Application and Theory of Petri Nets and Concurrency. PETRI NETS 2013

Preface

It is already a tradition to select papers from the annual PETRI NETS conference for a special issue of Fundamenta Informaticae. This volume presents six papers that extend or combine seven papers from the 34th International Conference on Application and Theory of Petri Nets and Concurrency which took place at the Università degli Studi di Milano-Bicocca in June 2013. The program committee chairs of the conference invited the respective authors to revise and extend their contributions for this special issue.

The main topic discussed at the PETRI NETS conferences is of course Petri net theory, with a particular emphasis on application. However, as the suffix "and Concurrency" indicates, the conference is also open to other approaches to concurrency. Such contributions may be concerned with, e.g., the relationship between Petri nets and other formalisms, or extensions of the Petri net formalism.

The first contribution of this issue, *Complexity Analysis of Continuous Petri Nets*, authored by Estíbaliz Fraca from Universidad de Zaragoza, Spain, together with Serge Haddad, École Normale Supérieure de Cachan, France, belongs to the latter category. Whereas transitions of usual Petri nets can only move single tokens, the firing rule of Continuous Petri Nets allows to move any positive real-valued multiple of tokens. Consequently, not only reachable markings are considered, but also limits of reachable markings after infinite occurrence sequences. Major contributions of this paper are improved complexity bounds for the most important Petri net properties, here transferred to Continuous Petri nets. The conference version of this paper received the Outstanding Paper Award from the program committee.

Also the second paper *ω-Petri Nets: Algorithms and Complexity* deals with an extension of the Petri net firing rule. Gilles Geeraerts and Jean-François Raskin from Université libre de Bruxelles, Belgium, M. Praveen from Laboratoire Bordelais de Recherche en Informatique, France, and Alexander Heußner from Otto-Friedrich Universität Bamberg, Germany, introduce and study ω-Petri nets, in which arcs may be annotated by ω with the semantics that, by firing the adjacent transition, any number of tokens can flow through this arc. Algorithms are proposed for verification problems like reachability, boundedness, covering, and termination. In addition, complexity and decidability results are provided for this net class, also when extended with reset and transfer arcs.

The next two papers are typical Petri net theory contributions. Ernst W. Mayr and Jeremias Weihmann, both from Technische Universität München, Germany, provide *Results for Problems of Communication-Free Petri Nets and Related Formalisms*. In a communication-free Petri net, each transition

has exactly one input place and the connecting arc has multiplicity one. Therefore, synchronization by shared transitions does not take place in communication-free Petri nets. This contribution studies analysis algorithms for well-known general properties restricted to this particular subclass of nets, and provides complexity bounds. In particular, for some boundedness and liveness problems as well as for the covering problem, NP-completeness is shown.

Whereas many other formalisms are modular by the inductive definition of models, Petri nets lack a single, natural concept of modularity, although there are various suggestions how modularity aspects can be added to Petri nets. Alexis Marechal from Universidad Privada Boliviana, Bolivia, and Didier Buchs from Université de Genève, Switzerland, propose in *Generalizing the Compositions of Petri Nets Modules* LLAMAS, a formalism which aims at standardizing definitions of previous approaches to modularity. The paper introduces formal background, syntax and semantics of LLAMAS, and a case study.

The final two papers can be viewed as Petri net theory papers with particular application domains, thus linking theory and application. Robin Bergenthum, FernUniversität in Hagen, Germany, and Robert Lorenz, Universität Augsburg, Germany, tackle the question how to decide whether a given run belongs to the set of runs specified by a Petri net. Their paper is titled *Verification of Scenarios in Petri Nets Using Compact Tokenflows*. This analysis question has important applications in conformance checks. There are various ways to define runs each leading to its own algorithm. The paper improves previous work by introducing compact token flows that avoid transitive arcs to characterise runs. Moreover, the idea of compact tokenflows is also applied to the case of nets with inhibitor arcs and other net classes.

The last paper, *Persistent and Nonviolent Steps and the Design of GALS Systems*, authored by Johnson Fernandes, Danil Sokolov, Maciej Koutny, Marta Pietkiewicz-Koutny, Alex Yakovlev, all from Newcastle University, U.K., and Łukasz Mikulski, Nicolaus Copernicus University, Toruń, Poland, is actually the merge of two conference papers. This contribution explicitly addresses an application domain, namely GALS systems in the context of VLSI circuits, where GALS stands for Globally Asynchronous Locally Synchronous. The aim of this paper is to re-design such a system, given by a Petri net, in such a way that signal management is optimized and concurrent events occur synchronously, i.e., within one clock tick. The core idea is based on steps – i.e., sets of concurrently enabled transitions – which are persistent and thus cannot be disabled by other events and non-violent and thus cannot disable other events.

We thank all authors for their effort to extend and rewrite their contributions. They were guided by reviewers, who gave numerous valuable suggestions. We are also grateful to Damian Niwiński who supported the publication of this volume as a special issue of Fundamenta Informaticae. Finally, we would like to pay tribute to Philippe Darondeau, member of the Program Committee of the PETRI NETS 2013 conference and distinguished colleague. Professor Darondeau died just a few days after the completion of the review process of the conference. His absence will be felt for many years to come.

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