Preface

This volume is a result of a special project the purpose of which was twofold. First of all, we wished to provide a bird's eye view of some novel directions in the broadly perceived "fuzzy logic," starting from more philosophical and foundational considerations, through a bunch of promising models for the analysis of data, decision-making, and systems modeling, to a logical consequence in view of the very topic covered by this volume, reflected in its title, that is, an account of some successful experiences in using fuzzy technology in practice, in business, and in technology. Second, from a more personal perspective, we wished this volume to be a token of appreciation to Prof. Christer Carlsson, from the Institute for Advanced Management Systems Research (IAMSR), Åbo Akademi University in Åbo (Turku) in Finland; a very special person, a friend and a peer, to the entire fuzzy logic community, who has managed for so many years to combine top-level theoretical research with applications, and finally implementations of various fuzzy logic based models in business and technology. Of course, before entering the field of fuzzy logic he was a prominent representative of the operations research community, notably that in multiple-criteria decision-making (MCDM).

What concerns the last two decades of his activities is that he has been a driving force behind the foundation and an unprecedented growth of his large research group, IAMSR, a rare research institution not only in Europe, but all over the world, which has been able to, for many years, continuously collect funds from research and development projects with business and industry. This should be considered as a sign of Prof. Carlsson's vision and far-sighted ideas on the fact that a close collaboration with practice is crucial for the academic world. After many years of personal success, this vision is today confirmed by the policies of both the European Union and other governments around the world.

Christer was a visionary and a proponent of modern applications of fuzzy technology, and—what has been rare and difficult—he has always been, and is, one of those not so numerous people in our academic community who have been able to secure substantial industrial grants for large research groups. It is worth mentioning that in his works he has always been able to find a synergistic combination of high scientific level with real-world applications.

Over many years he has been an active member of the International Fuzzy Systems Association (IFSA), its long-time Council member, Treasurer, and finally President. His devotion and vision have certainly contributed to an extraordinary success of IFSA and proliferation of fuzzy logic all over the world.

We are sure that this volume will be interesting to many people who deeply feel, as Christer has always felt, that a synergistic combination of high-level theory with real applications is not only possible, but also is necessary, and can certainly be successful.

Following what has been said, we start our volume with Part I: Foundations, in which some papers from a more general to some extent philosophical type are included, which are important, because they clarify many aspects and issues that are relevant both for the foundations and soundness of many applications. Enric Trillas and Rudolf Seising in their "Turning Around the Ideas of Meaning and Complement" consider an important problem that has been with fuzzy sets/logic since its inception, namely the fact that though fuzzy sets have been viewed as specifying the meaning of some linguistic terms. There has not been many works on a deeper analysis of how the meaning should be meant so that those linguistic terms could be subject of a scientific inquiry. In the paper the authors follow the path rooted in the Wittgenstein's 'identification' of meaning and linguistic use, in which meaningful predicates can be seen as those represented by quantities, whose measures are the membership functions. Unfortunately, fuzzy set theory is still missing a complete study on the meaning of connectives that, in fuzzy logic, are not universal, as they are in classical logic, but are context-dependent and purpose-driven. This issue is discussed in depth, as well as issues related to a proper definition of the negation. Deeper semantic analyses for concepts like negation or antonym in general are usually not addressed, since they are often just applied through the membership functions. In this paper, the idea of a linguistic concept of 'complement,' either meant as 'not' or is 'opposite' is analyzed. For a person working in the theory of fuzzy logic, some ideas of the practice of natural language are also included.

Jorma K. Mattila in "A Note on Fuzzy-Valued Inference" considers fuzzy-valued inference, which is analyzed by using concepts and properties of a theory of fuzzy-valued associative Kleene algebra. To be more specific, it is shown that the tools and techniques presented can be used to develop a fuzzy screening system as introduced by Yager.

Vesa A. Niskanen in "A Concept Map Approach to Approximate Reasoning with Fuzzy Extended Logic" discusses the important problem of how to develop computer models of approximate reasoning, notably in terms of modus ponens and modus tolens. He proposes the use of Zadeh's fuzzy extended logic and the idea of a concept map which has been widely used in many areas. An application in statistics is shown.

In Part II: Data Analysis, Decision-Making and Systems Modeling, we included papers that have presented more specific models for solving various problems of relevance. First, some problems related to broadly perceived data analysis are dealt with. Christian Borgelt and David Picado-Muíno in "Significant Frequent Item Sets

via Pattern Spectrum Filtering" deal with the important problem of the frequent item set mining. Unfortunately, set mining is often plagued by the fact that the sets of frequent items can be very large, in some cases the size of the output can even exceed the size of the set of data involved. The authors propose new extensions to some statistical approaches that produce only significant frequent item sets (or association rules derived from them), which combines data randomization with a so-called pattern spectrum filtering.

Adriano S. Koshiyama, Marley M.B.R. Vellasco, and Ricardo Tanscheit in "A Novel Genetic Fuzzy System for Regression Problems" consider a regression problem that is equivalent to finding a model that relates the behavior of an output or response variable to a given set of input or explanatory variables, and has a universal importance and applicability. To meet the requirements of linguistic interpretability and reasonable accuracy, the authors present a novel genetic fuzzy system (GFS), called genetic programming fuzzy inference system for regression problems (GPFIS-Regress). The system utilizes multi-gene genetic programming to build the premises of fuzzy rules, with various t-norms, negation, and linguistic hedge operators. The system is tested on some relevant benchmark examples and the results are promising.

Silvia Bortot, Mario Fedrizzi, Michele Fedrizzi, and Ricardo Alberto Marques Pereira in "A Multidistance Approach to Consensus Modeling" investigate the relationship between the soft measure of collective dissensus and the multidistance approach to consensus evaluation previously introduced by them. They propose a new approach in which a particular type of sum-based multidistance used as a measure of dissensus is defined. This multidistance is characterized by the application of a subadditive filtering function the effect of which is that small values of distances are emphasized and large ones are attenuated. In an example, a comparison of the new dissensus measure with the OWA-based multidistance obtained assuming that the weights are linearly decreasing with respect to increasing distance values is performed.

Janusz Kacprzyk, Dominika Gołuńska, and Sławomir Zadrożny in "A Consensus Reaching Support System Based on the Concepts of an Ideal and Anti-Ideal Agent and Option" an extension of a series of previous works on a moderator run consensus reaching process, and its related group decision-making process in a small group of autonomous decision-makers (agents) is presented. The approach proposed is based on fuzzy preferences, fuzzy majority represented as linguistic quantifiers, and fuzzy majority based soft measure of the consensus, and the emphasis is on the running of a consensus reaching process via a moderator. To help the moderator to run the process, additional higher-level information, notably in the form of linguistic data summaries is used. Specifically, a new concept of an ideal and anti-ideal point and its related TOPSIS method based approach, is proposed.

Elid Rubio, Oscar Castillo, and Patricia Melin in "Interval Type-2 Fuzzy System Design Based on the Interval Type-2 Fuzzy C-Means Algorithm" use the interval type-2 fuzzy C-means (IT2FCM) algorithm to develop an interval type-2 fuzzy inference systems, using the centroids and fuzzy membership matrices for the lower

and upper bound of the intervals obtained by the IT2FCM algorithm, in each data clustering step that occurs in this algorithm. Using these tools and techniques, the Mamdani, and Sugeno fuzzy inference systems for classification of data sets and time series prediction are developed.

Pavel Holeček, Jana Talašová, and Jan Stoklasa in "Multiple-Criteria Evaluation in the Fuzzy Environment Using the FuzzME Software" describe a software tool for fuzzy multiple-criteria evaluation called "FuzzME," and present how to apply the software for solving a broad range of fuzzy MCDM problems. The mathematical foundation on which the FuzzME software is built is also briefly described. An interesting feature is that for the aggregation of partial scores, various aggregation methods can be employed, notably fuzzy weighted average, fuzzy OWA operator, and fuzzified WOWA operator. In the case of interacting criteria, the fuzzified discrete Choquet integral, and also an aggregation function described by fuzzy rule base, defined by the experts, can be used.

Part III: Fuzzy Logic in Business and Industrial Practice concerns very important works related to the practical use of broadly perceived intelligent, notably fuzzy, technologies, and experience gained. Mikael Collan and Pasi Luukka in "Strategic R&D Project Analysis: Keeping It Simple and Smart" deal with strategic R&D projects that are the core of virtually all high-scale undertakings in many areas of human activities. They consider the situation, where forward-looking analysis is required and assume that the decision-makers face structural uncertainty. Detailed, precise information is very often, if not always, not available in the considered situation. This implies a need for robust management systems that are capable of handling imprecise and uncertain information, yet simple and comprehensive enough for managerial use. The authors propose a set of new weighted averaging operators that are able to consider interaction between variables and an approach that is based on scorecards in which triangular fuzzy numbers are used. This gives a simple, easy to understand, easy to visualize, low-cost, multi-expert analysis tool for strategic R&D projects that can be implemented on a laptop using spreadsheet software.

József Mezei and Matteo Brunelli in "Decision Analytics and Soft Computing with Industrial Partners: A Personal Retrospective" consider methods in decision analytics, which become essential tools to process an increasing amount of collected data, while being capable of representing and utilizing the tacit knowledge of experts. This boils down to a need from companies of methods that can make use of imprecise information to deliver insights in real time. The authors provide a summary of three closely related research projects within the area of knowledge mobilization, and provide solutions for typical business analytical problems, originating mainly from the process industry. They use fuzzy ontologies, represented as fuzzy relations. By analyzing the similarities among the three presented cases, they discuss the main lessons learnt and provide some advice as what should be considered in future applications of soft computing in industrial applications.

J.M. Sánchez-Lozano, M.S. García-Cascales, M.T. Lamata, and J.L. Verdegay in "Spatial Analysis Using GIS for Obtaining Optimal Locations for Solar Farms—A Case Study: The Northwest of the Region of Murcia" consider an important

problem of making decisions as to where to locate a photovoltaic solar farm, to provide the energy generated into the grid. They consider, first, the legislative factors involving a large number of restrictions with regards to protected areas, streams, watercourses, etc., and then some criteria exemplified by the proximity to power lines, slope, solar irradiation, etc., according to which an evaluation of the suitability of the areas will be made. They use spatial visualization tools such as geographic information systems (GIS). The main purpose is to show how the aggregation of GIS with decision procedures in the field of renewable energy can solve complex location problems. An example of determining suitable locations for photovoltaic solar farms in the northwest region of Murcia in Spain is shown.

We wish to thank all the contributors to this volume. We hope that their papers, which constitute a synergistic combination of foundational works, new data analysis tools and techniques, new decision-theoretic and -analytic models, new methodologies and techniques for system modeling, and papers on relevant real-world implementations, combined with an account of experience gained from various real and successful practical projects will be interesting and useful for a large audience.

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