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Mathematics in Computer Science

Foreword to the Special Focus on Advances in Symbolic and Numeric Computation II

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The present Special Focus of *Mathematics in Computer Science* is connected to SYMCOMP2017, the 3rd International Conference on Numerical and Symbolic Computation, which was held on April 6–7, 2017, in Guimarães, Minho, Portugal. This ECCOMAS Thematic Conference was a joint organization of IDMEC (Mechanical Engineering Institute) and University of Minho, under the auspice of APMTAC (Portuguese Society of Theoretical, Applied and Computational Mechanics).

The conference was also sponsored by Wolfram Research which distinguished two Young Researchers for their relevant works.

The conference proceedings book is published on-line as a 426-page .pdf file at ECCOMAS website, being accessible at http://www.eccomas.org/spacehome/1/10.

Most of the papers in this issue are extended versions of papers presented at the 3rd International Conference on Numerical and Symbolic Computation, and reflect the multidisciplinary character of this thematic conference. Both, numerical and symbolic computation techniques and methods are recognised as central tools in numerous fields of science and technology and it is with this perspective that the seven papers included on this Special Focus were selected.

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The main topics presented in these papers are summarized next:

Analysis and optimal control of an intracellular delayed HIV model with CTL immune response. Karam Allali, Sanaa Harroudi, Delfim F. M. Torres

This paper investigates a delayed model describing the dynamics of HIV (Human Immunodeficiency Virus) with CTL (Cytotoxic T Lymphocytes) immune response. The model includes four nonlinear differential equations describing the evolution of uninfected, infected, free HIV viruses, and CTL immune response cells. It includes also intracellular delay and two treatments (two controls). While the aim of the first treatment consists to block the viral proliferation, the role of the second is to prevent new infections. Firstly, the authors prove the well-posedness of the problem by establishing some positivity and boundedness results. Next, they give some conditions that insure the local asymptotic stability of the endemic and free equilibria. Finally, an optimal control problem, associated with the intracellular delayed HIV model with CTL immune response, is posed and investigated. The problem is shown to have a unique solution, characterized via Pontryagin's minimum principle for problems with delays. Numerical simulations are performed, confirming stability of the free and endemic equilibria and illustrating the effectiveness of the two incorporated treatments via optimal control.

PageRank Computation with MAAOR and Lumping Methods. I. R. Mendes and P. B. Vasconcelos

PageRank is a numerical method that Google uses to compute a page's importance, by assigning a score to every web page. PageRank is thus at the basis of Google's search engine success and can be mathematically explored either as an eigenvalue problem or as the solution of a homogeneous linear system. In both cases the Google matrix involved is large and sparse, so tuned algorithms must be developed to tackle it with the lowest computational cost and minimum memory requirements. In this work the recent Matrix Analogue of the Accelerated OverRelaxation (MAAOR) iterative method is explored for the PageRank computation. Additionally Lumping methods have been applied to the eigenproblem formulation and the authors propose a novel approach combining the Lumping and MAAOR methods for the solution of the linear system. Numerical experiments illustrating the MAAOR method and the MAAOR method combined with Lumping techniques applied to PageRank computations are presented.

A New One-Parameter Invariant Function for Algebras. J.M. Escobar, J. Núñez, P. Pérez-Fernández

In 2009, Hrivnák and Novotný introduced the ψ and ϕ one-parameter invariant functions and by taking their procedure into consideration the authors introduced the invariant two-parameter function $\bar{\psi}$. In the present paper a new one-parameter invariant function for algebras is introduced, the v function, which is related with $\bar{\psi}$. The values of this new function for several types of algebras are determined, particularly for filiform Lie algebras and Malcev algebras, and for the algebra induced by the Lorentz group SO(3); which allows proving that the n-dimensional classical-mechanical model built upon certain types of n-dimensional Lie algebras cannot be obtained as a limit process of a quantum-mechanical model based on a n-dimensional Heisenberg algebra, for certain values of n. It is also conjecture that $v \geq \psi$ for any algebra, which is indeed true for algebras of lower dimensions.

Symbolic approach to the general quadratic polynomial decomposition. Ângela Macedo, Teresa A. Mesquita, Zélia da Rocha

This work deals with a symbolic approach to the general quadratic polynomial decomposition. By means of a symbolic implementation, the authors investigate some properties of the components sequences like orthogonality and symmetry. Explicit results for a collection of well-known orthogonal cases are presented to illustrate this study.

Mixed precision bisection. Rui Ralha

This paper discusses the implementation of the bisection algorithm for the computation of the eigenvalues of symmetric tridiagonal matrices in a context of mixed precision arithmetic. This approach is motivated by the emergence of processors which carry out floating-point operations much faster in single precision than they do in

double precision. Perturbation theory results are used to decide when to switch from single to double precision. Numerical examples are considered to illustrate the present approach.

Dealing with functional coefficients within tau method. M. Trindade, J. Matos and P. B. Vasconcelos

This paper considers three approaches to tackle integro-differential equations with non-polynomial coefficients: (i) making use of function of matrices, (ii) applying orthogonal interpolation and (iii) solving auxiliary differential problems by the tau method itself. These approaches are part of the Tau Toolbox efforts for deploying a numerical library for the solution of integro-differential problems. Numerical experiments illustrate the use of all these polynomial approximations in the context of the tau method.

Solving differential and integral equations with Tau method. J.C. Matos, J.M.A. Matos, M.J. Rodrigues

The authors present a new approach for the implementation of operational Tau method for the solutions of linear differential and integral equations. In this approach they use the three terms relation of an orthogonal polynomial basis to compute the operational matrices. The paper illustrates this approach by giving a set of numerical applications of operational matrices to solve differential and integral problems using the operational Tau method.

As Guest Editors, we are very pleased to have been involved in the construction of this Special Focus and in making it now available to community.

We sincerely thank the authors of these contributions and also the anonymous referees who kindly volunteered their time to review these papers. Finally, we also wish to express our special thanks to the Editor-in-Chief, Professor Dongming Wang and to the Managing Editor, Professor Ilias Kotsireas for the opportunity to publish in *Mathematics in Computer Science*, as well as to the editorial staff, for their help and support.