

## Preface

With today's information overload, it has become increasingly difficult to analyze the huge amounts of data and to generate appropriate management decisions. Furthermore, the data are often imprecise and will include both quantitative and qualitative elements. For these reasons it is important to extend traditional decision making processes by adding intuitive reasoning, human subjectivity, and imprecision.

To deal with uncertainty, vagueness, and imprecision, Lotfi A. Zadeh introduced fuzzy sets and fuzzy logic. In the present volume, fuzzy classification is applied to extend portfolio analysis, scoring methods, customer segmentation, and performance measurement, and thus, to improve managerial decisions. As an integral part of the book, case studies show how fuzzy classification with its query facilities can extend customer equity, enable mass customization, and refine marketing campaigns.

Most publications in management and marketing do not address the problem, which can arise when using traditional, non-fuzzy or 'sharp' methods. With fuzzy classification, a customer can belong to more than one class with differing degrees of membership. This approach to membership not only provides a better description of the elements, it also helps to reveal both the potential strengths and the possible weakness of the class elements under consideration. As a result, marketing managers can treat their customers according to their true value. This book explores the possibilities and advantages created by fuzzy methods, through the presentation of thorough research and case studies.

The book covers a great variety of possible fuzzy logic approaches to customer relationship management and marketing. Examples are:

- Segmentation with Fuzzy Customer Classes
- Fuzzy Scoring Methods for Marketing
- Fuzzy Data Warehousing
- Inductive Fuzzy Classification for Marketing Programs
- Fuzzy-based Recommender Systems
- Fuzzy Portfolio Techniques in Marketing
- Community Marketing based on Fuzzy Logic
- Fuzzy Clustering of Web User Profiles
- Online Reputation and Fuzziness
- Building Fuzzy-based Ontologies
- Web Analytics and Web Controlling with Fuzziness
- Fuzzy-based Performance Measurement
- Improving Social Networks through Fuzzy Control

This book is not only intended for students and researchers but will also be valuable for executives, managers, marketing experts, and project leaders who would like to apply fuzzy classification to managerial decisions. The book presents a set of fuzzy methods, case studies, and Web-based tools, which together, make it possible to test the efficiency and effectiveness of fuzzy classification.

## OVERVIEW OF BOOK CHAPTERS

The book has been divided into four sections. The first section, *Fuzzy Modeling*, is characterized by its rather theoretical orientation. The second section, *Customer Relationship Management and Web Analytics*, addresses the main focus of the book and is its cornerstone. In the third section, *Performance Analysis*, the object of attention is the economic activity or the performance of a firm. The concluding section, *Market Analysis*, is particularly aimed at marketers.

### Fuzzy Modeling

Three chapters form the first section. Chapter 1, by the book's editors, introduces the topic area and begins the book. Yager and Yager in Chapter 2, *Fuzzy Soft Social Network Modeling and Marketing*, set out to model social networks. Their aim is to provide a language or a framework, which can be used to intelligently query a social network. A fuzzy set of operators is presented which can be used to retrieve human-focused network information. Perhaps the main difficulty the authors have to face is in translating linguistic descriptions into mathematical concepts. Fuzzy set theories or granular computing may help to construct the bridge between the human analyst and the formal model of the network.

First, the authors present a short introduction to graph theory. The notions of path, connected graph, and bridge are introduced. The composition operator, which is essential in relationships, is also explained. Then, the concept of *precision* is borrowed from Zadeh, which attempts to make the world understandable to the machine. Fuzzy set theory helps to bridge the gap between man and machine. In fact, man's common vocabulary is expressed in terms of fuzzy sets that are in a form the machine can manipulate. The authors use the linguistic modeling capability of fuzzy sets to provide more realistic formulations of concepts available in social networks analysis.

The notions of node importance, cluster, congested nodes, duration, directed graphs, and authority figures are each introduced and described. A section devoted to vector valued nodes and social network databases concludes the chapter. All these concepts can be formalized using fuzzy sets and permit the evaluation of any given social network.

Chapter 3, *Fuzzy Dynamic Groups: Measures and Implications for Television Audiences*, is by Mora. The author first notes that time affects groups of consumers in two fundamental ways: the characteristics of the individuals in the group change and the individual memberships in the group may change too. These two aspects introduce fuzziness into the definition of the group, which becomes dynamic. A dynamic group presented by the author is made up of the members of a family watching television.

The main question for the author is how to define and measure a group of viewers. In the context of television audiences, the author describes two important group characteristics: size and composition. The author proceeds first to the fuzzification of dynamic groups. Then he defines the degree of membership of individuals in the group. Group composition is a multidimensional construct reflecting the proportion of specific types of individuals in the group. Finally a generalized linear model is presented

with individual viewership as the dependent variable and as independent variables a set of individual characteristics and the proposed measures of cardinality and fuzziness. The estimation of the model confirms the hypotheses made about the characteristics of the group.

The contribution of Denize et al. forms Chapter 4, *Using Case Data to Ensure 'Real World' Input Validation within Fuzzy Set Theory Models*. As fuzzy set theories open up new ways of investigating business networks, the authors contend, it becomes necessary to validate the fuzzy models used within real-world contexts. They also note that these theories have not been used extensively within marketing and management disciplines. Furthermore, model validation and verification are not yet the rule. According to the authors, the process of validation has a number of advantages. First, it allows model builders to develop a fuzzy rule based system without working from a full factorial set of rules. Second, it checks for consistency and coverage of the fuzzy rule based system. Finally, it validates the simulation models within real world data sets. Thus this process improves both the efficiency of the validation and the sufficiency of the model.

First of all, the authors clarify the concept of validation. They argue that modelers make comparisons at critical points and that these comparisons constitute verification or validation. The authors are particularly interested “in the emergent processes in innovation networks and what combinations of network characteristics contribute to innovation success.” As they say, innovation processes occur within business networks.

The case study selected by the authors considers the solar cell industry in Australia during the period 1985-2008. Particularly illustrative is the flow chart given by the authors describing the validation process. The fuzzy modeling process is shown in three main steps. The first step is the identification of the variables' domains and their description (deriving fuzzy inputs). In the second step, the extraction of the initial set of rules is presented (deriving rules). The third step is devoted to the review and refinement of the fuzzy-rule based system. After this third step, it is possible to demonstrate the extent to which the fuzzy model results correspond to real-world case data. Finally, the authors conclude the chapter with six valuable lessons. Fuzzy models are not well understood and accepted by the research community. According to the authors, further improvements in the validation process will be achieved once the fuzzy set theory model becomes a more prominent tool within marketing research.

## **Customer Relationship Management and Web Analytics**

Five chapters make up this second section. In Chapter 5, *Fuzzy Clustering of Web User Profiles for Analyzing their Behavior and Interests*, Kreuzer and Hoebel address the problem of how to define, calculate, and visually present fuzzy clusters of Web visitors with respect to their behavior and supposed interests. The authors introduce a fuzzy clustering approach named CORD (Clustering of Ordinal Data) to analyse website contents, users' interests, and behavior. The CORD approach combines three modern clustering techniques and is able to process very large sets of ordinal data. The concept of “non-obvious user profiles” (NOPs) is introduced in order to measure the Web users' supposed interests. This profile is inferred from the user's behavior in one or more sessions on the website and represents the interests of one user in different topics.

A fuzzy k-modes algorithm extension for categorical data constitutes the basis of the CORD method. This algorithm uses the degree to which a record belongs to a certain centroid. This fuzziness, saved during the iteration process, makes it possible to choose the centroids and produce the cluster with greater accuracy. A valuable contribution of the authors is the presentation of a modified fuzzy centroid

algorithm. In fact, implementing the algorithm in a naïve way will greatly slow the computations. The authors have developed the idea of parallelizing the computations. In this way they can improve the speed considerably and are able to cluster very large datasets efficiently.

A case study based on a website gives the authors the opportunity to test the fuzzy CORD approach. The non-obvious profiles and feedback profiles of the Web users are stored. Then one can apply the algorithm and present the results visually, together with the fuzzy centroids. Two presentations are provided: a table view and an animation view. These representations appear very helpful in analyzing the data. The animation view permits the analysis of the behavior of the Web users and the study of the cluster changes over time.

Terán et al., in Chapter 6, *Using a Fuzzy-Based Cluster Algorithm for Recommending Candidates in E-Elections*, propose a fuzzy recommender system for e-Elections. The authors have developed a user-friendly interface – a Web application called smartvote – to help voters to find the most similar candidates according to the preferences of the individual voters. Their recommender system needs inputs from voters and candidates and is then able to make recommendations based on similarities that exist between voters and candidates. A fuzzy c-mean algorithm is applied to constitute these clusters of similar candidates. The recommender system is supported by an attractive graphic interface, which is able to display the cluster – N-closest candidates – together with the location of the voter.

Portmann et al., in Chapter 7, *Fuzzy Online Reputation Analysis Framework*, have set up a fuzzy online reputation analysis framework (foRa) in order to allow communications operatives to search the Social Web to find meaningful information in a straightforward manner. The foRa framework has three main parts. A fuzzy grassroots ontology collects data and converts them into an ontology. The ontology is managed and stored on a storage system. A reputation analysis engine carries out the analysis, and an interactive user interface called the dashboard allows the browsing of related topics.

The tagspace is a representation of a consistent picture and serves as the input for the ontology adaptor, which is intended to separate the tagspace into hierarchies of classes. A fuzzy c-means algorithm is used to do this. A prototype (youReputation) of a reputation analysis tool demonstrates the features of the foRa framework. The prototype gives reputation results based on search inputs.

According to Kaufmann and Graf in Chapter 8, *Fuzzy Target Groups in Analytic Customer Relationship Management*, three analytic techniques can be very helpful in supporting Customer Relationship Management activities: the selection of relevant attributes, the visual presentation of relevant associations, and the prediction of relevant class membership. The authors emphasize that inductive fuzzy logic techniques support these three types of analysis.

Based on a likelihood inductive approach, fuzzy membership degrees in the desired target classes are computed. This inductive fuzzy classification, which is based on normalized likelihood ratios, allows the authors to generate customer profiles based on a target class and the relevant customer attributes. The chapter concludes with the presentation of an implementation of the software.

For their case study, the authors consider the financial services provider *Swiss Post*, which wishes to contact customers with personal advertisement messages. Based on relevant customer attributes, a predictive inductive fuzzy model is constructed that assigns a numerical value to every customer record. A fuzzy target group can thus be identified.

Chapter 9, *Web Analytics with Fuzziness*, is by Zumstein. In its restrictive definition, Web analytics is essentially the measurement and analysis of Web data. As noted by the author, one significant problem in this context is that Web data often consist of metrics values and raw numbers, and are therefore difficult to interpret. The aim of the chapter is to propose a fuzzy logic concept making this analysis possible.

A first remark made by the author is that traditionally, Web metrics values are classified in a sharp way, which is not a very good solution. The need for a fuzzy classification is argued and an inductive fuzzy classification method proposed for the analysis of Web usage patterns. This fuzzification has a number of advantages in this context. Fuzzy classification in Web mining makes it possible to rank Web pages by a gradual degree of membership in classes. Furthermore, it appears that the results of methods based on fuzzy logic are easier to interpret. As an illustration, the author provides a case study concerning the use of fuzzy classification with real Web data.

## Performance Analysis

The third section has three chapters and begins with a contribution from Fasel and Shahzad. In Chapter 10, *Fuzzy Data Warehouse for Performance Analysis*, these authors consider classification with linguistic terms in the context of data warehousing. They argue that if a crisp strategy is applied, true values cannot be measured, and it is not possible to have a smooth transition between classes. Their approach, based on a fuzzy data warehouse model, attempts to integrate fuzzy concepts as meta-tables without affecting the core of a traditional data warehouse. One can immediately see the potential of such an approach. Both sharp and fuzzy analyses of data are made possible.

A fuzzy OLAP cube makes it possible to implement fuzziness within the data warehouse. Yet, by allowing the querying of both crisp and fuzzy data, thanks to their meta-table structure, they combine fuzzy association rules mining and other data mining techniques which require less effort than the proposed cube. The cube contains the membership degrees of the fuzzy sets as measures. The application of fuzzy association rules is thus made possible. This approach appears greatly to simplify the integration and aggregation of fuzzy concepts and can be integrated into existing traditional data warehouses rather simply.

An original part of the chapter is the presentation of a method for modeling a fuzzy data warehouse. In two specific steps, “Defining classification elements” and “Building a fuzzy data warehouse model,” the modeler is guided in the development of a fuzzy data warehouse without requiring a deep knowledge of fuzzy logic.

The case study presented by the authors is very helpful, not only to illustrate the implementation of a fuzzy data warehouse, but also to demonstrate the performance of this form of data warehouse. The case concerns a movie rental company. Particularly interesting is the integration of fuzzy concepts in the data warehouse. At the end of the process, the company benefits from a new set of performance measures. As the authors show, these measures can be very useful, for example for the analysis of customer revenue.

Werro and Stormer in Chapter 11 propose *A Fuzzy Logic Approach for the Assessment of Online Customers*. The authors adopt the customer equity principle to analyze and manage customer relationships. They argue that the fuzzy classification approach can improve the customer equity, launch loyalty programs, automate mass customization, and refine marketing campaigns. The toolkit supplied by the authors, which is an extension of the fuzzy classification query language, aims to reduce the complexity of customer data and through fuzzy classification makes possible the extraction of valuable hidden information. This is done by extending the relational database schema with meta-tables added to the system catalogue.

Furthermore, the authors show that it is possible to decompose a complex fuzzy classification into a hierarchy of fuzzy classifications. As a result, the complexity of the initial problem will be reduced, allowing a better definition and optimization of the different fuzzy sub-classifications. According to the



authors, a hierarchical fuzzy classification allows marketers to carry out better analyses. As an illustration, a practical example is given.

Ghasemy Yaghin and Fatemi Ghomi, in Chapter 12, *A Hybrid Fuzzy Multiple Objectives Approach to Lotsizing, Pricing and Marketing Planning Model*, note that few studies have simultaneously considered profit maximization and Return on Inventory Investment (ROII) maximization as performance criteria for the shortage constrained inventory model. The imprecise and fuzzy nature of parameters such as unit costs and marketing functions has led the authors to develop a fuzzy multiple objectives model. The profit, return on inventory investment, and a qualitative objective related to customer satisfaction are the objective functions considered. The model is able to determine the joint pricing, lotsizing, and marketing plan of the manufacturer. A real-world industrial case study illustrates the method.

## Market Analysis

The fourth and final section includes two chapters. Casabayó and Agell, in Chapter 13, propose *A Fuzzy Segmentation Approach to Guide Marketing Decisions*. As the authors note, the market segmentation concept has been widely used in market analysis and has had great success since its introduction. Yet there are numerous limitations in this approach. The consumer is a plural person, which cannot be reduced to a single category. The fuzzy segmentation approach proposed by the authors is an attempt to overcome this problem. Using a multi-behavioral model, they have been able to interpret non-exclusive segments and obtain a clearer image of market realities. In this way, the decision-making process is considerably improved.

The LAMDA technique is advocated as an alternative to non-overlapping segmentation techniques. LAMDA (Logical Association in Multivariate Data Analysis) is a fuzzy clustering method, which uses a fuzzy membership function as the measure of adequacy of a unit for a cluster. The authors reveal numerous advantages of the LAMDA method over traditional classification techniques. First, in comparison to classic data mining or the artificial intelligence methods, there is its simplicity, both in the understanding and the interpretation of the results. Beyond this, the method works with both quantitative and qualitative data, is fast, very intuitive, and requires less memory than other classifying techniques.

The case study is based on data from a leading company in the Spanish energy sector. Two segmentation techniques were applied: a non-hierarchical cluster analysis and the LAMDA method. A compatibility analysis of the two methods was undertaken. It appears that the fuzzy segmentation reveals more pertinent information than the other segmentation method and permits the firm to identify more accurately the multiple segments customers belong to and why.

Chapter 14, *Causal Recipes Sufficient for Identifying Market Gurus versus Mavens*, is by Chung and Woodside. The identification of Market Mavens, i.e. information diffusers, plays a central role in the study of consumer behavior. However, a second category of information diffuser has to be considered: Market Gurus. These are consumers others frequently seek out for advice but who do not seek advice from others. The authors' aim is to develop a theory of the characteristics of Market Gurus, to search for them, and thus to confirm the existence of Market Gurus among consumers.

The authors apply a fuzzy set qualitative comparative analysis to distinguish between Market Mavens and Market Gurus using multi-year data from a national U.S. omnibus survey. This method makes it possible to analyze complex configurations of causal conditions as explanations of an outcome condition. Configurations of behavior may be demographics, attitudes, interests, and opinions. The authors proceed first by calibrating fuzzy-set scores. This procedure allows them to describe the degree of

membership for a given case. Next “truth tables” are constructed to display all possible combinations of causal conditions and case distributions. These tables allow the authors to find multiple pathways to an outcome. The results obtained corroborate and extend previous research.

If you want to gain knowledge about recent research in fuzzy marketing methods or to build your company’s customer assets for optimal performance, then this book is for you.

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