Foundations of Computational Intelligence
Volume 2: Approximation Reasoning: Theoretical Foundations and Applications

Human reasoning usually is very approximate and involves various types of uncertainties. Approximate reasoning is the computational modelling of any part of the process used by humans to reason about natural phenomena or to solve real world problems. The scope of this book includes fuzzy sets, Dempster-Shafer theory, multi-valued logic, probability, random sets, rough set, near set and hybrid intelligent systems. Besides research articles and expository papers on theory and algorithms of approximation reasoning, papers on numerical experiments and real world applications were also encouraged. This Volume comprises of 12 chapters including an overview chapter providing an up-to-date and state-of-the research on the applications of Computational Intelligence techniques for approximation reasoning. The Volume is divided into 2 parts:

Part-I: Approximate Reasoning – Theoretical Foundations

Part-II: Approximate Reasoning – Success Stories and Real World Applications

Part I on **Approximate Reasoning – Theoretical Foundations** contains four chapters that describe several approaches of fuzzy and Para consistent annotated logic approximation reasoning.

In **Chapter 1**, "Fuzzy Sets, Near Sets, and Rough Sets for Your Computational Intelligence Toolbox" by *Peters* considers how a user might utilize fuzzy sets, near sets, and rough sets, taken separately or taken together in hybridizations as part of a computational intelligence toolbox.

In multi-criteria decision making, it is necessary to aggregate (combine) utility values corresponding to several criteria (parameters). The simplest way to combine these values is to use linear aggregation. In many practical situations, however, linear aggregation does not fully adequately describe the actual decision making process, so non-linear aggregation is needed. From the purely mathematical viewpoint, the next natural step after linear functions is the use of quadratic functions. However, in decision making, a different type of non-linearities is usually more adequate than quadratic ones: fuzzy-type non-linearities like OWA or Choquet integral that use min and max in addition to linear combinations. In **Chapter 2**, "Fuzzy Without Fuzzy: Why Fuzzy-Related Aggregation Techniques Are Often Better Even in Situations Without True Fuzziness" by *Nguyen et al.* gives a mathematical explanation for this empirical phenomenon. Specifically, the authors show that approximation by using fuzzy methodology is indeed the best (in some reasonable sense).

In **Chapter 3**, "Intermediate Degrees are needed for the World to be Cognizable: Towards a New Justification for Fuzzy Logic Ideas" *Nguyen et al.* prove that intermediate degrees are needed to describe real-world processes and it provides an additional explanation for the success of fuzzy techniques (and other techniques which use intermediate degrees) – which often goes beyond situations in which the intermediate degrees are needed to describe the experts' uncertainty.

Chapter 4, "Paraconsisitent annotated logic program Before After EVALSPN and its applications" by *Nakamatsu*, proposes a paraconsistent annotated logic program called EVALPSN. In EVALPSN, an annotation called an extended vector annotation is attached to each literal. In addition, the author introduces the bf-EVALPSN and its application to real-time process order control and its safety verification with simple examples.

Part II on **Approximate Reasoning – Success Stories and Real World Applications** contains eight chapters that describe several success stories and real world applications on approximation reasoning.

In **Chapter 5**, "A Fuzzy Set Approach to Software Reliability Modeling" *Zeephongsekul* provides a discussion of a fuzzy set approach, which is used to extend the notion of software debugging from a 0-1 (perfect/imperfect) crisp approach to one which incorporates some fuzzy sets ideas.

Chapter 6, "Computational Methods for Investment Portfolio: the Use of Fuzzy Measures and Constraint Programming for Risk Management" by *Majoc et al.* present a state of the art on computational techniques for portfolio management, that is, how to optimize a portfolio selection process and propose a novel approach involving utility-based multi-criteria decision making setting and fuzzy integration over intervals.

In **Chapter 7**, "A Bayesian Solution to the Modifiable Areal Unit Problem" *Hui* explores how the Modifiable Areal Unit Problem (MAUP) can be described and potentially solved by the Bayesian estimation (BYE). Specifically, the scale and the aggregation problems are analyzed using simulated data from an individual-based model.

In **chapter 8**, "Fuzzy Logic Control in Communication Networks" by *Chrysostomou and Pitsillides* discuss the difficulty of the congestion control problem and review the control approaches currently in use. The authors motivate the utility of Computational Intelligence based control and then through a number of examples, illustrate congestion control methods based on fuzzy logic control.

In **Chapter 9**, "Fuzzy Rule Based Classification Systems: A Study about Dealing with Imbalanced Data-Sets" *Fernandez et al.* present a short introduction on Fuzzy Rule Based Classification Systems, discussing their usefulness for getting interpretable models in Machine Learning. Then, the focus is on imbalanced data-sets, presenting a short study on these kind of problems, illustrating some results on the use of Fuzzy Rule Based Classification Systems on imbalanced data-sets.

In **Chapter 10**, "Adaptation in Classification Systems" *Bouchachia* investigates adaptation issues in learning classification systems from different perspectives. Special attention is given to adaptive neural networks and the most visible incremental learning mechanisms. Adaptation is also incorporated in the combination of incremental classifiers in different ways so that adaptive ensemble learners are obtained. These issues are illustrated by means of a numerical simulation.

In **Chapter 11**, "Music Instrument Estimation in Polyphonic Sound Based on Short-Term Spectrum Match" *Jiang et al.* provide a new solution to an important problem of instrument identification in polyphonic music: There is loss of information on non-dominant instruments during the sound separation process due to the overlapping of sound features. Experiments show that the sub-patterns detected from the power spectrum slices contain sufficient information for the multiple-timbre estimation tasks and improve the robustness of instrument identification.

In **Chapter 12**, "Ultrasound Biomicroscopy Glaucoma Images Analysis Based on Rough Set and Pulse Coupled Neural Network" *El-Dahshan et al.* present rough sets and pulse coupled neural network scheme for Ultrasound Biomicroscopy (UBM) glaucoma images analysis. The Pulse Coupled Neural Network (PCNN) with a median filter was used to adjust the intensity of the UBM images. This is followed by applying the PCNN-based segmentation algorithm to detect the boundary of the interior chamber of the eye image. Then, glaucoma clinical parameters are calculated and normalized, followed by application of a rough set analysis to discover the dependency between the parameters and to generate set of reducts that contains minimal number of attributes.

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