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KEY=LINEAR - PHILLIPS FRIEDMAN

Solutions Manual for Linear Programming

W.H. Freeman

Linear Programming

Macmillan **"This comprehensive treatment of the fundamental ideas and principles of linear programming covers basic theory, selected applications, network flow problems, and advanced techniques. Using specific examples to illuminate practical and theoretical aspects of the subject, the author clearly reveals the structures of fully detailed proofs. The presentation is geared toward modern efficient implementations of the simplex method and appropriate data structures for network flow problems. Completely self-contained, it develops even elementary facts on linear equations and matrices from the beginning."--Back cover.**

Algorithmische Mathematik

Springer-Verlag **Die Autoren stellen verschiedene Teilgebiete der Mathematik aus algorithmischer Perspektive vor und diskutieren dabei auch Implementierungs- und Laufzeitaspekte. Im Mittelpunkt der Darstellung stehen Analyse- und Lösungsstrategien für konkrete Probleme. Angesichts einer verkürzten Grundausbildung in Mathematik bei naturwissenschaftlichen Studiengängen wollen die Autoren einerseits möglichst viele Teilaspekte der Mathematik vorstellen und andererseits zu einer vertiefenden Beschäftigung mit dem einen oder anderen Aspekt anregen.**

Scientific and Technical Books and Serials in Print

Books in Print

The Traveling Salesman Problem

A Computational Study

Princeton University Press **This book presents the latest findings on one of the most intensely investigated subjects in computational mathematics--the traveling salesman problem. It sounds simple enough: given a set of cities and the cost of travel between each pair of them, the problem challenges you to find the cheapest route by which to visit all the cities and return home to where you began. Though seemingly modest, this exercise has inspired studies by mathematicians, chemists, and physicists. Teachers use it in the classroom. It has practical applications in genetics, telecommunications, and neuroscience. The authors of this book are the same pioneers who for nearly two decades have led the investigation into the traveling salesman problem. They have derived solutions to almost eighty-six thousand cities, yet a general solution to the problem has yet to be discovered. Here they describe the method and computer code they used to solve a broad range of large-scale problems, and along the way they demonstrate the interplay of applied mathematics with increasingly powerful computing platforms. They also give the fascinating history of the problem--how it developed, and why it continues to intrigue us.**

Whitaker's Cumulative Book List

Optimization in Operations Research

Prentice Hall **For first courses in operations research, operations management Optimization in Operations Research, Second Edition covers a broad range of optimization techniques, including linear programming, network flows,**

integer/combinational optimization, and nonlinear programming. This dynamic text emphasizes the importance of modeling and problem formulation andhow to apply algorithms to real-world problems to arrive at optimal solutions. Use a program that presents a better teaching and learning experience-for you and your students. Prepare students for real-world problems: Students learn how to apply algorithms to problems that get them ready for their field. Use strong pedagogy tools to teach: Key concepts are easy to follow with the text's clear and continually reinforced learning path. Enjoy the text's flexibility: The text features varying amounts of coverage, so that instructors can choose how in-depth they want to go into different topics.

Repräsentation konvexer Objekte durch lineare Constraints in Geoinformationssystemen

diplom.de **Inhaltsangabe:Gang der Untersuchung: Wie aus der Mathematik bekannt ist, können konvexe Objekte jeder Dimension mit Hilfe linearer Ungleichungen spezifiziert werden (Constraint Repräsentation). Diese linearen Constraints können z.B. aus der sogenannten Boundary Representation, die ein Objekt anhand seiner Eckpunkte und Kanten charakterisiert, gewonnen werden. Ein Ziel der Arbeit ist die effiziente Herleitung der Eckpunkte und Kanten zwei- bzw. dreidimensionaler Objekte, die durch die Constraint Repräsentation dargestellt werden, um diese Objekte visualisieren zu können. Das verwendete Verfahren basiert auf dem SIMPLEX-Algorithmus: der Breadth-First SIMPLEX. Im zweiten Teil werden die Möglichkeiten betrachtet, die die Constraint Repräsentation im Zusammenhang mit dem SIMPLEX-Verfahren bietet, wenn zwei Objekte geschnitten werden. Als Seiteneffekt werden zum einen die geometrische Lage der Objekte zueinander bzgl. topologischer Relationen nach Egenhofer und zum anderen die durch den Schnitt redundanten Ungleichungen ermittelt. Schließlich wird ein Algorithmus vorgestellt, der ein konkaves Polygon in mehrere disjunkte, konvexe Objektteile partitioniert. Somit kann über die Constraintrepräsentation festgestellt werden, ob sich ein beliebiger Punkt in oder außerhalb eines konkaven Polygons oder, in der Praxis, einer Landkarte befindet. Inhaltsverzeichnis:Inhaltsverzeichnis: 1.Einleitung1 2.Definitionen und Werkzeuge4 2.1Boundary-Repräsentation4 2.2Constraint-Repräsentation5 2.3SIMPLEX-Algorithmus7 2.3.1Tableau-Methode8 2.3.2Zusammenhang der SIMPLEX-Tableauschritte und des Gaußschen Eliminationsverfahrens14 2.3.3Künstliche Variablen16 2.4Constraint Solver21 3.Berechnung von Constraint- und Boundary-Repräsentatiom22 3.1Transformation Boundary- nach Constraint-Repräsentation22 3.1.1Zweidimensionale Objekte22 3.1.2Dreidimensionale Objekte25 3.2Transformation Constraint- nach Boundary-Repräsentation27 3.2.1Brute Force27 3.2.2Breadth-First SIMPLEX30 3.2.2.1Redundante Constraints36 3.2.2.2Entartete Eckpunkte41 3.2.2.3Vollständigkeit des Breadth-First SIMPLEX54 4.Operationen auf Objekten in Constraint Repräsentation56 4.1Durchschnitt56 4.2Vereinigung59 4.3Topologische Relationen60 4.3.1Relation Disjoint 64 4.3.2Relation Contains und Inside 65 4.3.3Relation Equal 65 4.3.4Relation Overlap 66 4.3.5Relation Covers und CoveredBy 66 4.3.6Relation Meet 69 5.Constraint-Repräsentation und konkave Objekte72 5.1Zerlegung [...]**

Combinatorial Mathematics

Cambridge University Press **This long-awaited textbook is the most comprehensive introduction to a broad swath of combinatorial and discrete mathematics. The text covers enumeration, graphs, sets, and methods, and it includes both classical results and more recent developments. Assuming no prior exposure to combinatorics, it explains the basic material for graduate-level students in mathematics and computer science. Optional more advanced material also makes it valuable as a research reference. Suitable for a one-year course or a one-semester introduction, this textbook prepares students to move on to more advanced material. It is organized to emphasize connections among the topics, and facilitate instruction, self-study, and research, with more than 2200 exercises (many accompanied by hints) at various levels of difficulty. Consistent notation and terminology are used throughout, allowing for a discussion of diverse topics in a unified language. The thorough bibliography, containing thousands of citations, makes this a valuable source for students and researchers alike.**

Computational Geometry

Algorithms and Applications

Springer Science & Business Media **This introduction to computational geometry focuses on algorithms. Motivation is provided from the application areas as all techniques are related to particular applications in robotics, graphics, CAD/CAM, and geographic information systems. Modern insights in computational geometry are used to provide solutions that are both efficient and easy to understand and implement.**

Books in Print Supplement

Includes authors, titles, subjects.

Lectures on Polytopes

Springer **Based on a graduate course at the Technische Universität, Berlin, this book presents a wealth of material on the modern theory of convex polytopes. With linear algebra as a prerequisite, the text moves quickly from the basics to topics of recent research.**

Linear Optimization and Duality

A Modern Exposition

CRC Press **Linear Optimization and Dualiyy: A Modern Exposition departs from convention in significant ways. Standard linear programming textbooks present the material in the order in which it was discovered. Duality is treated as a difficult add-on after coverage of formulation, the simplex method, and polyhedral theory. Students end up without knowing duality in their bones. This text brings in duality in Chapter 1 and carries duality all the way through the exposition. Chapter 1 gives a general definition of duality that shows the dual aspects of a matrix as a column of rows and a row of columns. The proof of weak duality in Chapter 2 is shown via the Lagrangian, which relies on matrix duality. The first three LP formulation examples in Chapter 3 are classic primal-dual pairs including the diet problem and 2-person zero sum games. For many engineering students, optimization is their first immersion in rigorous mathematics. Conventional texts assume a level of mathematical sophistication they don't have. This text embeds dozens of reading tips and hundreds of answered questions to guide such students. Features Emphasis on duality throughout Practical tips for modeling and computation Coverage of computational complexity and data structures Exercises and problems based on the learning theory concept of the zone of proximal development Guidance for the mathematically unsophisticated reader About the Author Craig A. Tovey is a professor in the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Institute of Technology. Dr. Tovey received an AB from Harvard College, an MS in computer science and a PhD in operations research from Stanford University. His principal activities are in operations research and its interdisciplinary applications. He received a Presidential Young Investigator Award and the Jacob Wolfowitz Prize for research in heuristics. He was named an Institute Fellow at Georgia Tech, and was recognized by the ACM Special Interest Group on Electronic Commerce with the Test of Time Award. Dr. Tovey received the 2016 Golden Goose Award for his research on bee foraging behavior leading to the development of the Honey Bee Algorithm.**

Constraint Solving and Planning with Picat

Springer **This book introduces a new logic-based multi-paradigm programming language that integrates logic programming, functional programming, dynamic programming with tabling, and scripting, for use in solving combinatorial search problems, including CP, SAT, and MIP (mixed integer programming) based solver modules, and a module for planning that is implemented using tabling. The book is useful for undergraduate and graduate students, researchers, and practitioners.**

Linear Programming

John Wiley & Sons Incorporated **Formulation of linear programming; the simplex method; geometry of the simplex method; duality in linear programming; revised (primal) simplex method; the dual simplex method; numerically stable forms of the simplex method; parametric linear programs; sensitivity analysis; degeneracy in linear programming; bounded-variable linear programs; the decomposition principle of linear programming; the transportation problem; computational complexity of the simplex algorithm; the ellipsoid method; iterative methods for linear inequalities and linear programs; vector minima.**

Geometry of Cuts and Metrics

Springer **Cuts and metrics are well-known objects that arise - independently, but with many deep and fascinating connections - in diverse fields: in graph theory, combinatorial optimization, geometry of numbers, combinatorial matrix theory, statistical physics, VLSI design etc. This book presents a wealth of results, from different mathematical disciplines, in a unified comprehensive manner, and establishes new and old links, which cannot be found elsewhere. It provides a unique and invaluable source for researchers and graduate students. From the Reviews: "This book is definitely a milestone in the literature of integer programming and combinatorial optimization. It draws from the Interdisciplinarity of these fields [...]. With knowledge about the relevant terms, one can enjoy special subsections without being entirely familiar with the rest of the chapter. This makes it not only an interesting research book but even a dictionary. [...] The longer one works with it, the more beautiful it becomes." Optima 56, 1997.**

The Art and Craft of Problem Solving

Wiley Global Education **Appealing to everyone from college-level majors to independent learners, The Art and Craft of Problem Solving, 3rd Edition introduces a problem-solving approach to mathematics, as opposed to the traditional**

exercises approach. The goal of The Art and Craft of Problem Solving is to develop strong problem solving skills, which it achieves by encouraging students to do math rather than just study it. Paul Zeitz draws upon his experience as a coach for the international mathematics Olympiad to give students an enhanced sense of mathematics and the ability to investigate and solve problems.

50 Years of Integer Programming 1958-2008

From the Early Years to the State-of-the-Art

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.**

Approximation Algorithms

Springer Science & Business Media **Covering the basic techniques used in the latest research work, the author consolidates progress made so far, including some very recent and promising results, and conveys the beauty and excitement of work in the field. He gives clear, lucid explanations of key results and ideas, with intuitive proofs, and provides critical examples and numerous illustrations to help elucidate the algorithms. Many of the results presented have been simplified and new insights provided. Of interest to theoretical computer scientists, operations researchers, and discrete mathematicians.**

Harmonic Grammar and Harmonic Serialism

Equinox **Harmonic Grammar and Harmonic Serialism introduces readers to current research in Optimality Theory that involves a reconsideration of two of Prince and Smolensky's (1993/2004) basic architectural decisions. One is the choice of constraint ranking over the numerically weighted constraints of OT's predecessor, Harmonic Grammar. The other is the choice of parallel evaluation over a version of OT in which the representation is changed and evaluated iteratively Harmonic Serialism. The contributions in this volume explore the consequences for phonological theory of adopting serial evaluation, weighted constraints, or both. Because the volume contains both introductory material and the latest research, the intended audience encompasses advanced undergraduates, graduate students and professionals in the field. Although the content is mainly phonological, the book will also be of use to researchers in OT syntax and computational linguistics.**

A First Course in Graph Theory

Courier Corporation **Written by two prominent figures in the field, this comprehensive text provides a remarkably student-friendly approach. Its sound yet accessible treatment emphasizes the history of graph theory and offers unique examples and lucid proofs. 2004 edition.**

Computer Vision - ECCV 2000

6th European Conference on Computer Vision Dublin, Ireland, June 26 - July 1, 2000 Proceedings, Part I

Springer **Ten years ago, the inaugural European Conference on Computer Vision was held in Antibes, France. Since then, ECCV has been held biennially under the auspices of the European Vision Society at venues around Europe. This year, the privilege of organizing ECCV 2000 falls to Ireland and it is a signal honour for us to host what has become one of the most important events in the calendar of the computer vision community. ECCV is a single-track conference comprising the highest quality, previously unpublished, contributed papers on new and original research in computer vision. This year, 266 papers were submitted and, following a rigorous double-blind review process, with each paper being reviewed by three referees, 116 papers were selected by the Programme Committee for presentation at the conference. The venue for ECCV 2000 is the University of Dublin, Trinity College. - unded in 1592, it is Ireland's oldest university and has a proud tradition of scholarship in the Arts, Humanities, and Sciences, alike. The Trinity campus, set in the heart of Dublin, is an oasis of tranquility and its beautiful squares, elegant buildings, and tree-lined playing- elds provide the perfect setting for any conference.**

Algorithm Engineering and Experimentation

International Workshop ALENEX'99 Baltimore, MD, USA, January 15-16, 1999, Selected Papers

Springer Science & Business Media **This book constitutes the thoroughly refereed post-workshop proceedings of the International Workshop on Algorithmic Engineering and Experimentation, ALENEX'99, held in Baltimore, Maryland, USA, in January 1999. The 20 revised full papers presented were carefully selected from a total of 42 submissions during two rounds of reviewing and improvement. The papers are organized in sections on combinatorial algorithms, computational geometry, software and applications, algorithms for NP-hard problems, and data structures.**

Edmonds Polyhedra and a Hierarchy of Combinatorial Problems

Finite Math and Applied Calculus

Cengage Learning **Full of relevant, diverse, and current real-world applications, Stefan Waner and Steven Costenoble's FINITE MATHEMATICS AND APPLIED CALCULUS, Sixth Edition helps you relate to mathematics. A large number of the applications are based on real, referenced data from business, economics, the life sciences, and the social sciences. Thorough, clearly delineated spreadsheet and TI Graphing Calculator instruction appears throughout the book. Acclaimed for its readability and supported by the authors' popular website, this book will help you grasp and understand mathematics--whatever your learning style may be. Available with InfoTrac Student Collections http://gocengage.com/infotrac. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.**

The Design of Approximation Algorithms

Cambridge University Press **Discrete optimization problems are everywhere, from traditional operations research planning (scheduling, facility location and network design); to computer science databases; to advertising issues in viral marketing. Yet most such problems are NP-hard; unless P = NP, there are no efficient algorithms to find optimal solutions. This book shows how to design approximation algorithms: efficient algorithms that find provably near-optimal solutions. The book is organized around central algorithmic techniques for designing approximation algorithms, including greedy and local search algorithms, dynamic programming, linear and semidefinite programming, and randomization. Each chapter in the first section is devoted to a single algorithmic technique applied to several different problems, with more sophisticated treatment in the second section. The book also covers methods for proving that optimization problems are hard to approximate. Designed as a textbook for graduate-level algorithm courses, it will also serve as a reference for researchers interested in the heuristic solution of discrete optimization problems.**

The Mathematical Gardner

Springer Science & Business Media **-~- T he articles in this book are dedicated to Martin Gardner, the world's greatest expositor and popularizer of mathematics. While our papers are confined to this single subject, Gardner's interests and accomplishments have a wide range of subjects. Hence, we have entitled the book the Mathematical Gardner, and would like to see other volumes such as the Magical, the Literary, the Philosophical, or the Scientific Gardner accompany it. Of course, our title is also an appropriate pun, for Martin Gardner's relationship to the mathematical community is similar to a gardener's relationship to a beautiful flower garden. The contributors to this volume comprise only a small part of a large body of mathematicians whose work has been nurtured by its exposition in "Mathematical Games"; Martin's column which appears every month in Scientific American. More than just a mathematical journalist, Martin connects his readers by passing along problems and information and stimulating creative activity. Thus, he is a force behind the scenes as well as a public figure. Two people were particularly helpful in putting this book together.**

Electrical Load Forecasting

Modeling and Model Construction

Elsevier **Succinct and understandable, this book is a step-by-step guide to the mathematics and construction of electrical load forecasting models. Written by one of the world's foremost experts on the subject, Electrical Load Forecasting provides a brief discussion of algorithms, their advantages and disadvantages and when they are best utilized. The book begins with a good description of the basic theory and models needed to truly understand how the**

models are prepared so that they are not just blindly plugging and chugging numbers. This is followed by a clear and rigorous exposition of the statistical techniques and algorithms such as regression, neural networks, fuzzy logic, and expert systems. The book is also supported by an online computer program that allows readers to construct, validate, and run short and long term models. Step-by-step guide to model construction Construct, verify, and run short and long term models Accurately evaluate load shape and pricing Creat regional specific electrical load models

On the Banks of the Mayyazhi

Railway Infrastructure Security

Springer **This comprehensive monograph addresses crucial issues in the protection of railway systems, with the objective of enhancing the understanding of railway infrastructure security. Based on analyses by academics, technology providers and railway operators, it explains how to assess terrorist and criminal threats, design countermeasures, and implement effective security strategies. In so doing, it draws upon a range of experiences from different countries in Europe and beyond. The book is the first to be devoted entirely to this subject. It will serve as a timely reminder of the attractiveness of the railway infrastructure system as a target for criminals and terrorists and, more importantly, as a valuable resource for stakeholders and professionals in the railway security field aiming to develop effective security based on a mix of methodological, technological and organizational tools. Besides researchers and decision makers in the field, the book will appeal to students interested in critical infrastructure protection.**

Hypergraph Seminar

Ohio State University, 1972

Springer

Temporal GIS

Advanced Functions for Field-Based Applications

Springer Science & Business Media **The book focuses on the development of advanced functions for field-based temporal geographical information systems (TGIS). These fields describe natural, epidemiological, economical, and social phenomena distributed across space and time. The book is organized around four main themes: "Concepts, mathematical tools, computer programs, and applications". Chapters I and II review the conceptual framework of the modern TGIS and introduce the fundamental ideas of spatiotemporal modelling. Chapter III discusses issues of knowledge synthesis and integration. Chapter IV presents state-of-the-art mathematical tools of spatiotemporal mapping. Links between existing TGIS techniques and the modern Bayesian maximum entropy (BME) method offer significant improvements in the advanced TGIS functions. Comparisons are made between the proposed functions and various other techniques (e.g., Kriging, and Kalman-Bucy filters). Chapter V analyzes the interpretive features of the advanced TGIS functions, establishing correspondence between the natural system and the formal mathematics which describe it. In Chapters IV and V one can also find interesting extensions of TGIS functions (e.g., non-Bayesian connectives and Fisher information measures). Chapters VI and VII familiarize the reader with the TGIS toolbox and the associated library of comprehensive computer programs. Chapter VIII discusses important applications of TGIS in the context of scientific hypothesis testing, explanation, and decision making.**

Integer and Combinatorial Optimization

John Wiley & Sons **Rave reviews for INTEGER AND COMBINATORIAL OPTIMIZATION "This book provides an excellent introduction and survey of traditional fields of combinatorial optimization . . . It is indeed one of the best and most complete texts on combinatorial optimization . . . available. [And] with more than 700 entries, [it] has quite an exhaustive reference list."-Optima "A unifying approach to optimization problems is to formulate them like linear programming problems, while restricting some or all of the variables to the integers. This book is an encyclopedic resource for such formulations, as well as for understanding the structure of and solving the resulting integer programming problems."-Computing Reviews "[This book] can serve as a basis for various graduate courses on discrete optimization as well as a reference book for researchers and practitioners."-Mathematical Reviews "This comprehensive and wide-ranging book will undoubtedly become a standard reference book for all those in the field of combinatorial optimization."-Bulletin of the London Mathematical Society "This text should be required reading for anybody who intends to do research in this area or even just to keep abreast of developments."-Times Higher Education Supplement, London Also of interest . . . INTEGER PROGRAMMING Laurence A. Wolsey Comprehensive and self-contained, this intermediate-level guide to integer programming provides readers with clear, up-to-date explanations on why some problems are difficult to solve, how techniques can be reformulated to give better results, and how mixed integer programming systems can be used more effectively. 1998 (0-471-28366-5) 260 pp.**

Genius At Play

The Curious Mind of John Horton Conway

Bloomsbury Publishing USA **Inside the eccentric world of John Horton Conway, gifted polymath and inventor of the Game of Life.**

Logical Analysis of Hybrid Systems

Proving Theorems for Complex Dynamics

Springer Science & Business Media **Hybrid systems are models for complex physical systems and have become a widely used concept for understanding their behavior. Many applications are safety-critical, including car, railway, and air traffic control, robotics, physical–chemical process control, and biomedical devices. Hybrid systems analysis studies how we can build computerized controllers for physical systems which are guaranteed to meet their design goals. The author gives a unique, logic-based perspective on hybrid systems analysis. It is the first book that leverages the power of logic for hybrid systems. The author develops a coherent logical approach for systematic hybrid systems analysis, covering its theory, practice, and applications. It is further shown how the developed verification techniques can be used to study air traffic and railway control systems. This book is intended for researchers, postgraduates, and professionals who are interested in hybrid systems analysis, cyberphysical or embedded systems design, logic and theorem proving, or transportation and automation.**

Multitude

War and Democracy in the Age of Empire

Penguin **In their international bestseller Empire, Michael Hardt and Antonio Negri presented a grand unified vision of a world in which the old forms of imperialism are no longer effective. But what of Empire in an age of "American empire"? Has fear become our permanent condition and democracy an impossible dream? Such pessimism is profoundly mistaken, the authors argue. Empire, by interconnecting more areas of life, is actually creating the possibility for a new kind of democracy, allowing different groups to form a multitude, with the power to forge a democratic alternative to the present world order.Exhilarating in its optimism and depth of insight, Multitude consolidates Hardt and Negri's stature as two of the most important political philosophers at work in the world today.**

The Vehicle Routing Problem

Smart Delivery Systems

Smart Delivery Systems: Solving Complex Vehicle Routing Problems examines both exact and approximate methods for delivering optimal solutions to rich vehicle routing problems, showing both the advantages and disadvantages of each approach. It shows how to apply machine learning and advanced data analysis techniques to improve routing systems, familiarizing readers with the concepts and technologies used in successfully implemented delivery systems. The book explains both the latest theoretical and practical advances in intelligent delivery and scheduling systems and presents practical applications for designing new algorithms for real-life scenarios. Emphasizes both sequential and parallel algorithms Uniquely combines methods and algorithms, real-life applications, and parallel computing Includes recommendations on how to choose between different methods for solving applications Provides learning aids, end of chapter references, bibliography, worked examples and exercises

Mixed Integer Nonlinear Programming

Springer Science & Business Media **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.**