

António E. Ruano and Annamária R. Várkonyi-Kóczy (Eds.)

New Advances in Intelligent Signal Processing

Studies in Computational Intelligence, Volume 372

Editor-in-Chief

Prof. Janusz Kacprzyk
Systems Research Institute
Polish Academy of Sciences
ul. Newelska 6
01-447 Warsaw
Poland
E-mail: kacprzyk@ibspan.waw.pl

Further volumes of this series can be found on our homepage: springer.com

Vol. 351. Ngoc Thanh Nguyen, Bogdan Trawiński, and Jason J. Jung (Eds.)
New Challenges for Intelligent Information and Database Systems, 2011
ISBN 978-3-642-19952-3

Vol. 352. Nik Bessis and Fatos Xhafa (Eds.)
Next Generation Data Technologies for Collective Computational Intelligence, 2011
ISBN 978-3-642-20343-5

Vol. 353. Igor Aizenberg
Complex-Valued Neural Networks with Multi-Valued Neurons, 2011
ISBN 978-3-642-20352-7

Vol. 354. Ljupco Kocarev and Shiguo Lian (Eds.)
Chaos-Based Cryptography, 2011
ISBN 978-3-642-20541-5

Vol. 355. Yan Meng and Yaochu Jin (Eds.)
Bio-Inspired Self-Organizing Robotic Systems, 2011
ISBN 978-3-642-20759-4

Vol. 356. Sławomir Koziel and Xin-She Yang (Eds.)
Computational Optimization, Methods and Algorithms, 2011
ISBN 978-3-642-20858-4

Vol. 357. Nadia Nedjah, Leandro Santos Coelho, Viviana Cocco Mariani, and Luiza de Macedo Mourelle (Eds.)
Innovative Computing Methods and their Applications to Engineering Problems, 2011
ISBN 978-3-642-20957-4

Vol. 358. Norbert Jankowski, Włodzisław Duch, and Krzysztof Grańbczewski (Eds.)
Meta-Learning in Computational Intelligence, 2011
ISBN 978-3-642-20979-6

Vol. 359. Xin-She Yang, and Sławomir Koziel (Eds.)
Computational Optimization and Applications in Engineering and Industry, 2011
ISBN 978-3-642-20985-7

Vol. 360. Mikhail Moshkov and Beata Zielosko
Combinatorial Machine Learning, 2011
ISBN 978-3-642-20994-9

Vol. 361. Vincenzo Pallotta, Alessandro Soro, and Eloisa Vargiu (Eds.)
Advances in Distributed Agent-Based Retrieval Tools, 2011
ISBN 978-3-642-21383-0

Vol. 362. Pascal Bouvry, Horacio González-Vélez, and Joanna Kolodziej (Eds.)
Intelligent Decision Systems in Large-Scale Distributed Environments, 2011
ISBN 978-3-642-21270-3

Vol. 363. Kishan G. Mehrotra, Chilukuri Mohan, Jae C. Oh, Pramod K. Varshney, and Moonis Ali (Eds.)
Developing Concepts in Applied Intelligence, 2011
ISBN 978-3-642-21331-1

Vol. 364. Roger Lee (Ed.)
Computer and Information Science, 2011
ISBN 978-3-642-21377-9

Vol. 365. Roger Lee (Ed.)
Computers, Networks, Systems, and Industrial Engineering 2011, 2011
ISBN 978-3-642-21374-8

Vol. 366. Mario Köppen, Gerald Schaefer, and Ajith Abraham (Eds.)
Intelligent Computational Optimization in Engineering, 2011
ISBN 978-3-642-21704-3

Vol. 367. Gabriel Luque and Enrique Alba
Parallel Genetic Algorithms, 2011
ISBN 978-3-642-22083-8

Vol. 368. Roger Lee (Ed.)
Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing 2011, 2011
ISBN 978-3-642-22287-0

Vol. 369. Dominik Ryżko, Piotr Gawrysiak, Henryk Rybinski, and Marzena Kryszkiewicz (Eds.)
Emerging Intelligent Technologies in Industry, 2011
ISBN 978-3-642-22731-8

Vol. 370. Alexander Mehler, Kai-Uwe Kühnberger, Henning Lobin, Harald Lüngen, Angelika Storrer, and Andreas Witt (Eds.)
Modeling, Learning, and Processing of Text Technological Data Structures, 2011
ISBN 978-3-642-22612-0

Vol. 371. Leonid Perlovsky, Ross Deming, and Roman Ilin (Eds.)
Emotional Cognitive Neural Algorithms with Engineering Applications, 2011
ISBN 978-3-642-22829-2

Vol. 372. António E. Ruano and Annamária R. Várkonyi-Kóczy (Eds.)
New Advances in Intelligent Signal Processing, 2011
ISBN 978-3-642-11738-1

António E. Ruano and Annamária R. Várkonyi-Kóczy
(Eds.)

New Advances in Intelligent Signal Processing

Editors

Prof. António E. Ruano
Universidade do Algarve
CSI / Centre for Intelligent Systems
Campus de Gambelas
8000 Faro
Portugal
E-mail: aruano@ualg.pt

Prof. Annamária R. Várkonyi-Kóczy
Óbuda University
Dept. of Mechatronics and Vehicle Engineering
Népszínház u. 8
1081 Budapest
Hungary
E-mail: varkonyi-koczy@uni-obuda.hu

ISBN 978-3-642-11738-1

e-ISBN 978-3-642-11739-8

DOI 10.1007/978-3-642-11739-8

Studies in Computational Intelligence

ISSN 1860-949X

Library of Congress Control Number: 2011933574

© 2011 Springer-Verlag Berlin Heidelberg

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, 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.

Typeset & Cover Design: Scientific Publishing Services Pvt. Ltd., Chennai, India.

Printed on acid-free paper

9 8 7 6 5 4 3 2 1

springer.com

Preface

The *IEEE International Symposium on Intelligent Signal Processing (WISP)* event series celebrated its 10 years anniversary in 2009. The current volume “*New Advances in Intelligent Signal Processing*” contains extended works based on a careful selection of papers presented originally at the jubilee conference.

The importance of linking the scientific communities working in the fields of intelligent systems and signal processing was recognized in the late nineties by the IEEE Instrumentation and Measurement Society. Such facts that complex industrial and engineering systems, especially within the framework of large-scale embedded and real-time systems, confront researchers and engineers with completely new challenges, helped in setting up this new direction of science and research. Furthermore, it turned out that information processing and measurement is much more than originally meant: measurement and signal processing systems are involved in almost all kinds of activities in those fields, where control problems, system identification problems, industrial technologies, etc., are to be solved, i.e., when signals, parameters, or attributes must be measured, monitored, approximated, or estimated.

In a large number of cases, traditional information processing tools and equipment failed to handle the problems. Not only the handling of the previously unseen spatial and temporal complexity became questionable, but also problems had to be addressed such as the interaction and communication of subsystems based on entirely different modeling and information expression methods, the handling of abrupt changes within the environment and/or the processing system, the possible temporal shortage of computational power, and/or loss of some data, the uncertainty and ambiguity of the information, data, and perceptions, and last but not least, the new concepts of optimality and effectiveness.

The solution meant the introduction of new ideas for specifying, designing, implementing, and operating sophisticated signal processing systems. Computational intelligence, i.e., artificial intelligence, soft computing, anytime, and machine intelligence methods became serious candidates for handling many of the theoretical and practical problems, providing a better description, and, in many cases, proved to be the best if not the only alternatives for emphasizing significant aspects of system behavior.

Up until recently, however, these new techniques have not been widely used in the field of signal processing because some of the critical questions related to the design and verification have not been answered properly and because the uncertainty has been maintained in a quite different way as it is in the classical metrology.

These initiated the IEEE IM Society, the IEEE Hungary Section, and the European Association for Signal Processing to call to life a new event, hoping that it will become a series of regular meetings attracting more and more scientists and engineers in these hot topics. As result, the biannual symposium was launched in 1999.

Since that, five symposia have served as forum and catalyst of new theoretical and practical achievements in both the intelligent systems and signal processing communities. The continuous interest in WISP events has proved the soundness of the initiative, i.e., to link and counteract the scientific communities working in the fields of intelligent systems and signal processing.

The jubilee sixth IEEE International Symposium on Intelligent Signal Processing (WISP'2009), held in Budapest Hungary, August 26–28, 2009, contained 58 accepted papers out of the 81 submitted, from which 11 have been selected to incorporated in this volume. Present book does not intent to be an overall survey on the fields of interest of the area, but tries to find topics which represent new, hot, and challenging problems.

The book begins with papers investigating selected problems of *Modeling, Identification, and Clustering*. Chapter 1 presents fuzzy random variables as integral components of regression models. Chapter 2 introduces evolutionary multi-objective neural network models evolving optimized model structures that meet pre-specified design criteria in acceptable computing time. Chapter 3 deals with the structural learning model of neural networks within a Boltzmann machine. Chapter 4 proposes robust DNA-based clustering techniques and finally, in Chapter 5 the advances of combining multi-criteria analysis of signals and pattern recognition using machine learning principles are discussed.

In the second part of the volume *Image Processing* is treated. Chapter 6 deals with fuzzy relation based image enhancement, addressing also detail sharpening and noise cancellation. Chapter 7 describes an image contrast control technique based on the application of Łukasiewicz algebra operators. In Chapter 8, low complexity situational models of image quality improvement are presented. Chapter 9 proposes a flexible representation to map images to quantum computers. In Chapter 10 object recognition in images is addressed and weakly supervised classification models are proposed. The last chapter of the book, Chapter 11, presents an image processing application for elderly care, performing real-time 3D tracking based on a new evolutive multi-modal algorithm.

We would like to express out appreciation to all to the authors of this volume. Without their contributions we will not have this book in our hands. We are also grateful to the reviewers for offering their time in reviewing the papers. Their effort made possible to match the prestige of the books published by Springer Verlag.

A particular acknowledgment goes to Prof. Janusz Kacprzyk (Editor-in-Chief, Springer Studies in Computational Intelligence Series), Dr. Thomas Ditzinger (Senior Editor, Engineering/Applied Sciences Springer-Verlag), Ms. Heather King (Editorial Assistance, Springer Verlag, Heidelberg), and Ms. Teréz Anna Várkonyi (Editorial Assistance, Óbuda University, Budapest) for the editorial assistance and excellent collaboration during the development of this volume.

We hope that the reader will share our excitement and find the volume “*New Advances in Intelligent Signal Processing*” both inspiring and useful.

March 2011

Annamária R. Várkonyi-Kóczy
António E. Ruano
Budapest, Hungary and Faro, Portugal

Contents

1	Formulation of Fuzzy Random Regression Model	1
	Junzo Watada, Shuming Wang, Witold Pedrycz	
1	Introduction	2
2	Fuzzy Random Variables	4
3	Fuzzy Random Regression Model	7
4	The Solution to the FRRM	11
	4.1 Vertices Method	11
	4.2 Heuristic Method	13
5	An Example	15
6	Concluding Remarks	17
	References	18
2	Evolutionary Multiobjective Neural Network Models	
	Identification: Evolving Task-Optimised Models	21
	Pedro M. Ferreira, António E. Ruano	
1	Introduction	21
2	Methodology	23
	2.1 Problem Definition	24
	2.2 Multiobjective Evolutionary Algorithms	25
	2.3 Model Design Cycle	29
	2.4 ANN Parameter Training	30
3	Example Model Identification Problems	35
	3.1 Electricity Consumption Prediction	35
	3.2 Cloudiness Estimation	43
4	Concluding Remarks	50
	References	50
3	Structural Learning Model of the Neural Network and Its	
	Application to LEDs Signal Retrofit	55
	Junzo Watada, Shamshul Bahar Yaakob	
1	Introduction	56
2	Hopfield and Boltzmann Machine	57

3	Boltzmann Machine Approach to Mean-Variance Analysis	59
4	Double-Layered Boltzmann Machine Example	62
5	Overview on LEDs Signal Retrofit	64
6	LEDs Signal Retrofit and Mean-Variance Problem	65
7	Numerical Example of LEDs Signal Retrofit	67
8	Conclusions	72
	References	73
4	Robustness of DNA-Based Clustering	75
	Rohani Abu Bakar, Chu Yu-Yi, Junzo Watada	
1	DNA Computing Methods for Solving Clustering Problems	75
2	Background Study of Clustering Problems	76
3	Robustness of DNA-Based Clustering Algorithms	78
4	Proximity Distance Approach	80
5	Robustness in Clustering	82
	5.1 Dataset and Parameter Implementation	83
	5.2 Robustness Evaluation of DNA-Based Clustering	83
6	Results and Discussion	85
7	Conclusions	90
	References	91
5	Advances in Automated Neonatal Seizure Detection	93
	Eoin M. Thomas, Andrey Temko, Gordon Lightbody, William P. Marnane, Geraldine B. Boylan	
1	Introduction	93
2	Data and Experiment Setup	96
3	Probabilistic Classification Framework	97
	3.1 Preprocessing and Feature Extraction	98
	3.2 Classification	99
	3.3 Postprocessing	102
	3.4 Metrics	103
4	Results	104
	4.1 Results over All Patients	104
	4.2 Results for Individual Patients	107
5	Discussion	109
6	Conclusion	112
	References	112
6	Design of Fuzzy Relation-Based Image Sharpeners	115
	Fabrizio Russo	
1	Introduction	115
2	Linear Unsharp Masking: A Brief Review	116
3	Nonlinear Unsharp Masking Based on Fuzzy Relations	118
4	Effects of Parameter Settings	120
5	Noise Prefiltering Using Fuzzy Relations	122

6	A Complete Fuzzy Relation-Based Image Enhancement System	127
7	Conclusion	130
	References	130
7	Application of Fuzzy Logic and Lukasiewicz Operators for Image Contrast Control	133
	Angel Barriga, Nashaat Mohamed Hussein Hassan	
1	Introduction	133
2	Contrast Control Techniques	135
3	Soft Computing Techniques	138
	3.1 Minimization of Image Fuzziness	138
	3.2 Direct Method	139
	3.3 Fuzzy Histogram Hiperbolation	140
	3.4 Sharpening and Noise Reduction	140
4	Hardware Realizations	141
5	Contrast Control by Means of Lukasiewicz Operators	142
6	Control Parameters Based on Fuzzy Logic	144
7	Contrast Controller Architecture	149
8	Conclusions	152
	References	153
8	Low Complexity Situational Models in Image Quality Improvement	155
	Annamária R. Várkonyi-Kóczy	
1	Introduction	155
2	Corner Detection	156
	2.1 Overview	157
	2.2 Detection of Corner Points	159
	2.3 Experimental Results	162
3	“Useful” Information Extraction	163
	3.1 Overview	166
	3.2 Surface Smoothing	169
	3.3 Edge Detection	170
	3.4 Edge Separation	171
	3.5 Illustrative Example	172
4	A Possible Application: 3D Reconstruction of Scenes	175
5	Conclusions	176
	References	176
9	A Flexible Representation and Invertible Transformations for Images on Quantum Computers	179
	Phuc Q. Le, Abdullahi M. Iiyasu, Fangyan Dong, Kaoru Hirota	
1	Introduction	179
2	Flexible Representation of Quantum Images and Its Polynomial Preparation	181

3	Quantum Image Compression Based on Minimization of Boolean Expressions	186
4	Image Processing Operators on Quantum Images Based on Invertible Transformations	191
5	Experiments on Quantum Images	194
5.1	Storage and Retrieval of Quantum Images	194
5.2	Analysis of Quantum Image Compression Ratios	196
5.3	Simple Detection of a Line in a Quantum Image Based on Quantum Fourier Transform	198
6	Conclusion	199
	References	202
10	Weakly Supervised Learning: Application to Fish School Recognition	203
	Riwal Lefort, Ronan Fablet, Jean-Marc Boucher	
1	Introduction	203
2	Notations and General Framework	205
3	Generative Model	206
4	Discriminative Model	209
4.1	Linear Model	209
4.2	Non Linear Model	210
5	Soft Decision Trees and Soft Random Forests	211
5.1	Soft Decision Trees	211
5.2	Soft Random Forest	213
6	Classifier Combination	214
7	Application to Fisheries Acoustics	215
7.1	Simulation Method	215
7.2	The Fish School Dataset	216
7.3	Results	217
8	Conclusion	221
	References	221
11	Intelligent Spaces as Assistive Environments: Visual Fall Detection Using an Evolutive Algorithm	225
	José María Cañas, Sara Marugán, Marta Marrón, Juan C. García	
1	Introduction	225
2	Global System Description	228
3	Multimodal Evolutive Algorithm for Vision Based 3D Tracking	229
3.1	Explorers and Races	231
3.2	Fitness Function Observation Model	233
3.3	Determine 3D Positions	236

4	Experiments	237
4.1	Typical Execution	239
4.2	Time Performance	241
4.3	System Accuracy	242
5	Conclusions	245
	References	246
	Author Index	249
	Subject Index	251