

Preface

The theory of nonadditive set functions and relevant nonlinear integrals, as a new mathematics branch, has been developed for more than thirty years. Starting from the beginning of the nineties of the last century, several monographs were published. The first author of this monograph and Professor George J. Klir (The State University of New York at Binghamton) have published two books, *Fuzzy Measure Theory* (Plenum Press, New York, 1992) and *Generalized Measure Theory* (Springer-verlag, New York, 2008) on this topic. These two books cover most of their theoretical research results with colleagues at the Chinese University of Hong Kong in the area of nonadditive set functions and relevant nonlinear integrals. Since the 1980s, nonadditive set functions and nonlinear integrals have been successfully applied in information fusion and data mining. However, only a few applications are involved in the above-mentioned books. As a supplement and in-depth material, the current monograph, *Nonlinear Integrals and Their Applications in Data Mining*, concentrates on the applications in data analysis. Since the number of attributes in any database is always finite, we focus on our fundamentally theoretical discussion of nonadditive set function and nonlinear integrals, which are presented in the first several chapters, on the finite universal set, and abandon all convergence and limit theorems.

As for the terminology adopted in the current monograph, words like *monotone measure* is used for a set function that is nonnegative, monotonic, and vanishing at the empty set. It has no fuzziness in the meaning of Zadeh's fuzzy sets. Unfortunately, its original name is *fuzzy measure* in literature. Word "fuzzy" here is not proper. For example,

words “fuzzy-valued fuzzy measure defined on fuzzy sets” causes confusion to some people. Such a revision is the same as made in book *Generalized Measure Theory*. However, in this monograph, we prefer to use *efficiency measure* to name a set function that is nonnegative and vanishing at the empty set, rather than using *general measure*. This is more convenient and intuitive, and leaves more space for further generalizing the domain or the range of the set functions. Hence, similar to the classical case in measure theory [Halmos 1950], the set functions that vanish at the empty set and may assume both nonnegative and negative real values are naturally named as *signed efficiency measures*. The signed efficiency measures were also called *non-monotonic fuzzy measures* by some scholars. Since, in general, the efficiency measures are non-monotonic too, to distinguish the set functions satisfying only the condition of vanishing at the empty set from the efficiency measures and to emphasize that they can assume both positive and negative values as well as zero, we prefer to use the current name, signed efficiency measures, for this type of set functions with the weakest restriction. Thus, in this monograph, we discuss and apply three layers of set functions named monotone measures, efficiency measures, and signed efficiency measures respectively.

The contents of this monograph have been used as the teaching materials of two graduate level courses at the University of Nebraska at Omaha since 2004. Also, some parts of this monograph have been provided to a number of master degree and Ph.D. degree graduate students in the University of Nebraska at Omaha, the University of Nebraska at Lincoln, the Chinese University of Hong Kong, and the Chinese Academy Sciences, for preparing their dissertations.

This monograph may benefit the relevant research workers. It is also possible to be used as a textbook of some graduate level courses for both mathematics and engineering major students. A number of exercises on the basic theory of nonadditive set functions and relevant nonlinear integrals are available in Chapters 2–5 of the monograph.

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