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Preface

Presenting the special issue on Rough-neuro computing

It goes without saying that a challenging quest for the construction of intelligent systems is realized through the development of hybrid information technologies and their vigorous and prudent exploitation. In a nutshell, what has emerged under the name of computational intelligence (CI) or soft computing is a well-orchestrated, highly synergistic consortium of technologies of neural networks, statistics, adaptive systems, granular computing and evolutionary methods. The knowledge is a multifaceted concept. So is the notion of CI as it attempts to take full advantage of the already mentioned technologies while compensating for some of their discrepancies or limitations. In a nutshell, we encounter a hybridization that looks into a matter of knowledge representation, uncertainty, and information granulation on one hand and an issue of learning, adaptation, and self-organization on the other. Granular computing including rough sets and fuzzy sets is about the first facet of hybrid intelligent systems. Neural networks are after the broad spectrum of learning.

This issue of *Neurocomputing* is a testimony to this ongoing hybridization of the technologies of neural networks and granular computing, in particular rough sets and fuzzy sets. There are 10 papers addressing various methodological, algorithmic and application aspects of the hybrid approach.

The paper by Andrzej Czyżewski and Rafał Królikowski addresses an interesting problem of neuro-rough hybridization applied to digital processing of audio signals. The application of some selected techniques of CI to non-stationary noise reduction is also described.

Pawan Lingras presents fuzzy-rough and rough-fuzzy serial combinations in neurocomputing. His paper introduces rough and neo-fuzzy neurons as well as the architectures of fuzzy-rough and rough-fuzzy subnets. Potential applications of the subnets are discussed together with illustrative examples.

Evolutionary modular design of rough knowledge-based neural network is discussed in the article by Sushmita Mitra, Pabitra Mitra, and Sankar K. Pal. This article describes a way of integrating rough set theory with a fuzzy MLP using a modular evolutionary algorithm, for classification and rule generation in soft computing paradigm. A rough set method is used for extracting dependency rules directly from a real-valued attribute table consisting of fuzzy membership values.

An application of rough sets for enhancement of local subspace classifiers is presented in the article by Władysław Skarbek. Local subspace classifiers are characterized by high performance. However, they lack a mechanism for recovery from errors. Confidence levels associated with the decision function in this kind of classifiers

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could help in creation of such procedure. The paper explains how rough set idea can be used to incorporate the confidence mechanism.

The article by Roman Swiniarski and Larry Hargis introduces rough sets as a front end of the neural networks texture classifiers. The discussed methods include singular value decomposition for feature extraction, principal components analysis for feature projection and reduction, and rough set methods for feature selection and reduction. For texture classification the feedforward backpropagation neural networks are used. It is reported that the neural network classifiers constructed over the reduced set of features provide better generalization.

The article by Marcin Szczuka and Piotr Wojdyłło discusses a neuro-wavelet classifier for EEG signals based on rough set methods. By applying the wavelets, frequential analysis, rough sets and dynamic scaling in connection with simple neural network a novel and reliable classifier architecture is obtained for classification of EEG signals. The proposed methods provide extended robustness and generalization abilities as well as possibility to directly interpret the results obtained.

Recurrent neuro-fuzzy techniques for the identification and simulation of time-dependent physical systems, in particular of viscoelastic models, are presented in the article by Andreas Nürnberger, Arne Radetzky, and Rudolf Kruse. The presented model is motivated by a cooperative neuro-fuzzy approach based on a vectorized recurrent neural network architecture. The usability in practice is demonstrated by an application of the model in the area of surgical simulation.

The article by Witold Pedrycz, L. Han, James F. Peters, S. Ramanna, and R. Zhai introduces a rough-fuzzy neural computing approach for calibration of software quality. A neural computing approach is introduced to estimate the number of changes needed in a software product. The approach is based on assessments of software quality with a combination of fuzzy logic and rough sets in a neural computing framework. Two forms of neural computation are considered: fuzzy-neural computation based on fuzzy sets and rough-neural computation based on rough sets. The performance of the two forms of neural computation is compared.

Ning Zhong, Juzhen Dong, and Setsuo Ohsuga describe two soft induction techniques for discovering classification rules from databases with uncertainty and incompleteness. The techniques are based on generalization distribution table (GDT), in which the probabilistic relationships between concepts and instances over discrete domains are represented. The first technique is a variant of neural connectionist networks. The second one is based on a combination of the GDT with the rough set methodology. It is reported that the latter technique is better than the former one for large, complex databases.

The paper by Witold Pedrycz and George Vukovich elaborates on a notion of granular neural networks by studying various ways in which granular computing and neural networks give rise to knowledge-oriented and highly adaptive architectures. As the last one in this issue, the paper attempts to make a clear point as to the inherent need of various facets of hybridization.

Finally, let us mention an emerging new *rough-neuro computing* paradigm based on an extension of rough sets called *rough mereology* (see, e.g., L. Polkowski and A. Skowron, Rough mereology: A new paradigm for approximate reasoning,

International Journal of Approximate Reasoning, 15 (4), (1996), 333–365 and L.Polkowski and A. Skowron, Rough-Neuro Computing, Proceedings of RSCTC'2000, October 2000, Banff, Canada (2000)) bringing new ideas related to rough-neuro computing. Using this approach foundations for *granular computing* (*computing with words, information granulation*), recently put forth by Lotfi Zadeh, have been developed. Progress in the development of granular computing methods is crucial for solving many real-life applications, like those related to spatial reasoning. The rough mereology offers *rough-neuro schemes* (agent schemes) for information granule construction. These schemes can be treated as a generalization of neural network architectures. The approximation spaces attached to the arguments of operations in the schemes correspond to the neuron weights in neural networks. The parameters of approximation spaces are tuned by parent agents to obtain optimal (sub-optimal) approximations of information granules delivered by children agents. The operations performed on information granules by agents correspond to the operations realized on real numbers by neurons. The rough-neuro schemes are used for construction of information granules with much more complex structure than those used in classical neural networks. An interesting problem arises, how such schemes can be efficiently constructed and tuned, e.g., by using developed methods based on classical neural networks. The, discussed in rough mereology, stability property of such schemes corresponds to the resistance to noise of classical neural networks.

There has been a substantial number of individuals who make this special issue a reality. The authors deserve our sincere thanks for sharing their expertise and presenting their recent findings in a lucid and authoritative fashion. Numerous reviewers generously contributed their time and knowledge to make the material coherent, highly readable. We would like to take this opportunity to thank Dr. V. David Sánchez A. for his invitation to launch this timely and important issue.

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