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Practical Goal Programming

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Dedicated to our parents

*Rahmat Tamiz and Mahtalat Helmi
and
James Jones and Brenda Jones*

Preface

The setting and attainment of goals is a fundamental aspect of human decision making, which is manifest in the modern discipline of operational research by the technique of goal programming. Influences from the fields of mathematical programming and multiple criteria decision making (MCDM) can be found in goal programming, and it is our view that in order to use goal programming most effectively, users should be aware of the basic aspects and concepts of both fields.

We are aware that this will not be the first book on goal programming and have ourselves learnt about the topic from the previous works of Charnes and Cooper (1961), Lee (1970), Ignizio (1976, 1982, 1985, 1994), and Romero (1991). We have noted, however, that most of these excellent books are now out of print, and practitioners and post-graduate students in the field are reporting increasing difficulty in obtaining a work that will allow them to grasp the fundamentals of goal programming and hence utilise the full power and flexibility of the technique. It is also our desire to see goal programming continue to develop and be applied in a practical and correct manner. We would also like users of the technique to have access to and the ability to choose from the full range of variants and extensions of goal programming and its analysis tools in order to build models that best reflect the preferences and desires of their decision maker(s).

The purpose of this book is therefore to empower academics and practitioners to be able to build effective goal programming models, as well as to detail the current state of the art in the topic and lay the foundation for its future development and continued application to new and varied fields of application as they arise.

The notation and terminology used in this book for investigating GP and its variants have been designed and refined in collaboration with the leading experts in the field. We believe they give the best description of the subject and would want them to become the standards.

This book is divided into nine chapters. Chapter 1 gives a brief history of goal programming and details the fundamental definitions arising from the fields of mathematical programming and multiple criteria decision making that are used throughout the text. A section on the underlying philosophies of goal programming is also included. Chapter 2 details the goal programming variants and defines them algebraically.

Chapter 3 is particularly important to readers unfamiliar with goal programming who wish to learn how to build effective goal programming models that avoid common modelling pitfalls and formulation errors. It details the step-by-step formulation of a basic goal programming model in the form of each of the three main variants, as well as discussing basic modelling techniques. Chapter 4 details more advanced modelling issues and highlights some recently proposed extensions as well as giving a new and pragmatic weight sensitivity algorithm.

Chapter 5 details the solution methodologies of goal programming, concentrating on computerised solution by the Excel Solver and LINGO packages for each of the three main variants. A discussion of the viability and use of specialised goal programming packages is also included. Chapter 6 discusses the linkages between Pareto efficiency and goal programming. The state of the art in detecting Pareto inefficiency and restoring Pareto efficiency for each of the major variants is given.

Chapters 3–6 are supported by a set of 10 exercises drawn from our two decades of experience of applying goal programming to practical decision-making situations. An Excel spreadsheet giving the basic solution of each example can be found on the accompanying website (www.mopgp.com).

Chapter 7 details the current state of the art in terms of the integration of goal programming with other techniques from operational research and artificial intelligence. This is a key area which we believe will be an important topic of future research.

The text concludes with two case studies which are chosen to demonstrate the application of goal programming in practice and to illustrate the principles developed in Chapters 1–7. Chapter 8 details an application in health care and Chapter 9 describes applications in portfolio selection.

We are indebted to the many researchers in the field whose works on goal programming, conversations, and presentations on the topic have helped shape this text. In particular we would like to acknowledge the seminal work of James Ignizio and Carlos Romero. We would also like to thank the many academic members, international visitors, and doctoral students of the Management Mathematics Group at the University of Portsmouth, who have contributed to our research on the theory and application of goal programming in the past two decades. These include Simon Mardle, Rishma Hasham, Keith Fargher, Bijan Hesni, Keyvan Mir-Razavi, Sita Patel, Zul Mohd-Nopiah, Richard Treloar, John-Paul Oddoye, Jon Large, Patrick Beullens, Reza Khorramshahgol, XiaoDong Li, Kevin Willis, Rania Azmi, Blanca Perez, Amelia Bilbao, Ali Foroughi, Mohammad Ali Yaghoobi, Mohammad Afzalinejad, and Ersilia Liguigli. We are also grateful to Dr Paul Schmidt of the Queen Alexandra Hospital in Portsmouth for his help in developing the case study described in Chapter 8. We would also like to thank the British Royal Society for providing Dr Jones with an international visiting fellowship to the University of Malaga, Spain, where writing of this book was started. Dr Jones would also like to thank Rafael Caballero and the members of the Department of Applied Economics at the University of Malaga; Maria-Victoria Rodriguez and the members of the Department of Quantitative Economics at the University of Oviedo; and Sydney Chu and the members of the Department of Mathematics, University of Hong Kong,

for their hospitality and useful discussions about goal programming during his stay at their respective institutions.

Last, but not least, we initiated the international series of bi-annual conferences in multi-objective and goal programming (MOPGP). The seventh conference was held in Portsmouth in September 2008. We would particularly like to thank Belaid Aouni and Ralph Steuer for their on-going commitment and help in ensuring the success of this conference series over the years. We also wish to thank all the delegates of these conferences for their participation, useful discussions, and indirect contributions to the completion of this book.

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September 2009

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