

## Preface: Special Issue on Soft Computing

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Soft computing is a consortium of methodologies which work synergetically and provides in one form or another flexible information processing capabilities for handling real life ambiguous situations. Its aim is to exploit the tolerance for imprecision, uncertainty, approximate reasoning and partial truth in order to achieve tractability, robustness and low solution cost. In other words, it provides the foundation for the conception and design of high MIQ (Machine IQ) systems, and therefore forms the basis of future generation computing systems. At this juncture, fuzzy logic (FL), artificial neural networks (ANN) and genetic algorithms (GA) are the three principal components where FL provides the algorithms for dealing with imprecision and uncertainty, ANN the machinery for learning and adaptation, GA for optimization and searching. Recently, the theory of rough sets (RS) has also proven to be another soft computing tool for handling ambiguity caused by the limited discernibility of objects in the domain of discourse. A large number of researchers, all over the world, are engaged in developing soft-computing methodologies for designing intelligent/ information systems, and demonstrating their success to different fields such as pattern recognition, image processing, control, business management and robotics.

There are many journals which publish papers on soft computing. The number of conferences/ meetings in this field has also been growing over the time. Mostly these reports are available to and readable by only specialists. There are many more people outside this community who can benefit from the application of soft modeling to their respective disciplines and applications. It may be mentioned that much of the success in research on soft computing has come from the cross-fertilization of ideas from disciplines like computer science, neurobiology, psychology, engineering, cognitive science, physics, statistics and mathematics.

The journal *Fundamenta Informaticae* (FI) is read, in general, by the theoretical computer science community. This special issue of FI reflects a cross-section of the current state-of-the-art in the theory and practice of soft modeling in solving various real life problems. This is expected to go a long way to increase the general awareness of readers. It has nine articles encompassing different theoretical and application aspects.

The issue starts with an important article "Using Possibilistic Logic for Modeling Quantitative Decision: ATMS-based Algorithms" by two pioneers of this field, D. Dubois, and H. Prade with their colleagues D. Le Berre, and R. Sabbadin. They have described how possibilistic logic (which has origin from the theory of fuzzy sets) can be used to model qualitative decision by developing a logical machinery. Two attitudes namely, a pessimistic risk-averse one and an opti-

mistic one are considered. A link is finally established between this model and an ATMS-based algorithm, followed by the development of algorithms for computing optimistic and pessimistic optimal decisions.

Chaos theory has provided many examples of simple, deterministic systems whose output appears to be totally random in character. This occurs because of the strong nonlinear nature and the extreme sensitivity of such systems to initial conditions. On imposition of control, transition of the network behavior from chaos to periodicity has been observed. The second article "Chaotic Dynamics in Iterated Map Neural Networks with Piecewise Linear Activation Function" by S. Sinha examines the discrete time chaotic dynamics of excitatory and inhibitory neuron models, connected in a network, with piecewise linear activation functions. Various properties of this simple system e.g., periodic oscillations, chaos and border-collision bifurcations are studied. Finally, its possible applications to auto-association, pattern classification, nonlinear function approximation and periodic sequence generation are discussed.

The third article on "Ecological Model of Virus-Evolutionary Genetic Algorithm" by N. Kubota and T. Fukuda is on evolutionary computation based on the mechanism of natural genetics. Here an ecological model of a virus-evolutionary genetic algorithms is described in order to maintain genetic diversity in a population. A new virus infection operator has been defined, and applied to travelling salesman problem, as an example, with a discussion on co-evolution of host and virus populations through numerical simulations.

In the article "Interval Regression Analysis with Polynomials and its Similarity to Rough Sets Concept", H. Tanaka and H. Lee have explained, first of all, the concepts of possibility and necessity measures, in brief; followed by formulation of three estimation models in interval regression analysis using these measures. Then interval regression with polynomials is described along with its similarity with the concept of rough sets. A measure of fitness to gauge the degree of approximation of the models to a given data is also introduced. The effectiveness of the models is explained through numerical examples.

M. Friedman, M. Ming and A. Kandel have described an algorithm, in their article "On Fuzzy Integral Equations", which approximates Riemann integral uniformly to design a soft computing tool for solving fuzzy Fredholm integral equations of second kind, with arbitrary kernel using a uniformly convergent iterative procedure. The proof for uniform convergence is given for trapezoidal rule.

The remaining four papers demonstrate some applications of soft computing to computer vision, process control and pattern recognition problems. Among them the last three (i.e., seventh to ninth) deal with different hybridizations.

The entire development of soft image processing and vision is based on the realization that the basic concepts of region, its edge, shape, border, boundary, and relation with others in a gray image do not lend themselves to precise definition. The sixth article on "Artificial Vision and Soft Computing" by V. D. Gesu addresses this issue and describes some applications of fuzzy computing to artificial vision problems after explaining the links between them.

In the article "Differential Evolution Based Fuzzy Logic Controller for Nonlinear Process

Control”, K. K. N. Sastry, L. Behera and I. J. Nagrath have demonstrated that for the control of pH in chemical industries, fuzzy logic controllers (FLCs) augmented with differential evolution (used for simultaneous design of membership function and rule sets) offer a powerful alternative to GA based FLCs. It is also shown that the search space smoothing function helps in faster convergence of a GA.

A framework for developing a broad variety of soft clustering and learning vector quantization (LVQ) algorithms based on gradient descent minimization of a reformulation function is described by N. B. Karayiannis in his article ”Reformulating Learning Vector Quantization and Radial Basis Neural Networks”. A close relationship between soft LVQ models, trained by an unsupervised learning scheme to perform pattern clustering, and RBF networks, trained by a supervised learning scheme to perform pattern classification and function approximation has been identified.

In the last article ”Relation Between VGA-classifier and MLP: Determination of Network Architecture” of the issue, S. Bandyopadhyay and S. K. Pal describe a methodology for determining the MLP architecture automatically based on the analogy between a GA based classification scheme (developed by them earlier using variable length chromosome) and multi-layer perceptron (MLP) based classifier. The analogy concerns with the optimal number of hyperplanes required to produce minimum error by these classifiers. Superiority of the MLP thus derived with the proposed method to those of several conventional MLPs has been extensively demonstrated for various artificially generated and real life data sets. This investigation shows how the principle of a GA based classifier can enrich/ enhance the theory and application domain of ANNs in soft computing paradigm.

Finally, I take this opportunity to thank Prof. A. Skowron, Editor-in-Chief, *Fundamenta Informaticae* for giving me an opportunity to act as the Guest Editor for this special issue while I was visiting the Institute of Mathematics, Warsaw University, Poland in February 1997 under an INDO-POLISH program for co-operative research. I am thankful to all the contributors and reviewers for their co-operation in bringing this issue out. My thanks are also due to Mr. Indranil Dutta for his sincere secretarial assistance.

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