

Contributions to Statistics

The series **Contributions to Statistics** contains publications in theoretical and applied statistics, including for example applications in medical statistics, biometrics, econometrics and computational statistics. These publications are primarily monographs and multiple author works containing new research results, but conference and congress reports are also considered.

Apart from the contribution to scientific progress presented, it is a notable characteristic of the series that publishing time is very short, permitting authors and editors to present their results without delay.

More information about this series at <http://www.springer.com/series/2912>

S. Ejaz Ahmed • Francisco Carvalho •
Simo Puntanen
Editors

Matrices, Statistics and Big Data

Selected Contributions from IWMS 2016

 Springer

Editors

S. Ejaz Ahmed
Department of Mathematics and Statistics
Brock University
St. Catharines, ON, Canada

Francisco Carvalho
Departmental Unit of Mathematics
and Physics
Polytechnic Institute of Tomar
Tomar, Portugal

Simo Puntanen
Faculty of Natural Sciences
University of Tampere
Tampere, Finland

ISSN 1431-1968

Contributions to Statistics

ISBN 978-3-030-17518-4

ISBN 978-3-030-17519-1 (eBook)

<https://doi.org/10.1007/978-3-030-17519-1>

Mathematics Subject Classification (2010): 60-xx, 15-xx, 62Hxx, 62Jxx, 62Kxx, 62-07, 15Axx, 15Bxx, 60Jxx

© Springer Nature Switzerland AG 2019

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To Ingram Olkin

Preface

The 25th International Workshop on Matrices and Statistics (IWMS-2016) was held in the city of Funchal on the beautiful Madeira Island, the Pearl of the Atlantic, on 6–9 June 2016.

The purpose of this workshop was to bring together researchers sharing an interest in a variety of aspects of statistics and its applications as well as matrix analysis and its applications to statistics and to offer them a possibility to discuss current developments in these subjects. The workshop contributed to bridge the gap among statisticians, computer scientists, and mathematicians in understanding each other's tools.

The Local Organizing Committee was chaired by Francisco Carvalho (Tomar, Portugal) and the International Organizing Committee by Simo Puntanen (Tampere, Finland), while George P. H. Styan (Montréal, Québec, Canada) was the Honorary Chair.

IWMS-2016 was organized by the Instituto Politécnico de Tomar and Universidade da Madeira and was supported by the CMA (Centro de Matemática e Aplicações) (FCT, UNL), CIMA (Centro de Investigação em Matemática e Aplicações) (UE), PSE (Produtos e Serviços de Estatística), INE (Instituto Nacional de Estatística), FLAD (Fundação Luso-Americana para o Desenvolvimento), Delta Cafés, and Associação de Promoção da Madeira.

The workshop comprised invited talks, contributed talks, and special sessions; for the details, see the conference report on IWMS-2016 in *IMAGE*, The Bulletin of the International Linear Algebra Society, Issue Number 57, pp. 18–19. The [final program](#) and the *Book of Abstracts*, edited by Daniel Klein and Francisco Carvalho, are online on the IWMS-2016 [website](#).

For previous IWMS workshops, see the [IWMS-website](#), from where, for example, “a short history of the International Workshop on Matrices and Statistics” can be downloaded: online [pdf](#). The 26th International Workshop on Matrices and Statistics was held in Montréal, Québec, Canada, in 2018, and the 27th International Workshop on Matrices and Statistics will be held in Shanghai, China, in 2019.

This volume, *Matrices, Statistics, and Big Data*, in the series Contributions to Statistics published by Springer, comprises selected refereed papers presented at the IWMS-2016.

We would like to thank all the authors for their valuable contributions to this volume. Our special thanks go to all the reviewers for their diligent reviews.

St. Catharines, ON, Canada
Tomar, Portugal
Tampere, Finland
October 2018

S. Ejaz Ahmed
Francisco Carvalho
Simo Puntanen

Contents

Further Properties of the Linear Sufficiency in the Partitioned Linear Model	1
Augustyn Markiewicz and Simo Puntanen	
Hybrid Model for Recurrent Event Data	23
Ivo Sousa-Ferreira and Ana Maria Abreu	
A New Look at Combining Information from Stratum Submodels	35
Radosław Kala	
Ingram Olkin (1924–2016): An Appreciation for a People Person	51
Simo Puntanen and George P. H. Styan	
A Notion of Positive Definiteness for Arithmetical Functions	61
Mika Mattila and Pentti Haukkanen	
Some Issues in Generalized Linear Modeling	75
Alan Agresti	
Orthogonal Block Structure and Uniformly Best Linear Unbiased Estimators	89
Sandra S. Ferreira, Dário Ferreira, Célia Nunes, Francisco Carvalho, and João Tiago Mexia	
Hadamard Matrices on Error Detection and Correction: Useful Links to BIBD	99
Carla Francisco, Teresa A. Oliveira, Amílcar Oliveira, and Francisco Carvalho	
Covariance Matrix Regularization for Banded Toeplitz Structure via Frobenius-Norm Discrepancy	111
Xiangzhao Cui, Zhenyang Li, Jine Zhao, Defei Zhang, and Jianxin Pan	

Penalized Relative Error Estimation of a Partially Functional Linear Multiplicative Model	127
Tao Zhang, Yuan Huang, Qingzhao Zhang, Shuangge Ma, and S. Ejaz Ahmed	
High-Dimensional Regression Under Correlated Design: An Extensive Simulation Study	145
S. Ejaz Ahmed, Hwanwoo Kim, Gökhan Yıldırım, and Bahadır Yüzbaşı	
An Efficient Estimation Strategy in Autoregressive Conditional Poisson Model with Applications to Hospital Emergency Department Data	177
S. Ejaz Ahmed, Khalifa Es-Sebaiy, Abdulkadir Hussein, Idir Ouassou, and Anne Snowdon	

Contributors

Ana Maria Abreu Universidade da Madeira, Funchal, Portugal

CIMA—Centro de Investigação em Matemática e Aplicações, Universidade da Madeira, Funchal, Portugal

Alan Agresti University of Florida, Gainesville, FL, USA

S. Ejaz Ahmed Department of Mathematics and Statistics, Brock University, St. Catharines, ON, Canada

Francisco Carvalho Departmental Unit of Mathematics and Physics, Polytechnic Institute of Tomar and Center of Mathematics and Applications, FCT/UNL, Monte da Caparica, Portugal

Xiangzhao Cui School of Mathematics, University of Honghe, Yunnan, China

Khalifa Es-Sebaïy National School of Applied Sciences, Marrakech, Morocco

Dário Ferreira Department of Mathematics and Center of Mathematics and Applications, University of Beira Interior, Covilhã, Portugal

Sandra S. Ferreira Department of Mathematics and Center of Mathematics and Applications, University of Beira Interior, Covilhã, Portugal

Carla Francisco Département des Sciences du Bois et de la Forêt, Université Laval, Québec, QC, Canada

Pentti Haukkanen School of Information Sciences, University of Tampere, Tampere, Finland

Yuan Huang Department of Biostatistics, University of Iowa, Iowa City, IA, USA

Abdulkadir Hussein University of Windsor, Windsor, ON, Canada

Radosław Kala Department of Mathematical and Statistical Methods, Poznań University of Life Sciences, Poznań, Poland

Hwanwoo Kim Department of Statistics, University of Michigan, Ann Arbor, MI, USA

Zhenyang Li School of Mathematics, University of Honghe, Yunnan, China

Shuangge Ma Department of Biostatistics, Yale University, New Haven, CT, USA
VA Cooperative Studies Program Coordinating Center, West Haven, CT, USA

Augustyn Markiewicz Department of Mathematical and Statistical Methods,
Poznań University of Life Sciences, Poznań, Poland

Mika Mattila Department of Mathematics, Tampere University of Technology,
Tampere, Finland

João Tiago Mexia Department of Mathematics and Center of Mathematics and
Applications, FCT/Universidade Nova de Lisboa, Monte da Caparica, Portugal

Célia Nunes Department of Mathematics and Center of Mathematics and Applica-
tions, University of Beira Interior, Covilhã, Portugal

Amílcar Oliveira Departamento de Ciências e Tecnologia, Universidade Aberta,
Lisboa, Portugal

Centro de Estatística e Aplicações, Universidade de Lisboa, Lisboa, Portugal

Teresa A. Oliveira Departamento de Ciências e Tecnologia, Universidade
Aberta, Lisboa, Portugal

Centro de Estatística e Aplicações, Universidade de Lisboa, Lisboa, Portugal

Idir Ouassou National School of Applied Sciences, Marrakech, Morocco

Simo Puntanen Faculty of Natural Sciences, University of Tampere, Tampere,
Finland

Jianxin Pan School of Mathematics, University of Manchester, Manchester, UK

George P. H. Styan Department of Mathematics and Statistics, McGill University,
Montréal, QC, Canada

Anne Snowdon University of Windsor, Windsor, ON, Canada

Ivo Sousa-Ferreira Universidade da Madeira, Funchal, Portugal

Gökhan Yıldırım Department of Mathematics and Statistics, York University,
Toronto, ON Canada

Bahadır Yüzbaşı Department of Econometrics, Inonu University, Malatya, Turkey

Defei Zhang School of Mathematics, University of Honghe, Yunnan, China

Tao Zhang School of Science, Guangxi University of Science and Technology,
Liuzhou, China

Qingzhao Zhang School of Economics and The Wang Yanan Institute for Studies
in Economics, Xiamen University, Xiamen, China

Jine Zhao School of Mathematics, University of Honghe, Yunnan, China