 held two keynote talks. The objective was to have inspiring talks given in an inclusive way, by providing a platform for junior and senior researchers to share their insights on important topics.

#### 4.1. Formal Modeling and Verification of Safety-Critical Systems – Mathias Volk

**Abstract** Safety-critical systems require rigorous analysis to guarantee their safe, reliable, and correct operation. In this talk, I will discuss the importance of formal modeling and model checking in the design and analysis of such systems. Our approach is based on probabilistic models, specifically Markov chains, to explicitly capture uncertainties, such as the probability of component failures. These models can then be analyzed using probabilistic model checking, enabling the evaluation of a wide range of quantitative metrics and supporting a variety of analysis techniques.

The talk will focus on (dynamic) fault trees, a prominent reliability model that describes how failures occur and propagate through a system. Despite their intuitive graphical representation, dynamic fault trees have intricate semantics that require careful formalization. We translate the fault trees into Markov chains to enable efficient and automated analysis via model checking. I will illustrate the benefits of this approach with an industrial case study on autonomous vehicles.

Finally, I will present ongoing research on automatically learning fault tree structures from failure data. By combining genetic algorithms with structural information, we aim to synthesize fault trees that are both accurate and concise - paving the way toward data-driven, model-based safety analysis.

**Biography** Matthias Volk is an Assistant Professor in the Formal System Analysis group at Eindhoven University of Technology (TU/e). His research goal is to improve the safety and reliability of complex, safety-critical systems using formal methods. In his research, Matthias Volk develops rigorous, automated techniques for modelling and analysing safety-critical systems, with a focus on probabilistic model checking. He is interested in providing optimised implementations in mature tools for use by other researchers, as well as applying the approaches in industrial collaborations.

Matthias Volk received his B.Sc. and M.Sc. degrees in Computer Science from RWTH Aachen University. He received his Ph.D. from RWTH Aachen University under the supervision of Joost-Pieter Katoen. He then worked as a postdoctoral researcher at the University of Twente. Since 2023, he is an assistant professor in the Formal System Analysis group at Eindhoven University of Technology.

#### 4.2. Modeling and LLMs in Continuous Software Engineering – Anne Koziolek

Abstract The notion of continuous software engineering extends practices like continuous integration to view the entire software development lifecycle as a continuous, interconnected flow of activities. At the same time, recent advances in large language models (LLMs) have revolutionized the way machines process natural language-language that plays a central role throughout software engineering, from requirements elicitation and design discussions to documentation. In this talk, I will outline a vision for the role of models in continuous software engineering, focusing particularly on their use in design activities. I will argue that models will remain central to software engineering, even in an era of AI-assisted development, and explore what future design assistants might look like. One key capability of such assistants will be the ability to establish and use trace links between artifacts. I will present recent results showing how LLMs, combined with heuristic techniques, can achieve high precision and recall in this task. Looking ahead, I will share our vision for how model-driven techniques can support more agile development of cyber-physical systems, and our ideas how LLMs can contribute to realizing the long-standing goal of model consistency. Finally, time permitting, I will also reflect on the use of LLMs in navigating software engineering literature and research data.

**Biography** Anne is a professor at Karlsruhe Institute of Technology (KIT), Germany. She received the Diplom degree in informatics from University of Oldenburg, Germany, in 2007 and the PhD degree in informatics from KIT in 2011. After

that, she was a Postdoc at the University of Zurich, Switzerland, before joining KIT as an assistant professor in 2013 and becoming a full professor in 2019. Anne is interested in conciliating model-based software engineering with development processes that have fast and agile feedback cycles and thus combine the benefits of both approaches. In particular, she is interested in tool support for systematic, yet low-cost model-based design space exploration to support making good design decisions. Here, she and her group explore two strands: (1) keeping architectural models consistent with code automatically and (2) using NLP to capture design discussions on e.g. whiteboards and in relating such information to (semi-)formal models and code. For her work, Anne received the 10-years most influential paper award from ICSA'21, ICPE'21 and ICPE'20 and distinguished reviewer awards from ASE'15, ECSA'22 and ICPE'23.

# 5. Committees

This edition of the conference was organized by two program co-chairs:

- Robbert Jongeling, Mälardalen University, Sweden
- Sébastien Mosser, McSCert, McMaster University, Canada

The Program Committee of ECMFA 2025 was composed of 24 international experts from both academia and industry. As part of a global effort towards diversity, equity, and inclusion, we invited members to represent genders and seniority in a balanced way. Compared to ECMFA 2024, the 2025 edition's PC is more balanced (almost tripling women's representation, from 12% to 38%) and reduced in size to avoid over-representation. It is worth noting that among the declined invitations to participate in the PC, 83% came from experts identifying as women. The complete PC was as follows:

- Shaukat Ali, Simula Research Laboratory & Oslo Metropolitan University, Norway
- Alessandra Bagnato, Softeam, France
- Mireille Blay-Fornarino, Université Côte d'Azur & CNRS (I3S), France
- Dominik Bork, TU Wien, Austria
- Erwan Bousse, Nantes Université, France
- Stéphanie Challita, University of Rennes & IRISA, France
- Federico Ciccozzi, Mälardalen University, Sweden
- Loek Cleophas, Eindhoven University of Technology, The Netherlands
- Davide Di Ruscio, University of L'Aquila, Italy
- Fiona Polack, University of Hull, United Kingdom
- Esther Guerra, Universidad Autónoma de Madrid, Spain
- Djamel Eddine Khelladi, University of Rennes & CNRS (IRISA), France
- Dimitris Kolovos, University of York, United Kingdom
- Nan Messe, University of Toulouse & CNRS (IRIT), France
- Judith Michael, University of Regensburg, Germany
- Richard Paige, McMaster University, Canada
- Alfonso Pierantonio, Università degli Studi dell'Aquila, Italy

- Bernhard Rumpe, RWTH Aachen University, Germany
- Maximilian Schiedermeier, Université du Québec à Montréal, Canada
- Bran Selic, Malina Software Corporation, Canada
- Perdita Stevens, University of Edinburgh, United Kingdom
- Gabriele Taentzer, Philipps-Universität Marburg, Germany
- Manuel Wimmer, JKU Linz, Austria
- Steffen Zschaler, King's College London, United Kingdom

Ten additional sub-reviewers helped with the papers during the reviewing process:

- Syed Juned Ali
- Muhammad Waseem Anwar
- Heraldo Borges
- Adrian Costin Marin
- Felipe de Azeredo Coutinho Xavier
- Lukas Sebastian Hofmann
- Malvina Latifaj
- Alexander Lauer
- Henrik Thillmann
- Sebastian Will

The ECMFA series is guided by the STAF steering committee. In addition, we would like to thank Ralf Lämmel, the STAF General Chair, and his team for hosting ECMFA 2025 in Koblenz.

# About the PC Chairs

**Robbert Jongeling** is associate senior lecturer (*biträdande lek-tor*) in the Industrial Software Engineering group and the Automated Software language and Software engineering group at the department of Innovation, Design, and Engineering at Mälardalen University in Västerås, Sweden. His research interests are in the continuous model-based development and the challenges of consistency management across evolving models and other development artifacts. You can contact the author at robbert.jongeling@mdu.se or visit https://robbert.science.

Sébastien Mosser is Associate Professor of Software Engineering at McMaster University (Ontario, Canada) and co-Editor-in-Chief of the Journal of Object Technology (JOT). At McMaster, he is Associate Chair of the Department of *Computing and Software* (CAS) and Associate Director of McSCert (*McMaster Centre for Software Certification*). His research interests are related to software engineering, software composition, domainspecific languages and modelling at large. You can contact the editor at mossers@mcmaster.ca or visit https://mosser.github.io.