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Domingo Barrera
Sara Remogna
Driss Sbibih *Editors*

Mathematical and Computational Methods for Modelling, Approximation and Simulation

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Springer

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Preface

This volume contains three plenary lectures presented at the International Conference on Mathematical and Computational Modelling, Approximation and Simulation (MACMAS 2019) which was held from 9 to 11 September 2019 in Granada, Spain, as well as nine contributed papers from the different topics covered at the conference.

MACMAS 2019 was jointly organized by the University of Granada (Spain), the Mohammed I University (Morocco), and the University of Torino (Italy).

MACMAS is a new phase in the series of international conferences on approximation methods and numerical modelling in environment and natural resources held every 2 years from 2005 to 2017. The following are among its goals:

- Gather the researchers interested on the fields of approximation, numerical modelling, and their applications.
- Reinforce the scientific interchange between researches from different countries, with special emphasis on the Mediterranean basin and neighborhood.
- Encourage young researchers to present the results of their scientific works.
- Help new international research projects to arise by facilitating contacts between tentative partners.

Stefano De Marchi, Pablo Pedregal, and Alessandra Sestini gave plenary lectures, sharing their research results with the participants.

Stefano de Marchi is an associate professor at the University of Padova (Italy), with habilitation to Full Professor of Numerical Analysis. Since 2005, he has been the coordinator of the "CAA Research Group" (Constructive Approximation and Applications), between the Universities of Verona and Padova. In addition, he has been responsible of the Italian Mathematical Union Thematic Group on Approximation Theory and Applications. His current main research topics are mapped bases approximation, RBF variably scaled discontinuous kernels, RBF and meshless approximation, multivariate polynomial approximation, and cubature.

Stefano De Marchi's plenary lecture dealt with the solution of approximation problems by polynomials to reduce Runge and Gibbs phenomena. The main idea is to avoid resampling the function or data and to rely on the mapped polynomials

or "fake" nodes approach. This technique turns out to be effective for stability by reducing the Runge effect and also in the presence of discontinuities by almost cancelling the Gibbs phenomenon. This technique is also applied to rational approximation and quadrature.

Pablo Pedregal obtained his bachelor's degree in mathematics in Madrid (Universidad Complutense de Madrid, 1986), and he moved to the United States to pursue his PhD, obtained at the University of Minnesota at the end of 1989, under the direction of David Kinderlehrer. He is currently full professor at the University of Castilla-La Mancha after a period at the Complutense University of Madrid as associate professor. His field of work is variational techniques applied to optimization problems in a very broad sense, covering the calculus of variations, non-convex vector problems, optimal design in continuous media, and optimal control.

Pablo Pedregal's plenary lecture focuses on two specific problems that show the enormous difficulties that arise when studying models that depend on the highly non-linear behavior of a system of partial differential equations. The first one is motivated by inverse problems in conductivity and the process to recover an unknown conductivity coefficient from measurements in the boundary. The second addresses an optimal control problem for soft robots. This paper has an outreach character to draw attention to these areas of research.

Alessandra Sestini is associate professor at the University of Firenze (Italy), with habilitation to Full Professor of Numerical Analysis. She has participated in several projects of the "Gruppo Nazionale per il Calcolo Scientifico," having been the responsible researcher in 2012 and 2019. In recent years, she has also conducted her research into the 5-year project "Splines for accUrate NumeRics: adaptIve models for Simulation Environments (SUNRISE)" of the INdAM *Istituto Nazionale di Alta Matematica ‹‹Francesco Severi››*. Her current research interests are numerical methods for approximation and for graphics, spline theory, numerical methods for ODEs, and isogeometric analysis.

Alessandra Sestini's plenary lecture is a collaborative work with Cesare Bracco, Carlotta Giannelli, David Großmann, Sofia Imperatore, and Dominik Mokriš, in which they present a two-stage scattered data fitting with truncated hierarchical B-splines (THB-splines) for the adaptive reconstruction of industrial models. The first stage deals with the computation of local least squares variational spline approximations. The second one involves hierarchical spline quasi-interpolation based on THB-splines to construct the adaptive spline surface approximating the whole scattered data set, and a suitable strategy to guide the adaptive refinement is introduced. A selection of examples on geometric models representing components of aircraft turbine blades highlights the performance of the scheme.

Following the end of MACMAS 2019, a call for papers was opened. The submissions received underwent a peer-review process and nine manuscripts were retained for publication.

The chapters by Abbadi and Ibáñez and Rahouti et al. deal with the construction of univariate quasi-interpolants, which somewhat complement the results in the literature and offer approximation schemes potentially useful in practice. Quasi-

interpolation is a subject that has attracted and continues to attract the interest not only of those working in the field of approximation theory but also of those who require tools to be used in practice. An example of this is the chapter by Sestini. The chapters by Allouch et al., Bellour et al., and Barrera et al. use spline quasi-interpolation to numerically solve Fredholm and Hammerstein integral equations, which are relevant areas in terms of the application of numerical methods. The chapter by Mbarki and Oubrahim provides new results on the notion of convexity in probabilistic metric spaces, which are applied to the study of the existence and uniqueness of the solution of a Volterra equation. The chapter by Korikache and Paquet focuses on the completely discretized problem of the dual mixed formulation for the heat diffusion equation in a polygonal domain by the Crank-Nicolson scheme in time. The authors show the existence and the stability, and provide *a priori* error estimates for the solution. The chapter by Akhrif et al. proposes the application of smoothing splines to the study of decomposed statistical series. The general scheme is illustrated by applying it to economic data from Morocco and Venezuela. The chapter by Illescas-Manzano et al. deals with the analysis of poverty measures, which is a topic of increased interest to society. This chapter contributes to the literature by developing percentile ratio estimators when there are missing data.

We want to thank all the contributors who have coauthored the chapters contained in this volume, as well as the anonymous referees who have revised the manuscripts, improving them with their comments and suggestions.

We would also like to express our gratitude to Francesca Bonadei from Springer for her patience, attention, and support at every step of the editorial process.

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