Book Review

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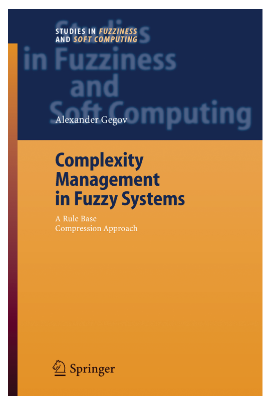
Complexity Management in Fuzzy Systems: A Rule Base Compression Approach by Alexander Gegov, Springer, Studies in Fuzziness and Soft Computing, Vol. 211, 2007, pp. 351, hardcover. ISBN: 978-3-540-38883-8.

Rule-based fuzzy models are one of the tools commonly used to approximate nonlinear, uncertain systems. The main advantage of fuzzy models is their ability to capture expert knowledge in a flexible manner. The price one pays for this flexibility is that fuzzy models become increasingly complex as the number of input and output variables grows. The reduction of complexity in fuzzy systems has been a subject of research since the 1990s. Most of the developments concern numerically oriented methods, such as orthogonal transforms for rule base reduction, similarity measures applied to the merging of membership functions, etc. The research monograph Complexity Management in Fuzzy Systems: A Rule Base Compression Approach, by Alexander Gegov, takes a different approach. The book presents a novel systematic methodology for the qualitative analysis of rule bases and provides methods and algorithms to manipulate and simplify them. The book comprises 10 chapters. In Chapter 1, which is a brief introduction to the book, the author first discusses the notion of complexity from his perspective. Then, fuzzy logic systems are introduced, and references to literature on complexity reduction are given. The introduction concludes with an overview of the rest of the book. Chapter 2 presents the Mamdani, Sugeno and Tsukamoto fuzzy systems in terms of their rule structure. Several types of conjunctive and disjunctive systems are discussed, as well as systems with multiple outputs, multiple rule bases and feedback fuzzy systems. The exponential growth in the number of rules with the number of inputs is illustrated. Chapter 3 is devoted to rule base reduction methods. It starts with the removal and merging of linguistic values (e.g., when they are detected to be similar) and proceeds to the removal and fusion of input and output variables. The chapter concludes with the topic of decomposing a complex rule-based system into several subsystems, organized, for instance, in a hierarchy. In Chapter 4, the author introduces two additional representations of a rule base—Boolean matrices and binary relations. Algorithms for converting a rule base from one representation to the other one are given. A large number of rule base properties are defined in terms of these representations, such as completeness, consistency, monotonicity, etc. Chapter 5 builds on the preliminaries introduced in the preceding chapter. The Boolean matrix and binary relation forms serve as a framework for six rule-base manipulation techniques: vertical merging and splitting, horizontal merging and splitting, and output merging and splitting. Numerical examples are given throughout the chapter to illustrate the operations on simple, synthetic rule bases. In Chapter 6, the rule-base manipulation techniques are extended to three special forms of rules bases: identity rules base, transpose rule base and permutation rule base. Again, a large number of synthetic numerical examples are given throughout the chapter to illustrate the operations. The chapter concludes by discussing the distinction between rule base properties (such as monotonicity) and patterns in rule bases (such as a permutation pattern). Chapters 7 and 8 are devoted to 'transformations,' which are introduced as more advanced methods for formal rule base manipulation. The aim is to compress fuzzy rule bases by removing redundancy while preserving the rule base mapping. Examples of transformations are repetitive merging or merging combined with splitting. While Chapter 7 considers feedforward systems, in Chapter 8 various forms of feedback rule-based systems are addressed. Examples range from a simple feedback combination of two systems to rather



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Conference Calendar

* Denotes a CIS-sponsored conference
Δ Denotes a CIS-cosponsored or cooperation conference

Δ International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications
September 6–8, 2007;
Dortmund, Germany
General Co-Chairs: Anatoly Sachenko and Peter Reusch
http://www.idaacs.net/

Δ International Conference on Artificial Neural Networks
September 9–13, 2007; Porto, Portugal
General Co-Chairs: Joaquim Marques de Sa and Luis Alexandre
www.icann2007.org

Δ Biometrics Symposium
September 11–13, 2007;
Baltimore, Maryland
General Co-Chairs: Larry Hornak, Anil Jain, Josef Kittler, and Tieniu Tan
http://www.citer.wvu.edu/bsym2007

*** 2007 IEEE Congress on Evolutionary Computation**
September 25–28, 2007; Singapore, Singapore
General Co-Chairs: Tan-Kay Chen and Jian-Xin Xu
Deadline for Paper Submissions: March 15, 2007
www.cec2007.org

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Δ Frontiers in the Convergence of Bioscience and Information Technologies Conference
October 11–13, 2007; Jeju-do, Korea
General Co-Chairs: Daniel Howard and Phill Kyue Rhee
http://www.sersc.org/FBIT2007

*** 2007 IEEE International Conference on Granular Computing**
November 2–4, 2007; Silicon Valley, California, USA
General Co-Chairs: T.Y. Lin, Ron Yager and Jerry M. Mendel
Deadline for Paper Submissions: June 1, 2007
www.cs.sjsu.edu/~grc/

Δ NIH Life Science Systems & Applications Workshop
November 8–9, 2007; Bethesda, Maryland
General Chair: Jie Chen
http://www.ieee-lssatc.org/lisa07

Δ International Conference on Information & Automation for Sustainability
December 4–6, 2007;
Melbourne, Australia
General Co-Chairs: Harry Watson and M. Palaniswami
http://www.mame.mu.oz.au/mechatronics/iciafs07

Δ International Conference on Bio-Inspired Models of Network, Information, and Computing Systems
December 10–12, 2007;
Budapest, Hungary
General Chair: Falko Dressler
http://www.bionetics.org

Δ International Workshop on Semantic Media Adaptation and Personalization
December 17–18, 2007;
London, England
General Co-Chairs: Phivos Mylonas, Manolis Wallace and Marios Angelides
www.smap2007.org

*** 2008 IEEE World Congress on Computational Intelligence A joint conference of 2008 International Joint Conference on Neural Networks, 2008 IEEE International Conference on Fuzzy Systems, and 2008 IEEE Congress on Evolutionary Computation**
June 1–6, 2008; Hong Kong Convention and Exhibition Center
General Chair: Jun Wang
Deadline for Paper Submissions: December 1, 2007
www.wcci2008.org/

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complex multi-variable fuzzy systems with feedback cross-coupling and canonical rule base networks. As opposed to Chapters 4 through 8, which address qualitative complexity, Chapter 9 focuses on quantitative complexity. Two rule base simplification techniques are presented: aggregation of inconsistent rules and filtering out non-monotonic rules. An application example is shown to illustrate the performance of the techniques.

Chapter 10 concludes the book by discussing the applicability of the methods presented and indicating several directions for future research. The research monograph, Complexity Management in Fuzzy Systems: A Rule Base Compression Approach, is probably the first book entirely devoted to the subject of complexity in fuzzy rule-based systems. Despite the fairly general title, the author has chosen not to include a presentation of established methods, such as similarity-driven rule base reduction. Instead, he develops his own original approach, which is primarily based on a qualitative manipulation of rules and rule bases.

Potential readers should definitely be aware of this focus in the scope of the monograph. In the whole, the book is not difficult to read, but at places the presentation would have benefited from more lively, practically relevant examples. On the other hand, given the novelty of the techniques presented, one can imagine that such examples are not readily available. In that sense, the book is likely to attract more readers from the academia than researchers in industry or practicing engineers.