

János Fodor, Ryszard Klempous, and Carmen Paz Suárez Araujo (Eds.)

Recent Advances in Intelligent Engineering Systems

Studies in Computational Intelligence, Volume 378

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and Carmen Paz Suárez Araujo (Eds.)

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Foreword

This book contains extended and updated versions of carefully selected contributions to INES 2010, the 14th IEEE International Conference on Intelligent Engineering Systems, held on May 5-7, 2010, in Las Palmas de Gran Canaria, Spain. INES 2010 was organized under the auspices of Óbuda University (Budapest, Hungary), University of Las Palmas of Gran Canaria (Spain), and Wroclaw University of Technology (Poland).

The series of INES conferences has a well-established tradition, started in Budapest in 1997. The next places are neighbors of Hungary: Austria (1998), Slovakia (1999) and Slovenia (2000). Then the geographical distribution of locations broadened with Finland (2001), Croatia (2002), Egypt (2003), Romania (2004), the Mediterranean Sea (2005), London (2006), again Budapest (2007), then Miami (2008) and Barbados (2009), and finally Las Palmas in 2010. This list together with the IEEE support is very impressive, giving prestige to the conference series.

The aim of the INES conference series is to provide researchers and practitioners from industry and academia with a platform to report on recent developments in the area of intelligent engineering systems. Intelligence covers the ability to adapt to varying situations by reasoning. A characteristic feature of intelligent systems is that they integrate competences from many different areas in analysis, design and implementation.

As technology and basic knowledge more closely merged, the demand for introducing intelligent techniques to various industrial problems became apparent and was encouraged. This is reflected in the contributions of the current volume made by various scientists, to whom I am much indebted.

I would like to thank the editors of this volume for their meritorious work in evaluating the proceedings papers and presented talks, and for the final product of this outstanding selection. It truly reflects the essential structure, spirit, and scientific quality of INES 2010.

Budapest, May 2011

Imre J. Rudas
Founding Honorary Chair of INES

Preface

It is our great pleasure and privilege to introduce this book entitled *Recent Advances in Intelligent Engineering Systems* to our collaborators, colleagues and the interested readers of computational intelligence. We do hope that everyone will find this book intellectually stimulating and professionally rewarding, and will benefit from the content.

The present edited volume is a collection of 19 invited chapters written by respectable experts of the fields. They contribute to diverse facets of intelligent engineering systems. The topics are in full harmony with the general aims of the 14th IEEE International Conference on Intelligent Engineering Systems (INES 2010), held on May 5-7, 2010, in Las Palmas de Gran Canaria, Spain, where preliminary versions of these selected contributions were presented.

The book is divided into three parts: Foundation of Computational Intelligence, Intelligent Computation in Networks, and Applications of Computational Intelligence. Here we comment briefly on these parts and their chapters that make up this volume.

The first part is devoted to the foundational aspects of computational intelligence. It consists of 8 chapters that include studies in genetic algorithms, fuzzy logic connectives, enhanced intelligence in product models, nature-inspired optimization technologies, particle swarm optimization, evolution algorithms, model complexity of neural networks, and fitness landscape analysis.

The first chapter by Michael Affenzeller, Stefan Wagner, Stephan M. Winkler and Andreas Beham gives a look inside the internal behavior of several enhanced genetic algorithms (GAs). After a treatment of fundamental notions and results on evolutionary algorithms, the authors oppose the characteristic behavior of conventional GAs with the typical behavior of generic hybrids based upon self-adaptive selection pressure steering. The observations are discussed with respect to the ability of the algorithms to inherit essential genetic information in the sense of Hollands schema theory and the according building block hypothesis. The characteristics of an empirical building block analysis for a standard GA, for an offspring selection GA, as well as for a relevant allele preserving GA are also presented.

Chapter 2 is written by József Dombi on families of fuzzy logic connectives that he calls multiplicative pliant system. He studies special De Morgan classes of fuzzy conjunctions, disjunctions and negations represented by strict t-norms, strict t-conorms and strong negations, respectively. In such a class the product of the additive generator of the t-norm and the additive generator of the t-conorm is equal to 1. The general form of negations together with their representation is established, and De Morgan classes with infinitely many negations are determined. The author studies some relationships among aggregative operators, uninorms, strict t-norms and t-conorms.

In Chapter 3 the authors, László Horváth and Imre J. Rudas, introduce one of their contributions in knowledge assisted intelligent control of engineering object definition at product model based engineering activities. The proposed modeling is devoted as an extension to currently prevailing product modeling in leading product life cycle management systems. Transferring knowledge from the human product definition process to the product model, method for better communication at object definition, new content definition for engineering objects and multilevel structure in order to facilitate implementation are discussed.

Chapter 4 by Czesław Smutnicki presents a critical survey of methods, approaches and tendencies observed in modern optimization. It focuses on nature-inspired techniques recommended for particularly hard discrete problems arising in practice. Applicability of these methods, depending the class of stated optimization task and classes of goal function, are discussed. Quality of each particular method depends on space landscape, ruggedness, big valley, distribution of solutions in the space and the problem balance between intensification and diversification of the search. The best promising approaches are indicated with practical recommendation of using. Some numerical as well as theoretical properties of these algorithms are also shown.

Chapter 5 by Ján Zelenka studies a scheduling problem a jobs sequence and allocation to machines during a time period in a manufacturing company. The author highlights that the many of the existing approaches are often impractical in dynamic real-world environments where there are complex constraints and a variety of unexpected disruptions. Then cooperation of one meta-heuristic optimization algorithm with manufacturing model by the dynamical rescheduling is described. Particle Swarm Optimization algorithm solved scheduling problem of real manufacturing system. Model of the manufacturing system is represented as discrete event system created by SimEvents toolbox of MATLAB programming environment.

Chapter 6 by Andrzej Cichon and Ewa Szlachcic presents an efficient strategy for self-adaptation mechanisms in a multi-objective differential evolution algorithm. The algorithm uses parameters adaptation and operates with two differential evolution schemes. Also, a novel DE mutation scheme combined with a transversal individual idea is introduced to support the convergence rate of the algorithm. The performance of the proposed algorithm, named DEMOSA, is tested on a set of benchmark problems. The numerical results confirm that the proposed algorithm performs considerably better than the one with simple DE scheme in terms of computational cost and quality of the identified non-dominated solutions sets.

Chapter 7 by Věra Kůrková investigates the role of dimensionality in approximation of functions by one-hidden layer neural networks. Methods from nonlinear approximation theory are used to describe sets of functions which can be approximated by neural networks with a polynomial dependence of model complexity on the input dimension. The results are illustrated by examples of Gaussian radial networks, where the author characterizes sets which can be tractably approximated in terms of suitable norms defined by constraints on magnitudes of derivatives.

In Chapter 8 the authors, Erik Pitzer and Michael Affenzeller, provide a comprehensive survey on fitness landscape analysis. They formally define fitness landscapes, provide an in-depth look at basic properties and give detailed explanations and examples of existing fitness landscape analysis techniques. Moreover, several common test problems or model fitness landscapes that are frequently used to benchmark algorithms or analysis methods are examined and explained and previous results are consolidated and summarized. Finally, the authors point out current limitations and open problems pertaining to the subject of fitness landscape analysis.

The second part of this book contains contributions to intelligent computation in networks, presented in 5 chapters. The covered subjects include the application of self-organizing maps for early detection of denial of service attacks, combating security threats via immunity and adaptability in cognitive radio networks, novel modifications in WSN network design for improved SNR and reliability, a conceptual framework for the design of audio based cognitive infocommunication channels, and a case study on the advantages of fuzzy and anytime signal- and image processing techniques.

In chapter 9 team led by Carmen Paz Suárez Araujo, is dealing with the Internet Cyber Attacks problems. Growing up Internet in an exponential way is associated, unfortunately, with the same rise of Denial of Service (DoS). The team presents a flexible method capable to overcome DoS attacks using Computer Intelligent System for DoS Attacks Detection (CISDAD). This is a hybrid intelligent system with a modular structure with a processing module based on the Kohonen Self-Organizing Artificial Neural Networks. It permits to detect several types of toxic traffics. Presented results prove the effectiveness of CISDAD managing traffic in highly distributed networking environment. It should be also underlined the integration of the CISDAD into a clinical workstation EDEVITALZH.

Chapter 10 written by Jan Nikodem et al. presents very important problems of security, immunity and adaptability of Cognitive Radio (CR) networks. An overview of available CR models, threats and their mitigation pattern was provided. The proposed novel relational method permits reconciling two (often dichotomous) points of view: immunity and adaptability to neighborhood. Management of complex system in such environment yields in growing both adaptability and immunity. By modeling CR network activities using relational approach the authors have managed to precisely describe the complex characteristics of network interactions. Moreover, at the same time they have eliminated the CR networks parameters. This attempt guarantee to scale the complexity of interactions and model with much higher precision various aspects of CR networks.

Chapter 11 written by Kamil Staniec and Grzegorz Debita is devoted the construction of a Wireless Network Structure (WSN) of minimized intra-network interference and structure. Authors examined their simulation algorithm for WSN operating in 2,5GHz ISM band. They have also developed a simulator for determining the ZigBee performance as a function of the numbers of nodes. The simulation results confirm that creating a redundancy in a self-organizing WSN is not a simply task. Received from neighbors the knowledge of the electromagnetic power level is not sufficient information. The information about nodes location, as well as some support from the network designer could be essential support here.

Chapter 12 written by Ádám Csapó and Péter Baranyi develops engineering systems which are capable of using cognitive info-communication channels in order to convey feedback information in novel and meaningful ways. They describe the main challenge behind the development of cognitive info-communication channels as a two-part problem which consists of the design of a synthesis algorithm and the design of a parameter-generating function for the synthesis algorithm. They use formal concept algebra to describe the kinds of synthesis algorithms which are capable of reflecting realistic forms of interaction between the user and the information which is to be communicated. Through an experimental evaluation of the application, the authors demonstrate that their approach can be used successfully for the design of cognitive info-communication channels.

In Chapter 13 the author, Teréz A. Várkonyi, starts from the observation that in practical engineering problems the available knowledge about the information to be processed is usually incomplete, ambiguous, noisy, or totally missing, and the available time and resources for fulfilling the task are often not only limited, but can change during the operation of the system. This urge researchers and engineers to turn towards non-classical methods which are very advantageous. For this reason, the author gives an overview about various imprecise, fuzzy and anytime, signal- and image processing methods and their applicability is discussed in treating the insufficiency of knowledge of the information necessary for handling, analyzing, modeling, identifying, and controlling of complex engineering problems.

Computational intelligence represents a widely spread interdisciplinary research area with many applications in various disciplines including engineering, medicine, technology, environment, among others. The Part III of this book is devoted to this practical aspect of computational intelligence, the applications. This part is a very important section of the volume because in it the reader could find a wide range of fields where the computational intelligence plays a significant role.

The first chapter of the Part III, chapter 14, is devoted to clinical decision support systems based on computational intelligence, concretely on neural computation. Patricio García Báez, Carmen Paz Suárez Araujo, Carlos Fernández Viadero and Aleš Procházka focus their studies on a very hard problem in clinical medicine, the Differential Diagnosis of Dementias (DDD). They propose new automatic diagnostic tools based on a data fusion scheme and neural ensemble approach for facing the DDD. The authors present HUMANN-S ensemble systems with missing data processing capability, where the neural architecture HUMANN-S is the main module of these intelligent decision support systems. Their ability was explored using a

novel information environment applied to DDD, different combinations of a battery of cognitive and functional/instrumental scales. In this chapter is also presented a comparative study between the proposed methods and a clinical expert, reaching these new intelligent systems a higher level of performance than the expert. Finally, in the chapter is shown that the proposal described is an alternative and effective complementary method to assist the diagnosis of dementia having important advantages referring to other computational solutions based on artificial neural networks.

Chapter 15, written by Martina Mudrová, Petra Slavíková and Aleš Procházka, presents an application in environmental engineering, the developments of new methods for air pollution detection. The authors deal with classification of microscope images of *Picea Abies* stomas. They base their proposal on the assumption that a stoma character strongly depends on the level of air pollution, so that stoma can stand for an important environmental bioindicator. The chapter is devoted to the development of an automatic algorithm which can recognize the level of stoma changes by means of methods of texture classification. In this study two basic principles are discussed, the application of gradient methods and the use of methods based on the wavelet transform. Several methods of image preprocessing as noise reduction, brightness correction and resampling are studied, as well. The authors present an algorithm validation study based upon the analysis of the set of about four hundred images collected from 6 localities in the Czech Republic and results achieved were compared with an experts sensual classification.

In Chapter 16, the authors Carlos M. Travieso, Juan C. Briceño and Jesús B. Alonso present a computational intelligence method in the Biometrics field. The main goal of this field is the identification of a person using her/his body features, in this concrete case the lips, which has a big interest in the security area. They propose a biometric identification approach based on lip shape with three main steps. The first step is devoted to detect the face and lips contour detection. In the second step, the lip features, based on angular coding, are extracted and afterwards transformed using Hidden Markov Model kernel (HMMK). Finally, a one-versus-all multiclass supervised approach based on Support Vector Machines (SVM) with RBF kernel is applied as a classifier.

The chapter 17 by Aleš Procházka, Martina Mudrová, Oldrich Vysata, Lucie Gráfová and Carmen Paz Suárez Araujo deals with an interdisciplinary research area based upon general digital signal processing methods and adaptive algorithms. It is the computational intelligence and signal analysis of multi-channel data working together. In this chapter is restricted to their use in biomedicine and particularly in electroencephalogram signal processing to find specific components of such multi-channel signals. The methods used by the authors included multi-channel signals de-noising, extraction of their components and the application of the double moving window for signal segmentation using its first principal component. During this preprocessing stage are used both the discrete Fourier transform and the discrete wavelet transform. Resulting pattern vectors will be classified using the artificial neural network approach, concretely self-organizing neural networks using a specific statistical criterion proposed to evaluate distances of individual feature vector values from corresponding cluster centers. Owing to the complexity of the

multi-channel signal processing, distributed computing is mentioned in the chapter as well. Proposed methods are verified in the MATLAB environment using distributed data processing.

The chapter 18 introduces an ambient intelligence application, an Intelligent TeleCare System. The authors, Stoicu-Tivadar, L. Stoicu-Tivadar, S. Puşcoci, D. Berian and V. Topac, explore several existing telecare solutions mainly from the technological point of view, but also considering the degree in which seamless care is achieved. Having this study as a background, the chapter describes a teleassistance / telemonitoring system assisting elderly persons, an integral, holistic solution, with emphasis on the server component, TELEASIS. The TELEASIS platform architecture, which is based on a service-oriented architecture, the hardware platform and infrastructure, the software platform, the dispatcher component and the web services are briefly described. The main idea provides by this chapter is not only to obtain an intelligent telecare system, but to contribute to improvement of the management of care for a specific category of persons, as well as a future generation telecare networking applications.

Chapter 19 by Nicolaie Popescu-Bodorin and Valentina Emilia Balas, presents a new authentication system based on supervised learning of iris biometric identities. They use a neural-evolutionary approach to iris authentication, reaching an important power of discrimination between the intra- and inter-class comparisons. The authors show that when using digital identities evolved by a logical and intelligent artificial agent (Intelligent Iris Verifier/Identifier) the separation between inter- and intra-class scores is so good that it ensures absolute safety for a very large percent of accepts. They also make comparison to a result previously obtained by Daugman. The difference between both studies comes from a different understanding of what it means to recognize: Daugman sustained the idea of a statistical decision landscape of recognition and the authors sustaining the idea of a logically consistent approach to recognition. This chapter, also discusses the latest trends in the field of evolutionary approaches to iris recognition, and announces the technological advance from inconsistent iris verification to consistent iris identification. It finally shows that the future iris-based identification will be inevitably marked by multi-enrollment, and by the newly proposed concept of consistent, intelligent, adaptive, evolutionary biometric system.

We would like to thank the INES 2010 Technical Program Committee Chairs Michael Affenzeller, László Horváth and Aleš Procházka for their meritorious work in evaluating the selected papers, as well as all program committee members who assisted the TPC Chairs.

The editors are grateful to the authors for their superior work. Thanks are also due to Jan Nikodem for his excellent editorial assistance and sincere effort in bringing out the volume nicely in time. Last but not least we want to thank Springer-Verlag for smooth cooperation in publication of this volume.

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