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Editorial

New trends in computational intelligence

Selected and improved papers of the 13th International Work-Conference on Artificial Neural Networks (IWANN 2015)

The International Work-Conference on Artificial Neural Networks (IWANN 2015) took place in Palma de Mallorca, Mallorca (Spain), in June 2015, gathering significant researchers in the fields of artificial neural networks, machine learning, computational intelligence and related topics. After the conference, a set of outstanding papers were selected and their authors invited to provide an extended version, which have underwent a thorough peer revision process. Ten accepted papers are the subject matter of this special issue of Neurocomputing.

IWANN 2015 has been the thirteenth edition of this biennial conference, whose course started in 1991 jointly chaired by researchers from the Universidad de Málaga, the Universidad de Granada, and the Universitat Politècnica de Catalunya. Since its inception, all the papers accepted to both the conferences themselves and the satellite workshops have been collected in 21 volumes published by Springer Verlag in the book series Lecture Notes in Computer Science [1–21]. Besides, selected papers from each one of the latter five editions were revised and extended, yielding special issues of the journal Neurocomputing [22–26].

The analysis of presentations delivered at IWANN conferences reveals that the field progresses towards an increasing sophistication and maturity, from both the point of view of rigorous foundations and efficient techniques that solve real-world problems. The contributions presented at IWANN 2015 address a wide range of topics, some of which are here enumerated, with no claim to be exhaustive:

- Mathematical and theoretical methods in computational intelligence.

  Mathematics for neural networks. RBF structures. Self-organizing networks and methods. Support vector machines and kernel methods. Fuzzy logic. Evolutionary and genetic algorithms.

- Neurocomputational formulations.

  Single-neuron modeling. Perceptual modeling. System-level neural modeling. Spiking neurons. Models of biological learning.

- Learning and adaptation.

  Adaptive systems. Imitation learning. Reconfigurable systems. Supervised, non-supervised, reinforcement and statistical algorithms.

- Emulation of cognitive functions.

  Decision making. Multi-agent systems. Sensor mesh. Natural language. Pattern recognition. Perceptual and motor functions (visual, auditory, tactile, virtual reality, etc.). Robotics. Planning motor control.

- Bio-inspired systems and neuro-engineering.

  Embedded intelligent systems. Evolvable computing. Evolving hardware. Microelectronics for neural, fuzzy and bioinspired systems. Neural prostheses. Retinomorphic systems. Brain–computer interfaces. Nanosystems. Nanocognitives ystems.

- Advanced topics in computational intelligence.

  Intelligent networks. Knowledge-intensive problem solving techniques. Multi-sensor data fusion using computational intelligence. Search and meta-heuristics. Softcomputing. Neuro-fuzzy systems. Neuro-evolutionary systems. Neuro-swarm. Hybridization with novel computing paradigms.

- Applications.

Expert systems. Image and signal processing. Ambient intelligence. Biomimetic applications. System identification, process control, and manufacturing. Computational Biology and Bioinformatics. Parallel and distributed computing. Human–computer interaction. Internet modeling, communication and networking. Intelligent systems in education. Human–robot interaction. Multi-agent systems. Time series analysis and prediction. Data mining and knowledge discovery.

Since the first artificial neural network (ANN) models, about six decades ago, despite the continuous deepening in its study, we are still far from equating the behavior of the natural neuronal system, for example, in flexibility, robustness, energy efficiency, etc. [27]. ANNs still imitate the behavior but not the neuronal structure or architecture that carries it out.

However, artificial neural networks are capable of performing a wide variety of tasks (classification, related to supervised learning, and associated to unsupervised learning) which are often challenging for conventional rule-based methods. Remarkably, such problems were already tackled by statistical methods, often with different notation and in impermeable scientific communities.

The contributions to successive IWANN editions have witnessed the approximation of both fields, providing rigorous foundations to

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neurocomputational algorithms, as well as enriching the toolbox of statistics. In a sense, neural networks are the non-linear counterpart to linear statistical methods, such as regression or principal component analysis.

The papers selected and presented in this special issue span the whole range of the field, from theoretical foundations to real-world applications, running parallel to the topics of IWANN 2015. A classification of the papers into four categories is proposed, although the class boundaries are certainly blurred. Four papers propose novel algorithms that can be framed within pattern recognition, with a more or less explicit statistical background. Two other papers are concerning with bio-inspired systems, specifically with brain-computer interfaces. Another paper is concerning with mathematical and theoretical methods, stressing the application of neural networks to simultaneous unknown input decoupling and fault estimation. Finally, three papers deal with applications on expert systems and optimization techniques in a broad sense, including ontology-based sensor selection, the use of genetic algorithm for optimization of models in the visual system, and weighted aggregation of partial rankings using ant colony optimization.

According to this classification, the list of papers is organized as follows.

1. Emulation of cognitive function

The paper *Improving CBR Adaptation for Recommendation of Associated References in a Knowledge-based Learning Assistant System*, by Sara Nasiri et al., proposes a knowledge-based recommendation system that analyzes the combination of visual and textual information in a Case Base Reasoning (CBR) medical system. The adaptation mechanism has a combination of value comparison based on requested word association profiles and manual adaptation based on user collaborative recommendation. In the adaptation process of the system, attract rate and adapt rate are defined and utilized for evaluating the adaptation results. Therefore, recommendation is a combination of references and learning materials with highest valued keyword association strength from the most similar cases.

In the paper *CBR-based Reactive Behavior Learning for the Memory-Prediction Framework*, I. Herrero-Reder et al. propose a CBR based learning methodology to build a set of nested behaviors in a bottom up architecture. Since CBR is conceptually similar to the Memory Prediction Framework, all the behaviors are acquired via CBR based learning. To cope with complexity-related CBR scalability problems, the authors propose a new 2-stage retrieval process. The framework has been tested by training a set of cooperative/competitive reactive behaviors for Aibo robots in a RoboCup environment. The authors claim that: the robot can acquire complex behaviors under supervised training and later unsupervisedly improve its knowledge; learning at reactive level allows to acquire knowledge that might be hard to model analytically; supervised training at low level implicitly acquires knowledge on robot kinematics and dynamics, plus on systematic actuator and sensor errors; casebase retrieval process is suitable to cope with scalability problems.

R.A. Becerra-García et al. have authored the paper *Data Mining Process for Identification of Non-spontaneous Saccadic Movements in Clinical Electrooculography*, where the problem of identifying non-spontaneous saccades in clinical electrooculography tests is addressed. To do this they use three different learning algorithms: Support Vector Machines (SVM), K-Nearest Neighbors (KNN) and Classification and Regression Trees (CART). The models they obtain are very efficient with only three attributes: amplitude deviation, absolute response latency and relative latency. Results obtained by the algorithm show accuracies over 98%, recalls over 98% and precisions over 95% for the three models evaluated.

The paper *Gene Selection in Autism – A Comparative Study*, by T. Latkowski and S. Osowski, investigates application of several methods of feature selection to identification of the most important genes in autism disorder. Presently, microarray gene expression data are studied to find the genes or sequences of genes which are the best associated with autism and might be treated as biomarkers. The applied methods analyze the importance of genes on the basis of different principles of selection; the results of these selections are fused into a common set of genes, which are the best associated with autism. The authors propose and compare three different methods of such a fusion: purity of the clusterization space, application of genetic algorithm and random forest in the role of integrator. The experimental results show that applied fusion strategy of many independent selection methods leads to the significant improvement of the autism recognition rate.

2. Bio-inspired systems

P. Martín-Smith et al. focus on a brain-computer interface (BCI) classification task based on linear discriminant analysis (LDA) classifiers, where the properties of multiresolution analysis (MRA) for signal analysis in temporal and spectral domains have been used to extract features from electroencephalogram (EEG) signals, as they propose in the paper *Supervised Filter Method for Multi-objective Feature Selection in EEG Classification based on Multi-resolution Analysis for BCI*. For this purpose the authors use a supervised filter method for evolutionary multi-objective feature selection for classification problems in high dimensional feature space. This method is evaluated by comparison with wrapper approaches for the same application. The results have allowed to evaluate the advantages and drawbacks of the different approaches with respect to time consumption, accuracy and generalization capabilities.

The paper *Age-related Differences in SSVEP-based BCI Performance*, by I. Volosyak et al., investigates the age-associated differences in BCI performance. For this purpose the authors compare accuracy and speed of a steady-state visual evoked potential (SSVEP)-based BCI spelling application controlled by participants of two different equally sized age groups. Twenty subjects (eleven female and nine male) participated in this study; each age group consisting of ten subjects, ranging from 19 to 27 years and from 64 to 76 years. The results confirm that elderly people may have a deteriorated information transfer rate (ITR). The mean (SD) ITR of the young age group was 27.36 (6.50) bit/min while the elderly people achieved a significantly lower ITR of 16.10 (5.90) bit/min.

3. Mathematical and theoretical methods

Piotr Witczak et al. tackle the problem of a neural network-based robust state and actuator fault estimator design for nonlinear discrete time systems, in their paper *A Neural Network Approach to Simultaneous State and Actuator Fault Estimation under Unknown Input Decoupling*. They proposes a less restrictive procedure for designing a neural network-based H_∞ observer. The proposed algorithm guaranties a predefined disturbance attenuation level and convergence of the observer, as well as unknown input decoupling and state and actuator fault estimation. The authors claim for their proposal, as its main advantage, the simplicity, since the procedure to design the observer is reduced to solving a set of linear matrix inequalities.

4. Applications on expert systems and optimization techniques

In the paper *MIMU-Wear: Ontology-based Sensor Selection for Real-World Wearable Activity Recognition*, Claudia Villalonga et al. deal with the problem of recognition of human activity based on wearable sensors. To provide interoperability and reconfigurability,