

# **27th International Symposium on Temporal Representation and Reasoning**

**TIME 2020, September 23–25, 2020, Bozen-Bolzano, Italy**

Edited by

**Emilio Muñoz-Velasco**

**Ana Ozaki**

**Martin Theobald**



*Editors*

**Emilio Muñoz-Velasco** 

University of Málaga, Spain  
ejmunoz@uma.es

**Ana Ozaki** 

University of Bergen, Norway  
Ana.Ozaki@uib.no

**Martin Theobald**

University of Luxembourg, Luxembourg  
martin.theobald@uni.lu

*ACM Classification 2012*

Theory of computation → Logic; Information systems → Temporal data; Computing methodologies → Knowledge representation and reasoning

**ISBN 978-3-95977-167-2**

*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/978-3-95977-167-2>.

*Publication date*

September, 2020

*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.TIME.2020.0

**ISBN 978-3-95977-167-2**

**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>Emilio Muñoz-Velasco, Ana Ozaki, and Martin Theobald</i>	0:vii
Authors	0:ix–0:xi
PC Members	0:xiii

### Invited Talks

Verifying Autonomous Robots: Challenges and Reflections <i>Clare Dixon</i>	1:1–1:4
Temporal Modalities in Answer Set Programming <i>Pedro Cabalar</i>	2:1–2:5
Time and Business Process Management: Problems, Achievements, Challenges <i>Johann Eder and Marco Franceschetti</i>	3:1–3:8

### Regular Papers

Negotiating Temporal Commitments in Cross-Organizational Business Processes <i>Marco Franceschetti and Johann Eder</i>	4:1–4:15
The Horn Fragment of Branching Algebra <i>Alessandro Bertagnon, Marco Gavanelli, Alessandro Passantino, Guido Sciavicco, and Stefano Trevisani</i>	5:1–5:16
Temporal Logic with Recursion <i>Florian Bruse and Martin Lange</i>	6:1–6:14
Parametric Model Checking Continuous-Time Markov Chains <i>Catalin-Andrei Ilie and James Ben Worrell</i>	7:1–7:18
Universal Solutions in Temporal Data Exchange <i>Zehui Cheng and Phokion G. Kolaitis</i>	8:1–8:17
Knowledge Extraction with Interval Temporal Logic Decision Trees <i>Guido Sciavicco and Ionel Eduard Stan</i>	9:1–9:16
Window-Slicing Techniques Extended to Spanning-Event Streams <i>Aurélie Suzanne, Guillaume Raschia, José Martinez, and Damien Tassetti</i>	10:1–10:14
Mining Significant Temporal Networks Is Polynomial <i>Guido Sciavicco, Matteo Zavatteri, and Tiziano Villa</i>	11:1–11:12
Dynamic Branching in Qualitative Constraint Networks via Counting Local Models <i>Michael Sioutis and Diedrich Wolter</i>	12:1–12:15

27th International Symposium on Temporal Representation and Reasoning (TIME 2020).

Editors: Emilio Muñoz-Velasco, Ana Ozaki, and Martin Theobald



Leibniz International Proceedings in Informatics

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

Non-Simultaneity as a Design Constraint <i>Jean Guyomarc'h, François Guerret, Bilal El Mejjati, Emmanuel Ohayon, Bastien Vincke, and Alain Mérigot</i> .....	13:1–13:15
One-Pass Context-Based Tableaux Systems for CTL and ECTL <i>Alex Abuin, Alexander Bolotov, Montserrat Hermo, and Paqui Lucio</i> .....	14:1–14:20
TESL: A Model with Metric Time for Modeling and Simulation <i>Hai Nguyen Van, Frédéric Boulanger, and Burkhardt Wolff</i> .....	15:1–15:15
Complexity of Qualitative Timeline-Based Planning <i>Dario Della Monica, Nicola Gigante, Salvatore La Torre, and Angelo Montanari</i> .	16:1–16:13
A Note on C <sup>2</sup> Interpreted over Finite Data-Words <i>Bartosz Bednarczyk and Piotr Witkowski</i> .....	17:1–17:14
Stab-Forests: Dynamic Data Structures for Efficient Temporal Query Processing <i>Jelle Hellings and Yuqing Wu</i> .....	18:1–18:19
On the Decidability of a Fragment of preferential LTL <i>Anasse Chafik, Fahima Cheikh-Alili, Jean-François Condotta, and Ivan Varzinczak</i>	19:1–19:19

## Preface

The 27th International Symposium on Temporal Representation and Reasoning (TIME 2020) was planned to be in Bozen-Bolzano, Italy, from the 23rd to the 24th of September, 2020. However, due to the special circumstances related to COVID-19, the conference was held virtually. This year's edition was organized as a part of the Bolzano Summer of Knowledge (BOSK 2020). TIME is a well-established symposium series that brings together researchers interested in reasoning about temporal aspects of information in all areas of computer science. The symposium aims to be interdisciplinary and to attract attendees from artificial intelligence, database management, logic and verification, and beyond.

TIME 2020 received 23 research paper submissions from Austria, Canada, Germany, India, Italy, Poland, Romania, Russia, South Africa, Spain, United Kingdom, and the United States, written by 59 different authors. We would like to thank all authors for submitting outstanding contributions to the conference. The submissions were carefully evaluated by the 23 members of the program committee, who deserve warm thanks for their high-quality and timely handling of the reviews. Each submission was reviewed by at least three PC members. In the end, 16 contributions were accepted for inclusion in the conference proceedings and presentation at the conference.

The TIME 2020 scientific program includes also three keynote presentations given, respectively, by Clare Dixon (University of Manchester, United Kingdom), Pedro Cabalar (University of Corunna, Spain), and Johann Eder (Alpen-Adria Universität Klagenfurt, Austria). We are delighted that all of them accepted our invitations and we are very grateful for their scientific contribution.

Finally, we would like to acknowledge the excellent work of all the people involved in the organization of the conference, in particular, the local chairs Alessandro Artale and Johann Gamper. Their support was indispensable for a smooth organization and preparation of the conference. Deep thanks also to Dr. Wagner and the LIPICS team for the support during the preparation of the conference proceedings.

Emilio Muñoz-Velasco  
Ana Ozaki  
Martin Theobald



## List of Authors

Alain Mérigot Université Paris-Saclay, CNRS France <a href="mailto:alain.merigot@universite-paris-saclay.fr">alain.merigot@universite-paris-saclay.fr</a>	Bastien Vincke Université Paris-Saclay, CNRS France <a href="mailto:bastien.vincke@universite-paris-saclay.fr">bastien.vincke@universite-paris-saclay.fr</a>
Alessandro Bertagnon University of Ferrara Italy <a href="mailto:alessandro.bertagnon@unife.it">alessandro.bertagnon@unife.it</a>	Bilal El Mejjati Krono-Safe France <a href="mailto:bilal.elmejjati@krono-safe.com">bilal.elmejjati@krono-safe.com</a>
Alessandro Passantino Università di Ferrara Italy <a href="mailto:alessandr.passantino@student.unife.it">alessandr.passantino@student.unife.it</a>	Burkhart Wolff Université Paris-Saclay, LRI France <a href="mailto:wolff@lri.fr">wolff@lri.fr</a>
Alex Abuin Yepes Ikerlan Technology Research Centre Spain <a href="mailto:aabuin@ikerlan.es">aabuin@ikerlan.es</a>	Catalin-Andrei Ilie University of Bucharest Romania <a href="mailto:cilie@fmi.unibuc.ro">cilie@fmi.unibuc.ro</a>
Alexander Bolotov University of Westminster United Kingdom <a href="mailto:a.bolotov@westminster.ac.uk">a.bolotov@westminster.ac.uk</a>	Damien Tassetti Polytech Nantes France <a href="mailto:damien.tassetti@etu.univ-nantes.fr">damien.tassetti@etu.univ-nantes.fr</a>
Anasse Chafik CRIL, Université d'Artois; CNRS France <a href="mailto:chafik@cril.fr">chafik@cril.fr</a>	Dario Della Monica Università degli Studi di Udine Italy <a href="mailto:dario.dellamonica@uniud.it">dario.dellamonica@uniud.it</a>
Angelo Montanari University of Udine Italy <a href="mailto:angelo.montanari@uniud.it">angelo.montanari@uniud.it</a>	Diedrich Wolter University of Bamberg Germany <a href="mailto:diedrich.wolter@uni-bamberg.de">diedrich.wolter@uni-bamberg.de</a>
Aurélie Suzanne LS2N France <a href="mailto:aurelie.suzanne@etu.univ-nantes.fr">aurelie.suzanne@etu.univ-nantes.fr</a>	Emmanuel Ohayon Krono-Safe France <a href="mailto:emmanuel.ohayon@krono-safe.com">emmanuel.ohayon@krono-safe.com</a>
Bartosz Bednarczyk University of Wrocław & TU Dresden Poland <a href="mailto:bartosz.bednarczyk@cs.uni.wroc.pl">bartosz.bednarczyk@cs.uni.wroc.pl</a>	Fahima Cheikh-Alili CRIL, Université d'Artois; CNRS France <a href="mailto:cheikh@cril.fr">cheikh@cril.fr</a>
	Florian Bruse Universität Kassel Germany <a href="mailto:florian.bruse@uni-kassel.de">florian.bruse@uni-kassel.de</a>

27th International Symposium on Temporal Representation and Reasoning (TIME 2020).

Editors: Emilio Muñoz-Velasco, Ana Ozaki, and Martin Theobald



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

François Guerret  
 Krono-Safe  
 France  
[francois.guerret@krono-safe.com](mailto:francois.guerret@krono-safe.com)

Frédéric Boulanger  
 CentraleSupélec, Université Paris-Saclay,  
 LRI  
 France  
[frederic.boulanger@lri.fr](mailto:frederic.boulanger@lri.fr)

Guido Sciavicco  
 University of Ferrara, Italy  
 Italy  
[guido.sciavicco@unife.it](mailto:guido.sciavicco@unife.it)

Guido Sciavicco  
 University of Ferrara, Italy  
 Italy  
[guido.sciavicco@unife.it](mailto:guido.sciavicco@unife.it)

Guido Sciavicco  
 Università di Ferrara  
 Italy  
[guido.sciavicco@unife.it](mailto:guido.sciavicco@unife.it)

Guillaume Raschia  
 LS2N  
 France  
[guillaume.raschia@univ-nantes.fr](mailto:guillaume.raschia@univ-nantes.fr)

Hai Nguyen Van  
 Université Paris-Saclay, LRI  
 France  
[hai.nguyenvan.phie@gmail.com](mailto:hai.nguyenvan.phie@gmail.com)

Ionel Eduard Stan  
 University of Ferrara, Italy, and  
 University of Parma, Italy  
 Italy  
[ioneleduard.stan@unife.it](mailto:ioneleduard.stan@unife.it)

Ivan Varzinczak  
 Univ. Artois and CNRS  
 France  
[ijv@acm.org](mailto:ijv@acm.org)

James Worrell  
 University of Oxford  
 United Kingdom  
[jbw@cs.ox.ac.uk](mailto:jbw@cs.ox.ac.uk)

Jean Guyomarc'H  
 Krono-Safe  
 France  
[jean.guyomarch@krono-safe.com](mailto:jean.guyomarch@krono-safe.com)

Jean-François Condotta  
 CRIL  
 France  
[j\\_condotta@yahoo.fr](mailto:j_condotta@yahoo.fr)

Jelle Hellings  
 University of California, Davis  
 United States  
[jhellings@ucdavis.edu](mailto:jhellings@ucdavis.edu)

Johann Eder  
 Alpen-Adria-Universitaet Klagenfurt  
 Austria  
[johann.eder@aau.at](mailto:johann.eder@aau.at)

José Martinez  
 LS2N  
 France  
[jose.martinez@univ-nantes.fr](mailto:jose.martinez@univ-nantes.fr)

Marco Franceschetti  
 Alpen-Adria-Universitaet Klagenfurt  
 Austria  
[marco.franceschetti@aau.at](mailto:marco.franceschetti@aau.at)

Marco Gavanelli  
 University of Ferrara  
 Italy  
[marco.gavanelli@unife.it](mailto:marco.gavanelli@unife.it)

Martin Lange  
 University of Kassel  
 Germany  
[martin.lange@uni-kassel.de](mailto:martin.lange@uni-kassel.de)

Matteo Zavatteri  
 Università degli Studi di Verona  
 Italy  
[matteo.zavatteri@gmail.com](mailto:matteo.zavatteri@gmail.com)

Michael Sioutis  
 University of Bamberg  
 Germany  
[michael\\_sioutis@hotmail.com](mailto:michael_sioutis@hotmail.com)

Montserrat Hermo  
The Universti of the Basque Country  
(UPV/EHU)  
Spain  
`montserrat.hermo@ehu.es`

Nicola Gigante  
University of Udine, Italy  
Italy  
`nicola.gigante@uniud.it`

Paqui Lucio  
University of the Basque Country  
Spain  
`paqui.lucio@ehu.es`

Phokion Kolaitis  
UC Santa Cruz and IBM Research -  
Almaden  
United States  
`kolaitis@ucsc.edu`

Piotr Witkowski  
University of Wrocław  
Poland  
`pwit@ii.uni.wroc.pl`

Salvatore La Torre  
University of Salerno, Italy  
Italy  
`slatorre@unisa.it`

Stefano Trevisani  
University of Ferrara  
Italy  
`stefan.trevisani@student.unife.it`

Tiziano Villa  
Universita' di Verona  
Italy  
`tiziano.villa@univr.it`

Yuqing Wu  
Pomona College  
United States  
`Melanie.Wu@pomona.edu`

Zehui Cheng  
UC Santa Cruz  
United States  
`zecheng@ucsc.edu`



## ■ List of PC Members

Alexander Artikis  
Klaus Berberich  
Camille Bourgaux  
Panagiotis Bouros  
Anton Dignös  
Clare Dixon  
Johann Gamper  
Rajeev Gore  
Víctor Gutiérrez-Basulto  
Fredrik Heintz  
Jean Christoph Jung  
Roman Kontchakov  
Cláudia Nalon  
Daniel Neider  
Kjetil Nørvåg  
Manuel Ojeda-Aciego  
Hector Pomares  
Dimitris Sacharidis  
Stephan Schlüter  
Guido Sciavicco

