
Preface

A number of different instruments for design can be unified in the context of lattice theory towards cross-fertilization

By “lattice theory” [1] we mean, equivalently, either a *partial ordering* relation [2, 3] or a *couple of binary algebraic* operations [3, 4]. There is a growing interest in computational intelligence based on lattice theory.

A number of researchers are currently active developing lattice theory based models and techniques in engineering, computer and information sciences, applied mathematics, and other scientific endeavours. Some of these models and techniques are presented here.

However, currently, lattice theory is not part of the mainstream of computational intelligence. A major reason for this is the “learning curve” associated with novel notions and tools. Moreover, practitioners of lattice theory, in specific domains of interest, frequently develop their own tools and/or practices without being aware of valuable contributions made by colleagues. Hence, (potentially) useful work may be ignored, or duplicated. Yet, other times, different authors may introduce a conflicting terminology.

The compilation of this book is an initiative towards proliferating established knowledge in the hope to further expand it, soundly.

There was a critical mass of people and ideas engaged to produce this book. Around two thirds of this book’s chapters are substantial enhancements of preliminary works presented lately in a three-part special session entitled “Computational Intelligence Based on Lattice Theory” organized in the context of the World Congress in Computational Intelligence (WCCI), FUZZ-IEEE program, July 16-21, 2006 in Vancouver, BC, Canada. The remaining book chapters are novel contributions by other researchers.

This book is a balanced synthesis of four parts emphasizing, in turn, neural computation, mathematical morphology, machine learning, and (fuzzy) inference/logic.

PART I focuses on neural computation. More specifically, chapter 1 (by Kaburlasos) presents a granular enhancement of two popular neural classifiers, namely fuzzy-ART and SOM, based on lattice (partial) ordering.

Chapter 2 (by Ritter and Urcid) introduces novel algorithms for learning described in terms of lattice algebraic computations in dendritic (neural) structures according to recent discoveries in neuroscience.

Chapter 3 (by Barmpoutis and Ritter) demonstrates, successfully, novel dendritic lattice computing in difficult classification problems.

Chapter 4 (by Healy and Caudell) uses generalized lattices, or equivalently categories, in neural networks in order to model distributed world semantics.

PART II focuses on mathematical morphology applications. In particular, chapter 5 (by Urcid and Ritter) demonstrates the capacity of novel lattice matrix associative memory techniques to recall images degraded by noise.

Chapter 6 (by Graña, Villaverde, Moreno, and Albizuri) introduces a new feature extraction technique, which is employed for visual pattern recognition.

Chapter 7 (by De Witte, Schulte, Nachtegaal, Mélange, and Kerre) presents a new approach for extending mathematical morphology from binary- to both greyscale- and color-images including also an image denoising method.

Chapter 8 (by Sussner and Valle) describes the storage and recall phases of morphological and certain fuzzy morphological associative memories including applications to classification and prediction.

PART III focuses on machine learning applications. In particular, chapter 9 (by Athanasiadis) introduces a rule-based perspective for fuzzy lattice reasoning (FLR) including also two environmental data mining applications.

Chapter 10 (by Petridis and Syrris) investigates the application of fuzzy lattice neurocomputing (FLN) in an environmental prediction problem.

Chapter 11 (by Piedra-Fernández, Cantón-Garbín, and Guindos-Rojas) demonstrates applications of a fuzzy lattice classifier to ocean satellite images.

Chapter 12 (by Al-Daraiseh, Kaylani, Georgiopoulos, Mollaghasemi, Wu, and Anagnostopoulos) presents three genetically optimized neural algorithms for classification applicable to a lattice of hyperboxes.

Chapter 13 (by Cripps and Nguyen) uses fuzzy lattice reasoning (FLR) classifier with similarity measures whose effectiveness is shown experimentally.

PART IV focuses on logic and inference. More specifically, chapter 14 (by Munoz-Hernandez and Vaucheret) enhances Fuzzy Prolog by default knowledge in order to represent incomplete information in logic programming.

Chapter 15 (by Knuth) considers lattice fuzzification by valuation functions towards a unification of probability- with information- theory.

Chapter 16 (by Hatzimichailidis and Papadopoulos) studies useful connections between L-fuzzy sets and intuitionistic fuzzy sets.

Chapter 17 (by Kehagias) studies extensions of both t-norms and t-conorms to a superlattice, the latter is a multi-valued analog of a lattice.

Chapter 18 (by Kehagias) describes the construction of fuzzy-valued both t-norms and t-conorms from families of multi-valued t-norms and t-conorms.

Algorithms are presented in several chapters. Often, there are cross references among book chapters. References and (possible) Appendices are shown per chapter. There is a single Index for all chapters at the end of this book.

We thank the authors for their contribution.

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References

1. Birkhoff G (1967) Lattice Theory, Colloquium Publications 25. American Mathematical Society, Providence, RI
2. Kaburlasos VG (2006) Towards a Unified Modeling and Knowledge-Representation Based on Lattice Theory — Computational Intelligence and Soft Computing Applications, Studies in Computational Intelligence 27. Springer, Heidelberg, Germany
3. Ritter GX, Gader PD (2006) Fixed points of lattice transforms and lattice associative memories. In: Hawkes P (ed) Advances in Imaging and Electron Physics 144:165–242. Elsevier, Amsterdam, The Netherlands
4. Ritter GX, Wilson JN (2000) Handbook of Computer Vision Algorithms in Image Algebra, 2nd ed. CRC Press, Boca Raton, FL

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