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Fuzzy Sets-Based Methods and Techniques for Modern Analytics

Springer

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To Arvin and Daniel

Preface

Analytics is the scientific process of transforming data into information to enable better decisions to be made. Therefore, analytics is fundamentally an interdisciplinary field, which has significant effects on attempts to design its core, its contents, and its boundaries. But this is not a easy task since, among other topics, analytics can consider

- Decision making (multicriteria and multiperson)
- Fusion of information from different sources and natures
- Analysis of data and information
- Management of sophisticated math software
- Problem solving
- Interpreting the meaning of information for others, etc.

On the one hand, analytics involves a great deal of different disciplines. On the other hand, if we review degrees in analytics from universities around the world, it is evident that the courses included therein are integrated into a variety of departments or faculties, such as Computing and Engineering departments, Business departments, or Management schools. Likewise, if we focus on master's degrees, a similar dispersion is observed, with some universities even offering courses within Mathematics or Statistics. This highlights that there is a certain discrepancy as what type of discipline analytics actually is, and there are a variety of aspects involved which come from different academic traditions.

Upon broadening the panorama a little further, it can be seen how analytics is related with three major scientific areas, namely Statistics, Intelligence of Business and Information Systems and Modeling and finally with Optimization. There are a few topics that are common to these areas, including Data Mining, Simulation and Risk, Intelligent Decision Support Systems, and Data Visualization.

Being analytics such an interdisciplinary field, an exhaustive coverage of all the topics that must be known to become an expert in analytics would be an impossible task for one single book. But it would also seem obvious that anyone who seeks to become an expert in analytics has the obligation to know the basic theoretical elements which will support their reports, analysis, and recommendations. Joining

these two facts together leads us to the fundamentals that are to be found in the area that they share—Computer Science, Statistics, and Operations Research. In that common place the three pillars of: Design of Algorithms, Descriptive Statistics, and Mathematical Programming must be highlighted.

Now considering the point of view of professional practice, analytics cannot be understood as a purely theoretical subject; on the contrary, it must be principally seen from a practical point of view. This does not mean that some solid and rigorous scientific foundations should be excluded but that they must be oriented to solve real-world problems. In this context, it is necessary to consider the omnipresent inaccuracy in the majority of the information we have. In fact, we usually express measurements, judgments, classifications, etc., with linguistic (verbal) terms which, although they are perfectly understood by humans, are not easily transferred neither to the context of computers, nor to mathematical models based on Boolean logic. Thus, the models that fuzzy logic provides seem to be the most appropriate to find the solutions we are interested in.

The methods and models of Fuzzy Mathematical Programming are in the intersection between Statistics, Mathematical Programming, and Computational Intelligence. Rigorous knowledge of Fuzzy Mathematical Programming is essential for what we call modern analytics, i.e., analytics not exclusively based on conventional (Boolean) models, but in Computational Intelligence (fuzzy) models, which is to say in what we could refer to as human-centric models.

Therefore, in the context of modern analytics, Fuzzy Mathematical Programming plays a fundamental role in dealing with a various range of problems such as those concerning Smart Cities, Intelligent and Multimodal Transport, Renewable Energies, etc., with the right amount of seriousness and scientific rigor. Consequently, this book is dedicated to the study of different Fuzzy Mathematical Programming models and methods. By presenting extensive theoretical information together with practical tools, it represents an outstanding reference guide helping experts to find the best solutions to the real problems they must face in their different work environments in today's Smart Society.

The book is divided into five chapters. In the first, a brief introduction is given of the key concepts of Fuzzy Sets that are most relevant for the models that are considered in the rest of the volume. The following chapter is dedicated to the different types of problems that can be considered in Fuzzy Linear Programming (FLP) as well as to rigorously describe the different solving methods that exist, which, as a whole, constitute the basis of all the subsequent theoretical and practical developments. Following that, the third and fourth chapters cover Linear Programming problems involving fuzzy parameters, by means of focuses based on the Simplex Algorithm and not based on the Simplex Algorithm, respectively. Finally, one of the problems that is most frequently the motive for analytics is considered: the Transport Problem. The relevance today of this type of problem in a variety of areas such as scheduling, production, investment, deciding plant location, inventory control, as well as all those related in some way to Intelligent Transport, means that its inclusion as a demonstration of the practical applicability of FLP problems is more than justified.

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