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Mathematical Software – ICMS 2020

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Braunschweig, Germany, July 13–16, 2020
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Anna Maria Bigatti
Dipartimento di Matematica
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Jacques Carette
Computing and Software
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Hamilton, ON, Canada

James H. Davenport
Department of Computer Science
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Bath, UK

Michael Joswig
Institut für Mathematik, MA 6-2
TU Berlin
Berlin, Germany

Timo de Wolff
Technische Universität Braunschweig
Braunschweig, Germany

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Preface

These are the proceedings of the 7th International Congress on Mathematical Software, which was held during July 13–16, 2020, and hosted by the Technische Universität Braunschweig, Germany. In fact, in the middle of the pandemic caused by the Sars-Cov-2 virus, the conference took place online, and the video recordings of the talks are available on the conference website to accompany this book.

The ICMS community believes that the appearance of mathematical software is one of the most important current developments in mathematics, and this phenomenon should be studied as a coherent whole. We hope this conference can serve as the main forum for mathematicians, scientists, and programmers who are interested in development of mathematical software. The program of the 2020 meeting consisted of 14 topical sessions, which made up the core of the program, consisting of more than 120 contributed talks. Session contributors were given the option to submit their work for publication in these proceedings, and 48 papers were selected through a peer-review process. For the first time this ICMS featured a special session with parallel software demonstrations.

The conference also featured three invited talks. Erika Ábrahám gave a talk on "Solving Real-Algebraic Formulas with SMT-RAT," Alan Edelman on "Julia—The Power of Language," and Victor Shoup on "NTL: a Library for Doing Number Theory." Short abstracts of these talks also appear in these proceedings. We thank the invited speakers for accepting our invitations to speak at ICMS 2020. We also thank all the contributors, session organizers, PC members, as well the local arrangement team and the members of the Advisory Board for helping to make this conference a success. Finally, we thank our sponsors, listed on the following pages, for the financial support of the event. Sebastian Gutsche and Amazon kindly provided technical support.

July 2020

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Abstracts of Invited Talks

Solving Real-Algebraic Formulas with SMT-RAT

Erika Ábrahám

RWTH Aachen, Germany
abraham@cs.rwth-aachen.de

In this talk we present our SMT solver named SMT-RAT, a tool for the automated check of quantifier-free real and integer arithmetic formulas for satisfiability. As a distinguishing feature, SMT-RAT provides a set of decision procedures and supports their strategic combination. We describe our CArL C++ library for arithmetic computations, the available modules implemented on top of CArL, and how modules can be combined to satisfiability-modulo-theories (SMT) solvers. Besides the traditional SMT approach, some new modules support also the recently proposed and highly promising model-constructing satisfiability calculus approach.

Julia—The Power of Language

Alan Edelman

MIT, USA
edelman@mit.edu

We often think of a programming language as a means to implement and check mathematics or as a sideshow to raise conjectures only to be hidden when the paper comes out. We argue that while all this is true, elegant open source software has the power to create much more. In this talk, we will provide examples, and suggest how the traditional academic view of paper first, computation secondary needs to be more flexible.

NTL: A Library for Doing Number Theory

Victor Shoup

Courant Institute, USA
shoup@cs.nyu.edu

NTL is a high-performance C++ library for doing arithmetic on polynomial over various rings (integers and finite fields), as well as a number of other algebraic structures. I will discuss the history of NTL, as well as some of the basic elements of its design and the algorithms it employs. I will also discuss recent work on making NTL exploit multicore and SIMD computer architectures, as well as NTL's use in implementing fully homomorphic encryption schemes.

Topical Sessions

Gröbner Bases in Theory and Practice

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Viktor Levandovskyy	RWTH Aachen, Germany

Real Algebraic Geometry

Session Chairs

Erika Ábrahám	RWTH Aachen, Germany
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Algebraic Geometry via Numerical Computation

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Software for Number Theory and Arithmetic Geometry

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Groups and Group Actions

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The Classification Problem in Geometry

Session Chair

Anton Betten	Colorado State University, USA

Polyhedral Methods in Geometry and Optimization

Session Chairs

Yue Ren	Swansea University, UK
Benjamin Schröter	Binghamton University, USA

Univalent Mathematics: Theory and Implementation

Session Chairs

Carlo Angiuli	Carnegie Mellon University, USA
Anders Mörtberg	Stockholm University, Sweden

Artificial Intelligence and Mathematical Software

Session Chairs

Changbo Chen	Chinese Academy of Sciences, China
Matthew England	Coventry University, UK

Databases in Mathematics

Session Chairs

Gavin Brown	University of Warwick, UK
Tom Coates	Imperial College London, UK
Alexander Kasprzyk	Nottingham University, UK

Accelerating Innovation Speed in Mathematics by Trading Mathematical Research Data

Session Chairs

Katja Berčič	FAU Erlangen-Nürnberg, Germany
Wolfgang Dalitz	Zuse Institute Berlin, Germany
Moritz Schubotz	FIZ Karlsruhe, Germany

The Jupyter Environment for Computational Mathematics

Session Chair

Nicolas M. Thiéry	Paris-Sud University, France

General Session

Session Chair

Michael Joswig	TU Berlin and MPI for Mathematics in the Sciences, Germany

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- HomotopyContinuation.jl - a package for solving systems of polynomials in Julia
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- A variant of van Hoeij's algorithm for computing hypergeometric term solutions of holonomic recurrence equations
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- Classifying Cubic Surfaces over Finite Fields with Orbiter
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