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Convex Optimization

Cambridge University Press **A comprehensive introduction to the tools, techniques and applications of convex optimization.**

Modeling and Optimization of Interdependent Energy Infrastructures

Springer Nature **This book opens up new ways to develop mathematical models and optimization methods for interdependent energy infrastructures, ranging from the electricity network, natural gas network, district heating network, and electrified transportation network. The authors provide methods to help analyze, design, and operate the integrated energy system more efficiently and reliably, and constitute a foundational basis for decision support tools for the next-generation energy network. Chapters present new operation models of the coupled energy infrastructure and the application of new methodologies including convex optimization, robust optimization, and equilibrium constrained optimization. Four appendices provide students and researchers with helpful tutorials on advanced optimization methods: Basics of Linear and Conic Programs; Formulation Tricks in Integer Programming; Basics of Robust Optimization; Equilibrium Problems. This book provides theoretical foundation and technical applications for energy system integration, and the the interdisciplinary research presented will be useful to readers in many fields including electrical engineering, civil engineering, and industrial engineering.**

Introduction to Online Convex Optimization

This book serves as a reference for a self-contained course on online convex optimization and the convex optimization approach to machine learning for the educated graduate student in computer science/electrical engineering/ operations research/statistics and related fields. An ideal reference.

Solutions Manual to accompany Nonlinear Programming Theory and Algorithms

John Wiley & Sons **As the Solutions Manual, this book is meant to accompany the maintitle, Nonlinear Programming: Theory and Algorithms, ThirdEdition. This book presents recent developments of keytopics in nonlinear programming (NLP) using a logical andself-contained format. The volume is divided into three sections:convex analysis, optimality conditions, and dual computationaltechniques. Precise statements of algortihms are given along withconvergence analysis. Each chapter contains detailed numericalexamples, graphical illustrations, and numerous exercises to aidreaders in understanding the concepts and methods discussed.**

Optimization in Practice with MATLAB

Cambridge University Press **This textbook is designed for students and industry practitioners for a first course in optimization integrating MATLAB® software.**

Mathematics for Machine Learning

Cambridge University Press **The fundamental mathematical tools needed to understand machine learning include linear algebra, analytic geometry, matrix decompositions, vector calculus, optimization, probability and statistics. These topics are traditionally taught in disparate courses, making it hard for data science or computer science students, or professionals, to efficiently learn the mathematics. This self-contained textbook bridges the gap between**

mathematical and machine learning texts, introducing the mathematical concepts with a minimum of prerequisites. It uses these concepts to derive four central machine learning methods: linear regression, principal component analysis, Gaussian mixture models and support vector machines. For students and others with a mathematical background, these derivations provide a starting point to machine learning texts. For those learning the mathematics for the first time, the methods help build intuition and practical experience with applying mathematical concepts. Every chapter includes worked examples and exercises to test understanding. Programming tutorials are offered on the book's web site.

Distributed Optimization and Statistical Learning Via the Alternating Direction Method of Multipliers

Now Publishers Inc **Surveys the theory and history of the alternating direction method of multipliers, and discusses its applications to a wide variety of statistical and machine learning problems of recent interest, including the lasso, sparse logistic regression, basis pursuit, covariance selection, support vector machines, and many others.**

A Gentle Introduction to Optimization

Cambridge University Press **Optimization is an essential technique for solving problems in areas as diverse as accounting, computer science and engineering. Assuming only basic linear algebra and with a clear focus on the fundamental concepts, this textbook is the perfect starting point for first- and second-year undergraduate students from a wide range of backgrounds and with varying levels of ability. Modern, real-world examples motivate the theory throughout. The authors keep the text as concise and focused as possible, with more advanced material treated separately or in starred exercises. Chapters are self-contained so that instructors and students can adapt the material to suit their own needs and a wide selection of over 140 exercises gives readers the opportunity to try out the skills they gain in each section. Solutions are available for instructors. The book also provides suggestions for further reading to help students take the next step to more advanced material.**

Introduction to Applied Linear Algebra

Vectors, Matrices, and Least Squares

Cambridge University Press **A groundbreaking introduction to vectors, matrices, and least squares for engineering applications, offering a wealth of practical examples.**

Numerical Optimization

Springer Science & Business Media **Optimization is an important tool used in decision science and for the analysis of physical systems used in engineering. One can trace its roots to the Calculus of Variations and the work of Euler and Lagrange. This natural and reasonable approach to mathematical programming covers numerical methods for finite-dimensional optimization problems. It begins with very simple ideas progressing through more complicated concepts, concentrating on methods for both unconstrained and constrained optimization.**

Convex Analysis and Optimization

Athena Scientific **A uniquely pedagogical, insightful, and rigorous treatment of the analytical/geometrical foundations of optimization. The book provides a comprehensive development of convexity theory, and its rich applications in optimization, including duality, minimax/saddle point theory, Lagrange multipliers, and Lagrangian relaxation/nondifferentiable optimization. It is an excellent supplement to several of our books: Convex Optimization Theory (Athena Scientific, 2009), Convex Optimization Algorithms (Athena Scientific, 2015), Nonlinear Programming (Athena Scientific, 2016), Network Optimization (Athena Scientific, 1998), and Introduction to Linear Optimization (Athena Scientific, 1997). Aside from a thorough account of convex analysis and optimization, the book aims to restructure the theory of the subject, by introducing several novel unifying lines of analysis, including: 1) A unified development of minimax theory and constrained optimization duality as special cases of duality between two simple geometrical problems. 2) A unified development of conditions for existence of solutions of convex optimization problems, conditions for the minimax equality to hold, and conditions for the absence of a duality gap in constrained optimization. 3) A unification of the major constraint qualifications allowing the use of Lagrange multipliers for nonconvex constrained optimization, using the notion of constraint pseudonormality and an enhanced form of the Fritz John necessary optimality conditions. Among its features the book: a) Develops rigorously and comprehensively the theory of convex sets and functions, in the classical tradition of Fenchel and Rockafellar b) Provides a geometric, highly visual treatment of convex and nonconvex optimization problems, including existence of solutions, optimality conditions, Lagrange multipliers, and duality c) Includes an insightful and comprehensive presentation of minimax theory and zero sum games, and its connection with duality d) Describes dual optimization, the associated computational methods, including the novel incremental subgradient methods, and applications in linear, quadratic, and integer programming e) Contains many examples, illustrations, and exercises with complete solutions (about 200**

pages) posted at the publisher's web site http://www.athenasc.com/convexity.html

Optimization Models

Cambridge University Press **This accessible textbook demonstrates how to recognize, simplify, model and solve optimization problems - and apply these principles to new projects.**

Convex Optimization Theory

Athena Scientific **An insightful, concise, and rigorous treatment of the basic theory of convex sets and functions in finite dimensions, and the analytical/geometrical foundations of convex optimization and duality theory. Convexity theory is first developed in a simple accessible manner, using easily visualized proofs. Then the focus shifts to a transparent geometrical line of analysis to develop the fundamental duality between descriptions of convex functions in terms of points, and in terms of hyperplanes. Finally, convexity theory and abstract duality are applied to problems of constrained optimization, Fenchel and conic duality, and game theory to develop the sharpest possible duality results within a highly visual geometric framework. This on-line version of the book, includes an extensive set of theoretical problems with detailed high-quality solutions, which significantly extend the range and value of the book. The book may be used as a text for a theoretical convex optimization course; the author has taught several variants of such a course at MIT and elsewhere over the last ten years. It may also be used as a supplementary source for nonlinear programming classes, and as a theoretical foundation for classes focused on convex optimization models (rather than theory). It is an excellent supplement to several of our books: Convex Optimization Algorithms (Athena Scientific, 2015), Nonlinear Programming (Athena Scientific, 2017), Network Optimization(Athena Scientific, 1998), Introduction to Linear Optimization (Athena Scientific, 1997), and Network Flows and Monotropic Optimization (Athena Scientific, 1998).**

Nonlinear Programming

Theory and Algorithms

John Wiley & Sons **COMPREHENSIVE COVERAGE OF NONLINEAR PROGRAMMING THEORY AND ALGORITHMS, THOROUGHLY REVISED AND EXPANDED Nonlinear Programming: Theory and Algorithms—now in an extensively updated Third Edition—addresses the problem of optimizing an objective function in the presence of equality and inequality constraints. Many realistic problems cannot be adequately represented as a linear program owing to the nature of the nonlinearity of the objective function and/or the nonlinearity of any constraints. The Third Edition begins with a general introduction to nonlinear programming with illustrative examples and guidelines for model construction. Concentration on the three major parts of nonlinear programming is provided: Convex analysis with discussion of topological properties of convex sets, separation and support of convex sets, polyhedral sets, extreme points and extreme directions of polyhedral sets, and linear programming Optimality conditions and duality with coverage of the nature, interpretation, and value of the classical Fritz John (FJ) and the Karush-Kuhn-Tucker (KKT) optimality conditions; the interrelationships between various proposed constraint qualifications; and Lagrangian duality and saddle point optimality conditions Algorithms and their convergence, with a presentation of algorithms for solving both unconstrained and constrained nonlinear programming problems Important features of the Third Edition include: New topics such as second interior point methods, nonconvex optimization, nondifferentiable optimization, and more Updated discussion and new applications in each chapter Detailed numerical examples and graphical illustrations Essential coverage of modeling and formulating nonlinear programs Simple numerical problems Advanced theoretical exercises The book is a solid reference for professionals as well as a useful text for students in the fields of operations research, management science, industrial engineering, applied mathematics, and also in engineering disciplines that deal with analytical optimization techniques. The logical and self-contained format uniquely covers nonlinear programming techniques with a great depth of information and an abundance of valuable examples and illustrations that showcase the most current advances in nonlinear problems.**

Statistical Learning with Sparsity

The Lasso and Generalizations

CRC Press **Discover New Methods for Dealing with High-Dimensional Data A sparse statistical model has only a small number of nonzero parameters or weights; therefore, it is much easier to estimate and interpret than a dense model. Statistical Learning with Sparsity: The Lasso and Generalizations presents methods that exploit sparsity to help recover the underlying signal in a set of data. Top experts in this rapidly evolving field, the authors describe the lasso for linear regression and a simple coordinate descent algorithm for its computation. They discuss the application of l1 penalties to generalized linear models and support vector machines, cover generalized penalties such as the elastic net and group lasso, and review numerical methods for optimization. They also present statistical inference methods for fitted (lasso) models, including the bootstrap, Bayesian methods, and recently developed approaches. In addition, the book examines matrix decomposition, sparse multivariate analysis, graphical models, and compressed sensing. It**

concludes with a survey of theoretical results for the lasso. In this age of big data, the number of features measured on a person or object can be large and might be larger than the number of observations. This book shows how the sparsity assumption allows us to tackle these problems and extract useful and reproducible patterns from big datasets. Data analysts, computer scientists, and theorists will appreciate this thorough and up-to-date treatment of sparse statistical modeling.

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.**

Aimms Optimization Modeling

Lulu.com **The AIMMS Optimization Modeling book provides not only an introduction to modeling but also a suite of worked examples. It is aimed at users who are new to modeling and those who have limited modeling experience. Both the basic concepts of optimization modeling and more advanced modeling techniques are discussed. The Optimization Modeling book is AIMMS version independent.**

Non-convex Optimization for Machine Learning

Foundations and Trends in Machine Learning **Non-convex Optimization for Machine Learning takes an in-depth look at the basics of non-convex optimization with applications to machine learning. It introduces the rich literature in this area, as well as equips the reader with the tools and techniques needed to apply and analyze simple but powerful procedures for non-convex problems. Non-convex Optimization for Machine Learning is as self-contained as possible while not losing focus of the main topic of non-convex optimization techniques. The monograph initiates the discussion with entire chapters devoted to presenting a tutorial-like treatment of basic concepts in convex analysis and optimization, as well as their non-convex counterparts. The monograph concludes with a look at four interesting applications in the areas of machine learning and signal processing, and exploring how the non-convex optimization techniques introduced earlier can be used to solve these problems. The monograph also contains, for each of the topics discussed, exercises and figures designed to engage the reader, as well as extensive bibliographic notes pointing towards classical works and recent advances. Non-convex Optimization for Machine Learning can be used for a semester-length course on the basics of non-convex optimization with applications to machine learning. On the other hand, it is also possible to cherry pick individual portions, such the chapter on sparse recovery, or the EM algorithm, for inclusion in a broader course. Several courses such as those in machine learning, optimization, and signal processing may benefit from the inclusion of such topics.**

Linear Matrix Inequalities in System and Control Theory

SIAM **In this book the authors reduce a wide variety of problems arising in system and control theory to a handful of convex and quasiconvex optimization problems that involve linear matrix inequalities. These optimization problems can be solved using recently developed numerical algorithms that not only are polynomial-time but also work very well in practice; the reduction therefore can be considered a solution to the original problems. This book opens up an important new research area in which convex optimization is combined with system and control theory, resulting in the solution of a large number of previously unsolved problems.**

Semidefinite Optimization and Convex Algebraic Geometry

SIAM **An accessible introduction to convex algebraic geometry and semidefinite optimization. For graduate students and researchers in mathematics and computer science.**

Engineering Design Optimization

Cambridge University Press **Based on course-tested material, this rigorous yet accessible graduate textbook covers both fundamental and advanced optimization theory and algorithms. It covers a wide range of numerical methods and topics, including both gradient-based and gradient-free algorithms, multidisciplinary design optimization, and uncertainty, with instruction on how to determine which algorithm should be used for a given application. It also provides an overview of models and how to prepare them for use with numerical optimization, including derivative**

computation. Over 400 high-quality visualizations and numerous examples facilitate understanding of the theory, and practical tips address common issues encountered in practical engineering design optimization and how to address them. Numerous end-of-chapter homework problems, progressing in difficulty, help put knowledge into practice. Accompanied online by a solutions manual for instructors and source code for problems, this is ideal for a one- or two-semester graduate course on optimization in aerospace, civil, mechanical, electrical, and chemical engineering departments.

An Easy Path to Convex Analysis and Applications

Morgan & Claypool Publishers **Convex optimization has an increasing impact on many areas of mathematics, applied sciences, and practical applications. It is now being taught at many universities and being used by researchers of different fields. As convex analysis is the mathematical f**

Linear Programming and Network Flows

John Wiley & Sons Incorporated **Table of contents**

An Introduction to Signal Detection and Estimation

Springer Science & Business Media **The purpose of this book is to introduce the reader to the basic theory of signal detection and estimation. It is assumed that the reader has a working knowledge of applied probabil ity and random processes such as that taught in a typical first-semester graduate engineering course on these subjects. This material is covered, for example, in the book by Wong (1983) in this series. More advanced concepts in these areas are introduced where needed, primarily in Chapters VI and VII, where continuous-time problems are treated. This book is adapted from a one-semester, second-tier graduate course taught at the University of Illinois. However, this material can also be used for a shorter or first-tier course by restricting coverage to Chapters I through V, which for the most part can be read with a background of only the basics of applied probability, including random vectors and conditional expectations. Sufficient background for the latter option is given for exam pIe in the book by Thomas (1986), also in this series.**

Fundamentals of Wireless Communication

Cambridge University Press **This textbook takes a unified view of the fundamentals of wireless communication and explains cutting-edge concepts in a simple and intuitive way. An abundant supply of exercises make it ideal for graduate courses in electrical and computer engineering and it will also be of great interest to practising engineers.**

Calculus of Variations and Optimal Control Theory

A Concise Introduction

Princeton University Press **This textbook offers a concise yet rigorous introduction to calculus of variations and optimal control theory, and is a self-contained resource for graduate students in engineering, applied mathematics, and related subjects. Designed specifically for a one-semester course, the book begins with calculus of variations, preparing the ground for optimal control. It then gives a complete proof of the maximum principle and covers key topics such as the Hamilton-Jacobi-Bellman theory of dynamic programming and linear-quadratic optimal control. Calculus of Variations and Optimal Control Theory also traces the historical development of the subject and features numerous exercises, notes and references at the end of each chapter, and suggestions for further study. Offers a concise yet rigorous introduction Requires limited background in control theory or advanced mathematics Provides a complete proof of the maximum principle Uses consistent notation in the exposition of classical and modern topics Traces the historical development of the subject Solutions manual (available only to teachers) Leading universities that have adopted this book include: University of Illinois at Urbana-Champaign ECE 553: Optimum Control Systems Georgia Institute of Technology ECE 6553: Optimal Control and Optimization University of Pennsylvania ESE 680: Optimal Control Theory University of Notre Dame EE 60565: Optimal Control**

Convex Analysis and Monotone Operator Theory in Hilbert Spaces

Springer **This reference text, now in its second edition, offers a modern unifying presentation of three basic areas of nonlinear analysis: convex analysis, monotone operator theory, and the fixed point theory of nonexpansive operators. Taking a unique comprehensive approach, the theory is developed from the ground up, with the rich connections and interactions between the areas as the central focus, and it is illustrated by a large number of examples. The Hilbert space setting of the material offers a wide range of applications while avoiding the technical difficulties of general Banach spaces. The authors have also drawn upon recent advances and modern tools to simplify the proofs of key results making the book more accessible to a broader range of scholars and users. Combining a strong emphasis on** applications with exceptionally lucid writing and an abundance of exercises, this text is of great value to a large audience including pure and applied mathematicians as well as researchers in engineering, data science, machine learning, physics, decision sciences, economics, and inverse problems. The second edition of Convex Analysis and Monotone Operator Theory in Hilbert Spaces greatly expands on the first edition, containing over 140 pages of new material, over 270 new results, and more than 100 new exercises. It features a new chapter on proximity operators including two sections on proximity operators of matrix functions, in addition to several new sections distributed throughout the original chapters. Many existing results have been improved, and the list of references has been updated. Heinz H. Bauschke is a Full Professor of Mathematics at the Kelowna campus of the University of British Columbia, Canada. Patrick L. Combettes, IEEE Fellow, was on the faculty of the City University of New York and of Université Pierre et Marie Curie – Paris 6 before joining North Carolina State University as a Distinguished Professor of Mathematics in 2016.

Understanding Machine Learning

From Theory to Algorithms

Cambridge University Press **Introduces machine learning and its algorithmic paradigms, explaining the principles behind automated learning approaches and the considerations underlying their usage.**

Convex Optimization & Euclidean Distance Geometry

Meboo Publishing USA **The study of Euclidean distance matrices (EDMs) fundamentally asks what can be known geometrically given onlydistance information between points in Euclidean space. Each point may represent simply locationor, abstractly, any entity expressible as a vector in finite-dimensional Euclidean space.The answer to the question posed is that very much can be known about the points;the mathematics of this combined study of geometry and optimization is rich and deep.Throughout we cite beacons of historical accomplishment.The application of EDMs has already proven invaluable in discerning biological molecular conformation.The emerging practice of localization in wireless sensor networks, the global positioning system (GPS), and distance-based pattern recognitionwill certainly simplify and benefit from this theory.We study the pervasive convex Euclidean bodies and their various representations.In particular, we make convex polyhedra, cones, and dual cones more visceral through illustration, andwe study the geometric relation of polyhedral cones to nonorthogonal bases biorthogonal expansion.We explain conversion between halfspace- and vertex-descriptions of convex cones,we provide formulae for determining dual cones,and we show how classic alternative systems of linear inequalities or linear matrix inequalities and optimality conditions can be explained by generalized inequalities in terms of convex cones and their duals.The conic analogue to linear independence, called conic independence, is introducedas a new tool in the study of classical cone theory; the logical next step in the progression:linear, affine, conic.Any convex optimization problem has geometric interpretation.This is a powerful attraction: the ability to visualize geometry of an optimization problem.We provide tools to make visualization easier.The concept of faces, extreme points, and extreme directions of convex Euclidean bodiesis explained here, crucial to understanding convex optimization.The convex cone of positive semidefinite matrices, in particular, is studied in depth.We mathematically interpret, for example,its inverse image under affine transformation, and we explainhow higher-rank subsets of its boundary united with its interior are convex.The Chapter on "Geometry of convex functions",observes analogies between convex sets and functions:The set of all vector-valued convex functions is a closed convex cone.Included among the examples in this chapter, we show how the real affinefunction relates to convex functions as the hyperplane relates to convex sets.Here, also, pertinent results formultidimensional convex functions are presented that are largely ignored in the literature;tricks and tips for determining their convexityand discerning their geometry, particularly with regard to matrix calculus which remains largely unsystematizedwhen compared with the traditional practice of ordinary calculus.Consequently, we collect some results of matrix differentiation in the appendices.The Euclidean distance matrix (EDM) is studied,its properties and relationship to both positive semidefinite and Gram matrices.We relate the EDM to the four classical axioms of the Euclidean metric;thereby, observing the existence of an infinity of axioms of the Euclidean metric beyondthe triangle inequality. We proceed byderiving the fifth Euclidean axiom and then explain why furthering this endeavoris inefficient because the ensuing criteria (while describing polyhedra)grow linearly in complexity and number.Some geometrical problems solvable via EDMs,EDM problems posed as convex optimization, and methods of solution arepresented;\eg, we generate a recognizable isotonic map of the United States usingonly comparative distance information (no distance information, only distance inequalities).We offer a new proof of the classic Schoenberg criterion, that determines whether a candidate matrix is an EDM. Our proofrelies on fundamental geometry; assuming, any EDM must correspond to a list of points contained in some polyhedron(possibly at its vertices) and vice versa.It is not widely known that the Schoenberg criterion implies nonnegativity of the EDM entries; proved here.We characterize the eigenvalues of an EDM matrix and then devisea polyhedral cone required for determining membership of a candidate matrix(in Cayley-Menger form) to the convex cone of Euclidean distance matrices (EDM cone); \ie,a candidate is an EDM if and only if its eigenspectrum belongs to a spectral cone for EDM^N.We will see spectral cones are not unique.In the chapter "EDM cone", we explain the geometric relationship betweenthe EDM cone, two positive semidefinite cones, and the elliptope.We illustrate geometric requirements, in particular, for projection of a candidate matrixon a positive semidefinite cone that establish its membership to the EDM cone. The faces of the EDM cone are described,but still**

open is the question whether all its faces are exposed as they are for the positive semidefinite cone.The classic Schoenberg criterion, relating EDM and positive semidefinite cones, isrevealed to be a discretized membership relation (a generalized inequality, a new Farkas''''''-like lemma)between the EDM cone and its ordinary dual. A matrix criterion for membership to the dual EDM cone is derived thatis simpler than the Schoenberg criterion.We derive a new concise expression for the EDM cone and its dual involvingtwo subspaces and a positive semidefinite cone."Semidefinite programming" is reviewedwith particular attention to optimality conditionsof prototypical primal and dual conic programs,their interplay, and the perturbation method of rank reduction of optimal solutions(extant but not well-known).We show how to solve a ubiquitous platonic combinatorial optimization problem from linear algebra(the optimal Boolean solution x to Ax=b)via semidefinite program relaxation.A three-dimensional polyhedral analogue for the positive semidefinite cone of 3X3 symmetricmatrices is introduced; a tool for visualizing in 6 dimensions.In "EDM proximity"we explore methods of solution to a few fundamental and prevalentEuclidean distance matrix proximity problems; the problem of finding that Euclidean distance matrix closestto a given matrix in the Euclidean sense.We pay particular attention to the problem when compounded with rank minimization.We offer a new geometrical proof of a famous result discovered by Eckart \& Young in 1936 regarding Euclideanprojection of a point on a subset of the positive semidefinite cone comprising all positive semidefinite matriceshaving rank not exceeding a prescribed limit rho.We explain how this problem is transformed to a convex optimization for any rank rho.

Algorithms for Convex Optimization

Cambridge University Press **In the last few years, Algorithms for Convex Optimization have revolutionized algorithm design, both for discrete and continuous optimization problems. For problems like maximum flow, maximum matching, and submodular function minimization, the fastest algorithms involve essential methods such as gradient descent, mirror descent, interior point methods, and ellipsoid methods. The goal of this self-contained book is to enable researchers and professionals in computer science, data science, and machine learning to gain an in-depth understanding of these algorithms. The text emphasizes how to derive key algorithms for convex optimization from first principles and how to establish precise running time bounds. This modern text explains the success of these algorithms in problems of discrete optimization, as well as how these methods have significantly pushed the state of the art of convex optimization itself.**

An Introduction to Structural Optimization

Springer Science & Business Media **This book has grown out of lectures and courses given at Linköping University, Sweden, over a period of 15 years. It gives an introductory treatment of problems and methods of structural optimization. The three basic classes of geometrical - timization problems of mechanical structures, i. e. , size, shape and topology op- mization, are treated. The focus is on concrete numerical solution methods for d- crete and (?nite element) discretized linear elastic structures. The style is explicit and practical: mathematical proofs are provided when arguments can be kept e- mentary but are otherwise only cited, while implementation details are frequently provided. Moreover, since the text has an emphasis on geometrical design problems, where the design is represented by continuously varying—frequently very many— variables, so-called ?rst order methods are central to the treatment. These methods are based on sensitivity analysis, i. e. , on establishing ?rst order derivatives for - jectives and constraints. The classical ?rst order methods that we emphasize are CONLIN and MMA, which are based on explicit, convex and separable appro- mations. It should be remarked that the classical and frequently used so-called op- mality criteria method is also of this kind. It may also be noted in this context that zero order methods such as response surface methods, surrogate models, neural n- works, genetic algorithms, etc. , essentially apply to different types of problems than the ones treated here and should be presented elsewhere.**

Interior-point Polynomial Algorithms in Convex Programming

SIAM **Specialists working in the areas of optimization, mathematical programming, or control theory will find this book invaluable for studying interior-point methods for linear and quadratic programming, polynomial-time methods for nonlinear convex programming, and efficient computational methods for control problems and variational inequalities. A background in linear algebra and mathematical programming is necessary to understand the book. The detailed proofs and lack of "numerical examples" might suggest that the book is of limited value to the reader interested in the practical aspects of convex optimization, but nothing could be further from the truth. An entire chapter is devoted to potential reduction methods precisely because of their great efficiency in practice.**

Lectures on Modern Convex Optimization

Analysis, Algorithms, and Engineering Applications

SIAM **Here is a book devoted to well-structured and thus efficiently solvable convex optimization problems, with emphasis on conic quadratic and semidefinite programming. The authors present the basic theory underlying these problems as well as their numerous applications in engineering, including synthesis of filters, Lyapunov stability**

analysis, and structural design. The authors also discuss the complexity issues and provide an overview of the basic theory of state-of-the-art polynomial time interior point methods for linear, conic quadratic, and semidefinite programming. The book's focus on well-structured convex problems in conic form allows for unified theoretical and algorithmical treatment of a wide spectrum of important optimization problems arising in applications.

Information, Physics, and Computation

Oxford University Press **A very active field of research is emerging at the frontier of statistical physics, theoretical computer science/discrete mathematics, and coding/information theory. This book sets up a common language and pool of concepts, accessible to students and researchers from each of these fields.**

A Survey of Relaxations and Approximations of the Power Flow Equations

Foundations and Trends (R) in Electric Energy Systems **The techniques described in this monograph form the basis of running an optimally efficient modern day power system. It is a must-read for all students and researchers working on the cutting edge of electric power systems.**

Quantum Mechanics

Cambridge University Press **A self-contained introduction for advanced students in physics who want to acquire serious knowledge and understanding of quantum mechanics.**

Optimization and Its Applications in Control and Data Sciences

In Honor of Boris T. Polyak’s 80th Birthday

Springer **This book focuses on recent research in modern optimization and its implications in control and data analysis. This book is a collection of papers from the conference “Optimization and Its Applications in Control and Data Science” dedicated to Professor Boris T. Polyak, which was held in Moscow, Russia on May 13-15, 2015. This book reflects developments in theory and applications rooted by Professor Polyak’s fundamental contributions to constrained and unconstrained optimization, differentiable and nonsmooth functions, control theory and approximation. Each paper focuses on techniques for solving complex optimization problems in different application areas and recent developments in optimization theory and methods. Open problems in optimization, game theory and control theory are included in this collection which will interest engineers and researchers working with efficient algorithms and software for solving optimization problems in market and data analysis. Theoreticians in operations research, applied mathematics, algorithm design, artificial intelligence, machine learning, and software engineering will find this book useful and graduate students will find the state-of-the-art research valuable.**

Problem Complexity and Method Efficiency in Optimization

John Wiley & Sons

Simulation and the Monte Carlo Method

John Wiley & Sons **This accessible new edition explores the major topics in Monte Carlo simulation that have arisen over the past 30 years and presents a sound foundation for problem solving Simulation and the Monte Carlo Method, Third Edition reflects the latest developments in the field and presents a fully updated and comprehensive account of the state-of-the-art theory, methods and applications that have emerged in Monte Carlo simulation since the publication of the classic First Edition over more than a quarter of a century ago. While maintaining its accessible and intuitive approach, this revised edition features a wealth of up-to-date information that facilitates a deeper understanding of problem solving across a wide array of subject areas, such as engineering, statistics, computer science, mathematics, and the physical and life sciences. The book begins with a modernized introduction that addresses the basic concepts of probability, Markov processes, and convex optimization. Subsequent chapters discuss the dramatic changes that have occurred in the field of the Monte Carlo method, with coverage of many modern topics including: Markov Chain Monte Carlo, variance reduction techniques such as importance (re-)sampling, and the transform likelihood ratio method, the score function method for sensitivity analysis, the stochastic approximation method and the stochastic counter-part method for Monte Carlo optimization, the cross-entropy method for rare events estimation and combinatorial optimization, and application of Monte Carlo techniques for counting problems. An extensive range of**

exercises is provided at the end of each chapter, as well as a generous sampling of applied examples. The Third Edition features a new chapter on the highly versatile splitting method, with applications to rare-event estimation, counting, sampling, and optimization. A second new chapter introduces the stochastic enumeration method, which is a new fast sequential Monte Carlo method for tree search. In addition, the Third Edition features new material on: • Random number generation, including multiple-recursive generators and the Mersenne Twister • Simulation of Gaussian processes, Brownian motion, and diffusion processes • Multilevel Monte Carlo method • New enhancements of the cross-entropy (CE) method, including the "improved" CE method, which uses sampling from the zero-variance distribution to find the optimal importance sampling parameters • Over 100 algorithms in modern pseudo code with flow control • Over 25 new exercises Simulation and the Monte Carlo Method, Third Edition is an excellent text for upper-undergraduate and beginning graduate courses in stochastic simulation and Monte Carlo techniques. The book also serves as a valuable reference for professionals who would like to achieve a more formal understanding of the Monte Carlo method. Reuven Y. Rubinstein, DSc, was Professor Emeritus in the Faculty of Industrial Engineering and Management at Technion-Israel Institute of Technology. He served as a consultant at numerous large-scale organizations, such as IBM, Motorola, and NEC. The author of over 100 articles and six books, Dr. Rubinstein was also the inventor of the popular score-function method in simulation analysis and generic cross-entropy methods for combinatorial optimization and counting. Dirk P. Kroese, PhD, is a Professor of Mathematics and Statistics in the School of Mathematics and Physics of The University of Queensland, Australia. He has published over 100 articles and four books in a wide range of areas in applied probability and statistics, including Monte Carlo methods, cross-entropy, randomized algorithms, tele-traffic c theory, reliability, computational statistics, applied probability, and stochastic modeling.

Optimization for Machine Learning

MIT Press **An up-to-date account of the interplay between optimization and machine learning, accessible to students and researchers in both communities. The interplay between optimization and machine learning is one of the most important developments in modern computational science. Optimization formulations and methods are proving to be vital in designing algorithms to extract essential knowledge from huge volumes of data. Machine learning, however, is not simply a consumer of optimization technology but a rapidly evolving field that is itself generating new optimization ideas. This book captures the state of the art of the interaction between optimization and machine learning in a way that is accessible to researchers in both fields. Optimization approaches have enjoyed prominence in machine learning because of their wide applicability and attractive theoretical properties. The increasing complexity, size, and variety of today's machine learning models call for the reassessment of existing assumptions. This book starts the process of reassessment. It describes the resurgence in novel contexts of established frameworks such as first-order methods, stochastic approximations, convex relaxations, interior-point methods, and proximal methods. It also devotes attention to newer themes such as regularized optimization, robust optimization, gradient and subgradient methods, splitting techniques, and second-order methods. Many of these techniques draw inspiration from other fields, including operations research, theoretical computer science, and subfields of optimization. The book will enrich the ongoing cross-fertilization between the machine learning community and these other fields, and within the broader optimization community.**