Linear And Mixed Integer Programming For Portfolio Optimization Euro Advanced Tutorials On Operational Research

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CYNTHIA DARIO

Julia Programming for Operations Research Springer Science & Business Media
This book presents solutions to the general problem of single period portfolio optimization. It introduces different linear models, arising from different performance measures, and the mixed integer linear models resulting from the introduction of real features. Other linear models, such as models for portfolio rebalancing and index tracking, are also covered. The book discusses computational issues and provides a theoretical framework, including the concepts of risk-averse preferences, stochastic dominance and coherent risk measures. The material is presented in a style that requires no background in finance or in portfolio optimization; some experience in linear and mixed integer models, however, is required. The book is thoroughly didactic, supplementing the concepts with comments and illustrative examples.
Integer and Mixed-integer Programming Models Changhyun Kwon
Optimization Toolbox provides functions for finding parameters that minimize or maximize objectives while satisfying constraints. The toolbox includes solvers for linear programming (LP), mixed-integer linear programming (MILP), quadratic programming (QP), nonlinear programming (NLP), constrained linear least squares, nonlinear least squares, and nonlinear equations. You can define your optimization problem with functions and matrices or by specifying variable expressions that reflect the underlying mathematics. You can use the toolbox solvers to fin optimal solutions to continuous and discrete problems, perform trade of analyses, and incorporate optimization methods into algorithms and applications. The toolbox lets you perform design optimization tasks, including parameter estimation, component selection, and parameter tuning. It can be used to fin optimal solutions in applications such as portfolio optimization, resource allocation, and production planning and scheduling.You can use the toolbox solvers to find optimal solutions to continuous and discrete problems, perform tradeoff analyses, and incorporate optimization methods into algorithms and applications. The toolbox lets you perform design optimization tasks, including parameter estimation, component selection, and parameter tuning. It can be used to find optimal solutions in applications such as portfolio optimization, resource allocation, and production planning and scheduling.
4 - F Springer Science & Business Media
In 1958, Ralph E. Gomory transformed the field of integer programming when he published a paper that described a cutting-plane algorithm for pure integer programs and announced that the method could be refined to give a finite algorithm for integer programming. In 2008, to commemorate the anniversary of this seminal paper, a special workshop celebrating fifty years of integer programming was held in Aussois, France, as part of the 12th Combinatorial Optimization Workshop. It contains reprints of key historical articles and written versions of survey lectures on six of the hottest topics in the field by distinguished members of the integer programming community. Useful for anyone in mathematics, computer science and operations research, this book exposes mathematical optimization, specifically integer programming and combinatorial optimization, to a broad audience.
Advances in Sensitivity Analysis and Parametric Programming Walter de Gruyter GmbH & Co KG
Abstract The here presented thesis deals with optimization problems where the underlying problem data are subject to uncertainty. Sources of data uncertainty in practical problems are manifold, and so are the ways to model uncertainty in a mathematical programming context. The position taken in this thesis is that the underlying problem is a linear or mixedinteger program where some part of the problem data, e.g., the constraint matrix, is described by a set of possible matrices instead of a single one. There are two opposite viewpoints on this: The optimist assumes that he can influence the uncertainty and, thus, can choose a constraint matrix along with values for the variables of the underlying problem. The pessimist, however, assumes that he has to take a decision without having this possibility to choose and, therefore, assumes the worst case. The former viewpoint is expressed by a so called generalized mixed-integer program, the latter by a so called robust mixed-integer program. In the first part of this thesis, robust problems with uncertainty in the cost vector are investigated. Here, the emphasis lies on considering simply structured uncertainties that allow the reduction of a problem with uncertainty to a series of problems of the same type but without uncertainty. It is known from the literature that this is possible for robust 0-1 programs and the robust minimum-cost flow problem if the uncertainty is a (higher dimensional) interval where the upper bound corner is cut off by a single cardinality constraint; this constraint permits control over the amount of robustness in the problem. In this thesis, it is demonstrated that this is still possible for uncertainties where the upper bound is cut off by arbitrarily many knapsack constraints with non-negative coefficients, which permits more detailed control. For the robust minimum-cost flow problem, a subgradient optimization approach is proposed; this is more practical than the binary search method proposed in literature. The second part of this thesis is concerned with more general uncertainties, mainly polyhedral ones, and robust and generalized mixed-integer programs. Reformulations of these problems as mixed-integer programs are discussed, and some useful tools known from linear programming, like duality and Farkas' lemma, are reviewed for linear programs with uncertainty. With help of these, it is shown that lattice-free cuts for robust mixed-integer programs are generated by generalized linear programs while lattice-free cuts for generalized mixed-integer programs are generated by robust linear programs. Strengthening procedures, known from literature for the non-uncertain case, and, finally, problems with uncertainties described by convex conic sets are

investigated. The performance of the lattice-free cuts for robust mixed-integer programs is assessed in terms of the amount of gap closed and the time spent for cut generation by a computational study. Zusammenfassung Die hier vorgelegte Dissertation beschäftigt sich mit Optimierungsproblemen, bei denen die zugrundeliegenden Daten Unsicherheit unterliegen. Quellen für Unsicherheit der Daten praktischer Probleme sind vielfältiger Natur und genauso vielfältig sind demnach die Herangehensweisen, Unsicherheit im Kontext der mathematischen Programmierung zu modellieren. Der Standpunkt dieser Arbeit ist, dass das zugrundeliegende Problem ein lineares oder gemischt-ganzzahliges Programm ist, bei dem ein Teil der Daten, zum Beispiel die Nebenbedingungsmatrix, anstatt durch eine einzelne Matrix durch eine Menge an möglichen Matrizen beschrieben ist. Hierauf gibt es zwei entgegengesetzte Sichtweisen: Der Optimist geht davon aus, dass er die Unsicherheit beeinflussen kann und so eine Nebenbedingungsmatrix zusammen mitWerten für die Variablen des zugrundeliegenden Problems frei wählen kann. Der Pessimist jedoch nimmt an, dass er eine Entscheidung ohne dieseWahlmöglichkeit treffen muss, und geht daher vom schlimmsten Fall aus. Erstere Sichtweise drückt sich durch ein sogenanntes verallgemeinertes gemischt-ganzzahliges Programm aus, letztere durch ein sogenanntes robustes gemischt-ganzzahliges Programm. Im ersten Teil dieser Dissertation werden robuste Probleme mit Unsicherheit im Kostenvektor untersucht. Hier liegt der Schwerpunkt bei der Betrachtung von einfach strukturierten Unsicherheiten, die es erlauben, das Problem mit Unsicherheit auf eine Reihe von Problemen gleichen Typs, aber ohne Unsicherheit zurückzuführen. Aus der Literatur ist bekannt, dass dies für robuste 0-1-Programme und für das robuste Minimum-Cost-Flow-Problem möglich ist, sofern die Unsicherheit durch ein (mehrdimensionales) Intervall gegeben ist, bei dem die obere Schranke durch eine Kapazitätsungleichung abgeschnitten wird; diese Ungleichung ermöglicht es, das Maß an Robustheit im Problem zu regulieren. In dieser Arbeit wird gezeigt, dass dies immer noch für Unsicherheiten, bei denen die obere Schranke durch beliebig viele Knapsack-Ungleichungen mit nichtnegativen Koeffizienten abgeschnitten wird und die so eine genauere Regulierung der Robustheit erlauben, immer noch möglich ist. Für das robuste Minimum-Cost-Flow-Problem wird hierbei ein Subgradientenverfahren vorgeschlagen, welches für die Praxis geeigneter ist als die in der Literatur vorgeschlagene binäre Suche. Der zweite Teil dieser Dissertation beschäftigt sich mit allgemeineren Unsicherheiten, hauptsächlich polyedrischen, bei robusten und verallgemeinerten gemischt-ganzzahligen Programmen. Zunächst werden einige Reformulierungen solcher Probleme als gemischt-ganzzahlige Programme diskutiert, gefolgt von einem Überblick über einige nützliche Hilfsmittel für lineare Programme mit Unsicherheit, die bereits von der klassischen linearen Programmierung bekannt sind, etwa Dualität und Farkas Lemma. Mit deren Hilfe wird dann gezeigt, dass Lattice-Free-Cuts für robuste gemischt-ganzzahlige Programme durch verallgemeinerte lineare Programme erzeugt werden, sowie dass Lattice-Free-Cuts für verallgemeinerte gemischt-ganzzahlige Programme durch robuste lineare Programme erzeugt werden. Darüber hinaus werden Strengthening-Methoden, bekannt aus der Literatur für den Fall ohne Unsicherheit, und schließlich Probleme mit konvex-konischer Unsicherheit untersucht. Die Güte der Lattice-Free-Cuts für robuste gemischt-ganzzahlige Programme wird anhand von rechnergestützten Experimenten hinsichtlich der überbrückten Ganzzahligkeitslücke und der zur Cut-Generierung benötigten Zeit bewertet.

Applied Integer Programming Springer

Understand common scheduling as well as other advanced operational problems with this valuable reference from a recognized leader in the field. Beginning with basic principles and an overview of linear and mixed-integer programming, this unified treatment introduces the fundamental ideas underpinning most modeling approaches, and will allow you to easily develop your own models. With more than 150 figures, the basic concepts and ideas behind the development of different approaches are clearly illustrated. Addresses a wide range of problems arising in diverse industrial sectors, from oil and gas to fine chemicals, and from commodity chemicals to food manufacturing. A perfect resource for engineering and computer science students, researchers working in the area, and industrial practitioners.

ASME 71-VIBR-117 OmniaScience

Integer Programming: Theory and Practice contains refereed articles that explore both theoretical aspects of integer programming as well as major applications. This volume begins with a description of new constructive and iterative search methods for solving the Boolean optimization problem (BOOP). Following a review of recent developments on convergent Lagrangian techniques that use objective level-cut and domain-cut methods to solve separable nonlinear integer-programming problems, the book discusses the generalized assignment problem (GAP). The final theoretical chapter analyzes the use of decomposition methods to obtain bounds on the optimal value of solutions to integer linear-programming problems. The first application article contains models and solution algorithms for the rescheduling of airlines following the temporary closure of airports. The next chapters deal with the determination of an optimal mix of chartered and self-owned vessels needed to transport a product. The book then presents an application of integer programming that involves the capture, storage, and transmission of large quantities of data collected during testing scenarios involving military applications related to vehicles, medicine, equipment, missiles, and aircraft. The next article develops an integer linear-programming model to determine the assortment of products that must be carried by stores within a retail chain to maximize profit, and the final article contains an overview of noncommercial software tools for the solution of mixed-integer linear programs (MILP). The authors purposefully include applications and theory that are usually not found in contributed books in order to appeal to a wide variety of researchers and practitioners.

Integer Programming Cuvillier Verlag

This book provides a complete background on metaheuristics to solve complex bi-level optimization problems (continuous/discrete, mono-objective/multi-objective) in a diverse range of application domains. Readers learn to solve large scale bi-level optimization problems by efficiently combining metaheuristics with complementary metaheuristics and mathematical programming approaches. Numerous real-world examples of problems demonstrate how metaheuristics are applied in such fields as networks, logistics and transportation, engineering design, finance and security.

Mixed Integer Nonlinear Programming CRC Press

This book is an elegant and rigorous presentation of integer programming, exposing the subject’s mathematical depth and broad applicability. Special attention is given to the theory behind the algorithms used in state-of-the-art solvers. An abundance of

concrete examples and exercises of both theoretical and real-world interest explore the wide range of applications and ramifications of the theory. Each chapter is accompanied by an expertly informed guide to the literature and special topics, rounding out the reader’s understanding and serving as a gateway to deeper study. Key topics include: formulations polyhedral theory cutting planes decomposition enumeration semidefinite relaxations Written by renowned experts in integer programming and combinatorial optimization, Integer Programming is destined to become an essential text in the field.

Approaches to Integer Programming Springer

The NATO Advanced Research Workshop (ARW) "Algorithms and Model Formulations in Mathematical Programming" was held at Chr. Michelsen Institute in Bergen, Norway, from June 15 to June 19, 1987. The ARW was organized on behalf of the Committee on Algorithms (COAL) of the Mathematical Programming Society (MPS). Co-directors were Jan Telgen (Van Dien+Co Organisatie, Utrecht, The Netherlands) and Roger J-B Wets (The University of California at Davis, USA). 43 participants from 11 countries attended the ARW. The workshop was organized such that each day started with a - minute keynote presentation, followed by a 45-minute plenary discussion. The first part of this book contains the contributions of the five keynote speakers. The plenary discussions were taped, and the transcripts given to the keynote speakers. They have treated the transcripts differently, some by working the discussions into their papers, others by adding a section which sums up the discussions. The plenary discussions were very interesting and stimulating due to active participation of the audience. The five keynote speakers were asked to view the topic of the workshop, the interaction between algorithms and model formulations, from different perspectives. On the first day of the workshop Professor Alexander H.G. Rinnooy Kan (Erasmus University, Rotterdam, The Netherlands) put the theme into a larger context by his talk "Mathematical programming as an intellectual activity". This is an article of importance to any mathematical programmer who is interested in his field's history and present state.

Theory and Practice John Wiley & Sons

In this thesis we study how to solve some nonconvex optimization problems by using methods that capitalize on the success of Linear Programming (LP) based solvers for Mixed Integer Linear Programming (MILP). A common aspect of our solution approaches is the use, development and analysis of small but strong extended LP/MILP formulations and approximations.

Mixed-Integer Programming Models and Methods Springer

OGRAMMING, Nonlinear programming, Linear programming, Optimization, Theorems*Integer programming, Mixed integer programmingIt is well-known that mixed-integer formulations can be used to model important classes of non-convex functions such as fixed-charge functions and linear economy-of-scale cost functions. The purpose of the paper is to formulate a rigorous definition of a mixed-integer model of a given function, and to study the properties of the functions that can be so modelled. An interesting by-product of this approach is the identification of a simple class of functions that cannot be modelled by computer-representable mixed-integer formulations, even though mixed-integer models based on the use of a single arbitrary irrational constant are available for this class. (Author).

A Method for Non-linear Mixed-integer Programming and Its Application to Design Problems Springer

A PRACTICAL GUIDE TO OPTIMIZATION PROBLEMS WITH DISCRETE OR INTEGER VARIABLES, REVISED AND UPDATED The revised second edition of Integer Programming explains in clear and simple terms how to construct custom-made algorithms or use existing commercial software to obtain optimal or near-optimal solutions for a variety of real-world problems. The second edition also includes information on the remarkable progress in the development of mixed integer programming solvers in the 22 years since the first edition of the book appeared. The updated text includes information on the most recent developments in the field such as the much improved preprocessing/presolving and the many new ideas for primal heuristics included in the solvers. The result has been a speed-up of several orders of magnitude. The other major change reflected in the text is the widespread use of decomposition algorithms, in particular column generation (branch-(cut)-and-price) and Benders’ decomposition. The revised second edition: Contains new developments on column generation Offers a new chapter on Benders’ algorithm Includes expanded information on preprocessing, heuristics, and branch-and-cut Presents several basic and extended formulations, for example for fixed cost network flows Also touches on and briefly introduces topics such as non-bipartite matching, the complexity of extended formulations or a good linear program for the implementation of lift-and-project Written for students of integer/mathematical programming in operations research, mathematics, engineering, or computer science, Integer Programming offers an updated edition of the basic text that reflects the most recent developments in the field.

Linear Integer Programming Springer Science & Business Media

Interest in constrained optimization originated with the simple linear pro gramming model since it was practical and perhaps the only computationally tractable model at the time. Constrained linear optimization models were soon adopted in numerous application areas and are perhaps the most widely used mathematical models in operations research and management science at the time of this writing. Modelers have, however, found the assumption of linearity to be overly restrictive in expressing the real-world phenomena and problems in economics, finance, business, communication, engineering design, computational biology, and other areas that frequently demand the use of nonlinear expressions and discrete variables in optimization models. Both of these extensions of the linear programming model are NP-hard, thus representing very challenging problems. On the brighter side, recent advances in algorithmic and computing technology make it possible to re visit these problems with the hope of solving practically relevant problems in reasonable amounts of computational time. Initial attempts at solving nonlinear programs concentrated on the de velopment of local optimization methods guaranteeing globality under the assumption of convexity. On the other hand, the integer programming liter ature has concentrated on the development of methods that ensure global optima. The aim of this book is to marry the advancements in solving nonlinear and integer programming models and to develop new results in the more general framework of mixed-integer nonlinear programs (MINLPs) with the goal of devising practically efficient global optimization algorithms for MINLPs.

Linear and Mixed Integer Programming for Portfolio Optimization Springer Science & Business Media

Integer Programming: Theory and Practice contains refereed articles that explore both theoretical aspects of integer programming as well as major applications. This volume begins

with a description of new constructive and iterative search methods for solving the Boolean optimization problem (BOOP). Following a review of recent developments on convergent Lagrangian techniques that use objective level-cut and domain-cut methods to solve separable nonlinear integer-programming problems, the book discusses the generalized assignment problem (GAP). The final theoretical chapter analyzes the use of decomposition methods to obtain bounds on the optimal value of solutions to integer linear-programming problems. The first application article contains models and solution algorithms for the rescheduling of airlines following the temporary closure of airports. The next chapters deal with the determination of an optimal mix of chartered and self-owned vessels needed to transport a product. The book then presents an application of integer programming that involves the capture, storage, and transmission of large quantities of data collected during testing scenarios involving military applications related to vehicles, medicine, equipment, missiles, and aircraft. The next article develops an integer linear-programming model to determine the assortment of products that must be carried by stores within a retail chain to maximize profit, and the final article contains an overview of noncommercial software tools for the solution of mixed-integer linear programs (MILP). The authors purposefully include applications and theory that are usually not found in contributed books in order to appeal to a wide variety of researchers and practitioners.

Moddeling Support for the Analysis of Linear Programming and Mixed Integer Programming Problems Oxford University Press on Demand

This book presents the state-of-the-art methods in Linear Integer Programming, including some new algorithms and heuristic methods developed by the authors in recent years. Topics as Characteristic equation (CE), application of CE to bi-objective and multi-objective problems, Binary integer problems, Mixed-integer models, Knapsack models, Complexity reduction, Feasible-space reduction, Random search, Connected graph are also treated.

Mixed Integer Linear Programming Based Implementations of Logical Analysis of Data and Its Applications John Wiley & Sons

Theory of Linear and Integer Programming Alexander Schrijver Centrum voor Wiskunde en Informatica, Amsterdam, The Netherlands This book describes the theory of linear and integer programming and surveys the algorithms for linear and integer programming problems, focusing on complexity analysis. It aims at complementing the more practically oriented books in this field. A special feature is the author's coverage of important recent developments in linear and integer programming. Applications to combinatorial optimization are given, and the author also includes extensive historical surveys and bibliographies. The book is intended for graduate students and researchers in operations research, mathematics and computer science. It will also be of interest to mathematical historians. Contents 1 Introduction and preliminaries; 2 Problems, algorithms, and complexity; 3 Linear algebra and complexity; 4 Theory of lattices and linear diophantine equations; 5 Algorithms for linear diophantine equations; 6 Diophantine approximation and basis reduction; 7 Fundamental concepts and results on polyhedra, linear inequalities, and linear programming; 8 The structure of polyhedra; 9 Polarity, and blocking and anti-blocking polyhedra; 10 Sizes and the theoretical complexity of linear inequalities and linear programming; 11 The simplex method; 12 Primal-dual, elimination, and relaxation methods; 13 Khachiyan's method for linear programming; 14 The ellipsoid method for polyhedra more generally; 15 Further polynomiality results in linear programming; 16 Introduction to integer linear programming; 17 Estimates in integer linear programming; 18 The complexity of integer linear programming; 19 Totally unimodular matrices: fundamental properties and examples; 20 Recognizing total unimodularity; 21 Further theory related to total unimodularity; 22 Integral polyhedra and total dual integrality; 23 Cutting planes; 24 Further methods in integer linear programming; Historical and further notes on integer linear programming; References; Notation index; Author index; Subject index

50 Years of Integer Programming 1958-2008 Springer Science & Business Media

The objective of this dissertation is to develop systematic procedures, which take advantage of advanced combinatorial optimization techniques and computer-related developments, to build on a previously successful two-class classification method, called Logical Analysis of Data (LAD), for optimizing feature selection and identifying the set of combinatorial patterns in large-scale data analysis. First, we propose an embedded pattern-based feature selection technique. Our feature selection algorithm aims at identifying a small subset of highly influential features from a large-scale dataset to build reliable LAD classification models. The proposed method searches among different feature subsets and interacts with the LAD classification algorithm and its ability to discriminate among the classes. To accomplish this we develop a new software tool, called LFW, which can be used to determine the highest ranking features in the dataset. Next, we propose a new approach based on integer programming and network flows to select significant patterns to generate accurate LAD models. Our algorithm allows the user-specified significance requirements on patterns such as statistical significance, Hamming distances to ideal patterns, and other pattern characteristics including homogeneity and prevalence. We evaluate, through several experiments on artificial and benchmark datasets, the accuracy of LAD classification models built using our proposed approach, as compared to the accuracy of greedy-heuristic based LAD models. Traditionally the LAD algorithm is designed to solve two-class classification problems. We present a mixed integer linear program to extend the LAD algorithm to multi-class classification. Our multi-class LAD algorithm efficiently generates reliable multi-class LAD models and takes advantage of parallel programming. The utility of the proposed approach is demonstrated through several experiments on multi-class benchmark datasets. Finally, we apply the techniques developed in this dissertation to a real-world medical dataset collected as part of the African-American Study of Kidney Disease and Hypertension (AASK). We present various classification models to predict the progression rate of chronic kidney disease and to identify the set of serum proteomic features highly related to the disease outcome.

Convexification and Global Optimization in Continuous and Mixed-Integer Nonlinear Programming Springer

Combinatorial optimization is a multidisciplinary scientific area, lying in the interface of three major scientific domains: mathematics, theoretical computer science and management. The three volumes of the Combinatorial Optimization series aim to cover a wide range of topics in this area. These topics also deal with fundamental notions and approaches as with several classical applications of combinatorial optimization. Concepts of

Combinatorial Optimization, is divided into three parts: - On the complexity of combinatorial optimization problems, presenting basics about worst-case and randomized complexity; - Classical solution methods, presenting the two most-known methods for solving hard combinatorial optimization problems, that are Branch-and-Bound and Dynamic Programming; - Elements from mathematical programming, presenting fundamentals from mathematical programming based methods that are in the heart of Operations Research since the origins of this field.

Integer Programming Springer Science & Business Media

This is a textbook about linear and integer linear optimization. There is a growing need in industries such as airline, trucking, and financial engineering to solve very large linear and integer linear optimization problems. Building these models requires uniquely trained individuals. Not only must they have a thorough understanding of the theory behind mathematical programming, they must have substantial knowledge of how to solve very large models in today's computing environment. The major goal of the book is to develop the theory of linear and integer linear optimization in a unified manner and then demonstrate how to use this theory in a modern computing environment to solve very large real world problems. After presenting introductory material in Part I, Part II of this book is de voted to the theory of linear and integer linear optimization. This theory is developed using two simple, but unifying ideas: projection and inverse projec tion. Through projection we take a system of linear inequalities and replace some of the variables with additional linear inequalities. Inverse projection, the dual of this process, involves replacing linear inequalities with additional variables. Fundamental results such as weak and strong duality, theorems of the alternative, complementary slackness, sensitivity analysis, finite basis the orems, etc. are all explained using projection or inverse projection. Indeed, a unique feature of this book is that these fundamental results are developed and explained before the simplex and interior point algorithms are presented.

Large Scale Linear and Integer Optimization: A Unified Approach Cambridge University Press

This textbook provides a comprehensive modeling, reformulation and optimization approach for solving production planning and supply chain planning problems, covering topics from a basic introduction to planning systems, mixed integer programming (MIP) models and algorithms through the advanced description of mathematical results in polyhedral combinatorics required to solve these problems. Based on twenty years worth of research in which the authors have played a significant role, the book addresses real life industrial production planning problems (involving complex production structures with multiple production stages) using MIP modeling and reformulation approach. The book provides an introduction to MIP modeling and to planning systems, a unique collection of reformulation results, and an easy to use problem-solving library. This approach is demonstrated through a series of real life case studies, exercises and detailed illustrations. Review by Jakub Marecek (Computer Journal) The emphasis put on mixed integer rounding and mixing sets, heuristics in-built in general purpose integer programming solvers, as well as on decompositions and heuristics using integer programming should be praised... There is no doubt that this volume offers the present best introduction to integer programming formulations of lotsizing problems, encountered in production planning. (2007)