

Communications in Computer and Information Science

1125

Commenced Publication in 2007

Founding and Former Series Editors:

Phoebe Chen, Alfredo Cuzzocrea, Xiaoyong Du, Orhun Kara, Ting Liu,
Krishna M. Sivalingam, Dominik Ślęzak, Takashi Washio, Xiaokang Yang,
and Junsong Yuan

Editorial Board Members

Simone Diniz Junqueira Barbosa 

*Pontifical Catholic University of Rio de Janeiro (PUC-Rio),
Rio de Janeiro, Brazil*

Joaquim Filipe 

Polytechnic Institute of Setúbal, Setúbal, Portugal

Ashish Ghosh

Indian Statistical Institute, Kolkata, India

Igor Kotenko 

*St. Petersburg Institute for Informatics and Automation of the Russian
Academy of Sciences, St. Petersburg, Russia*

Lizhu Zhou

Tsinghua University, Beijing, China

More information about this series at <http://www.springer.com/series/7899>


Jürgen Gerhard · Ilias Kotsireas (Eds.)

Maple in Mathematics Education and Research

Third Maple Conference, MC 2019
Waterloo, Ontario, Canada, October 15–17, 2019
Proceedings

Editors

Jürgen Gerhard
Maplesoft
Waterloo, ON, Canada

Ilias Kotsireas 
Wilfrid Laurier University
Waterloo, ON, Canada

ISSN 1865-0929 ISSN 1865-0937 (electronic)
Communications in Computer and Information Science
ISBN 978-3-030-41257-9 ISBN 978-3-030-41258-6 (eBook)
<https://doi.org/10.1007/978-3-030-41258-6>

© Springer Nature Switzerland AG 2020

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The Maple Conference is a meeting of Maple enthusiasts and experts from around the world, covering topics in education, algorithms, and applications of the mathematical software Maple. This conference has existed in various forms on and off for over two decades, permitting participants to benefit from the experiences and insights of both leading researchers in mathematics and computer science, and of passionate educators. It was a great pleasure to be part of its revival this year, and to welcome participants from around the world, including Canada, the USA, France, China, Spain, Belgium, and the UK.

In three decades, Maple has grown from a research project in symbolic computation to a complete environment for mathematical problem solving and exploration that is used by mathematicians, engineers, scientists, educators, and students around the globe. Thousands of sophisticated algorithms are implemented in Maple today, and this tremendous growth is due to both Maple visionaries and developers, but also to Maple users. Maple has been used as a crucial ingredient in countless Master and PhD theses in academia worldwide, as well as in commercial and government projects in robotics, medicine, green energy, space exploration, and more.

The Maple Conference 2019 was held at the University of Waterloo in Waterloo, Ontario, Canada, during October 15–17, 2019. This conference featured two keynote speakers:

- Dr. Marvin Weinstein, physicist at the Stanford Linear Accelerator Center for 42 years and now CSO of Quantum Insights
- Dr. Laurent Bernardin, President and CEO of Maplesoft, the developers of Maple

This volume contains the contributed papers from the conference, as well as extended abstracts of contributed talks. All submissions were reviewed by an international committee, and the quality of the accepted papers was very impressive.

We would like to thank the authors and presenters for making the conference both interesting and useful. We thank the members of the Maple Conference 2019 Program Committee and additional referees for their insightful comments and suggestions for the authors. We also offer thanks to Kathleen McNichol, Eithne Murray, Stacey Nichols, and Jennifer Iorgulescu from Maplesoft, for their tireless support of this conference and the proceedings. Additionally, we thank the staff at Springer for their help in completing this Maple Conference 2019 book of proceedings.

We are proud to recognize the invaluable patronage of the Maple Conference 2019 partners and sponsors, namely the Perimeter Institute for Theoretical Physics, the Fields Institute for Mathematical Sciences, Springer, the University of Waterloo, and Wilfrid Laurier University.

Finally, we are delighted to serve as Proceedings Editors for the present volume and hope Maple users will refer to it in the future, to learn the latest algorithmic

developments, be inspired to conduct further research in interesting topics using Maple, and enlarge their outlook on how to use Maple effectively in educational contexts in high school and university.

October 2019

Jürgen Gerhard
Ilias Kotsireas

Organization

Scientific Program Committee

Alin Bostan	Inria Saclay, France
Jacques Carette	McMaster University, Canada
Bruce Char	Drexel University, USA
Shaoshi Chen	Chinese Academy of Sciences, China
Paulina Chin	Maplesoft, Canada
Frédéric Chyzak	Inria Saclay, France
Robert Corless	Western University, Canada
Thierry Dana-Picard	Jerusalem College of Technology, Israel
James Davenport	University of Bath, UK
Paul DeMarco	Maplesoft, Canada
Jürgen Gerhard	Maplesoft, Canada
Mark Giesbrecht	University of Waterloo, Canada
Laureano Gonzalez-Vega	Universidad de Cantabria, Spain
Jonathan Hauenstein	University of Notre Dame, USA
David Jeffrey	Western University, Canada
Manuel Kauers	Johannes Kepler University, Austria
Alexander Kobel	Max Planck Institut für Informatik, Germany
George Labahn	University of Waterloo, Canada
Victor Levandovskyy	RWTH Aachen University, Germany
Robert Martin	University of Manitoba, Canada
John May	Maplesoft, USA
Michael Monagan	Simon Fraser University, Canada
Guillaume Moroz	Inria Nancy, France
Eithne Murray	Maplesoft, Canada
Erik Postma	Maplesoft, Canada
Clemens Raab	Johannes Kepler University, Austria
Fabrice Rouillier	Inria Paris, France
Sivabal Sivaloganathan	University of Waterloo, Canada
Arne Storjohann	University of Waterloo, Canada
Mark van Hoeij	Florida State University, USA
Gilles Villard	Université de Lyon, France
Stephen Watt	University of Waterloo, Canada
Thomas Wolf	Brock University, Canada

Organizing Committee

Ilias S. Kotsireas (Chair)	Wilfrid Laurier University, Canada
Kathleen McNichol	Maplesoft, Canada
Jürgen Gerhard	Maplesoft, Canada
Eithne Murray	Maplesoft, Canada

Contents

Keynote

Your Data Wants You to Ask Better Questions. Do It!	3
<i>Marvin Weinstein</i>	

Full Papers – Research Stream

The LegendreSobolev Package and Its Applications in Handwriting Recognition	13
<i>Parisa Alvandi and Stephen M. Watt</i>	
On the Effective Computation of Stabilizing Controllers of 2D Systems.	30
<i>Yacine Bouzidi, Thomas Cluzeau, Alban Quadrat, and Fabrice Rouillier</i>	
Using Maple to Analyse Parallel Robots	50
<i>Damien Chablat, Guillaume Moroz, Fabrice Rouillier, and Philippe Wenger</i>	
Studying Wythoff and Zometool Constructions Using Maple	65
<i>Benoit Charbonneau and Spencer Whitehead</i>	
Approximate GCD in a Bernstein Basis	77
<i>Robert M. Corless and Leili Rafiee Sevyeri</i>	
Using Maple to Compute the Intersection Curve of Two Quadrics: Improving the Intersectplot Command	92
<i>Laureano Gonzalez-Vega and Alexandre Trocado</i>	
Exact Parametric Solutions for the Intersections of Quadric Surfaces Using MAPLE.	101
<i>Samir Hamdi, David I. W. Levin, and Brian Morse</i>	
Decomposing the Parameter Space of Biological Networks via a Numerical Discriminant Approach	114
<i>Heather A. Harrington, Dhagash Mehta, Helen M. Byrne, and Jonathan D. Hauenstein</i>	
The Z_Polyhedra Library in MAPLE	132
<i>Rui-Juan Jing and Marc Moreno Maza</i>	
Detecting Singularities Using the PowerSeries Library	145
<i>Mahsa Kazemi and Marc Moreno Maza</i>	

A Maple Package for the Symbolic Computation of Drazin Inverse Matrices
with Multivariate Transcendental Functions Entries 156
Jorge Caravantes, J. Rafael Sendra, and Juana Sendra

A Poly-algorithmic Quantifier Elimination Package in Maple 171
Zak Tonks

Full Papers – Education/Applications Stream

The Creation of Animated Graphs to Develop Computational Thinking
and Support STEM Education 189
*Alice Barana, Alberto Conte, Cecilia Fissore, Francesco Floris,
Marina Marchisio, and Matteo Sacchet*

Effective Problem Solving Using SAT Solvers 205
Curtis Bright, Jürgen Gerhard, Ilias Kotsireas, and Vijay Ganesh

Using Maple to Make Manageable Matrices 220
Ana C. Camargos Couto and David J. Jeffrey

Use of Maple and Möbius in an Undergraduate Course on Cryptography 230
Bruce Char and Jeremy R. Johnson

Enhance Faculty Experience and Skills Using Maple
in the 21st Century Classroom 245
Lancelot Arthur Gooden

Undergraduate Upper Division Quantum Mechanics:
An Experiment in Maple[®] Immersion 254
Scot A. C. Gould

The Fermat-Torricelli Problem of Triangles on the Sphere
with Euclidean Metric: A Symbolic Solution with Maple 263
Xiaofeng Guo, Tuo Leng, and Zhenbing Zeng

Using Leslie Matrices as the Application of Eigenvalues
and Eigenvectors in a First Course in Linear Algebra 279
Michael Monagan

Transforming Maple into an Intelligent Model-Tracing Math Tutor 292
Dimitrios Sklavakis

A Heilbronn Type Inequality for Plane Nonagons 307
Zhenbing Zeng, Jian Lu, Lydia Dehbi, Liangyu Chen, and Jianlin Wang

Extended Abstracts – Research Stream

PseudoLinearSystems – A MAPLE Package for Studying Systems of Pseudo-Linear Equations	327
<i>Moulay Barkatou, Thomas Cluzeau, and Ali El Hajj</i>	
Machine Learning to Improve Cylindrical Algebraic Decomposition in Maple	330
<i>Matthew England and Dorian Florescu</i>	
Ball Arithmetic as a Tool in Computer Algebra	334
<i>Fredrik Johansson</i>	
The Lie Algebra of Vector Fields Package with Applications to Mappings of Differential Equations	337
<i>Zahra Mohammadi, Gregory J. Reid, and S.-L. Tracy Huang</i>	
Polynomial Factorization in Maple 2019	341
<i>Michael Monagan and Baris Tuncer</i>	

Extended Abstracts – Education/Applications Stream

Distributive Laws Between the Operads <i>Lie</i> and <i>Com</i>	349
<i>Murray Bremner and Vladimir Dotsenko</i>	
Classifying Discrete Structures by Their Stabilizers	353
<i>Gilbert Labelle</i>	
How Maple Has Improved Student Understanding in Differential Equations . . .	357
<i>Douglas B. Meade</i>	
Author Index	363