CONTEMPORARY MATHEMATICS

754

75 Years of Mathematics of Computation

Symposium
Celebrating 75 Years of Mathematics of Computation
November 1–3, 2018
The Institute for Computational and Experimental Research in Mathematics (ICERM)

Susanne C. Brenner
Igor Shparlinski
Chi-Wang Shu
Daniel B. Szyld
Editors

AMS American Mathematical Society

75 Years of Mathematics of Computation

CONTEMPORARY MATHEMATICS

754

75 Years of Mathematics of Computation

Symposium
Celebrating 75 Years of Mathematics of Computation
November 1–3, 2018
The Institute for Computational and Experimental Research in Mathematics (ICERM)

Susanne C. Brenner
Igor Shparlinski
Chi-Wang Shu
Daniel B. Szyld
Editors

AMS American Mathematical Society

2010 *Mathematics Subject Classification.* Primary 11Mxx, 11Gxx, 16Zxx, 35Rxx, 41Axx, 65Fxx, 65Mxx, 65Nxx.

Library of Congress Cataloging-in-Publication Data

Names: Celebrating 75 Years of Mathematics of Computation (2018: Providence, R.I.), author. | Brenner, Susanne C., editor. | Shparlinski, Igor E., editor. | Shu, Chi-Wang, editor. | Szyld, Daniel, editor.

Title: 75 years of Mathematics of computation : symposium on Celebrating 75 Years of Mathematics of Computation, November 1-3, 2018, the Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, Rhode Island / Susanne C. Brenner, Igor Shparlinski, Chi-Wang Shu, Daniel B. Szyld, editors.

Other titles: Mathematics of computation.

Description: Providence, Rhode Island : American Mathematical Society, [2020] | Series: Contemporary mathematics, 0271-4132 ; volume 754 | Includes bibliographical references.

Identifiers: LCCN 2019056241 | ISBN 9781470451639 (paperback) | ISBN 9781470456375 (ebook)

Subjects: LCSH: Numerical analysis–Congresses. | Number theory–Data processing–Congresses. | Computational complexity–Congresses. — AMS: Number theory – Zeta and L-functions: analytic theory. | Number theory – Arithmetic algebraic geometry (Diophantine geometry). | Associative rings and algebras – Computational aspects of associative rings. | Partial differential equations – Miscellaneous topics. | Approximations and expansions | Numerical analysis – Numerical linear algebra. | Numerical analysis – Partial differential equations, initial value and time-dependent initial-boundary value problems. | Numerical analysis – Partial differential equations, boundary value problems.

Classification: LCC QA297 .C393 2020 | DDC 518–dc23

LC record available at https://lccn.loc.gov/2019056241

DOI: https://doi.org/10.1090/conm/754

Contents

Preface

The year 2018 marked the 75th anniversary of the founding of *Mathematics of Computation*, one of the four primary research journals published by the American Mathematical Society and the oldest research journal devoted to computational mathematics. To celebrate this milestone, the symposium "Celebrating 75 Years of Mathematics of Computation" was held during November 1–3, 2018, at the Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, Rhode Island. (A symposium for the 50th anniversary of the journal took place in Vancouver in 1993.)

The sixteen papers in this volume, written by the symposium speakers and editors of the journal, include both survey articles and new contributions.

On the discrete side, there are four papers covering topics in computational number theory and computational algebra. On the continuous side, there are twelve papers covering topics in machine learning, high dimensional approximations, nonlocal and fractional elliptic problems, gradient flows, hyperbolic conservation laws, Maxwell's equations, Stokes's equations, a posteriori error estimation, and iterative methods. Together they provide a snapshot of significant achievements in the past quarter century in computational mathematics and also in important current trends.

We are thankful to the administration and staff members at ICERM for everything they did to make the symposium a great success. Funding for the event by the National Science Foundation is gratefully acknowledged.

Last but not least, we thank the speakers at the symposium and the authors of the papers in this volume for their excellent contributions. A list of the nineteen invited lectures at the symposium in the order that they were presented is provided on the following page.

Susanne C. Brenner
Igor Shparlinski
Chi-Wang Shu
Daniel B. Szyld

Invited presentations at the symposium

- Gunter Malle (Technische Universität Kaiserslautern), Character tables of finite groups.
- Bettina Eick (Technische Universität Braunschweig), The classification of groups of prime-power order.
- Paul Zimmermann (Institut National de Recherche en Informatique et en Automatique), What if Gauss had had a computer?
- Renate Scheidler (University of Calgary), Dan Shanks' CUFFQI algorithm resurrected.
- Andrew Odlyzko (University of Minnesota), The Riemann Hypothesis and computers.
- Carl Pomerance (Dartmouth College), Primality testing, then and now.
- Chi-Wang Shu (Brown University), Bound-preserving high order schemes for hyperbolic equations- survey and recent developments.
- Wolfgang Dahmen (University of South Carolina), Accuracy controlled computation - the merit of residuals.
- Peter Monk (University of Delaware), Finite element methods for Maxwell's equations.
- Andrea Bertozzi (University of California, Los Angeles), Graphical models in machine learning, networks and uncertainty quantification.
- Adam M. Oberman (McGill University), Partial differential equations approaches to optimization and regularization of deep neural networks.
- Qiang Du (Columbia University), Nonlocal modeling, analysis and computation.
- Yousef Saad (University of Minnesota), A brief journey to the past of iterative methods for solving sparse linear systems.
- Bjorn Engquist (University of Texas, Austin), Fast solvers for frequency domain wave propagation.
- Ricardo Nochetto (University of Maryland, College Park), Numerical methods for fractional diffusion.
- Olof B. Widlund (New York University), BDDC domain decomposition algorithms.

- Frances Kuo (University of New South Wales), High dimensional integration - the Quasi-Monte Carlo way.
- Jie Shen (Purdue University), A new and robust approach to construct energy stable schemes for gradient flows.
- Douglas Arnold (University of Minnesota), Mathematics of Computation meets geometry.

The full program for the ICERM symposium, including the names and affiliations of all the participants and the slides for most of the invited talks, can be found online at

`https://icerm.brown.edu/topical_workshops/tw18-7-ymc/`

The slides of a brief presentation of the history of *Mathematics of Computation* from the welcome reception is also available there.

Selected Published Titles in This Series

754 **Susanne C. Brenner, Igor Shparlinski, Chi-Wang Shu, and Daniel B. Szyld, Editors,** 75 Years of Mathematics of Computation, 2020

752 **Samuel Coskey and Grigor Sargsyan, Editors,** Trends in Set Theory, 2020

751 **Ashish K. Srivastava, André Leroy, Ivo Herzog, and Pedro A. Guil Asensio, Editors,** Categorical, Homological and Combinatorial Methods in Algebra, 2020

750 **A. Bourhim, J. Mashreghi, L. Oubbi, and Z. Abdelali, Editors,** Linear and Multilinear Algebra and Function Spaces, 2020

749 **Guillermo Cortiñas and Charles A. Weibel, Editors,** K-theory in Algebra, Analysis and Topology, 2020

748 **Donatella Danielli and Irina Mitrea, Editors,** Advances in Harmonic Analysis and Partial Differential Equations, 2020

747 **Paul Bruillard, Carlos Ortiz Marrero, and Julia Plavnik, Editors,** Topological Phases of Matter and Quantum Computation, 2020

746 **Erica Flapan and Helen Wong, Editors,** Topology and Geometry of Biopolymers, 2020

745 **Federico Binda, Marc Levine, Manh Toan Nguyen, and Oliver Röndigs, Editors,** Motivic Homotopy Theory and Refined Enumerative Geometry, 2020

744 **Pieter Moree, Anke Pohl, L'ubomír Snoha, and Tom Ward, Editors,** Dynamics: Topology and Numbers, 2020

743 **H. Garth Dales, Dmitry Khavinson, and Javad Mashreghi, Editors,** Complex Analysis and Spectral Theory, 2020

742 **Francisco-Jesús Castro-Jiménez, David Bradley Massey, Bernard Teissier, and Meral Tosun, Editors,** A Panorama of Singularities, 2020

741 **Houssam Abdul-Rahman, Robert Sims, and Amanda Young, Editors,** Analytic Trends in Mathematical Physics, 2020

740 **Alina Bucur and David Zureick-Brown, Editors,** Analytic Methods in Arithmetic Geometry, 2019

739 **Yaiza Canzani, Linan Chen, and Dmitry Jakobson, Editors,** Probabilistic Methods in Geometry, Topology and Spectral Theory, 2019

738 **Shrikrishna G. Dani, Surender K. Jain, Jugal K. Verma, and Meenakshi P. Wasadikar, Editors,** Contributions in Algebra and Algebraic Geometry, 2019

737 **Fernanda Botelho, Editor,** Recent Trends in Operator Theory and Applications, 2019

736 **Jane Hawkins, Rachel L. Rossetti, and Jim Wiseman, Editors,** Dynamical Systems and Random Processes, 2019

735 **Yanir A. Rubinstein and Bernard Shiffman, Editors,** Advances in Complex Geometry, 2019

734 **Peter Kuchment and Evgeny Semenov, Editors,** Differential Equations, Mathematical Physics, and Applications, 2019

733 **Peter Kuchment and Evgeny Semenov, Editors,** Functional Analysis and Geometry, 2019

732 **Samuele Anni, Jay Jorgenson, Lejla Smajlović, and Lynne Walling, Editors,** Automorphic Forms and Related Topics, 2019

731 **Robert G. Niemeyer, Erin P. J. Pearse, John A. Rock, and Tony Samuel, Editors,** Horizons of Fractal Geometry and Complex Dimensions, 2019

730 **Alberto Facchini, Lorna Gregory, Sonia L'Innocente, and Marcus Tressl, Editors,** Model Theory of Modules, Algebras and Categories, 2019

729 **Daniel G. Davis, Hans-Werner Henn, J. F. Jardine, Mark W. Johnson, and Charles Rezk, Editors,** Homotopy Theory: Tools and Applications, 2019

For a complete list of titles in this series, visit the
AMS Bookstore at **www.ams.org/bookstore/conmseries/**.

CONM 754

75 Years of Mathematics of Computation • Brenner et al., Editors

The year 2018 marked the 75th anniversary of the founding of *Mathematics of Computation*, one of the four primary research journals published by the American Mathematical Society and the oldest research journal devoted to computational mathematics. To celebrate this milestone, the symposium "Celebrating 75 Years of Mathematics of Computation" was held from November 1–3, 2018, at the Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, Rhode Island.

The sixteen papers in this volume, written by the symposium speakers and editors of the journal, include both survey articles and new contributions.

On the discrete side, there are four papers covering topics in computational number theory and computational algebra. On the continuous side, there are twelve papers covering topics in machine learning, high dimensional approximations, nonlocal and fractional elliptic problems, gradient flows, hyperbolic conservation laws, Maxwell's equations, Stokes's equations, a posteriori error estimation, and iterative methods. Together they provide a snapshot of significant achievements in the past quarter century in computational mathematics and also in important current trends.

AMS
www.ams.org

ISBN 978-1-4704-5163-9
9 781470 451639
CONM/754

AMS