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Convex Optimization Lectures on Convex Optimization Algorithms for Convex Optimization Convex Analysis for Optimization Convex Optimization Convex Optimization Algorithms Selected Applications of Convex Optimization Conjugate Duality in Convex Optimization An Easy Path to Convex Analysis and Applications Convex Analysis and Optimization Optimality Conditions in Convex Optimization Lectures on Modern Convex Optimization Convex Optimization for Signal Processing and Communications Convex Optimization Theory A Mathematical View of Interior-point Methods in Convex Optimization Convexity and Optimization in Banach Spaces Introduction to Online Convex Optimization, second edition Large-Scale Convex Optimization Convex Optimization with Computational Errors Convex Optimization in Signal Processing and Communications Linear and Convex Optimization Introductory Lectures on Convex Optimization Convex Optimization & Euclidean Distance Geometry Optimization on Solution Sets of Common Fixed Point Problems Introductory Lectures on Convex Optimization Introductory Lectures on Convex Optimization Convex Optimization in Normed Spaces An Easy Path to Convex Analysis and Applications Code Generation for Embedded Convex Optimization The Projected Subgradient Algorithm in Convex Optimization Conjugate Duality and Optimization Duality for Nonconvex Approximation and Optimization A Branch-and-Bound Algorithm for Multiobjective Mixed-integer Convex Optimization Convex Optimization Statistical Inference Via Convex Optimization □□□□□□□□□□□□ Convex Optimization Convex Optimization of Power Systems Interior-point Polynomial Algorithms in Convex Programming Totally Convex Functions for Fixed Points Computation and Infinite Dimensional Optimization

Convex Optimization

2004-03-08

convex optimization problems arise frequently in many different fields this book provides a comprehensive introduction to the subject and shows in detail how such problems can be solved numerically with great efficiency the book begins with the basic elements of convex sets and functions and then describes various classes of convex optimization problems duality and approximation techniques are then covered as are statistical estimation techniques various geometrical problems are then presented and there is detailed discussion of unconstrained and constrained minimization problems and interior point methods the focus of the book is on recognizing convex optimization problems and then finding the most appropriate technique for solving them it contains many worked examples and homework exercises and will appeal to students researchers and practitioners in fields such as engineering computer science mathematics statistics finance and economics

Lectures on Convex Optimization

2018-11-19

this book provides a comprehensive modern introduction to convex optimization a field that is becoming increasingly important in applied mathematics economics and finance engineering and computer science notably in data science and machine learning written by a leading expert in the field this book includes recent advances in the algorithmic theory of convex optimization naturally complementing the existing literature it contains a unified and rigorous presentation of the acceleration techniques for minimization schemes of first and second order it provides readers with a full treatment of the smoothing technique which has tremendously extended the abilities of gradient type methods several powerful approaches in structural optimization including optimization in relative scale and polynomial time interior point methods are also discussed in detail researchers in theoretical optimization as well as professionals working on optimization problems will find this book very useful it presents many successful examples of how to develop very fast specialized minimization algorithms based on the author s lectures it can naturally serve as the basis for introductory and advanced courses in convex optimization for students in engineering economics computer science and mathematics

Algorithms for Convex Optimization

2021-10-07

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

Convex Analysis for Optimization

2020-05-05

this textbook offers graduate students a concise introduction to the classic notions of convex optimization written in a highly accessible style and including numerous examples and illustrations it presents everything readers need to know about convexity and convex optimization the book introduces a systematic three step method for doing everything which can be summarized as conify work deconify it starts with the concept of convex sets their primal description constructions topological properties and dual description and then moves on to convex functions and the fundamental principles of convex optimization and their use in the complete analysis of convex optimization problems by means of a systematic four step method lastly it includes chapters on alternative formulations of optimality conditions and on illustrations of their use the author deals with the delicate subjects in a precise yet light minded spirit for experts in the field this book not only offers a unifying view but also opens a door to new discoveries in convexity and optimization perfectly suited for classroom teaching shuzhong zhang professor of industrial and systems engineering university of minnesota

Convex Optimization

2021-01-05

this book provides easy access to the basic principles and methods for solving constrained and unconstrained convex optimization problems included are sections that cover basic methods for solving constrained and unconstrained optimization problems with differentiable objective functions convex sets and their properties convex functions and their properties and generalizations and basic principles of sub differential calculus and convex programming problems convex optimization provides detailed proofs for most of the results presented in the book and also includes many figures and exercises for a better understanding of the material exercises are given at the end of each chapter with solutions and hints to selected exercises given at the end of the book undergraduate and graduate students researchers in different disciplines as well as practitioners will all benefit from this accessible approach to convex optimization methods

Convex Optimization Algorithms

2015-02-01

this book provides a comprehensive and accessible presentation of algorithms for solving convex optimization problems it relies on rigorous mathematical analysis but also aims at an intuitive exposition that makes use of visualization where possible this is facilitated by the extensive use of analytical and algorithmic concepts of duality which by nature lend themselves to geometrical interpretation the book places particular emphasis on modern developments and their widespread applications in fields such as large scale resource allocation problems signal processing and machine learning the book is aimed at students researchers and practitioners roughly at the first year graduate level it is similar in style to the author s 2009 convex optimization theory book but can be read independently the latter book focuses on convexity theory and

optimization duality while the present book focuses on algorithmic issues the two books share notation and together cover the entire finite dimensional convex optimization methodology to facilitate readability the statements of definitions and results of the theory book are reproduced without proofs in appendix b

Selected Applications of Convex Optimization

2015-03-26

this book focuses on the applications of convex optimization and highlights several topics including support vector machines parameter estimation norm approximation and regularization semi definite programming problems convex relaxation and geometric problems all derivation processes are presented in detail to aid in comprehension the book offers concrete guidance helping readers recognize and formulate convex optimization problems they might encounter in practice

Conjugate Duality in Convex Optimization

2009-12-24

the results presented in this book originate from the last decade research work of the author in the eld of duality theory in convex optimization the reputation of duality in the optimization theory comes mainly from the major role that it plays in formulating necessary and suf cient optimality conditions and consequently in generatingdifferent algorithmic approachesfor solving mathematical programming problems the investigations made in this work prove the importance of the duality theory beyond these aspects and emphasize its strong connections with different topics in convex analysis nonlinear analysis functional analysis and in the theory of monotone operators the rst part of the book brings to the attention of the reader the perturbation approach as a fundamental tool for developing the so called conjugate duality t ory the classical lagrange and fenchel duality approaches are particular instances of this general concept more than that the generalized interior point regularity conditions stated in the past for the two mentioned situations turn out to be p ticularizations of the ones given in this general setting in our investigations the perturbationapproachrepresentsthestartingpointforderivingnewdualityconcepts for several classes of convex optimization problems moreover via this approach generalized moreau rockafellar formulae are provided and in connection with them a new class of regularity conditions called closedness type conditions for both stable strong duality and strong duality is introduced by stable strong duality we understand the situation in which strong duality still holds whenever perturbing the objective function of the primal problem with a linear continuous functional

An Easy Path to Convex Analysis and Applications

2022-05-31

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 foundation for convex optimization having deep knowledge of convex analysis helps students and researchers apply its tools more effectively the main goal of this book is to provide an easy access to the most fundamental parts of convex analysis and its

applications to optimization modern techniques of variational analysis are employed to clarify and simplify some basic proofs in convex analysis and build the theory of generalized differentiation for convex functions and sets in finite dimensions we also present new applications of convex analysis to location problems in connection with many interesting geometric problems such as the fermat torricelli problem the heron problem the sylvester problem and their generalizations of course we do not expect to touch every aspect of convex analysis but the book consists of sufficient material for a first course on this subject it can also serve as supplemental reading material for a course on convex optimization and applications

Convex Analysis and Optimization

2003-03-01

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 athenasc com convexity html

Optimality Conditions in Convex Optimization

2011-10-17

optimality conditions in convex optimization explores an important and central issue in the field of convex optimization optimality conditions it brings together the most important and recent results in this area that have been scattered in the literature notably in the area of convex analysis essential in developing many of the important results in this book and not usually found in conventional texts unlike other books on

convex optimization which usually discuss algorithms along with some basic theory the sole focus of this book is on fundamental and advanced convex optimization theory although many results presented in the book can also be proved in infinite dimensions the authors focus on finite dimensions to allow for much deeper results and a better understanding of the structures involved in a convex optimization problem they address semi infinite optimization problems approximate solution concepts of convex optimization problems and some classes of non convex problems which can be studied using the tools of convex analysis they include examples wherever needed provide details of major results and discuss proofs of the main results

Lectures on Modern Convex Optimization

2001-01-01

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

Convex Optimization for Signal Processing and Communications

2017-01-24

convex optimization for signal processing and communications from fundamentals to applications provides fundamental background knowledge of convex optimization while striking a balance between mathematical theory and applications in signal processing and communications in addition to comprehensive proofs and perspective interpretations for core convex optimization theory this book also provides many insightful figures remarks illustrative examples and guided journeys from theory to cutting edge research explorations for efficient and in depth learning especially for engineering students and professionals with the powerful convex optimization theory and tools this book provides you with a new degree of freedom and the capability of solving challenging real world scientific and engineering problems

Convex Optimization Theory

2009-06-01

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

A Mathematical View of Interior-point Methods in Convex Optimization

2001-01-01

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

Convexity and Optimization in Banach Spaces

2012-01-03

an updated and revised edition of the 1986 title convexity and optimization in banach spaces this book provides a self contained presentation of basic results of the theory of convex sets and functions in infinite dimensional spaces the main emphasis is on applications to convex optimization and convex optimal control problems in banach spaces a distinctive feature is a strong emphasis on the connection between theory and application this edition has been updated to include new results pertaining to advanced concepts of subdifferential for convex functions and new duality results in convex programming the last chapter concerned with convex control problems has been rewritten and completed with new research concerning boundary control systems the dynamic programming equations in optimal control theory and periodic optimal control problems finally the structure of the book has been modified to highlight the most recent progression in the field including fundamental results on the theory of infinite dimensional convex analysis and includes helpful bibliographical notes at the end of each chapter

Introduction to Online Convex Optimization, second edition

2022-09-06

new edition of a graduate level textbook on that focuses on online convex optimization a machine learning framework that views optimization as a process in many practical applications the environment is so complex that it is not feasible to lay out a comprehensive theoretical model and use classical algorithmic theory and or mathematical optimization introduction to online convex optimization presents a robust machine learning approach that contains elements of mathematical optimization game theory and learning theory an optimization method that learns from experience as more aspects of the problem are observed this view of optimization as a process has led to some spectacular successes in modeling and systems that have become part of our daily lives based on the theoretical machine learning course taught by the author at princeton university the second edition of this widely used graduate level text features thoroughly updated material throughout new chapters on boosting adaptive regret and approachability and expanded exposition on optimization examples of applications including prediction from expert advice portfolio selection matrix completion and recommendation systems svm training offered throughout exercises that guide students in completing parts of proofs

Large-Scale Convex Optimization

2022-11-30

a unified analysis of first order optimization methods including parallel distributed algorithms using monotone operators

Convex Optimization with Computational Errors

2020-01-31

the book is devoted to the study of approximate solutions of optimization problems in the presence of computational errors it contains a number of results on the convergence behavior of algorithms in a hilbert space which are known as important tools for solving optimization problems the research presented in the book is the continuation and the further development of the author s c 2016 book numerical optimization with computational errors springer 2016 both books study the algorithms taking into account computational errors which are always present in practice the main goal is for a known computational error to find out what an approximate solution can be obtained and how many iterates one needs for this the main difference between this new book and the 2016 book is that in this present book the discussion takes into consideration the fact that for every algorithm its iteration consists of several steps and that computational errors for different steps are generally different this fact which was not taken into account in the previous book is indeed important in practice for example the subgradient projection algorithm consists of two steps the first step is a calculation of a subgradient of the objective function while in the second one we calculate a projection on the feasible set in each of these two steps there is a computational error and these two computational errors are different in general it may happen that the feasible set is simple and the objective function is complicated as a result the computational error made when one calculates the projection is essentially smaller than the computational error of the calculation of the subgradient clearly an opposite case is possible too another feature of this book is a study of a number of important algorithms which appeared recently in the literature and which are not discussed in the previous book this monograph contains 12 chapters chapter 1 is an introduction in chapter 2 we study the subgradient projection algorithm for minimization of convex and

nonsmooth functions we generalize the results of noce and establish results which has no prototype in noce in chapter 3 we analyze the mirror descent algorithm for minimization of convex and nonsmooth functions under the presence of computational errors for this algorithm each iteration consists of two steps the first step is a calculation of a subgradient of the objective function while in the second one we solve an auxiliary minimization problem on the set of feasible points in each of these two steps there is a computational error we generalize the results of noce and establish results which has no prototype in noce in chapter 4 we analyze the projected gradient algorithm with a smooth objective function under the presence of computational errors in chapter 5 we consider an algorithm which is an extension of the projection gradient algorithm used for solving linear inverse problems arising in signal image processing in chapter 6 we study continuous subgradient method and continuous subgradient projection algorithm for minimization of convex nonsmooth functions and for computing the saddle points of convex concave functions under the presence of computational errors all the results of this chapter has no prototype in noce in chapters 7 12 we analyze several algorithms under the presence of computational errors which were not considered in noce again each step of an iteration has a computational errors and we take into account that these errors are in general different an optimization problems with a composite objective function is studied in chapter 7 a zero sum game with two players is considered in chapter 8 a predicted decrease approximation based method is used in chapter 9 for constrained convex optimization chapter 10 is devoted to minimization of quasiconvex functions minimization of sharp weakly convex functions is discussed in chapter 11 chapter 12 is devoted to a generalized projected subgradient method for minimization of a convex function over a set which is not necessarily convex the book is of interest for researchers and engineers working in optimization it also can be useful in preparation courses for graduate students the main feature of the book which appeals specifically to this audience is the study of the influence of computational errors for several important optimization algorithms the book is of interest for experts in applications of optimization to engineering and economics

Convex Optimization in Signal Processing and Communications

2010

leading experts provide the theoretical underpinnings of the subject plus tutorials on a wide range of applications from automatic code generation to robust broadband beamforming emphasis on cutting edge research and formulating problems in convex form make this an ideal textbook for advanced graduate courses and a useful self study guide

Linear and Convex Optimization

2021-01-13

discover the practical impacts of current methods of optimization with this approachable one stop resource linear and convex optimization a mathematical approach delivers a concise and unified treatment of optimization with a focus on developing insights in problem structure modeling and algorithms convex optimization problems are covered in detail because of their many applications and the fast algorithms that have been developed to solve them experienced researcher and undergraduate teacher mike veatch presents the main algorithms used in linear integer and convex optimization in a mathematical style with an emphasis on what makes a class of problems practically

solvable and developing insight into algorithms geometrically principles of algorithm design and the speed of algorithms are discussed in detail requiring no background in algorithms the book offers a breadth of recent applications to demonstrate the many areas in which optimization is successfully and frequently used while the process of formulating optimization problems is addressed throughout linear and convex optimization contains a wide variety of features including coverage of current methods in optimization in a style and level that remains appealing and accessible for mathematically trained undergraduates enhanced insights into a few algorithms instead of presenting many algorithms in cursory fashion an emphasis on the formulation of large data driven optimization problems inclusion of linear integer and convex optimization covering many practically solvable problems using algorithms that share many of the same concepts presentation of a broad range of applications to fields like online marketing disaster response humanitarian development public sector planning health delivery manufacturing and supply chain management ideal for upper level undergraduate mathematics majors with an interest in practical applications of mathematics this book will also appeal to business economics computer science and operations research majors with at least two years of mathematics training software to accompany the text can be found here gordon edu michaelveatch optimization

Introductory Lectures on Convex Optimization

2003-12-31

it was in the middle of the 1980s when the seminal paper by kar markar opened a new epoch in nonlinear optimization the importance of this paper containing a new polynomial time algorithm for linear op timization problems was not only in its complexity bound at that time the most surprising feature of this algorithm was that the theoretical pre diction of its high efficiency was supported by excellent computational results this unusual fact dramatically changed the style and direc tions of the research in nonlinear optimization thereafter it became more and more common that the new methods were provided with a complexity analysis which was considered a better justification of their efficiency than computational experiments in a new rapidly develop ing field which got the name polynomial time interior point methods such a justification was obligatory afteralmost fifteen years of intensive research the main results of this development started to appear in monographs 12 14 16 17 18 19 approximately at that time the author was asked to prepare a new course on nonlinear optimization for graduate students the idea was to create a course which would reflect the new developments in the field actually this was a major challenge at the time only the theory of interior point methods for linear optimization was polished enough to be explained to students the general theory of self concordant functions had appeared in print only once in the form of research monograph 12

Convex Optimization & Euclidean Distance Geometry

2005

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

Optimization on Solution Sets of Common Fixed Point Problems

2021-08-09

this book is devoted to a detailed study of the subgradient projection method and its variants for convex optimization problems over the solution sets of common fixed point problems and convex feasibility problems these optimization problems are investigated to determine good solutions obtained by different versions of the subgradient projection algorithm in the presence of sufficiently small computational errors the use of selected algorithms is highlighted including the cimmino type subgradient the iterative subgradient and the dynamic string averaging subgradient all results presented are new optimization problems where the underlying constraints are the solution sets of other problems frequently occur in applied mathematics the reader should not miss the section in chapter 1 which considers some examples arising in the real world applications the problems discussed have an important impact in optimization theory as well the book will be useful for researches interested in the optimization theory and its applications

Introductory Lectures on Convex Optimization

2004

it was in the middle of the 1980s when the seminal paper by kar markar opened a new epoch in nonlinear optimization the importance of this paper containing a new polynomial time algorithm for linear op timization problems was not only in its complexity bound at that time the most surprising feature of this algorithm was that the theoretical pre diction of its high efficiency was supported by excellent computational results this unusual fact dramatically changed the style and direc tions of the research in nonlinear optimization thereafter it became more and more common

that the new methods were provided with a complexity analysis which was considered a better justification of their efficiency than computational experiments in a new rapidly develop ing field which got the name polynomial time interior point methods such a justification was obligatory afteralmost fifteen years of intensive research the main results of this development started to appear in monographs 12 14 16 17 18 19 approximately at that time the author was asked to prepare a new course on nonlinear optimization for graduate students the idea was to create a course which would reflect the new developments in the field actually this was a major challenge at the time only the theory of interior point methods for linear optimization was polished enough to be explained to students the general theory of self concordant functions had appeared in print only once in the form of research monograph 12

Introductory Lectures on Convex Optimization

2013-12-01

this work is intended to serve as a guide for graduate students and researchers who wish to get acquainted with the main theoretical and practical tools for the numerical minimization of convex functions on hilbert spaces therefore it contains the main tools that are necessary to conduct independent research on the topic it is also a concise easy to follow and self contained textbook which may be useful for any researcher working on related fields as well as teachers giving graduate level courses on the topic it will contain a thorough revision of the extant literature including both classical and state of the art references

Convex Optimization in Normed Spaces

2015-03-18

this book examines the most fundamental parts of convex analysis and its applications to optimization and location problems accessible techniques of variational analysis are employed to clarify and simplify some basic proofs in convex analysis and to build a theory of generalized differentiation for convex functions and sets in finite dimensions the book serves as a bridge for the readers who have just started using convex analysis to reach deeper topics in the field detailed proofs are presented for most of the results in the book and also included are many figures and exercises for better understanding the material applications provided include both the classical topics of convex optimization and important problems of modern convex optimization convex geometry and facility location

An Easy Path to Convex Analysis and Applications

2023-06-16

convex optimization is widely used in many fields but is nearly always constrained to problems solved in a few minutes or seconds and even then nearly always with a human in the loop the advent of parser solvers has made convex optimization simpler and more accessible and greatly increased the number of people using convex optimization most current applications however are for the design of systems or analysis of data it is possible to use convex optimization for real time or embedded applications where the optimization solver is a part of a larger system here the optimization algorithm must find solutions much faster than a generic solver and often has a hard real time

deadline use in embedded applications additionally means that the solver cannot fail and must be robust even in the presence of relatively poor quality data for ease of embedding the solver should be simple and have minimal dependencies on external libraries convex optimization has been successfully applied in such settings in the past however they have usually necessitated a custom hand written solver this requires signficant time and expertise and has been a major factor preventing the adoption of convex optimization in embedded applications this work describes the implementation and use of a prototype code generator for convex optimization cvxgen that creates high speed solvers automatically using the principles of disciplined convex programming cvxgen allows the user to describe an optimization problem in a convenient high level language then receive code for compilation into an extremely fast robust embeddable solver

Code Generation for Embedded Convex Optimization

2011

this focused monograph presents a study of subgradient algorithms for constrained minimization problems in a hilbert space the book is of interest for experts in applications of optimization to engineering and economics the goal is to obtain a good approximate solution of the problem in the presence of computational errors the discussion takes into consideration the fact that for every algorithm its iteration consists of several steps and that computational errors for different steps are different in general the book is especially useful for the reader because it contains solutions to a number of difficult and interesting problems in the numerical optimization the subgradient projection algorithm is one of the most important tools in optimization theory and its applications an optimization problem is described by an objective function and a set of feasible points for this algorithm each iteration consists of two steps the first step requires a calculation of a subgradient of the objective function the second requires a calculation of a projection on the feasible set the computational errors in each of these two steps are different this book shows that the algorithm discussed generates a good approximate solution if all the computational errors are bounded from above by a small positive constant moreover if computational errors for the two steps of the algorithm are known one discovers an approximate solution and how many iterations one needs for this in addition to their mathematical interest the generalizations considered in this book have a significant practical meaning

The Projected Subgradient Algorithm in Convex Optimization

2020-11-25

the theory of duality in problems of optimization is developed in a setting of finite and infinite dimensional spaces using convex analysis applications to convex and nonconvex problems expository account containing many new results author

Conjugate Duality and Optimization

1974-01-01

the theory of convex optimization has been constantly developing over the past 30 years most recently many researchers have been studying more complicated classes of problems

that still can be studied by means of convex analysis so called anticonvex and convex anticonvex optimizaton problems this manuscript contains an exhaustive presentation of the duality for these classes of problems and some of its generalization in the framework of abstract convexity this manuscript will be of great interest for experts in this and related fields

Duality for Nonconvex Approximation and Optimization

2007-03-12

stefan rocktäschel introduces a branch and bound algorithm that determines a cover of the efficient set of multiobjective mixed integer convex optimization problems he examines particular steps of this algorithm in detail and enhances the basic algorithm with additional modifications that ensure a more precise cover of the efficient set finally he gives numerical results on some test instances

A Branch-and-Bound Algorithm for Multiobjective Mixed-integer Convex Optimization

2020-01-21

this monograph presents the main complexity theorems in convex optimization and their corresponding algorithms it begins with the fundamental theory of black box optimization and proceeds to guide the reader through recent advances in structural optimization and stochastic optimization the presentation of black box optimization strongly influenced by the seminal book by nesterov includes the analysis of cutting plane methods as well as accelerated gradient descent schemes special attention is also given to non euclidean settings relevant algorithms include frank wolfe mirror descent and dual averaging and discussing their relevance in machine learning the text provides a gentle introduction to structural optimization with fista to optimize a sum of a smooth and a simple non smooth term saddle point mirror prox nemirovski s alternative to nesterov s smoothing and a concise description of interior point methods in stochastic optimization it discusses stochastic gradient descent mini batches random coordinate descent and sublinear algorithms it also briefly touches upon convex relaxation of combinatorial problems and the use of randomness to round solutions as well as random walks based methods

Convex Optimization

2015-11-12

this authoritative book draws on the latest research to explore the interplay of high dimensional statistics with optimization through an accessible analysis of fundamental problems of hypothesis testing and signal recovery anatoli juditsky and arkadi nemirovski show how convex optimization theory can be used to devise and analyze near optimal statistical inferences statistical inference via convex optimization is an essential resource for optimization specialists who are new to statistics and its applications and for data scientists who want to improve their optimization methods juditsky and nemirovski provide the first systematic treatment of the statistical techniques that have arisen from advances in the theory of optimization they focus on four well known statistical problems sparse recovery hypothesis testing and recovery from indirect observations of both signals and functions of signals demonstrating how

they can be solved more efficiently as convex optimization problems the emphasis throughout is on achieving the best possible statistical performance the construction of inference routines and the quantification of their statistical performance are given by efficient computation rather than by analytical derivation typical of more conventional statistical approaches in addition to being computation friendly the methods described in this book enable practitioners to handle numerous situations too difficult for closed analytical form analysis such as composite hypothesis testing and signal recovery in inverse problems statistical inference via convex optimization features exercises with solutions along with extensive appendixes making it ideal for use as a graduate text

Statistical Inference Via Convex Optimization

2020-04-07

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2005-09

over the past two decades it has been recognized that advanced image processing techniques provide valuable information to physicians for the diagnosis image guided therapy and surgery and monitoring of human diseases convex optimization theory methods and applications introduces novel and sophisticated mathematical problems which encourage the development of advanced optimization and computing methods especially convex optimization the authors go on to study steffensen king type methods of convergence to approximate a locally unique solution of a nonlinear equation and also in problems of convex optimization real world applications are also provided the following study is focused on the design and testing of a matlab code of the frank wolfe algorithm the nesterov step is proposed in order to accelerate the algorithm and the results of some numerical experiments of constraint optimization are also provided lagrangian methods for numerical solutions to constrained convex programs are also explored for enhanced algorithms the traditional lagrange multiplier update is modified to take a soft reflection across the zero boundary this coupled with a modified drift expression is shown to yield improved performance next newton s mesh independence principle was used to solve a certain class of optimal design problems from earlier studies motivated by optimization considerations the authors show that under the same computational cost a finer mesh independence principle can be given than before this compilation closes with a presentation on a local convergence analysis for eighth order variants of hansen patrick s family for approximating a locally unique solution of a nonlinear equation the radius of convergence and computable error bounds on the distances involved are also provided

Convex Optimization

2019

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

Convex Optimization of Power Systems

2015

the main purpose of this book is to present in a unified approach several algorithms for fixed point computation convex feasibility and convex optimization in infinite dimensional banach spaces and for problems involving eventually infinitely many constraints for instance methods like the simultaneous projection algorithm for feasibility the proximal point algorithm and the augmented lagrangian algorithm are rigorously formulated and analyzed in this general setting and shown to be applicable to much wider classes of problems than previously known for this purpose a new basic concept total convexity is introduced its properties are deeply explored and a comprehensive theory is presented bringing together previously unrelated ideas from banach space geometry finite dimensional convex optimization and functional analysis for making a general approach possible the work aims to improve upon classical results like the holder minkowsky inequality of □p

Interior-point Polynomial Algorithms in Convex Programming

1994-01-01

Totally Convex Functions for Fixed Points Computation and Infinite Dimensional Optimization

2000

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