Multicriteria Decision Aid Classification Methods

Applied Optimization

Volume 73

Series Editors:

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The titles published in this series are listed at the end of this volume.

Multicriteria Decision Aid Classification Methods

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KLUWER ACADEMIC PUBLISHERS
NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW

eBook ISBN: 0-306-48105-7
Print ISBN: 1-4020-0805-8

Created in the United States of America

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To my parents Christos and Aikaterini Doumpos

To my wife Kleanthi Koukouraki and my son Dimitrios Zopounidis

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Prologue

Decision making problems, according to their nature, the policy of the decision maker, and the overall objective of the decision, may require the choice of an alternative solution, the ranking of the alternatives from the best to the worst ones or the assignment of the considered alternatives into predefined homogeneous classes. This last type of decision problem is referred to as classification or sorting. Classification problems are often encountered in a variety of fields including finance, marketing, environmental and energy management, human resources management, medicine, etc.

The major practical interest of the classification problem has motivated researchers in developing an arsenal of methods for studying such problems, in order to develop mathematical models achieving the higher possible classification accuracy and predicting ability. For several decades multivariate statistical analysis techniques such as discriminant analysis (linear and quadratic), and econometric techniques such as logit and probit analysis, the linear probability model, etc., have dominated this field. However, the parametric nature and the statistical assumptions/restrictions of such approaches have been an issue of major criticism and skepticism on the applicability and the usefulness of such methods in practice.

The continuous advances in other fields including operations research and artificial intelligence led many scientists and researchers to exploit the new capabilities of these fields, in developing more efficient classification techniques. Among the attempts made one can mention neural networks, machine learning, fuzzy sets as well as multicriteria decision aid. Multicriteria decision aid (MCDA) has several distinctive and attractive features, involving, mainly, its decision support orientation. The significant advances in MCDA over the last three decades constitute a powerful non-parametric alternative methodological approach to study classification problems. Al-

though the MCDA research, until the late 1970s, has been mainly oriented towards the fundamental aspects of this field, as well as to the development of choice and ranking methodologies, during the 1980s and the 1990s significant research has been undertaken on the study of the classification problem within the MCDA framework.

Following the MCDA framework, the objective of this book is to provide a comprehensive discussion of the classification problem, to review the existing parametric and non-parametric techniques, their problems and limitations, and to present the MCDA approach to classification problems. Special focus is given to the preference disaggregation approach of MCDA. The preference disaggregation approach refers to the analysis (disaggregation) of the global preferences (judgement policy) of the decision maker in order to identify the criteria aggregation model that underlies the preference result (classification).

The book is organized in seven chapters as follows:

Initially, in chapter 1 an introduction to the classification problem is presented. The general concepts related to the classification problem are discussed, along with an outline of the procedures used to develop classification models.

Chapter 2 provides a comprehensive review of existing classification techniques. The review involves parametric approaches (statistical and econometric techniques) such as the linear and quadratic discriminant analysis, the logit and probit analysis, as well as non-parametric techniques from the fields of neural networks, machine learning, fuzzy sets, and rough sets.

Chapter 3 is devoted to the MCDA approach. Initially, an introduction to the main concepts of MCDA is presented along with a panorama of the MCDA methodological streams. Then, the existing MCDA classification techniques are reviewed, including multiattribute utility theory techniques, outranking relation techniques and goal programming formulations.

Chapter 4 provides a detailed description of the UTADIS and MHDIS methods, including their major features, their operation and model development procedures, along with their mathematical formulations. Furthermore, a series of issues is also discussed involving specific aspects of the functionality of the methods and their model development processes.

Chapter 5 presents an extensive comparison of the UTADIS and MHDIS methods with a series of well-established classification techniques including the linear and quadratic discriminant analysis, the logit analysis and the rough set theory. In addition, ELECTRE TRI a well-known MCDA classification method based on the outranking relation theory is also considered in the comparison and a new methodology is presented to estimate the parameters of classification models developed through ELECTRE TRI. The comparison is performed through a Monte-Carlo simulation, in order to investi-

gate the classification performance (classification accuracy) of the considered methods under different data conditions.

Chapter 6 is devoted to the real-world application of the proposed methodological framework for classification problems. The applications considered originate from the field of finance, including bankruptcy prediction, corporate credit risk assessment and stock evaluation. For each application a comparison is also conducted with all the aforementioned techniques.

Finally, chapter 7 concludes the book, summarizes the main findings and proposes future research directions with respect to the study of the classification problem within a multidimensional context.

In preparing this book, we are grateful to Kiki Kosmidou, Ph.D. candidate at the Technical University of Crete, for her important notes on an earlier version of the book and her great help in the preparation of the final manuscript.