

Application and Theory of Petri Nets and Concurrency 2019: Special Issue of Selected Papers

Preface

This volume presents selected papers from the 40th International Conference on Application and Theory of Petri Nets and Concurrency (Petri Nets 2019), which was organized by the Process and Data Science (PADS) group at RWTH Aachen University, Aachen, Germany, in June 2019. The Program Committee selected 23 out of 41 papers submitted to Petri Nets 2020 by authors from 19 different countries. Each paper was reviewed by three reviewers. After the conference, five papers were distinguished by the Program Committee members. The authors were invited to revise and extend their conference papers for this special issue, and the extended submissions have been reviewed in a separate reviewing process, to meet the standards of *Fundamenta Informaticae*.

Three of these works address the synthesis problem, albeit from rather different points of views (complexity, compositionality and synthesis in a timed context). New results on the complexity and expressiveness of Recursive Petri nets and an in-depth investigation of the intricate connection between sequential and concurrent semantics in Petri nets reversibility, complete this special issue.

- Raymond Devillers' work, *Articulations and Products of Transition Systems and their Applications to Petri Net Synthesis*, focuses on structural properties of transition systems and their decompositions, so as to exploit compositionality in the synthesis of a Petri net, both for the acceleration and analysis of the synthesis procedure.
- Alain Finkel, Serge Haddad and Igor Khmelnitsky address *Coverability, Termination, and Finiteness in Recursive Petri Nets*. Such Petri nets introduce counters and recursion, as is motivated by e.g. distributed planning in multi-agent systems. The article addresses expressiveness and complexity issues in this class of models. Interestingly, the results show that the coverability languages for Recursive Petri nets strictly include the union of context-free languages and coverability language for Petri nets; nonetheless, the coverability, termination, boundedness and finiteness problems have the same complexity, EXSPACE-complete, as their counterparts for Petri nets; there is no extra cost for the gain in expressiveness, so to speak.

- David de Frutos Escrig, Maciej Koutny, and Łukasz Mikulski tackle a novel aspect of the intricate connection between sequential and concurrent semantics by *Investigating Reversibility of Steps in Petri Nets*. The question of how, and when, to reverse partial computations is here lifted to the context of *step* firings, allowing (multi-)sets of transitions to act jointly. Reversing such a step action may be allowed either restricted to using either purely original *or* reversed transitions (*direct reversibility*), or with a mixture of reversed and original transitions (*mixed reversibility*). Interestingly, the need for mixed reversibility arises crucially in the case of multiset steps, as direct reversibility is shown to not be implementable in that setting.
- Another synthesis problem is treated by Didier Lime, Olivier H. Roux and Charlotte Seidner, in *Cost Problems for Parametric Time Petri Nets*. In the parameter synthesis for time Petri nets, the authors associate a cost variable that evolves discretely when a transition fires, and continuously during the passage of time. The problem of interest is then to synthesize these parameters jointly to ensure reachability of a given marking, with a cost that is minimal, or at least below a given bound. Unfortunately, even existence of values to satisfy the second property is shown undecidable; however, symbolic semi-algorithms for both problems are developed, and proven to be sound and complete whenever they terminate. Additional benefit can be drawn in the sub-problem with bounded parameters; the algorithms terminate in that context, and the symbolic constraints obtained allow effective further analysis via linear programming.
- Ronny Tredup addresses the synthesis of very general Petri net types, parametrized by a type parameter τ . This work, which extends a series of articles by the same author on synthesis problems, focuses on the case of pure b -bounded nets, with $b \geq 2$, in which the complexity class for synthesis had not previously been known. Via the introduction of extension for such nets, in which interaction between nodes are added so as to simulate additions of integers modulo $b + 1$, solvability and NP-completeness of the associated synthesis problem is established.

As editors of this special issue we would like to warmly thank the reviewers for their detailed and in-depth comments on the papers, and for the authors that have taken them into full and adequate consideration. It was very often an exchange of ideas and of point of views, that we believe was very stimulating for everybody involved in this special issue preparation, as we hope it will be your reading,

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