Leen Lambers
Sebastián Uchitel (Eds.)

Fundamental Approaches to Software Engineering

26th International Conference, FASE 2023
Held as Part of the European Joint Conferences
on Theory and Practice of Software, ETAPS 2023
Paris, France, April 22–27, 2023
Proceedings

ETAPS

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ETAPS Foreword

Welcome to the 26th ETAPS! ETAPS 2023 took place in Paris, the beautiful capital of France. ETAPS 2023 was the 26th instance of the European Joint Conferences on Theory and Practice of Software. ETAPS is an annual federated conference established in 1998, and consists of four conferences: ESOP, FASE, FoSSaCS, and TACAS. Each conference has its own Program Committee (PC) and its own Steering Committee (SC). The conferences cover various aspects of software systems, ranging from theoretical computer science to foundations of programming languages, analysis tools, and formal approaches to software engineering. Organising these conferences in a coherent, highly synchronized conference programme enables researchers to participate in an exciting event, having the possibility to meet many colleagues working in different directions in the field, and to easily attend talks of different conferences. On the weekend before the main conference, numerous satellite workshops took place that attracted many researchers from all over the globe.

ETAPS 2023 received 361 submissions in total, 124 of which were accepted, yielding an overall acceptance rate of 34.3%. I thank all the authors for their interest in ETAPS, all the reviewers for their reviewing efforts, the PC members for their contributions, and in particular the PC (co-)chairs for their hard work in running this entire intensive process. Last but not least, my congratulations to all authors of the accepted papers!

ETAPS 2023 featured the unifying invited speakers Véronique Cortier (CNRS, LORIA laboratory, France) and Thomas A. Henzinger (Institute of Science and Technology, Austria) and the conference-specific invited speakers Mooly Sagiv (Tel Aviv University, Israel) for ESOP and Sven Apel (Saarland University, Germany) for FASE. Invited tutorials were provided by Ana-Lucia Varbanescu (University of Twente and University of Amsterdam, The Netherlands) on heterogeneous computing and Joost-Pieter Katoen (RWTH Aachen, Germany and University of Twente, The Netherlands) on probabilistic programming.

As part of the programme we had the second edition of TOOLympics, an event to celebrate the achievements of the various competitions or comparative evaluations in the field of ETAPS.

ETAPS 2023 was organized jointly by Sorbonne Université and Université Sorbonne Paris Nord. Sorbonne Université (SU) is a multidisciplinary, research-intensive and worldclass academic institution. It was created in 2018 as the merge of two first-class research-intensive universities, UPMC (Université Pierre and Marie Curie) and Paris-Sorbonne. SU has three faculties: humanities, medicine, and 55,600 students (4,700 PhD students; 10,200 international students), 6,400 teachers, professor-researchers and 3,600 administrative and technical staff members. Université Sorbonne Paris Nord is one of the thirteen universities that succeeded the University of Paris in 1968. It is a major teaching and research center located in the north of Paris. It has five campuses, spread over the two departments of Seine-Saint-Denis and Val

d'Oise: Villetaneuse, Bobigny, Saint-Denis, the Plaine Saint-Denis and Argenteuil. The university has more than 25,000 students in different fields, such as health, medicine, languages, humanities, and science. The local organization team consisted of Fabrice Kordon (general co-chair), Laure Petrucci (general co-chair), Benedikt Bollig (workshops), Stefan Haar (workshops), Étienne André (proceedings and tutorials), Céline Ghibaudo (sponsoring), Denis Poitrenaud (web), Stefan Schwoon (web), Benoît Barbot (publicity), Nathalie Sznajder (publicity), Anne-Marie Reytier (communication), Hélène Pétridis (finance) and Véronique Criart (finance).

ETAPS 2023 is further supported by the following associations and societies: ETAPS e.V., EATCS (European Association for Theoretical Computer Science), EAPLS (European Association for Programming Languages and Systems), EASST (European Association of Software Science and Technology), Lip6 (Laboratoire d'Informatique de Paris 6), LIPN (Laboratoire d'informatique de Paris Nord), Sorbonne Université, Université Sorbonne Paris Nord, CNRS (Centre national de la recherche scientifique), CEA (Commissariat à l'énergie atomique et aux énergies alternatives), LMF (Laboratoire méthodes formelles), and Inria (Institut national de recherche en informatique et en automatique).

The ETAPS Steering Committee consists of an Executive Board, and representatives of the individual ETAPS conferences, as well as representatives of EATCS, EAPLS, and EASST. The Executive Board consists of Holger Hermanns (Saarbrücken), Marieke Huisman (Twente, chair), Jan Kofroň (Prague), Barbara König (Duisburg), Thomas Noll (Aachen), Caterina Urban (Inria), Jan Křetínský (Munich), and Lenore Zuck (Chicago).

Other members of the steering committee are: Dirk Beyer (Munich), Luís Caires (Lisboa), Ana Cavalcanti (York), Bernd Finkbeiner (Saarland), Reiko Heckel (Leicester), Joost-Pieter Katoen (Aachen and Twente), Naoki Kobayashi (Tokyo), Fabrice Kordon (Paris), Laura Kovács (Vienna), Orna Kupferman (Jerusalem), Leen Lambers (Cottbus), Tiziana Margaria (Limerick), Andrzej Murawski (Oxford), Laure Petrucci (Paris), Elizabeth Polgreen (Edinburgh), Peter Ryan (Luxembourg), Sriram Sankaranarayanan (Boulder), Don Sannella (Edinburgh), Natasha Sharygina (Lugano), Pawel Sobocinski (Tallinn), Sebastián Uchitel (London and Buenos Aires), Andrzej Wasowski (Copenhagen), Stephanie Weirich (Pennsylvania), Thomas Wies (New York), Anton Wijs (Eindhoven), and James Worrell (Oxford).

I would like to take this opportunity to thank all authors, keynote speakers, attendees, organizers of the satellite workshops, and Springer-Verlag GmbH for their support. I hope you all enjoyed ETAPS 2023.

Finally, a big thanks to Laure and Fabrice and their local organization team for all their enormous efforts to make ETAPS a fantastic event.

April 2023   Marieke Huisman
                                                                   ETAPS SC Chair
                                                              ETAPS e.V. President

Preface

This book contains the proceedings of FASE 2023, the 26th International Conference on Fundamental Approaches to Software Engineering, held in Paris, France, in April 2023, as part of the annual European Joint Conferences on Theory and Practice of Software (ETAPS 2023).

FASE is concerned with the foundations on which software engineering is built. We solicited four categories of papers, research, empirical, new ideas and emerging results, and tool demonstrations; all of which should make novel contributions to making software engineering a more mature and soundly-based discipline.

The contributions accepted for presentation at the conference were carefully selected by means of a thorough double-blind review process which included no less than 3 reviews per paper. We received 50 submissions, which after a reviewing period of nine weeks and intensive discussion resulted in 16 accepted papers, representing a 32% acceptance rate.

We also ran an artifact track where authors of accepted papers optionally submitted artifacts described in their papers for evaluation. 10 artifacts were submitted for evaluation, 8 of which were successfully evaluated.

In addition, FASE 2023 hosted the 5th International Competition on Software Testing (Test-Comp 2023), which is an annual comparative evaluation of automatic tools for test generation. A total of 13 tools participated this year, from seven countries. The tools were developed in academia and in industry. The submitted tools and the submitted system-description papers were reviewed by a separate program committee: the Test-Comp jury. Each tool and paper was assessed by at least three reviewers. These proceedings contain the competition report and one selected system description of a participating tool. Two sessions in the FASE program were reserved for the presentation of the results: the summary by the Test-Comp chair and of the participating tools by the developer teams in the first session, and the community meeting in the second session.

We thank the ETAPS 2023 general chair, Marieke Huisman, the ETAPS 2023 organizers, Fabrice Kordon and Laure Petrucci, as well as the FASE SC chair, Andrzej Wasowksi, for their support during the whole process. We thank our invited speaker, Sven Apel, for his keynote. We thank all the authors for their hard work and willingness to contribute. We thank all the Program Committee members, external reviewers, who invested time and effort in the selection process to ensure the scientific quality of the program. Last but not least, we thank the Test-Comp chair Dirk Beyer,

the artifact evaluation committee chairs, Marie-Christine Jakobs and Carlos Diego Nascimento Damasceno, and their evaluation committees.

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Brains on Code: Towards a Neuroscientific Foundation of Program Comprehension (Abstract of an Invited Talk)

Sven Apel

Saarland University, Saarland Informatics Campus

Abstract. Research on program comprehension has a fundamental limitation: program comprehension is a cognitive process that cannot be directly observed, which leaves considerable room for misinterpretation, uncertainty, and confounders. In the project Brains On Code, we are developing a neuroscientific foundation of program comprehension. Instead of merely observing whether there is a difference regarding program comprehension (e.g., between two programming methods), we aim at precisely and reliably determining the key factors that cause the difference. This is especially challenging as humans are the subjects of study, and inter-personal variance and other confounding factors obfuscate the results. The key idea of Brains On Code is to leverage established methods from cognitive neuroscience to obtain insights into the underlying processes and influential factors of program comprehension.

Brains On Code pursues a multimodal approach that integrates different neuro-physiological measures as well as a cognitive computational modeling approach to establish the theoretical foundation. This way, Brains On Code lays the foundations of measuring and modeling program comprehension and offers substantial feedback for programming methodology, language design, and education. With Brains On Code, addressing longstanding foundational questions such as "How can we reliably measure program comprehension?", "What makes a program hard to understand?", and "What skills should programmers have?" comes into reach. Brains On Code does not only help answer these questions, but also provides an outline for applying the methodology beyond program code (models, specifications, requirements, etc.).

Keywords: Program comprehension · Neuro-imaging · Computational cognitive modeling

Contents

Competition Contributions