Logical Methods in Computer Science
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PREFACE

Welcome to the special issue of the Logical Methods in Computer Science on the theory of concurrency. This special issue is dedicated to selected papers from the 31st International Conference on Concurrency Theory - CONCUR 2020, that was held online during September 1–4, 2020 in Vienna, Austria, as part of the umbrella conference QONFEST 2020.

Theory and Application of Concurrent Systems. The theory and application of concurrent systems touch upon an array of topics from semantics, logics, verification and analysis of concurrent systems. As such, the CONCUR conference series draws on many concepts and techniques developed in the context of concurrency models, including abstract machines, domain-theoretic models, game-theoretic models, process algebras, graph transformation system, Petri nets, hybrid systems, mobile and collaborative systems, probabilistic systems, real-time systems, biology-inspired systems, and synchronous systems. Logical frameworks need to be developed to capture the semantics of the respective concurrency models, using for example fragments and extensions of modal logics, probabilistic and stochastic logics, temporal logics, and resource logics. Based on the wide variety of concurrency models and logics, verification and analysis techniques for concurrent systems have emerged by exploiting and combining abstract interpretation, atomicity checking, model checking, race detection, pre-order and equivalence checking, run-time verification, state-space exploration, static analysis, synthesis, testing, theorem proving, type systems, and security analysis. Tailored distributed algorithms, data structures, and concurrent architectures, in support of concurrent system analysis, have further been proposed and applied, for example in the context of geo-replicated systems, communication networks, and multiprocessor and multi-core architectures, to only mention a few.

Earlier versions of all articles have already been published in the proceedings of the 31st International Conference on Concurrency Theory - CONCUR 2020.

Contributions. This special issue contains ten contributions in concurrency theory, with each contribution corresponding to an extended version of a selected paper published at CONCUR 2020. Each contribution in this special issue underwent a thorough reviewing process, ensuring that each contribution meets the highest standards with respect to scientific contributions and novelty.

Five contributions in this special issue focus on challenges in the semantics of concurrent models, by studying the existence of finite equational axiomatisations of parallel compositions; showing undecidability of the big-O problem over weighted automata; introducing fuzzy lax extensions for quantitative model logics; and developing the theory of residual nominal automata for active learning in data languages. In addition to modeling and logical formalizations of concurrency systems, five contributions of this special issue present algorithmic solutions and boundaries towards concurrent system verification. As such, this special issue describes theoretical foundations for developing a reachability analysis framework for general FIFO machines; draws a complete decidability/complexity landscape of the membership problem for deterministic register and timed automata; describes a low-overhead approach towards termination detection in distributed systems; establishes a generic and effective characterisation for the computability of rational and regular functions, used for example in string transducers; and develops algebraic techniques to reason about concurrent behaviours modelled as languages of Mazurkiewicz traces and asynchronous automata.

Closing. To conclude, a wide variety of techniques can be employed to model, analyse and verify concurrent systems, and we hope that this special issue will play a key part in further strengthening the CONCUR community. We would finally like to thank the reviewers of both CONCUR 2020 and this special issue for the thorough job they have undertaken.

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