Lecture Notes in Computer Science 8372

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Algebraic and Algorithmic Aspects of Differential and Integral Operators

5th International Meeting, AADIOS 2012
Held at the Applications of Computer Algebra
Conference, ACA 2012
Sofia, Bulgaria, June 25-28, 2012
Selected and Invited Papers

Springer

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Preface

Symbolic analysis may be defined as the study of differential equations in symbolic computation; this implies a certain preference of algebraic over geometric concepts and a strong bias toward constructive methods. Over the last decades, this field has seen an exceptionally fruitful period of growth in many different directions. It is therefore important to refocus the subject area by offering a suitable vantage point for workshops and papers. Choosing the *operator perspective* as such a vantage point, two of us (Georg Regensburger, Markus Rosenkranz) set up the first Algebraic and Algorithmic Aspects of Differential and Integral Operator Session (AADIOS) at the Conference on Applications of Computer Algebra (ACA), held in July 2008 at the Research Institute for Symbolic Computation (RISC) at Hagenberg, Austria.

The perspective of algebraic operator rings was chosen not only to provide a common leading theme for much interesting work in symbolic analysis. It is also instrumental in bringing together the two main streams of analysis—*differentiation and integration.* There is no question that between the two, the algebraic theory of differential operators is by far the more developed one. On the other hand, the theory of Rota–Baxter algebras is also rapidly expanding with new applications in fields as diverse as perturbative quantum field theory and multiple zeta values. Therefore, we have always given special attention to approaches that provide a link between these theories.

The venues of previous AADIOS were Hagenberg in 2008, Montréal in 2009, Vlora in 2010, Houston in 2011, Sofia in 2012, Malaga in 2013, and the next AADIOS is already scheduled for 2014 in New York. Since 2012, the AADIOS has been co-organized with Moulay Barkatou and Thomas Cluzeau. Based on the AADIOS 2008–2010 events, we have published an MCS Special Issue (Vol. 4, Nos. 2–3, 2010).

For the current proceedings volume of AADIOS 2012, the Call for Papers listed the following (non-exclusive) topics of interest:

- Symbolic Computation for Operator Algebras
- Factorization of Differential/Integral Operators
- Linear Boundary Problems and Green's Operators
- Initial Value Problems for Differential Equations
- Symbolic Integration and Differential Galois Theory
- Symbolic Operator Calculi
- Algorithmic D-Module Theory
- Rota–Baxter Algebra
- Differential Algebra
- Discrete Analogs of the above
- Software Aspects of the above

We received 13 submissions from Austria, Bulgaria, France, The Netherlands, Russian Federation, Spain, USA, and Vietnam; of these, seven research papers containing new results were finally accepted (acceptance rate 0.54). To ensure a high-quality review process, we asked six associate editors to join our team. All reviews were discussed via EasyChair by all editors, and joint decisions were reached. A total of 33 reviews were carried out (30 of these from a pool of 27 external reviewers). In addition to the contributed papers (which were not limited to AADIOS participants), we have also included two invited survey papers on crucial AADIOS topics. For these papers we drew on informative feedback from selected external reviewers and some associate editors.

The survey paper by *Xing Gao and Li Guo* features integro-differential algebras—one of those algebraic structures that bring together differential and integral operators—and reports on new constructions of the free object in this category. The survey by *José Gómez-Torrecillas* takes a more abstract viewpoint, studying operator algebras from the unified perspective of computational module theory. It ends with an appendix on computer algebra systems written by *Viktor Levandovskyy.*

The paper by *Ivan Dimovski and Margarita Spiridonova* sets up new operational calculi in the spirit of Mikusiński (introducing the differential operator as a suitable convolution inverse) for nonlocal Cauchy problems with resonances. The intertwining Laplace transformations studied by *Elena I. Ganzha* are an interesting class of operators generalizing Laplace's classic cascade method for solving hyperbolic linear partial differential equations. Integral operators are investigated in the paper by *Anja Korporal and Georg Regensburger*, in particular the composition and factorization of generalized Green's operators (solution operators for singular boundary problems). In their paper on relativistic Coulomb integrals, *Christoph Koutschan, Peter Paule, and Sergei K. Suslov* employ Zeilberger's machinery of holonomic functions (those defined by holonomic ideals of differential operators with polynomial coefficients) in a novel and sophisticated way. The paper by *Alexander Levin* takes up the classic topic of measuring the dimension of differential field extensions (corresponding to Einstein's notion of strength in relativistic equations) and applies it to a new class of inversive difference field extensions. The paper by *Laurent Poinsot* is devoted to a functor-based investigation and generalization of differential monoid and semigroup algebras (their main flavor—the ring of differential polynomials—forming the algebraic standard model of nonlinear differential operators). In the paper by *Yulian Tsankov*, a suitable operational calculus (as above) is applied to obtain a detailed solution to a class of local as well as nonlocal boundary value problems for the Laplace equation in a rectangle.

It is our pleasure to thank the authors of submitted papers for all their efforts. We are also very grateful to the authors of the invited papers for providing their topical surveys. We would also like to thank our associate editors (see below) and all external reviewers; without their diligent work a proceedings volume such as this would not be possible. In the same vein, we would like to credit the great work of the ACA organizers and the ACA working group for providing

a constant and reliable platform to present and discuss hot topics in computer algebra (those of the AADIOS as well as many other interesting themes)! Last but not least we thank Springer for all their professional support in putting together this LNCS volume.

January 2014

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Organization

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