

30th International Conference on Concurrency Theory

CONCUR 2019, August 27–30, 2019,
Amsterdam, the Netherlands

Edited by

Wan Fokkink

Rob van Glabbeek



Editors

Wan Fokkink

Vrije Universiteit Amsterdam, the Netherlands
w.j.fokkink@vu.nl

Rob van Glabbeek

Data61, CSIRO, Sydney, Australia
rvg@cs.stanford.edu

ACM Classification 2012

Theory of computation → Concurrency

ISBN 978-3-95977-121-4

Published online and open access by

Schloss Dagstuhl – Leibniz-Zentrum für Informatik GmbH, Dagstuhl Publishing, Saarbrücken/Wadern, Germany. Online available at <https://www.dagstuhl.de/dagpub/978-3-95977-121-4>.

Publication date

August, 2019

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <https://portal.dnb.de>.

License

This work is licensed under a Creative Commons Attribution 3.0 Unported license (CC-BY 3.0):
<https://creativecommons.org/licenses/by/3.0/legalcode>.



In brief, this license authorizes each and everybody to share (to copy, distribute and transmit) the work under the following conditions, without impairing or restricting the authors' moral rights:

- Attribution: The work must be attributed to its authors.

The copyright is retained by the corresponding authors.

Digital Object Identifier: 10.4230/LIPIcs.CONCUR.2019.0

ISBN 978-3-95977-121-4

ISSN 1868-8969

<https://www.dagstuhl.de/lipics>

LIPICs – Leibniz International Proceedings in Informatics

LIPICs is a series of high-quality conference proceedings across all fields in informatics. LIPICs volumes are published according to the principle of Open Access, i.e., they are available online and free of charge.

Editorial Board

- Luca Aceto (*Chair*, Gran Sasso Science Institute and Reykjavik University)
- Christel Baier (TU Dresden)
- Mikolaj Bojanczyk (University of Warsaw)
- Roberto Di Cosmo (INRIA and University Paris Diderot)
- Javier Esparza (TU München)
- Meena Mahajan (Institute of Mathematical Sciences)
- Dieter van Melkebeek (University of Wisconsin-Madison)
- Anca Muscholl (University Bordeaux)
- Luke Ong (University of Oxford)
- Catuscia Palamidessi (INRIA)
- Thomas Schwentick (TU Dortmund)
- Raimund Seidel (Saarland University and Schloss Dagstuhl – Leibniz-Zentrum für Informatik)

ISSN 1868-8969

<https://www.dagstuhl.de/lipics>

■ Contents

Preface	
<i>Wan Fokkink and Rob van Glabbeek</i>	0:ix

Invited Contributions

Safety Verification for Deep Neural Networks with Provable Guarantees	
<i>Marta Z. Kwiatkowska</i>	1:1–1:5
Synthesis of Safe, Optimal and Compact Strategies for Stochastic Hybrid Games	
<i>Kim G. Larsen</i>	2:1–2:5
Program Invariants	
<i>Joël Ouaknine</i>	3:1–3:1
Concurrent Algorithms and Data Structures for Model Checking	
<i>Jaco van de Pol</i>	4:1–4:1

Markov Decision Processes

Of Cores: A Partial-Exploration Framework for Markov Decision Processes	
<i>Jan Křetínský and Tobias Megendorfer</i>	5:1–5:17
Combinations of Qualitative Winning for Stochastic Parity Games	
<i>Krishnendu Chatterjee and Nir Piterman</i>	6:1–6:17
Near-Linear Time Algorithms for Streett Objectives in Graphs and MDPs	
<i>Krishnendu Chatterjee, Wolfgang Dvořák, Monika Henzinger, and Alexander Svozil</i>	7:1–7:16
Life Is Random, Time Is Not: Markov Decision Processes with Window Objectives	
<i>Thomas Brihaye, Florent Delgrange, Youssouf Oualhadj, and Mickael Randour</i> ...	8:1–8:18

Probabilistic systems

Computing Probabilistic Bisimilarity Distances for Probabilistic Automata	
<i>Giorgio Bacci, Giovanni Bacci, Kim G. Larsen, Radu Mardare, Qiyi Tang, and Franck van Breugel</i>	9:1–9:17
Asymmetric Distances for Approximate Differential Privacy	
<i>Dmitry Chistikov, Andrzej S. Murawski, and David Purser</i>	10:1–10:17
Event Structures for Mixed Choice	
<i>Marc de Visme</i>	11:1–11:16

Reachability

Verification of Flat FIFO Systems	
<i>Alain Finkel and M. Praveen</i>	12:1–12:17

30th International Conference on Concurrency Theory (CONCUR 2019).

Editors: Wan Fokkink and Rob van Glabbeek



Leibniz International Proceedings in Informatics

Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

The Complexity of Subgame Perfect Equilibria in Quantitative Reachability Games <i>Thomas Brihaye, Véronique Bruyère, Aline Goeminne, Jean-François Raskin, and Marie van den Bogaard</i>	13:1–13:16
On the Complexity of Reachability in Parametric Markov Decision Processes <i>Tobias Winkler, Sebastian Junges, Guillermo A. Pérez, and Joost-Pieter Katoen</i> .	14:1–14:17
Timed Basic Parallel Processes <i>Lorenzo Clemente, Piotr Hofman, and Patrick Totzke</i>	15:1–15:16
 Automata	
Revisiting Local Time Semantics for Networks of Timed Automata <i>R. Govind, Frédéric Herbretreau, B. Srivathsan, and Igor Walukiewicz</i>	16:1–16:15
Approximate Learning of Limit-Average Automata <i>Jakub Michaliszyn and Jan Otop</i>	17:1–17:16
Alternating Weak Automata from Universal Trees <i>Laure Daviaud, Marcin Jurdziński, and Karoliina Lehtinen</i>	18:1–18:14
Good for Games Automata: From Nondeterminism to Alternation <i>Udi Boker and Karoliina Lehtinen</i>	19:1–19:16
 Games	
Determinacy in Discrete-Bidding Infinite-Duration Games <i>Milad Aghajohari, Guy Avni, and Thomas A. Henzinger</i>	20:1–20:17
Energy Mean-Payoff Games <i>Véronique Bruyère, Quentin Hautem, Mickael Randour, and Jean-François Raskin</i>	21:1–21:17
Equilibrium Design for Concurrent Games <i>Julian Gutierrez, Muhammad Najib, Giuseppe Perelli, and Michael Wooldridge</i> ...	22:1–22:16
Partial Order Reduction for Reachability Games <i>Frederik Meyer Bønneland, Peter Gjol Jensen, Kim G. Larsen, Marco Muñoz, and Jiří Srba</i>	23:1–23:15
 Synthesis	
Synthesis of Data Word Transducers <i>Léo Exibard, Emmanuel Filiot, and Pierre-Alain Reynier</i>	24:1–24:15
Register-Bounded Synthesis <i>Ayrat Khalimov and Orna Kupferman</i>	25:1–25:16
Translating Asynchronous Games for Distributed Synthesis <i>Raven Beutner, Bernd Finkbeiner, and Jesko Hecking-Harbusch</i>	26:1–26:16

VASS and concurrent programming

Long-Run Average Behavior of Vector Addition Systems with States <i>Krishnendu Chatterjee, Thomas A. Henzinger, and Jan Otop</i>	27:1–27:16
Reachability for Bounded Branching VASS <i>Filip Mazowiecki and Michał Pilipczuk</i>	28:1–28:13
Reasoning About Distributed Knowledge of Groups with Infinitely Many Agents <i>Michell Guzmán, Sophia Knight, Santiago Quintero, Sergio Ramírez, Camilo Rueda, and Frank Valencia</i>	29:1–29:15
Robustness Against Transactional Causal Consistency <i>Sidi Mohamed Beillahi, Ahmed Bouajjani, and Constantin Enea</i>	30:1–30:18

Broadcast and fault-tolerance

Expressive Power of Broadcast Consensus Protocols <i>Michael Blondin, Javier Esparza, and Stefan Jaar</i>	31:1–31:16
Reconfiguration and Message Losses in Parameterized Broadcast Networks <i>Nathalie Bertrand, Patricia Bouyer, and Anirban Majumdar</i>	32:1–32:15
Verification of Randomized Consensus Algorithms Under Round-Rigid Adversaries <i>Nathalie Bertrand, Igor Konnov, Marijana Lazić, and Josef Widder</i>	33:1–33:15
A Sound Foundation for the Topological Approach to Task Solvability <i>Jérémy Ledent and Samuel Mimram</i>	34:1–34:15

Coalgebra and model checking

Game-Based Local Model Checking for the Coalgebraic μ -Calculus <i>Daniel Hausmann and Lutz Schröder</i>	35:1–35:16
Graded Monads and Graded Logics for the Linear Time – Branching Time Spectrum <i>Ulrich Dorsch, Stefan Milius, and Lutz Schröder</i>	36:1–36:16
Bialgebraic Semantics for String Diagrams <i>Filippo Bonchi, Robin Piedeleu, Pawel Sobocinski, and Fabio Zanasi</i>	37:1–37:17

Session types and Kleene algebra

A Sound Algorithm for Asynchronous Session Subtyping <i>Mario Bravetti, Marco Carbone, Julien Lange, Nobuko Yoshida, and Gianluigi Zavattaro</i>	38:1–38:16
Domain-Aware Session Types <i>Luís Caires, Jorge A. Pérez, Frank Pfenning, and Bernardo Toninho</i>	39:1–39:17
Reordering Derivatives of Trace Closures of Regular Languages <i>Hendrik Maarand and Tarmo Uustalu</i>	40:1–40:16
Kleene Algebra with Observations <i>Tobias Kappé, Paul Brunet, Jurriaan Rot, Alexandra Silva, Jana Wagemaker, and Fabio Zanasi</i>	41:1–41:16

■ Preface

This volume contains the proceedings of the 30th Conference on Concurrency Theory, which was held in Amsterdam, The Netherlands, on August 27–30, 2019. CONCUR 2019 was organized by CWI. At its 30th anniversary the CONCUR conference series has returned to its place of birth, as the first two instalments, in 1990 and 1991, took place in Amsterdam.

CONCUR is a forum for the development and dissemination of leading research in concurrency theory and its applications. Its aim is to bring together researchers, developers, and students to exchange and discuss latest theoretical developments and learn about challenging practical problems. CONCUR is the reference annual event for researchers in the field.

The principal topics include basic models of concurrency such as abstract machines, domain-theoretic models, game-theoretic models, process algebras, graph transformation systems, Petri nets, hybrid systems, mobile and collaborative systems, probabilistic systems, real-time systems, biology-inspired systems, and synchronous systems; logics for concurrency such as modal logics, probabilistic and stochastic logics, temporal logics, and resource logics; verification and analysis techniques for concurrent systems such as 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; distributed algorithms and data structures: design, analysis, complexity, correctness, fault tolerance, reliability, availability, consistency, self-organisation, self-stabilisation, protocols. Also the theoretical foundations of more applied topics like architectures, execution environments, and software development for concurrent systems such as geo-replicated systems, communication networks, multiprocessor and multi-core architectures, shared and transactional memory, resource management and awareness, compilers and tools for concurrent programming, programming models such as component-based, object- and service-oriented can be found at CONCUR.

This edition of the conference attracted 93 full paper submissions. We thank the authors for their interest in CONCUR 2018. After careful reviewing and discussions, the Program Committee selected 37 papers for presentation at the conference. Each submission was reviewed by at least three reviewers who wrote detailed evaluations and gave insightful comments. We warmly thank the members of the Program Committee and the additional reviewers for their excellent work, including the constructive discussions. The full list of reviewers is available as part of these proceedings.

The conference programme was greatly enriched by the invited presentations by Marta Kwiatkowska (University of Oxford, UK), Kim G. Larsen (Aalborg University, Denmark), Joël Ouaknine (Max Planck Institute for Software Systems, Germany) and Jaco van de Pol (Aarhus University, Denmark). The abstracts of their talks are available as part of these proceedings.

This year, the conference was jointly organised with the 17th International Conference on Formal Modelling and Analysis of Timed Systems (FORMATS 2019) and the 24th International Conference on Formal Methods for Industrial Critical Systems (FMICS 2019). Additionally, the event was enriched by six satellite events: the Combined 26th International Workshop on Expressiveness in Concurrency and 16th Workshop on Structural Operational Semantics (EXPRESS/SOS 2019), the 8th IFIP WG 1.8 Workshop on Trends in Concurrency Theory (TRENDS 2019), the 9th Young Researchers Workshop on Concurrency Theory (YR-CONCUR 2019), the 4th International Workshop on Timing Performance Engineering

30th International Conference on Concurrency Theory (CONCUR 2019).
Editors: Wan Fokkink and Rob van Glabbeek



Leibniz International Proceedings in Informatics
LIPIC Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

for Safety Critical Systems (TIPS 2019), the 3rd International Workshop on Methods and Tools for Distributed Hybrid Systems (DHS 2019), and the 2nd International Workshop on Recent Advances in Concurrency and Logic (RADICAL 2019).

As usual, the CONCUR proceedings are available for open access via LIPICs. We thank the authors and the participants for making this year's CONCUR a success.

Wan Fokkink (Vrije Universiteit Amsterdam, The Netherlands)

Rob van Glabbeek (Data61, CSIRO, Sydney, Australia)

■ Committees

Programme Committee

Christel Baier
Jiri Barnat
Benedikt Bollig
Borzoo Bonakdarpour
Ilaria Castellani
Taolue Chen
Rance Cleaveland
Yuxin Deng
Josée Desharnais
Adrian Francalanza
Wan Fokkink (co-chair)
Ansgar Fehnker
David de Frutos-Escrig
Yuxi Fu
Rob van Glabbeek (co-chair)
Alexey Gotsman
Radu Grosu
Ichiro Hasuo
Marieke Huisman
Barbara König
Gerald Lüttgen
Bas Luttik
Anca Muscholl
Uwe Nestmann
Jun Pang
Jean-François Raskin
Grigore Rosu
Jiri Srba
Simone Tini
Frank Valencia
James Worrell
Gianluigi Zavattaro

Steering Committee

Javier Esparza
Pedro D'Argenio
Wan Fokkink
Joost-Pieter Katoen
Catuscia Palamidessi
Davide Sangiorgi
Jiri Srba

General Chair

Jos Baeten

Workshop Chair

Bas Luttik



■ External Reviewers

Samy Abbes
Luca Aceto
Antonis Achilleos
C. Aiswarya
S. Akshay
Étienne André
Alasdair Armstrong
Paolo Baldan
Jaroslav Bendík
Nikola Beneš
Giovanni Bernardi
Raphaël Berthon
Laura Bocchi
Filippo Bonchi
Patricia Bouyer
Luboš Brim
Paul Brunet
Frederik M. Bønneland
Marco Carbone
Valentina Castiglioni
Ivana Černá
Andrea Cerone
Marek Chalupa
Minas Charalambides
Xiaohong Chen
Corina Cirstea
Lorenzo Clemente
Thomas Colcombet
Silvia Crafa
Cas Cremers
Sandeep Dasgupta
Marc de Visme
Giorgio Delzanno
Laurent Doyen
Jannik Dreier
Jérémy Dubut
Richard Eggert
Nathanael Fijalkov
János Flesch
Simon Fowler
Dan Frumin
Hongfei Fu
Ignacio Fábregas
Maurizio Gabbrielli
Pierre Ganty
Patrick Gardy
Gilles Geeraerts
Raffaella Gentilini
Paola Giannini
Thomas Given-Wilson
Shibashis Guha
Julian Gutierrez
Peter Habermehl
Ernst Moritz Hahn
Daniel Hirschhoff
Ross Horne
Justin Hsu
Mingzhang Huang
Md. Ariful Islam
Guilhem Jaber
Stefan Jaksic
Wojtek Jamroga
Christian Johansen
Sebastian Joosten
Vincent Jugé
Marcin Jurdzinski
Tobias Kappé
Isabella Kaufmann
Bartek Klin
Alexander Knapp
Sophia Knight
Siddharth Krishna
Jean Krivine
Satoshi Kura
Ori Lahav
Yngve Lamo
Ivan Lanese
Julien Lange
Ruggero Lanotte
Sophie Lathouwers
Henrich Lauko
Stéphane Le Roux
Mathieu Lehaut
Karoliina Lehtinen
Huan Long
Florian Lorber
Michele Loreti
Anna Lukina
Nicolas Markey
Johannes Marti

30th International Conference on Concurrency Theory (CONCUR 2019).

Editors: Wan Fokkink and Rob van Glabbeek



Leibniz International Proceedings in Informatics
Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

Richard Mayr
Michael Mendler
Philipp J. Meyer
Jan Midtgaard
Lukasz Mikulski
Marius Mikućionis
Arthur Milchior
Andrzej Mizera
Joshua Moerman
Jean-Francois Monin
Benjamin Monmege
Marco Muniz
David Müller
Thomas Neele
Wytse Oortwijn
Youssef Oualhadj
Luca Padovani
Miguel Palomino
Samuel Pastva
Soumya Paul
Adriano Peron
Kirstin Peters
Anna Philippou
Jakob Piribauer
Nir Piterman
Chris Poskitt
Damien Pous
Vinayak Prabhu
M. Praveen
Tobias Prehn
Guillermo Pérez
Jorge A. Pérez
Karin Quaas
Tim Quatmann
Yasmeen Rafiq
Sergio Rajsbaum
Steven Ramsay
Mickael Randour
Vishal Jagannath Ravi
Christina Rickmann
Chloe Rispal
Camilo Rueda
Claudio Sacerdoti Coen
Mohsen Safari
Prakash Saivasan
Matteo Sammartino
Arnaud Sangnier
Zdeněk Sawa

Sylvain Schmitz
Olivier Serre
Pawel Sobocinski
Ana Sokolova
Marcelo Sousa
Gheorghe Stefanescu
Nathalie Sznajder
Vasco T. Vasconcelos
Toru Takisaka
Max Tschaikowski
Takeshi Tsukada
Andrea Turrini
Irek Ulidowski
Franck van Breugel
Marie Van Den Bogaard
Ingo van Duijn
Georg Weissenbacher
Tim Willemse
Sascha Wunderlich
Ming Xu
Xian Xu
Qizhe Yang
Eugene Yip
Margherita Zorzi