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

Nonlinearoptimizationproblemscontainingbothcontinuousanddiscretevariables are called mixed integer nonlinear programs (MINLP). Such problems arise in many ?elds, such as process industry, engineering design, communications, and ?nance. There is currently a huge gap between MINLP and mixed integer linear programming(MIP) solvertechnology.With a modernstate-of-the-artMIP solver itispossibletosolvemodelswithmillionsofvariablesandconstraints,whereasthe dimensionofsolvableMINLPsisoftenlimitedbyanumberthatissmallerbythree or four orders of magnitude. It is theoretically possible to approximate a general MINLP by a MIP with arbitrary precision. However, good MIP approximations are usually much larger than the original problem. Moreover, the approximation of nonlinear functions by piecewise linear functions can be di?cult and ti- consuming. In this book relaxation and decomposition methods for solving nonconvex structured MINLPs are proposed. In particular, a generic branch-cut-and-price (BCP) framework for MINLP is presented. BCP is the underlying concept in almost all modern MIP solvers. Providing a powerful decomposition framework for both sequential and parallel solvers, it made the success of the current MIP technology possible. So far generic BCP frameworks have been developed only for MIP, for example,COIN/BCP (IBM, 2003) andABACUS (OREAS GmbH, 1999). In order to generalize MIP-BCP to MINLP-BCP, the following points have to be taken into account: • A given (sparse) MINLP is reformulated as a block-separable program with linear coupling constraints.The block structure makes it possible to generate Lagrangian cuts and to apply Lagrangian heuristics. • In order to facilitate the generation of polyhedral relaxations, nonlinear c- vex relaxations are constructed. • The MINLP separation and pricing subproblems for generating cuts and columns are solved with specialized MINLP solvers.

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)

Explaining how to apply to mathematical programming to network design and control, Linear Programming and Algorithms for Communication Networks: A Practical Guide to Network Design, Control, and Management fills the gap between mathematical programming theory and its implementation in communication networks. From the basics all the way through to more advanced concepts, its comprehensive coverage provides readers with a solid foundation in mathematical programming for communication networks. Addressing optimization problems for communication networks, including the shortest path problem, max flow problem, and minimum-cost flow problem, the book covers the fundamentals of linear programming and integer linear programming required to address a wide range of problems. It also: Examines several problems on finding disjoint paths for reliable communications Addresses optimization problems in optical wavelength-routed networks Describes several routing strategies for maximizing network utilization for various traffic-demand models Considers routing problems in Internet Protocol (IP) networks Presents mathematical puzzles that can be tackled by integer linear programming (ILP) Using the GNU Linear Programming Kit (GLPK) package, which is designed for solving linear programming and mixed integer programming problems, it explains typical problems and provides solutions for communication networks. The book provides algorithms for these problems as well as helpful examples with demonstrations. Once you gain an understanding of how to solve LP problems for communication networks using the GLPK descriptions in this book, you will also be able to easily apply your knowledge to other solvers.

Filling a void in chemical engineering and optimization literature, this book presents the theory and methods for nonlinear and mixed-integer optimization, and their applications in the important area of process synthesis. Other topics include modeling issues in process synthesis, and optimization-based approaches in the synthesis of heat recovery systems, distillation-based systems, and reactor-based systems. The basics of convex analysis and nonlinear optimization are also covered and the elementary concepts of mixed-integer linear optimization are introduced. All chapters have several illustrations and geometrical interpretations of the material as well as suggested problems. Nonlinear and Mixed-Integer Optimization will prove to be an invaluable source--either as a textbook or a reference--for researchers and graduate students interested in continuous and discrete nonlinear optimization issues in engineering design, process synthesis, process operations, applied mathematics, operations research, industrial management, and systems engineering.

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.

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 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.

This paper considers heuristic procedures for general mixed integer linear programming with inequality constraints. It focuses on the question of how to most effectively initialize such procedures by constructing an interior path from which to search for good feasible solutions. These paths lead from an optimal solution for the corresponding linear programming problem (i.e., deleting integrality restrictions) into the interior of the feasible region for this problem. Previous methods for constructing linear paths of this kind are analyzed from a statistical viewpoint, which motivates a promising new method. These methods are then extended to piecewise linear paths in order to improve the direction of search in certain cases where constraints that are not binding on the optimal linear programming solution become particularly relevant. Computational experience is reported. (Author).

This book opens the door to multiobjective optimization for students in fields such as engineering, management, economics and applied mathematics. It offers a comprehensive introduction to multiobjective optimization, with a primary emphasis on multiobjective linear programming and multiobjective integer/mixed integer programming. A didactic book, it is mainly intended for undergraduate and graduate students, but can also be useful for researchers and practitioners. Further, it is accompanied by an interactive software package - developed by the authors for Windows platforms - which can be used for teaching and decision-making support purposes in multiobjective linear programming problems. Thus, besides the textbook's coverage of the essential concepts, theory and methods, complemented with illustrative examples and exercises, the computational tool enables students to experiment and enhance their technical skills, as well as to capture the essential characteristics of real-world problems.

This hands-on tutorial text for non-experts demonstrates biological applications of a versatile modeling and optimization technique.

Many engineering, operations, and scientific applications include a mixture of discrete and continuous decision variables and nonlinear relationships involving the decision variables that have a pronounced effect on the set of feasible and optimal solutions. Mixed-integer nonlinear programming (MINLP) problems combine the numerical difficulties of handling nonlinear functions with the challenge of optimizing in the context of nonconvex functions and discrete variables. MINLP is one of the most flexible modeling paradigms available for optimization; but because its scope is so broad, in the most general cases it is hopelessly intractable. Nonetheless, an expanding body of researchers and practitioners — including chemical engineers, operations researchers, industrial engineers, mechanical engineers, economists, statisticians, computer scientists, operations managers, and mathematical programmers — are interested in solving large-scale MINLP instances.

This textbook covers the fundamentals of optimization, including linear, mixed-integer linear, nonlinear, and dynamic optimization techniques, with a clear engineering focus. It carefully describes classical optimization models and algorithms using an engineering problem-solving perspective, and emphasizes modeling issues using many real-world examples related to a variety of application areas. Providing an appropriate blend of practical applications and optimization theory makes the text useful to both practitioners and students, and gives the reader a good sense of the power of optimization and the potential difficulties in applying optimization to modeling real-world systems. The book is intended for undergraduate and graduate-level teaching in industrial engineering and other engineering specialties. It is also of use to industry practitioners, due to the inclusion of real-world applications, opening the door to advanced courses on both modeling and algorithm development within the industrial engineering and operations research fields.

A mixed-integer linear programming formulation is developed for minimizing delay to traffic in a signal controlled road network. Offsets, splits of green time and a common cycle time for the network are considered as decision variables simultaneously. The traffic flow pattern is modeled as a periodic platoon, and a link performance function is derived in the form of a piecewise linear convex surface representing the delay incurred by these platoons. Stochastic effects are accounted for by a saturation deterrence function representing the expected overflow queue on each link and are included as an additive component in the objective function. Computational results, using the MPSX system, are given for an arterial with 11 signals in Waltham, Mass., and a portion of the UTCS network in Washington, D.C. containing 20 nodes, 63 links and 21 loops.

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.

Fundamental concepts of mathematical modeling Modeling is one of the most effective, commonly used tools inengineering and the applied sciences. In this book, the authorsdeal with mathematical programming models both linear and nonlinearand across a wide range of practical applications. Whereas other books concentrate on standard methods of analysis,the authors focus on the power of modeling methods for solvingpractical problems-clearly showing the connection between physicaland mathematical realities-while also describing and exploring themain concepts and tools at work. This highly computational coverageincludes: * Discussion and implementation of the GAMS programmingsystem * Unique coverage of compatibility * Illustrative examples that showcase the connection between modeland reality * Practical problems covering a wide range of scientificdisciplines, as well as hundreds of examples and end-of-chapterexercises * Real-world applications to probability and statistics, electricalengineering, transportation systems, and more Building and Solving Mathematical Programming Models in Engineeringand Science is practically suited for use as a professionalreference for mathematicians, engineers, and applied or industrialscientists, while also tutorial and illustrative enough foradvanced students in mathematics or engineering.

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.

An accessible treatment of the modeling and solution of integer programming problems, featuring modern applications and software In order to fully comprehend the algorithms associated with integer programming, it is important to understand not only how algorithms work, but also why they work. Applied Integer Programming features a unique emphasis on this point, focusing on problem modeling and solution using commercial software. Taking an application-oriented approach, this book addresses the art and science of mathematical modeling related to the mixed integer programming (MIP) framework and discusses the algorithms and associated practices that enable those models to be solved most efficiently. The book begins with coverage of successful applications, systematic modeling procedures, typical model types, transformation of non-MIP models, combinatorial optimization problem models, and automatic preprocessing to obtain a better formulation. Subsequent chapters present algebraic and geometric basic concepts of linear programming theory and network flows needed for understanding integer programming. Finally, the book concludes with classical and modern solution approaches as well as the key components for building an integrated software system capable of solving large-scale integer programming and combinatorial optimization problems. Throughout the book, the authors demonstrate essential concepts through numerous examples and figures. Each new concept or algorithm is accompanied by a numerical example, and, where applicable, graphics are used to draw together diverse problems or approaches into a unified whole. In addition, features of solution approaches found in today's commercial software are identified throughout the book. Thoroughly classroom-tested, Applied Integer Programming is an excellent book for integer programming courses at the upper-undergraduate and graduate levels. It also serves as a well-organized reference for professionals, software developers, and analysts who work in the fields of applied mathematics, computer science, operations research, management science, and engineering and use integer-programming techniques to model and solve real-world optimization problems.

Supply Chain Management concerns organizational aspects of integrating legally separated firms as well as coordinating materials and information flows within a production-distribution network. The book provides insights regarding the concepts underlying APS, with special emphasis given to modelling supply chains and successfully implementing APS in industry. Understanding is enhanced through the use of case studies as well as an introduction to the solution algorithms used.

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.

Algorithms for solving site-selection and similar fixed charge problems with upper bound constraints are presented. The basic approach is to formulate the problem as a mixed integer program and to solve these programs by decomposing them into a master integer program and a series of subproblems which are linear programs. To reduce the number of vertices to be examined to manageable proportions, the bound-and-scan algorithm by F.S. Hillier was adapted to the fixed charge problem. Algorithms are presented for four classes of problems: (1) Fixed charge problem with linear variable costs and a fixed charge for each variable at non-zero level. (2) Problem 1 with separable concave or convex variable costs. (3) A warehouse location problem in which variable costs and constraints are of the transportation type. A fixed charge is associated with each warehouse opened. (4) The fixed charge transportation problem in which a fixed charge is associated with each route rather than with each warehouse. Computational results for Problems 1, 2, and 4 are presented. (Author).

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.

Mathematical Foundations for Signal Processing, Communications, and Networking describes mathematical concepts and results important in the design, analysis, and optimization of signal processing algorithms, modern communication systems, and networks. Helping readers master key techniques and comprehend the current research literature, the book offers a comprehensive overview of methods and applications from linear algebra, numerical analysis, statistics, probability, stochastic processes, and optimization. From basic transforms to Monte Carlo simulation to linear programming, the text covers a broad range of mathematical techniques essential to understanding the concepts and results in signal processing, telecommunications, and networking. Along with discussing mathematical theory, each self-contained chapter presents examples that illustrate the use of various mathematical concepts to solve different applications. Each chapter also includes a set of homework exercises and readings for additional study. This text helps readers understand fundamental and advanced results as well as recent research trends in the interrelated fields of signal processing, telecommunications, and networking. It provides all the necessary mathematical background to prepare students for more advanced courses and train specialists working in these areas.

This book focuses on solving optimization problems with MATLAB. Descriptions and solutions of nonlinear equations of any form are studied first. Focuses are made on the solutions of various types of optimization problems, including unconstrained and constrained optimizations, mixed integer, multiobjective and dynamic programming problems. Comparative studies and conclusions on intelligent global solvers are also provided.

Linear programming is one of the most extensively used techniques in the toolbox of quantitative methods of optimization. One of the reasons of the popularity of linear programming is that it allows to model a large variety of situations with a simple framework. Furthermore, a linear program is relatively easy to solve. The simplex method allows to solve most linear programs efficiently, and the Karmarkar interior-point method allows a more efficient solving of some kinds of linear programming. The power of linear programming is greatly enhanced when came the opportunity of solving integer and mixed integer linear programming. In these models all or some of the decision variables are integers, respectively. In this book we provide a brief introduction to linear programming, together with a set of exercises that introduce some applications of linear programming. We will also provide an introduction to solve linear programming in R. For each problem a possible solution through linear programming is introduced, together with the code to solve it in R and its numerical solution.

Linear and Mixed Integer Programming for Portfolio OptimizationSpringer

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.

Disjunctive Programming is a technique and a discipline initiated by the author in the early 1970's, which has become a central tool for solving nonconvex optimization problems like pure or mixed integer programs, through convexification (cutting plane) procedures combined with enumeration. It has played a major role in the revolution in the state of the art of Integer Programming that took place roughly during the period 1990-2010. The main benefit that the reader may acquire from reading this book is a deeper understanding of the theoretical underpinnings and of the applications potential of disjunctive programming, which range from more efficient problem formulation to enhanced modeling capability and improved solution methods for integer and combinatorial optimization. Egon Balas is University Professor and Lord Professor of Operations Research at Carnegie Mellon University's Tepper School of Business.

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.

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.

A. Planning Company Operations: The General Problem At more or less regular intervals, the management of an industrial enter prise is confronted with the problem of planning operations for a coming period. Within this category of management problems falls not only the overall planning of the company's aggregate production but problems of a more limited nature such as, for example, figuring the least-cost combina tion of raw materials for given output or the optimal transportation schedule. Any such problem of production planning is most rationally solved in two stages: (i) The first stage is to determine the feasible alternatives. For example, what alternative production schedules are at all compatible with the given capacity limitations? What combinations of raw materials satisfy the given quality specifications for the products? etc. The data required for solving this part of the problem are largely of a technological nature. (ii) The second is to select from among these alternatives one which is economically optimal: for example, the aggregate production programme which will lead to maximum profit, or the least-cost combination of raw materials. This is where the economist comes in; indeed, any economic problem is concerned with making a choice be.tween alternatives, using some criterion of optimal utilization of resources.

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