Smart Innovation, Systems and Technologies

Volume 102

Series editors

Robert James Howlett, Bournemouth University and KES International, Shoreham-by-sea, UK
e-mail: rjhowlett@kesinternational.org

Lakhmi C. Jain, University of Technology Sydney, Broadway, Australia; University of Canberra, Canberra, Australia; KES International, UK
e-mail: jainlakhmi@gmail.com; jainlc2002@yahoo.co.uk

The Smart Innovation, Systems and Technologies book series encompasses the topics of knowledge, intelligence, innovation and sustainability. The aim of the series is to make available a platform for the publication of books on all aspects of single and multi-disciplinary research on these themes in order to make the latest results available in a readily-accessible form. Volumes on interdisciplinary research combining two or more of these areas is particularly sought.

The series covers systems and paradigms that employ knowledge and intelligence in a broad sense. Its scope is systems having embedded knowledge and intelligence, which may be applied to the solution of world problems in industry, the environment and the community. It also focusses on the knowledge-transfer methodologies and innovation strategies employed to make this happen effectively. The combination of intelligent systems tools and a broad range of applications introduces a need for a synergy of disciplines from science, technology, business and the humanities. The series will include conference proceedings, edited collections, monographs, handbooks, reference books, and other relevant types of book in areas of science and technology where smart systems and technologies can offer innovative solutions.

High quality content is an essential feature for all book proposals accepted for the series. It is expected that editors of all accepted volumes will ensure that contributions are subjected to an appropriate level of reviewing process and adhere to KES quality principles.

More information about this series at http://www.springer.com/series/8767

Anna Esposito · Marcos Faundez-Zanuy
Francesco Carlo Morabito · Eros Pasero
Editors

Neural Advances in Processing Nonlinear Dynamic Signals

Springer

Editors
Anna Esposito
Dipartimento di Psicologia
Università della Campana Luigi Vanvitelli
Caserta, Italy

and

International Institute for Advanced Scientific Studies (IIASS)
Vietri sul Mare, Italy

Marcos Faundez-Zanuy
Fundació Tecnocampus
Pompeu Fabra University
Mataro, Barcelona, Spain

Francesco Carlo Morabito
Department of Civil, Environmental, Energy, and Material Engineering
University Mediterranea of Reggio Calabria
Reggio Calabria, Italy

Eros Pasero
Laboratorio di Neuronica, Dipartimento Elettronica e Telecomunicazioni
Politecnico di Torino
Torino, Italy

ISSN 2190-3018 ISSN 2190-3026 (electronic)
Smart Innovation, Systems and Technologies
ISBN 978-3-319-95097-6 ISBN 978-3-319-95098-3 (eBook)
https://doi.org/10.1007/978-3-319-95098-3

Library of Congress Control Number: 2018946683

© Springer International Publishing AG, part of Springer Nature 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.

Printed on acid-free paper

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

Preface

This book proposes neural network algorithms and advanced machine learning techniques for processing nonlinear dynamic signals such as audio, speech, financial signals, feedback loops, waveform generations, filtering, equalization, signals from arrays of sensors, and perturbation in the automatic control of industrial production processes.

Computational intelligence (CI) and information communication technologies (ICT) are research fields providing sophisticated processing methodologies able to develop appropriate transmission codes, detection, and recognition algorithms to manage promptly, efficiently, and effectively huge amount of data. To this aim, neural networks, deep learning networks, genetic algorithms, fuzzy logic, and complex artificial intelligence designs are favored because their easy handling of nonlinearities while discovering new data structure and new original patterns to enhance the efficiency of industrial and economic applications.

The growing interest in these research areas favors the presentation of a book devoted to collect the current progress in *Neural Advances in Processing Nonlinear Dynamic Signals* and shows the latest evolvements in these communities.

Key aspects considered are the integration of neural adaptive algorithms for the recognition, analysis, and detection of dynamic complex structures and the implementation of systems for discovering patterns in industrial and economic data. The primary goal is to exploit the commonalities between computational intelligence (CI) and information communication technologies (ICT) to promote transversal skills and sophisticated processing techniques in industrial and economic application.

The proposed contributions introduce computational intelligence thematic in financial, industrial, and ICT engineering research. These fields are closely connected to the problems they afford and provide fundamental insights for cross-exchanges among these disciplines.

The chapters composing this book were first discussed at the international workshop on neural networks (WIRN 2017) held in Vietri Sul Mare from June 14 to June16, 2017, in the regular and special sessions. In particular, it is worth to mention the special session on: "**Computational Intelligence and related**

techniques in industrial and ICT engineering" organized by Giovanni Angiulli, Mario Versaci, and the special session on "**Intelligent tools for decision making in economics and finance**" organized by Marco Corazza.

The scientists contributing to this book are specialists in their respective disciplines. We are indebted to them for making (through their chapters) the book a meaningful effort. The coordination and production of this book have been brilliantly conducted by the Springer project coordinator for books production Mr. Ayyasamy Gowrishankar, the Springer executive editor Dr. Thomas Ditzinger, and the editor assistant Mr. Holger Schaepe. They are the recipient of our deepest appreciation. This initiative has been skillfully supported by the editors in chief of the Springer series Smart Innovation, Systems and Technologies, Profs. Jain Lakhmi C. and Howlett Robert James, to whom goes out deepest gratitude.

Caserta, Itlay/Vietri sul Mare, Italy	Anna Esposito
Mataro, Spain	Marcos Faundez-Zanuy
Reggio Calabria, Italy	Francesco Carlo Morabito
Torino, Italy	Eros Pasero

The chapters submitted to this book have been carefully reviewed by the following technical committee to which the editors are extremely grateful.

Technical Reviewer Committee

Altilio Rosa, Università di Roma "La Sapienza"
Alonso-Martinez Carlos, Universitat Pompeu Fabra
Angiulli Giovanni, Università Mediterranea di Reggio Calabria
Bevilacqua Vitoantonio, Politecnico di Bari
Bramanti Alessia, ISASI-CNR "Eduardo Caianiello" Messina
Brandenburger Jens, VDEh-Betriebsforschungsinstitut GmbH, BFI, Dusseldorf
Buonanno Amedeo, Università degli Studi della Campania "Luigi Vanvitelli"
Camastra Francesco, Università Napoli Parthenope
Carcangiu Sara, University of Cagliari
Campolo Maurizio, Università degli Studi Mediterranea Reggio Calabria
Capuano Vincenzo, Seconda Università di Napoli
Cauteruccio Francesco, Università degli Studi della Calabria
Celotto Emilio, Ca' Foscari University of Venice
Ciaramella Angelo, Università Napoli Parthenope
Ciccarelli Valentina, Università di Roma "La Sapienza"
Cirrincione Giansalvo, UPJV
Colla Valentina, Scuola Superiore S. Anna
Comajuncosas Andreu, Universitat Pompeu Fabra
Commimiello Danilo, Università di Roma "La Sapienza"
Committeri Giorgia, Università di Chieti

Cordasco Gennaro, Seconda Università di Napoli
De Carlo Domenico, Università Mediterranea di Reggio Calabria
De Felice Domenico, Università Napoli Parthenope
Dell'Orco Silvia, Università degli Studi della Basilicata
Diaz Moises, Universidad del Atlántico Medio
Droghini Diego, Università Politecnica delle Marche
Ellero Andrea, Ca' Foscari University of Venice
Esposito Anna, Università degli Studi della Campania "Luigi Vanvitelli" and IIASS
Esposito Antonietta Maria, sezione di Napoli Osservatorio Vesuviano
Esposito Francesco, Università di Napoli Parthenope
Esposito Marilena, International Institute for Advanced Scientific Studies (IIASS)
Faundez-Zanuy Marcos, Universitat Pompeu Fabra
Ferretti Paola, Ca' Foscari University of Venice
Gallicchio Claudio, University of Pisa
Giove Silvio, University of Venice
Giribone Pier Giuseppe, Banca Carige, Financial Engineering and Pricing
Kumar Rahul, University of South Pacific
Ieracitano Cosimo, Università degli Studi Mediterranea Reggio Calabria
Inuso Giuseppina, University Mediterranea of Reggio Calabria
Invitto Sara, Università del Salento
La Foresta Fabio, Università degli Studi Mediterranea Reggio Calabria
Lenori Stefano, University of Rome "La Sapienza"
Lo Giudice Paolo, University "Mediterranea" of Reggio Calabria
Lupelli Ivan, Culham Centre for Fusion Energy
Maldonato Mauro, Università di Napoli "Federico II"
Manghisi Vito, Politecnico di Bari
Mammone Nadia, IRCCS Centro Neurolesi Bonino-Pulejo, Messina
Maratea Antonio, Università Napoli Parthenope
Marcolin Federica, Politecnico di Torino
Martinez Olalla Rafael, Universidad Politécnica de Madrid
Matarazzo Olimpia, Seconda Università di Napoli
Mekyska Jiri, Brno University
Micheli Alessio, University of Pisa
Militello Carmelo, Consiglio Nazionale delle Ricerche (IBFM-CNR), Cefalù (PA)
Militello Fulvio, Culham Centre for Fusion Energy
Monda Vincenzo, Università degli Studi della Campania "Luigi Vanvitelli"
Morabito Francesco Carlo, Università Mediterranea di Reggio Calabria
Nardone Davide, Università di Napoli "Parthenope"
Narejo Sanam, Politecnico di Torino
Neffelli Marco, University of Genova
Parisi Raffaele, Università di Roma "La Sapienza"
Paschero Maurizio, University of Rome "La Sapienza"
Pedrelli Luca, University of Pisa
Portero-Tresserra Marta, Universitat Pompeu Fabra
Principi Emanuele, Università Politecnica delle Marche

Josep Roure, Universitat Pompeu Fabra
Rovetta Stefano, Università di Genova (IT)
Rundo Leonardo, Università degli Studi di Milano-Bicocca
Salvi Giampiero, KTH, Sweden
Sappey-Marinier Dominique, Université de Lyon
Scardapane Simone, Università di Roma "La Sapienza"
Scarpiniti Michele, Università di Roma "La Sapienza"
Senese Vincenzo Paolo, Seconda Università di Napoli
Sesa-Nogueras Enric, Universitat Pompeu Fabra
Sgrò Annalisa, Università Mediterranea di Reggio Calabria
Staiano Antonino, Università Napoli Parthenope
Stamile Claudio, Université de Lyon
Statue-Villar Antonio, Universitat Pompeu Fabra
Suchacka Grażyna, Opole University
Taisch Marco, Politecnico di Milano
Terracina Giorgio, Università della Calabria
Theoharatos Christos, Computer Vision Systems, IRIDA Labs S.A.
Troncone Alda, Seconda Università di Napoli
Vitabile Salvatore, Università degli Studi di Palermo
Xavier Font-Aragones, Universitat Pompeu Fabra
Uncini Aurelio, Università di Roma "La Sapienza"
Ursino Domenico, Università Mediterranea di Reggio Calabria
Vasquez Juan Camilo, University of Antioquia
Vesperini Fabio, Università Politecnica delle Marche
Vitabile Salvatore, Università degli Studi di Palermo
Wesenberg Kjaer Troels, Zealand University Hospital
Walkden Nick, Culham Centre for Fusion Energy
Zucco Gesualdo, Università di Padova

Sponsoring Institutions

International Institute for Advanced Scientific Studies (IIASS) of Vietri S/M (Italy)
Department of Psychology, Università degli Studi della Campania "Luigi Vanvitelli" (Italy)
Provincia di Salerno (Italy)
Comune di Vietri sul Mare, Salerno (Italy)
International Neural Network Society (INNS)
Università Mediterranea di Reggio Calabria (Italy)

Contents

Part I Introduction

1 Processing Nonlinearities 3
Anna Esposito, Marcos Faundez-Zanuy, Francesco Carlo Morabito and Eros Pasero

Part II Processing Nonlinearities

2 Temporal Artifacts from Edge Accumulation in Social Interaction Networks 11
Matt Revelle, Carlotta Domeniconi and Aditya Johri

3 Data Mining by Evolving Agents for Clusters Discovery and Metric Learning 23
Alessio Martino, Mauro Giampieri, Massimiliano Luzi and Antonello Rizzi

4 Neural Beamforming for Speech Enhancement: Preliminary Results 37
Stefano Tomassetti, Leonardo Gabrielli, Emanuele Principi, Daniele Ferretti and Stefano Squartini

5 Error Resilient Neural Networks on Low-Dimensional Manifolds 49
Alexander Petukhov and Inna Kozlov

6 FIS Synthesis by Clustering for Microgrid Energy Management Systems 61
Stefano Leonori, Maurizio Paschero, Antonello Rizzi and Fabio Massimo Frattale Mascioli

7 Learning Activation Functions from Data Using Cubic Spline Interpolation 73
Simone Scardapane, Michele Scarpiniti, Danilo Comminiello and Aurelio Uncini

8 Context Analysis Using a Bayesian Normal Graph 85
Amedeo Buonanno, Paola Iadicicco, Giovanni Di Gennaro and Francesco A. N. Palmieri

9 A Classification Approach to Modeling Financial Time Series 97
Rosa Altilio, Giorgio Andreasi and Massimo Panella

10 A Low-Complexity Linear-in-the-Parameters Nonlinear Filter for Distorted Speech Signals 107
Danilo Comminiello, Michele Scarpiniti, Simone Scardapane, Raffaele Parisi and Aurelio Uncini

11 Hierarchical Temporal Representation in Linear Reservoir Computing 119
Claudio Gallicchio, Alessio Micheli and Luca Pedrelli

12 On 4-Dimensional Hypercomplex Algebras in Adaptive Signal Processing 131
Francesca Ortolani, Danilo Comminiello, Michele Scarpiniti and Aurelio Uncini

13 Separation of Drum and Bass from Monaural Tracks 141
Michele Scarpiniti, Simone Scardapane, Danilo Comminiello, Raffaele Parisi and Aurelio Uncini

14 Intelligent Quality Assessment of Geometrical Features for 3D Face Recognition 153
G. Cirrincione, F. Marcolin, S. Spada and E. Vezzetti

Part III Computational Intelligence and Related Techniques in Industrial and ICT Engineering

15 Convolutional Neural Networks for the Identification of Filaments from Fast Visual Imaging Cameras in Tokamak Reactors 167
Barbara Cannas, Sara Carcangiu, Alessandra Fanni, Ivan Lupelli, Fulvio Militello, Augusto Montisci, Fabio Pisano, Giuliana Sias and Nick Walkden

16 Applying Network Analysis for Extracting Knowledge About Environment Changes from Heterogeneous Sensor Data Streams 179
Francesco Cauteruccio, Paolo Lo Giudice, Giorgio Terracina and Domenico Ursino

17 Advanced Computational Intelligence Techniques to Detect and Reconstruct Damages in Reinforced Concrete for Industrial Applications 191
Salvatore Calcagno and Fabio La Foresta

18 Appraisal of Enhanced Surrogate Models for Substrate Integrate Waveguide Devices Characterization 201
Domenico De Carlo, Annalisa Sgrò and Salvatore Calcagno

19 Improving the Stability of Variable Selection for Industrial Datasets 209
Silvia Cateni, Valentina Colla and Vincenzo Iannino

20 Cause and Effect Analysis in a Real Industrial Context: Study of a Particular Application Devoted to Quality Improvement 219
Silvia Cateni, Valentina Colla, Antonella Vignali and Jens Brandenburger

21 An Improved PSO for Flexible Parameters Identification of Lithium Cells Equivalent Circuit Models 229
Massimiliano Luzi, Maurizio Paschero, Antonello Rizzi and Fabio Massimo Frattale Mascioli

Part IV Intelligent Tools for Decision Making in Economics and Finance

22 Yield Curve Estimation Under Extreme Conditions: Do RBF Networks Perform Better? 241
Alessia Cafferata, Pier Giuseppe Giribone, Marco Neffelli and Marina Resta

23 New Challenges in Pension Industry: Proposals of Personal Pension Products 253
Valeria D'Amato, Emilia Di Lorenzo and Marilena Sibillo

24 A PSO-Based Framework for Nonsmooth Portfolio Selection Problems 265
Marco Corazza, Giacomo di Tollo, Giovanni Fasano and Raffaele Pesenti

25 Can PSO Improve TA-Based Trading Systems? 277
Marco Corazza, Francesca Parpinel and Claudio Pizzi

26 Asymmetry Degree as a Tool for Comparing Interestingness Measures in Decision Making: The Case of Bayesian Confirmation Measures 289
Emilio Celotto, Andrea Ellero and Paola Ferretti

27 A Method Based on OWA Operator for Scientific Research Evaluation 299
Marta Cardin, Giuseppe De Nadai and Silvio Giove

28 A Cluster Analysis Approach for Rule Base Reduction 307
Luca Anzilli and Silvio Giove