Preface to the Special Issue on Hybrid Intelligent Systems using Neural Networks, Fuzzy Logic, and Genetic Algorithms

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Soft computing can be used to build hybrid intelligent systems for achieving different goals in real-world applications. Soft Computing (SC) techniques include, at the moment, fuzzy logic, neural networks, genetic algorithms, chaos theory methods, and similar techniques that have been proposed in recent years. Each of these techniques has advantages and disadvantages, and several real-world problems have been solved, by using one of these techniques. However, many real-world complex problems require the integration of several of these techniques to really achieve the efficiency and accuracy needed in practice. In particular, genetic algorithms can be used to optimize the topology of a fuzzy or a neural system. Also, there are neuro-fuzzy approaches or even neuro-fuzzy-genetic approaches for designing the best intelligent system for a particular application. With all of this in mind, we did organize this Special Issue to show the most recent research results of this type of work.

This special issue consists of ten papers that consider the use and integration of different soft computing techniques for the development of hybrid intelligent systems for modeling, simulation and control of non-linear dynamical systems. The ten papers, of this special issue, describe different applications of soft computing techniques to real-world problems and can be considered a significant contribution to the field of hybrid intelligent systems.

The first paper, “The Communication in Intelligent Agents for Distributed Fault Tolerant Systems” by Arnulfo Alanis et al., deals with a new approach using intelligent agents to design and implement distributed fault tolerant systems. To achieve good performance the communication between agents has to be defined very carefully. Experimental results show the suitability of the architecture and effectiveness of the proposed intelligent approach.

The second paper, “An Integral Plus States Adaptive Neural Control of Aerobic Continuous Stirred Tank Reactor” by Ieroham Baruch et al., describes an adaptive neural network control structure to regulate a biological fermentation processes. The method is applied to achieve the goal of keeping the concentration of the recycled biomass proportional to the influent flow rate in the presence of periodically acting disturbances, process parameter variations and measurement noise. Comparative simulation results confirmed the applicability of the proposed control scheme.

The third paper, “Approximate Method for Concrete Mix Design: A Layered Fuzzy-Neuro System Model” by M. C. Nataraja et al., describes the use of fuzzy-neuro approach for concrete mix design. Human experts perform the design of concrete mix and the design process is not amenable to precise mathematical formulations. It is practically impossible to achieve the design strength of the mix in the field and what is realized in field is somewhere *around* the design strength. For this reason a fuzzy-neuro approach is proposed to solve this problem. Simulation results show the efficiency and accuracy of the proposed design method.

The fourth paper, “Hybrid Genetic Algorithms: a review” by T. Elmihoub et al., describes the state of the art on hybrid genetic algorithms. Hybrid genetic algorithms have received significant interest in recent years and are being increasingly used to solve real-world problems. A genetic algorithm is able to incorporate other techniques within its framework to produce a hybrid that reaps the best from the combination. In this paper, different forms of integration between genetic algorithms and other search and optimization techniques are reviewed.

The fifth paper, “Genetic Algorithm-Based Neural Fuzzy Controller for Flexible-Link Manipulator” by M. N. H. Siddique and M. O. Tokhi, describes a new intelligent hybrid approach for controlling manipulators. The limitations of conventional model-based control mechanisms for flexible manipulator systems have stimulated the development of intelligent control mechanisms incorporating fuzzy logic and neural networks. A PD-PI-type fuzzy controller has been developed where the membership functions are adjusted by tuning the scaling factors using a neural network. It has been demonstrated that the sigmoidal function and its shape can represent the nonlinearity of the system. A genetic algorithm is used to learn the weights, biases and shape of the sigmoidal function of the neural network.

The sixth paper, “Voice Recognition with Neural Networks, Type-2 Fuzzy Logic and Genetic Algorithms” by Patricia Melin et al., proposes a new hybrid intelligent approach for pattern recognition. In this paper the use of neural networks, fuzzy logic and genetic algorithms for voice recognition is described. In particular, the case of speaker recognition by analyzing the sound signals with the help of intelligent techniques, such as the neural networks and fuzzy systems, is described. Neural networks are used for analyzing the sound signal of an unknown speaker, and after this first step, a set of type-2 fuzzy rules is used for decision making. Fuzzy logic is used due to the uncertainty of the decision process. Genetic algorithms are used to optimize the architecture of the neural networks.

The seventh paper, “Tracking Fuzzy Logic Control for Unicycle Mobile Robots” by Oscar Castillo et al., describes a new fuzzy logic approach for trajectory tracking of an autonomous mobile robot. Based on backstepping and a Mamdani fuzzy model, a stable tracking controller is designed. Simulation results of the fuzzy controller for a unicycle mobile robot show good performance. Comparison with other approaches for control also indicated that the proposed approach is a good alternative for this type of problems.

The eighth paper, “Intelligent Control of an Autonomous Mobile Robot using Type-2 Fuzzy Logic” by Leslie Astudillo et al., deals with the application of type-2 fuzzy logic and genetic algorithms for controlling autonomous mobile robots. A tracking controller for the dynamic model of unicycle mobile robot was developed, by integrating a kinematic controller and a torque controller based on Fuzzy Logic Theory. Computer simulations are presented confirming the performance of the tracking controller and its application to different navigation problems.

The ninth paper, “The Human Evolutionary Model: A new approach for solving nonlinear optimization problems avoiding the problem of cycling” by Oscar Montiel et al., proposes a new evolutionary approach for problem optimization. The aim of this paper is to give a method for reducing the problem of getting trapped in local optima (cycling), which is a common problem in evolutionary algorithms. For solving this problem a Tabu method was used for avoiding already visited regions, this in

combination with a novel fuzzy method that can handle imperfect knowledge in a broader way than Intuitionistic fuzzy logic does. This fuzzy method can manage non-contradictory, doubtful, and contradictory information provided by experts, providing a mediated solution, so we called it Mediative Fuzzy Logic.

The tenth paper, "Analyzing the Effects of the Footprint of Uncertainty in Type-2 Fuzzy Logic Controllers" by Roberto Sepulveda et al., describes a study of the relationship between the size of the footprint of uncertainty and the performance of a type-2 fuzzy logic controller. Uncertainty is an inherent part in controllers used for real-world applications. The use of new methods for handling incomplete information is of fundamental importance in engineering applications. The effects of uncertainty produced by the instrumentation elements in type-1 and type-2 fuzzy logic controllers was simulated to perform a comparative analysis of the systems' response, in the presence of uncertainty. A proposal to optimize interval type-2 membership functions using an average of two type-1 systems is presented. Some experiments where the MFs are optimized under different ranges values for the Footprint Of Uncertainty (FOU) and different noise values are presented.

We can conclude this introduction by saying that, in our opinion, all of the papers, in this special issue, make an important contribution to the state of the art in the field of hybrid intelligent systems, in general, and also to the areas of fuzzy logic, neural networks, and genetic algorithms, in particular. Finally, we have to say that it is our sincere hope that this issue will be of great interest and use to researchers and students all over the world.