

Multicriteria Optimization and Decision Making

Principles, Algorithms and Case Studies

Michael Emmerich and André Deutz
LIACS Master Course: Autumn/Winter 2006



Multicriteria Optimization Multicriteria Optimization

Roman Statnikov



Multicriteria Optimization Multicriteria Optimization:

Multicriteria Optimization Matthias Ehrgott, 2006-01-16 Decision makers in many areas from industry to engineering and the social sector face an increasing need to consider multiple conflicting objectives in their decision processes In many cases these real world decision problems can be formulated as multicriteria mathematical optimization models The solution of such models requires appropriate techniques to compute so called efficient or Pareto optimal or compromise solutions that unlike traditional mathematical programming methods take the contradictory nature of the criteria into account This book provides the necessary mathematical foundation of multicriteria optimization to solve nonlinear linear and combinatorial problems with multiple criteria Motivational examples illustrate the use of multicriteria optimization in practice Numerous illustrations and exercises as well as an extensive bibliography are provided In the new edition a chapter on optimality conditions has been added The linear programming part has been extended and includes new developments Moreover motivational examples are now introducing the majority of chapters

Multicriteria Optimization Nodari Vakhania, Frank Werner, 2020-11-26 Multi criteria optimization problems naturally arise in practice when there is no single criterion for measuring the quality of a feasible solution Since different criteria are contradictory it is difficult and often impossible to find a single feasible solution that is good for all the criteria Hence some compromise is needed As such this book examines the commonly accepted compromise of the traditional Pareto optimality approach It also proposes one new alternative approach for generating feasible solutions to multi criteria optimization problems Finally the book presents two chapters on the existing solution methods for two real life multi criteria optimization problems

Multicriteria Optimization in Engineering and in the Sciences Wolfram Stadler, 2013-12-14 We are rarely asked to make decisions based on only one criterion most often decisions are based on several usually conflicting criteria In nature if the design of a system evolves to some final optimal state then it must include a balance for the interaction of the system with its surroundings certainly a design based on a variety of criteria Furthermore the diversity of nature's designs suggests an infinity of such optimal states In another sense decisions simultaneously optimize a finite number of criteria while there is usually an infinity of optimal solutions Multicriteria optimization provides the mathematical framework to accommodate these demands Multicriteria optimization has its roots in mathematical economics in particular in consumer economics as considered by Edgeworth and Pareto The critical question in an exchange economy concerns the equilibrium point at which each of N consumers has achieved the best possible deal for himself or herself Ultimately this is a collective decision in which any further gain by one consumer can occur only at the expense of at least one other consumer Such an equilibrium concept was first introduced by Edgeworth in 1881 in his book on mathematical psychics Today such an optimum is variously called Pareto optimum after the Italian French welfare economist who continued and expanded Edgeworth's work efficient nondominated and so on

Multicriteria Design Optimization Hans Eschenauer, Juhani Koski, Andrzej Osyczka, 2012-12-06 Interest in the

fascinating field of multicriteria optimization and its application to design processes has grown very quickly in recent years. Researchers and practising engineers will find this book an comprehensive presentation of this subject. After an introduction to multicriteria optimization and the advantages of using multicriteria techniques the first part of the book presents methods and computer procedures for solving multicriteria optimum design problems including interactive methods and knowledge based systems. The second part presents an extensive range of applications of these methods to design processes in the following fields: mechanisms and dynamic systems, aircraft and space technology, machine tool design, metal forming and cast metal technology, civil and architectural engineering and structures made of advanced materials. *Multicriteria*

Optimization and Engineering R.B. Statnikov, J.B. Matusov, 2012-12-06. This method enables readers to efficiently design higher quality lower cost objects with less metal requirements, vibration and noise and with lower dynamic loads and energy consumption. It determines optimal solutions regardless of the number of criteria involved and to identify relationships among different criteria and between criteria and design variables. It accurately accounts for discrepancies between theoretical and actual characteristics using a special set of adequacy criteria. It determines optimal design variables for complex finite element models. In addition the book helps readers enhance the potential of the PSI method with theoretical investigations and algorithms for approximating the feasible solutions set and Pareto optimal set. It facilitates proficient problem solving by incorporating recently obtained results from the theory of uniformly distributed sequences. It evaluates design procedures by observing examples ranging from machine tools and agricultural equipment to automobiles and aviation. This practical in depth treatment of multicriteria optimization and engineering is essential for engineers and designers working in research and development of manufacturing machines, mechanisms and structures. It is also an important text for students of applied mathematics, mechanical engineering, optimal control and operations research. **Multiobjective Heuristic Search** Pallab Dasgupta, P. P. Chakrabarti, S. C. DeSarkar, 2013-11-11. A large number of problems require the optimization of multiple criteria. These criteria are often non commensurate and sometimes conflicting in nature making the task of optimization more difficult. In such problems the task of creating a combined optimization function is often not easy. Moreover the decision procedure can be affected by the sensitivity of the solution space and the trade off is often non linear. In real life we traditionally handle such problems by suggesting not one but several non dominated solutions. Finding a set of non dominated solutions is also useful in multistaged optimization problems where the solution of one stage of optimization is passed on to the next stage. One classic example is that of circuit design where high level synthesis, logic synthesis and layout synthesis comprise important stages of optimization of the circuit. Passing a set of non dominated partial solutions from one stage to the next typically ensures better global optimization. This book presents a new approach to multi criteria optimization based on heuristic search techniques. Classical multicriteria optimization techniques rely on single criteria optimization algorithms and hence we are either required to optimize one criterion at a time under constraints on the others or we are asked for a

single scalar combined optimization function On the other hand the multiobjective search approach maps each optimization criterion onto a distinct dimension of a vector valued cost structure

Multicriteria Optimization in Engineering and in the Sciences Wolfram Stadler,1988-03-31 We are rarely asked to make decisions based on only one criterion most often decisions are based on several usually conflicting criteria In nature if the design of a system evolves to some final optimal state then it must include a balance for the interaction of the system with its surroundings certainly a design based on a variety of criteria Furthermore the diversity of nature's designs suggests an infinity of such optimal states In another sense decisions simultaneously optimize a finite number of criteria while there is usually an infinity of optimal solutions Multicriteria optimization provides the mathematical framework to accommodate these demands Multicriteria optimization has its roots in mathematical economics in particular in consumer economics as considered by Edgeworth and Pareto The critical question in an exchange economy concerns the equilibrium point at which each of N consumers has achieved the best possible deal for himself or herself Ultimately this is a collective decision in which any further gain by one consumer can occur only at the expense of at least one other consumer Such an equilibrium concept was first introduced by Edgeworth in 1881 in his book on mathematical psychics Today such an optimum is variously called Pareto optimum after the Italian French welfare economist who continued and expanded Edgeworth's work efficient nondominated and so on

Multiple Criteria Optimization Matthias Ehrgott,Xavier Gandibleux,2002-06-30 The roots of Multiple Criteria Decision Making and Multiple Criteria Optimization were laid by Pareto at the end of the 19th century and since then the discipline has prospered and grown especially during the last three decades Today many decision support systems incorporate methods to deal with conflicting objectives The foundation for such systems is a mathematical theory of optimization under multiple objectives Since its beginnings there have been a vast number of books journal issues papers and conferences that have brought the field to its present state Despite this vast body of literature there is no reliable guide to provide an access to this knowledge Over the years many literature surveys and bibliographies have been published With the ever rapidly increasing rate of publications in the area and the development of subfields these were mostly devoted to particular aspects of multicriteria optimization Multiobjective Integer Programming Multi objective Combinatorial Optimization Vector Optimization Multiobjective Evolutionary Methods Applications of MCDM MCDM Software Goal Programming Hence the need for a comprehensive overview of the literature in multicriteria optimization that could serve as a state of the art survey and guide to the vast amount of publications Multiple Criteria Optimization State of the Art Annotated Bibliographic Surveys is precisely this book Experts in various areas of multicriteria optimization have contributed to the volume The chapters in this book roughly follow a thread from most general to more specific Some of them are about particular types of problems Theory of Vector Optimization Nonlinear Multiobjective Programming Fuzzy Multiobjective Programming Multiobjective Combinatorial Optimization Multicriteria Scheduling Problems while the others are focused on multi objective methodologies

Goal Programming Interactive Methods Evolutionary Algorithms Data Envelopment Analysis All contributing authors invested great effort to produce comprehensive overviews and bibliographies and to have references that are as precise as possible

Multicriteria Design Roman Statnikov, 1999-03-31 This book is devoted to the PSI method Its appearance was a reaction to the unsatisfactory situation in applications of optimization methods in engineering After comprehensive testing of the PSI method in various fields of machine engineering it has become obvious that this method substantially surpasses all other available techniques in many respects It has now become known that the PSI method is successfully used not only in machine design at which it was initially aimed but also in polymer chemistry pharmacy nuclear energy biology geophysics and many other fields of human activity To all appearances this method has become so popular for its potential of taking into account the specific features of applied optimization better than other methods being at the same time comparatively simple and friendly and because unlike traditional optimization methods which are intended only for searching for optimal solutions the PSI method is also aimed at correctly formulating engineering optimization problems One well known aircraft designer once said To solve an optimization problem in engineering means first of all to be able to state this problem properly In this sense the PSI method has no competitors Although this method has been presented in Russia in numerous papers and books Western readers have had the opportunity to familiarize themselves with this method only recently Ozernoy 1988 Lieberman 1991 Stadler and Dauer 1992 Dyer Fishburn Steuer Wallenius and Zionts 1992 Steuer and Sun 1995 etc

Multiobjective Optimization Jürgen Branke, 2008-10-15 Multiobjective optimization deals with solving problems having not only one but multiple often conflicting criteria Such problems can arise in practically every field of science engineering and business and the need for efficient and reliable solution methods is increasing The task is challenging due to the fact that instead of a single optimal solution multiobjective optimization results in a number of solutions with different trade offs among criteria also known as Pareto optimal or efficient solutions Hence a decision maker is needed to provide additional preference information and to identify the most satisfactory solution Depending on the paradigm used such information may be introduced before during or after the optimization process Clearly research and application in multiobjective optimization involve expertise in optimization as well as in decision support This state of the art survey originates from the International Seminar on Practical Approaches to Multiobjective Optimization held in Dagstuhl Castle Germany in December 2006 which brought together leading experts from various contemporary multiobjective optimization fields including evolutionary multiobjective optimization EMO multiple criteria decision making MCDM and multiple criteria decision aiding MCDA This book gives a unique and detailed account of the current status of research and applications in the field of multiobjective optimization It contains 16 chapters grouped in the following 5 thematic sections Basics on Multiobjective Optimization Recent Interactive and Preference Based Approaches Visualization of Solutions Modelling Implementation and Applications and Quality Assessment Learning and Future Challenges

Multicriteria Optimization of Nondifferentiable Stochastic

Biosystems James Carl Schäper,1998

Handbook of Multicriteria Analysis Constantin Zopounidis,Panos M.

Pardalos,2010-05-25 Multicriteria analysis is a rapidly growing aspect of operations research and management science with numerous practical applications in a wide range of fields This book presents all the recent advances in multicriteria analysis including multicriteria optimization goal programming outranking methods and disaggregation techniques The latest developments on robustness analysis preference elicitation and decision making when faced with incomplete information are also discussed together with applications in business performance evaluation finance and marketing Finally the interactions of multicriteria analysis with other disciplines are also explored including among others data mining artificial intelligence and evolutionary methods

Special Issue on Multicriteria Optimization in Industry Karl-Heinz Küfer,Kaisa Miettinen,Stefan

Ruzika,Serpil Sayın,2022

Evolutionary Multiobjective Optimization Ajith Abraham,L. C. Jain,2005-04-22

Evolutionary Multiobjective Optimization is a rare collection of the latest state of the art theoretical research design challenges and applications in the field of multiobjective optimization paradigms using evolutionary algorithms It includes two introductory chapters giving all the fundamental definitions several complex test functions and a practical problem involving the multiobjective optimization of space structures under static and seismic loading conditions used to illustrate the various multiobjective optimization concepts Important features include Detailed overview of all the multiobjective optimization paradigms using evolutionary algorithms Excellent coverage of timely advanced multiobjective optimization topics State of the art theoretical research and application developments Chapters authored by pioneers in the field Academics and industrial scientists as well as engineers engaged in research development and application of evolutionary algorithm based Multiobjective Optimization will find the comprehensive coverage of this book invaluable

Nonlinear Multiobjective Optimization Kaisa Miettinen,2012-12-06

Problems with multiple objectives and criteria are generally known as multiple criteria optimization or multiple criteria decision making MCDM problems So far these types of problems have typically been modelled and solved by means of linear programming However many real life phenomena are of a nonlinear nature which is why we need tools for nonlinear programming capable of handling several conflicting or incommensurable objectives In this case methods of traditional single objective optimization and linear programming are not enough we need new ways of thinking new concepts and new methods nonlinear multiobjective optimization Nonlinear Multiobjective Optimization provides an extensive up to date self contained and consistent survey review of the literature and of the state of the art on nonlinear deterministic multiobjective optimization its methods its theory and its background The amount of literature on multiobjective optimization is immense The treatment in this book is based on approximately 1500 publications in English printed mainly after the year 1980 Problems related to real life applications often contain irregularities and nonsmoothnesses The treatment of nondifferentiable multiobjective optimization in the literature is rather rare For this reason this book contains material about the possibilities background theory and methods of nondifferentiable multiobjective optimization as

well This book is intended for both researchers and students in the areas of applied mathematics engineering economics operations research and management science it is meant for both professionals and practitioners in many different fields of application The intention has been to provide a consistent summary that may help in selecting an appropriate method for the problem to be solved It is hoped the extensive bibliography will be of value to researchers

The Power of Compromise Kai-Simon Goetzmann, 2013

Simulation-multicriteria Optimization Technique as a Decision Support System for Rice Production Evangelyn C. Alocilja, 1987

The Parameter Space Investigation Method Toolkit Roman Statnikov, Alexander Statnikov, 2011 The Parameter Space Investigation PSI method was developed to help engineers with a wide range of multicriteria optimization problems such as design identification design of control systems and operational development of prototypes This unique resource shows you how to use PSI to construct a feasible solution set without limitations on the number of parameters and criteria The book presents visualization tools that are used to construct the feasible solution set conduct multicriteria analysis and correct the initial problem statement You explore topics that have not been covered in any other books including multicriteria analysis from observational data multicriteria optimization of large scale systems in parallel mode adopting the PSI method for database searches and interpretation of the prototype improvement problem The book also offers guidance in understanding and using the accompanying newly released MOVI software package

A Method for Including A-priori-preferences in Multicriteria Optimization Heike Trautmann, Jörn Mehnen, 2005

Multicriterion Optimization in Engineering with FORTRAN Programs Andrzej Osyczka, 1984

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