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Book Review

Hung T. Nguyen, Carol L. Walker, and Elbert A. Walker *A First Course in Fuzzy Logic* (4th edition) CRC Press, Taylor & Francis Book, Boca Raton, Florida, 2019

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What this book is about and who it is for. This is a textbook whose main objective is to introduce students to fuzzy techniques. It is intended as a one-semester course for advanced undergraduate and/or graduate students.

While this is the main intended audience, this book can be of use to others as well. The book has clear explanations, numerous exercises – and solutions to many of them. With this much pedagogical material, this book is also perfect for self-study.

What should a reader know before studying this book. Ideally, students should be familiar with the basics of set theory and probabilities.

This will help – but this is not required: the main concepts of set theory and probability theory are reminded to the readers.

How is this book different from all other introductory books on fuzzy: main difference. The main difference is that all the material is presented with *mathematical rigor*: yes, there are informal motivations, but they are always followed by precise definitions and results – and for most of these results, proofs are also presented in the book.

This feature makes the book perfect for math majors and for mathematicians in general. Others will also benefit from this rigor, when everything is precisely defined and all results are precisely formulated.

Which fuzzy topics are covered. Practically all basic fuzzy topics are covered in this book, from the basics of fuzzy logic – including fuzzy analogs of "and" (t-norms), "or" (t-conorms) and fuzzy negation and implication, fuzzy relations, fuzzy reasoning, and the use of fuzzy techniques in modeling and control.

In all these topics, this textbook goes beyond the usual introductory expositions: e.g., in addition to describing possible t-norms and t-conorms, the textbook also describes (and proves) which t-norms and t-conorms are the least sensitive to the uncertainty with which we know the original degrees.

Also, many other topics and covered, topics which are not always covered in introductory textbooks,

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such as universal approximation results, interval-valued and type-2 fuzzy logics, fuzzy measures and the corresponding integrals, possibilistic reasoning, canonic forms of propositional statements, and powers of t-norms.

Many non-fuzzy topics are covered too. One of the interesting features of this book is that it also describes many non-fuzzy topics which turns out to be related to fuzzy. For example, the study of the usual [0, 1]-valued fuzzy logic starts with the analysis of 3-valued logic where the truth values are "true", "false", and "unknown". A description and analysis of t-norms – fuzzy equivalents of "and"-operations – is accompanied by a description of *copulas* – probabilistic analogues of "and"-operations – and of how they are related to t-norms. The study of conditional fuzzy statement is accompanied by a description of conditional events in probability theory. A special attention is devoted to random sets and their relation with fuzzy sets.

Other interesting not-exactly-fuzzy-but-related-to-fuzzy topics studied in this book are belief functions and fractal dimension.

Summarizing. Lotfi Zadeh, the father of fuzzy logic, liked to emphasize that while one of the main *purposes* of fuzzy technique is to study and process imprecise ("fuzzy") statements, there is nothing fuzzy about the techniques themselves: most fuzzy techniques are well-defined in precise mathematical terms. This book is a rich and exciting celebration of this statement: it shows that fuzzy techniques can be described in precise mathematical terms, and that the resulting mathematics is closely related to mathematics covering other types of uncertainty, such as probabilistic and possibilistic uncertainty.

Whether you are a student wanting to learn more about fuzzy or a practician wanting to learn about foundations of fuzzy – or even a researcher actively working in this area – from this book, everyone will learn many new ideas, many new techniques.