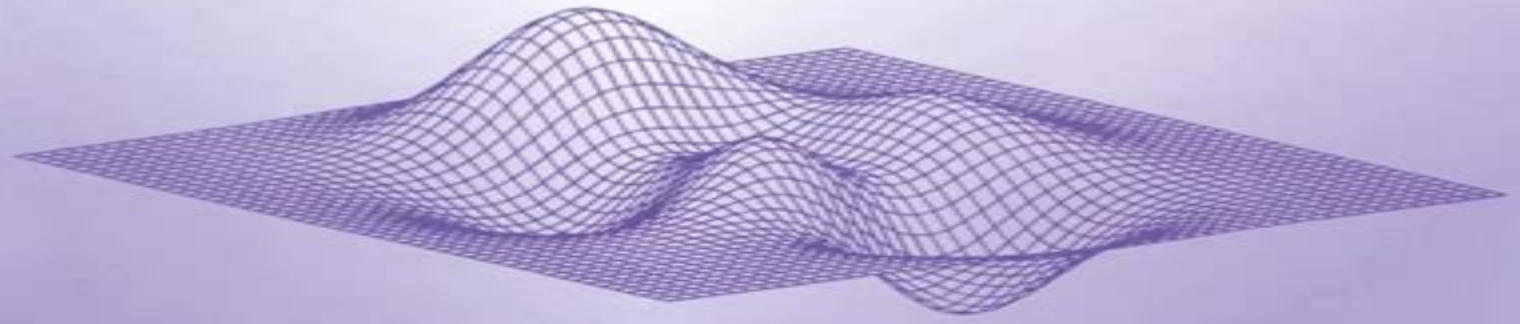
NONCONVEX OPTIMIZATION AND ITS APPLICATIONS

A Reformulation-Linearization Technique for Solving Discrete and Continuous Nonconvex Problems

Hanif D. Sherali and Warren P. Adams



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Reformulation Linearization Technique For Solving Discrete And Continuous Nonconvex Problems

David Yang Gao,Raymond W. Ogden,Georgios E. Stavroulakis

Reformulation Linearization Technique For Solving Discrete And Continuous Nonconvex Problems:

A Reformulation-Linearization Technique for Solving Discrete and Continuous Nonconvex Problems Hanif D. Sherali,W. P. Adams,2013-04-17 This book deals with the theory and applications of the Reformulation Linearization Convexification Technique RL T for solving nonconvex optimization problems A unified treatment of discrete and continuous nonconvex programming problems is presented using this approach In essence the bridge between these two types of nonconvexities is made via a polynomial representation of discrete constraints For example the binariness on a 0 1 variable x can be equivalently J expressed as the polynomial constraint x 1 x 0 The motivation for this book is J J the role of tight linear convex programming representations or relaxations in solving such discrete and continuous nonconvex programming problems The principal thrust is to commence with a model that affords a useful representation and structure and then to further strengthen this representation through automatic reformulation and constraint generation techniques As mentioned above the focal point of this book is the development and application of RL T for use as an automatic reformulation procedure and also to generate strong valid inequalities The RLT operates in two phases In the Reformulation Phase certain types of additional implied polynomial constraints that include the aforementioned constraints in the case of binary variables are appended to the problem The resulting problem is subsequently linearized except that certain convex constraints are sometimes retained in XV particular special cases in the Linearization Convexijication Phase This is done via the definition of suitable new variables to replace each distinct variable product term The higher dimensional representation yields a linear or convex programming relaxation **Stochastic and Global Optimization** G. Dzemyda,V. Saltenis,A. Žilinskas,2006-04-11 In the paper we propose a model of tax incentives optimization for inve ment projects with a help of the mechanism of accelerated depreciation Unlike the tax holidays which influence on effective income tax rate accelerated preciation affects on taxable income In modern economic practice the state actively use for an attraction of vestment into the creation of new enterprises such mechanisms as accelerated depreciation and tax holidays The problem under our consideration is the following Assume that the state region is interested in realization of a certain investment project for ex ple the creation of a new enterprise In order to attract a potential investor the state decides to use a mechanism of accelerated tax depreciation The foll ing question arise What is a reasonable principle for choosing depreciation rate From the state s point of view the future investor s behavior will be rat nal It means that while looking at economic environment the investor choose such a moment for investment which maximizes his expected net present value NPV from the given project For this case both criteria and investment rule depend on proposed by the state depreciation policy For the simplicity we will suppose that the purpose of the state for a given project is a maximi tion of a discounted tax payments into the budget from the enterprise after its creation Of course these payments depend on the moment of investor s entry and therefore on the depreciation policy established by the state **Nonsmooth/Nonconvex Mechanics** David Yang Gao,Raymond W. Ogden,Georgios E.

Stavroulakis,2013-12-01 Nonsmooth and nonconvex models arise in several important applications of mechanics and engineering The interest in this field is growing from both mathematicians and engineers The study of numerous industrial applications including contact phenomena in statics and dynamics or delamination effects in composites require the consideration of nonsmoothness and nonconvexity The mathematical topics discussed in this book include variational and hemivariational inequalities duality complementarity variational principles sensitivity analysis eigenvalue and resonance problems and minimax problems Applications are considered in the following areas among others nonsmooth statics and dynamics stability of quasi static evolution processes friction problems adhesive contact and debonding inverse problems pseudoelastic modeling of phase transitions chaotic behavior in nonlinear beams and nonholonomic mechanical systems This volume contains 22 chapters written by various leading researchers and presents a cohesive and authoritative overview of recent results and applications in the area of nonsmooth and nonconvex mechanics Audience Faculty graduate students and researchers in applied mathematics optimization control and engineering **Foundations of Computational Intelligence Volume 3** Ajith Abraham,Aboul-Ella Hassanien,Patrick Siarry,Andries Engelbrecht,2009-05-01 Global optimization is a branch of applied mathematics and numerical analysis that deals with the task of finding the absolutely best set of admissible conditions to satisfy certain criteria objective function s formulated in mathematical terms Global optimization includes nonlinear stochastic and combinatorial programming multiobjective programming control games geometry approximation algorithms for parallel architectures and so on Due to its wide usage and applications it has gained the attention of researchers and practitioners from a plethora of scientific domains Typical practical examples of global optimization applications include Traveling salesman problem and electrical circuit design minimize the path length safety engineering building and mechanical structures mathematical problems Kepler conjecture Protein structure prediction minimize the energy function etc Global Optimization algorithms may be categorized into several types Deterministic example branch and bound methods Stochastic optimization example simulated annealing Heuristics and meta heuristics example evolutionary algorithms etc Recently there has been a growing interest in combining global and local search strategies to solve more complicated optimization problems This edited volume comprises 17 chapters including several overview Chapters which provides an up to date and state of the art research covering the theory and algorithms of global optimization Besides research articles and expository papers on theory and algorithms of global optimization papers on numerical experiments and on real world applications were also encouraged The book is divided into 2 main parts **Moments, Positive Polynomials and Their Applications** Jean-Bernard Lasserre,2010 1 The generalized moment problem 1 1 Formulations 1 2 Duality theory 1 3 Computational complexity 1 4 Summary 1 5 Exercises 1 6 Notes and sources 2 Positive polynomials 2 1 Sum of squares representations and semi definite optimization 2 2 Nonnegative versus s o s polynomials 2 3 Representation theorems univariate case 2 4 Representation theorems mutivariate case 2 5 Polynomials positive on a compact basic semi

algebraic set 2 6 Polynomials nonnegative on real varieties 2 7 Representations with sparsity properties 2 8 Representation of convex polynomials 2 9 Summary 2 10 Exercises 2 11 Notes and sources 3 Moments 3 1 The one dimensional moment problem 3 2 The multi dimensional moment problem 3 3 The K moment problem 3 4 Moment conditions for bounded density 3 5 Summary 3 6 Exercises 3 7 Notes and sources 4 Algorithms for moment problems 4 1 The overall approach 4 2 Semidefinite relaxations 4 3 Extraction of solutions 4 4 Linear relaxations 4 5 Extensions 4 6 Exploiting sparsity 4 7 Summary 4 8 Exercises 4 9 Notes and sources 4 10 Proofs 5 Global optimization over polynomials 5 1 The primal and dual perspectives 5 2 Unconstrained polynomial optimization 5 3 Constrained polynomial optimization semidefinite relaxations 5 4 Linear programming relaxations 5 5 Global optimality conditions 5 6 Convex polynomial programs 5 7 Discrete optimization 5 8 Global minimization of a rational function 5 9 Exploiting symmetry 5 10 Summary 5 11 Exercises 5 12 Notes and sources 6 Systems of polynomial equations 6 1 Introduction 6 2 Finding a real solution to systems of polynomial equations 6 3 Finding all complex and or all real solutions a unified treatment 6 4 Summary 6 5 Exercises 6 6 Notes and sources 7 Applications in probability 7 1 Upper bounds on measures with moment conditions 7 2 Measuring basic semi algebraic sets 7 3 Measures with given marginals 7 4 Summary 7 5 Exercises 7 6 Notes and sources 8 Markov chains applications 8 1 Bounds on invariant measures 8 2 Evaluation of ergodic criteria 8 3 Summary 8 4 Exercises 8 5 Notes and sources 9 Application in mathematical finance 9 1 Option pricing with moment information 9 2 Option pricing with a dynamic model 9 3 Summary 9 4 Notes and sources 10 Application in control 10 1 Introduction 10 2 Weak formulation of optimal control problems 10 3 Semidefinite relaxations for the OCP 10 4 Summary 10 5 Notes and sources 11 Convex envelope and representation of convex sets 11 1 The convex envelope of a rational function 11 2 Semidefinite representation of convex sets 11 3 Algebraic certificates of convexity 11 4 Summary 11 5 Exercises 11 6 Notes and sources 12 Multivariate integration 12 1 Integration of a rational function 12 2 Integration of exponentials of polynomials 12 3 Maximum entropy estimation 12 4 Summary 12 5 Exercises 12 6 Notes and sources 13 Min max problems and Nash equilibria 13 1 Robust polynomial optimization 13 2 Minimizing the sup of finitely many rational cunctions 13 3 Application to Nash equilibria 13 4 Exercises 13 5 Notes and sources 14 Bounds on linear PDE 14 1 Linear partial differential equations 14 2 Notes and sources **Handbook of Discrete and Combinatorial Mathematics** Kenneth H. Rosen,2017-10-19 Handbook of Discrete and Combinatorial Mathematics provides a comprehensive reference volume for mathematicians computer scientists engineers as well as students and reference librarians The material is presented so that key information can be located and used quickly and easily Each chapter includes a glossary Individual topics are covered in sections and subsections within chapters each of which is organized into clearly identifiable parts definitions facts and examples Examples are provided to illustrate some of the key definitions facts and algorithms Some curious and entertaining facts and puzzles are also included Readers will also find an extensive collection of biographies This second edition is a major revision It includes extensive additions and updates Since the first edition

appeared in 1999 many new discoveries have been made and new areas have grown in importance which are covered in this edition *Advanced Computational Methods for Knowledge Engineering* Ngoc Thanh Nguyen,Tien van Do,Hoai An Thi,2013-03-22 The book consists of 29 extended chapters which have been selected and invited from the submissions to the 1st International Conference on Computer Science Applied Mathematics and Applications ICCSAMA 2013 held on 9 10 May 2013 in Warsaw Poland The book is organized into five parts which are Advanced Optimization Methods and Their Applications Queuing Theory and Applications Computational Methods for Knowledge Engineering Knowledge Engineering with Cloud and Grid Computing and Logic Based Methods for Decision Making and Data Mining respectively All chapters in the book discuss theoretical and practical issues connected with computational methods and optimization methods for knowledge engineering Assignment Problems, Revised Reprint Rainer Burkard,Mauro Dell'Amico,Silvano Martello,2012-10-31 Assignment Problems is a useful tool for researchers practitioners and graduate students In 10 self contained chapters it provides a comprehensive treatment of assignment problems from their conceptual beginnings through present day theoretical algorithmic and practical developments The topics covered include bipartite matching algorithms linear assignment problems quadratic assignment problems multi index assignment problems and many variations of these Researchers will benefit from the detailed exposition of theory and algorithms related to assignment problems including the basic linear sum assignment problem and its variations Practitioners will learn about practical applications of the methods the performance of exact and heuristic algorithms and software options This book also can serve as a text for advanced courses in areas related to discrete mathematics and combinatorial optimisation The revised reprint provides details on a recent discovery related to one of Jacobi s results new material on inverse assignment problems and quadratic assignment problems and an updated bibliography Metaheuristics Karl F. Doerner,Michel Gendreau,Peter Greistorfer,Walter Gutjahr,Richard F. Hartl,Marc Reimann,2007-08-13 The aim of Metaheuristics Progress in Complex Systems Optimization is to provide several different kinds of information a delineation of general metaheuristics methods a number of state of the art articles from a variety of well known classical application areas as well as an outlook to modern computational methods in promising new areas Therefore this book may equally serve as a textbook in graduate courses for students as a reference book for people interested in engineering or social sciences and as a collection of new and promising avenues for researchers working in this field Highlighted are recent developments in the areas of Simulated Annealing Path Relinking Scatter Search Tabu Search Variable Neighborhood Search Hyper heuristics Constraint Programming Iterated Local Search GRASP bio inspired algorithms like Genetic Algorithms Memetic Algorithms Ant Colony Optimization or Swarm Intelligence and several other paradigms Approximation and Complexity in Numerical Optimization Panos M. Pardalos,2013-06-29 There has been much recent progress in approximation algorithms for nonconvex continuous and discrete problems from both a theoretical and a practical perspective In discrete or combinatorial optimization many approaches have been developed

recently that link the discrete universe to the continuous universe through geomet ric analytic and algebraic techniques Such techniques include global optimization formulations semidefinite programming and spectral theory As a result new ap proximate algorithms have been discovered and many new computational approaches have been developed Similarly for many continuous nonconvex optimization prob lems new approximate algorithms have been developed based on semidefinite pro gramming and new randomization techniques On the other hand computational complexity originating from the interactions between computer science and numeri cal optimization is one of the major theories that have revolutionized the approach to solving optimization problems and to analyzing their intrinsic difficulty The main focus of complexity is the study of whether existing algorithms are efficient for the solution of problems and which problems are likely to be tractable The quest for developing efficient algorithms leads also to elegant general approaches for solving optimization problems and reveals surprising connections among problems and their solutions A conference on Approximation and Complexity in Numerical Optimization Con tinuous and Discrete Problems was held during February 28 to March 2 1999 at the Center for Applied Optimization of the University of Florida Logistik Management Stefan Voß,Julia Pahl,Silvia Schwarze,2009-08-21 Die Globalisierung und Virtualisierung von Gesch ftsbeziehungen vergr ert die Bedeutung und die Komplexit t logistischer Herausforderungen Das Management logistischer Netzwerke wird zu einem wesentlichen Wettbewerbsfaktor f r Unternehmen Das Buch wie die gleichnamige Tagung September 2009 haben zum Ziel den internationalen Gedankenaustausch und die Diskussion zwischen Wissenschaft und Praxis gezielt zu f rdern damit Strategien Methoden und Werkzeuge entwickelt werden k nnen die es erm glichen den wachsenden Anforderungen gerecht zu werden

Optimization with Multivalued Mappings Stephan Dempe,Vyacheslav Kalashnikov,2006-09-19 In the field of nondifferentiable nonconvex optimization one of the most intensely investigated areas is that of optimization problems involving multivalued mappings in constraints or as the objective function This book focuses on the tremendous development in the field that has taken place since the publication of the most recent volumes on the subject The new topics studied include the formulation of optimality conditions using different kinds of generalized derivatives for set valued mappings such as for example the coderivative of Mordukhovich the opening of new applications e g the calibration of water supply systems or the elaboration of new solution algorithms e g smoothing methods The book is divided into three parts The focus in the first part is on bilevel programming The chapters in the second part contain investigations of mathematical programs with equilibrium constraints The third part is on multivalued set valued optimization The chapters were written by outstanding experts in the areas of bilevel programming mathematical programs with equilibrium or complementarity constraints MPEC and set valued optimization problems **From Convexity to Nonconvexity** R.P. Gilbert,Panagiotis D. Panagiotopoulos,Panos M. Pardalos,2013-12-01 This collection of papers is dedicated to the memory of Gaetano Fichera a great mathematician and also a good friend to the editors Regrettably it took an unusual amount of time to bring this

collection out This was primarily due to the fact that the main editor who had collected all of the materials for this volume P D Panagiotopoulos died unexpectedly during the period when we were editing the manuscript The other two editors in appreciation of Panagiotopoulos contribution to this field believe it is therefore fitting that this collection be dedicated to his memory also The theme of the collection is centered around the seminal research of G Fichera on the Signorini problem Variants on this idea enter in different ways For example by bringing in friction the problem is no longer self adjoint and the minimization formulation is not valid A large portion of this collection is devoted to survey papers concerning hemivariational methods with a main point of its application to nonsmooth mechanics Hemivariational inequali ties which are a generalization of variational inequalities were pioneered by Panagiotopoulos There are many applications of this theory to the study of non convex energy functionals occurring in many branches of mechanics An area of concentration concerns contact problems in particular quasistatic and dynamic contact problems with friction and damage Nonsmooth optimization methods which may be divided into the main groups of subgradient methods and bundle methods are also discussed in this collection Natural Gas Processing from Midstream to Downstream Nimir O. Elbashir,Mahmoud M. El-Halwagi,Ioannis G. Economou,Kenneth R. Hall,2018-11-26 A comprehensive review of the current status and challenges for natural gas and shale gas production treatment and monetization technologies Natural Gas Processing from Midstream to Downstream presents an international perspective on the production and monetization of shale gas and natural gas The authors review techno economic assessments of the midstream and downstream natural gas processing technologies Comprehensive in scope the text offers insight into the current status and the challenges facing the advancement of the midstream natural gas treatments Treatments covered include gas sweeting processes sulfur recovery units gas dehydration and natural gas pipeline transportation The authors highlight the downstream processes including physical treatment and chemical conversion of both direct and indirect conversion The book also contains an important overview of natural gas monetization processes and the potential for shale gas to play a role in the future of the energy market specifically for the production of ultra clean fuels and value added chemicals This vital resource Provides fundamental chemical engineering aspects of natural gas technologies Covers topics related to upstream midstream and downstream natural gas treatment and processing Contains well integrated coverage of several technologies and processes for treatment and production of natural gas Highlights the economic factors and risks facing the monetization technologies Discusses supply chain environmental and safety issues associated with the emerging shale gas industry Identifies future trends in educational and research opportunities directions and emerging opportunities in natural gas monetization Includes contributions from leading researchers in academia and industry Written for Industrial scientists academic researchers and government agencies working on developing and sustaining state of the art technologies in gas and fuels production and processing Natural Gas Processing from Midstream to Downstream provides a broad overview of the current status and challenges for natural gas production treatment and

monetization technologies Applications of Combinatorial Optimization Vangelis Th. Paschos,2014-09-15 Combinatorial optimization is a multidisciplinary scientific area lying in the interface of three major scientific domains mathematics theoretical computer science and management The three volumes of the Combinatorial Optimization series aim to cover a wide range of topics in this area These topics also deal with fundamental notions and approaches as with several classical applications of combinatorial optimization Concepts of Combinatorial Optimization is divided into three parts On the complexity of combinatorial optimization problems presenting basics about worst case and randomized complexity Classical solution methods presenting the two most known methods for solving hard combinatorial optimization problems that are Branch and Bound and Dynamic Programming Elements from mathematical programming presenting fundamentals from mathematical programming based methods that are in the heart of Operations Research since the origins of this field

Vector Variational Inequalities and Vector Equilibria F. Giannessi,2013-12-01 The book deals with the mathematical theory of vector variational inequalities with special reference to equilibrium problems Such models have been introduced recently to study new problems from mechanics structural engineering networks and industrial management and to revisit old ones The common feature of these problems is that given by the presence of concurrent objectives and by the difficulty of identifying a global functional like energy to be extremized The vector variational inequalities have the advantage of both the variational ones and vector optimization which are found as special cases Among several applications the equilibrium flows on a network receive special attention Audience The book is addressed to academic researchers as well as industrial ones in the fields of mathematics engineering mathematical programming control theory operations research computer science and economics **Broadband Mobile Multimedia** Yan Zhang,Shiwen Mao,Laurence T. Yang,Thomas M Chen,2008-06-03 Multimedia service provisioning is believed to be one of the prerequisites to guarantee the success of next generation wireless networks Examining the role of multimedia in state of the art wireless systems and networks Broadband Mobile Multimedia Techniques and Applications presents a collection of introductory concepts fundamental tech *Optimization in Computational Chemistry and Molecular Biology* Christodoulos A. Floudas,Panos M. Pardalos,2000-02-29 Optimization in Computational Chemistry and Molecular Biology Local and Global Approaches covers recent developments in optimization techniques for addressing several computational chemistry and biology problems A tantalizing problem that cuts across the fields of computational chemistry biology medicine engineering and applied mathematics is how proteins fold Global and local optimization provide a systematic framework of conformational searches for the prediction of three dimensional protein structures that represent the global minimum free energy as well as low energy biomolecular conformations Each contribution in the book is essentially expository in nature but of scholarly treatment The topics covered include advances in local and global optimization approaches for molecular dynamics and modeling distance geometry protein folding molecular structure refinement protein and drug design and molecular and peptide docking Audience The book is addressed not only to

researchers in mathematical programming but to all scientists in various disciplines who use optimization methods in solving problems in computational chemistry and biology **Handbook of Semidefinite Programming** Henry Wolkowicz,Romesh Saigal,Lieven Vandenberghe,2012-12-06 Semidefinite programming SDP is one of the most exciting and active research areas in optimization It has and continues to attract researchers with very diverse backgrounds including experts in convex programming linear algebra numerical optimization combinatorial optimization control theory and statistics This tremendous research activity has been prompted by the discovery of important applications in combinatorial optimization and control theory the development of efficient interior point algorithms for solving SDP problems and the depth and elegance of the underlying optimization theory The Handbook of Semidefinite Programming offers an advanced and broad overview of the current state of the field It contains nineteen chapters written by the leading experts on the subject The chapters are organized in three parts Theory Algorithms and Applications and Extensions *Learning and Intelligent Optimization* Carlos A. Coello-Coello,2011-12-15 This book constitutes the thoroughly refereed post conference proceedings of the 5th International Conference on Learning and Intelligent Optimization LION 5 held in Rome Italy in January 2011 The 32 revised regular and 3 revised short papers were carefully reviewed and selected from a total of 99 submissions In addition to the contributions to the general track there are 11 full papers and 3 short papers presented at the following four special sessions IMON Intelligent Multiobjective OptimizatioN LION PP Performance Prediction Self EAs Self tuning self configuring and self generating evolutionary algorithms LION SWAP Software and Applications

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