Deterministic Global Optimization

Christodoulos A. Floudas 2013-09-01

Significant research activity has occurred in the area of global optimization over the past two decades. The number of practitioners in the field has increased, and the importance of global optimization, d.c. programming, and new class of algorithms for solving large combinatorial problems has been recognized. This has led, for the first time, to the ability to present a comprehensive, self-contained overview of the methodology, algorithms, and software available for solving global optimization problems. The book is motivated by the scarcity of global optimization test problems and represents the first systematic collection of test problems for evaluating and testing constrained global optimization algorithms. This collection includes problems arising in a variety of engineering applications, and test problems from published computational reports.

A Collection of Test Problems for Constrained Global Optimization Algorithms

Christodoulos A. Floudas 1999-09-15

Significant research activity has occurred in the area of global optimization over the past two decades. The number of practitioners in the field has increased, and the importance of global optimization, d.c. programming, and new class of algorithms for solving large combinatorial problems has been recognized. This has led, for the first time, to the ability to present a comprehensive, self-contained overview of the methodology, algorithms, and software available for solving global optimization problems. The book is motivated by the scarcity of global optimization test problems and represents the first systematic collection of test problems for evaluating and testing constrained global optimization algorithms. This collection includes problems arising in a variety of engineering applications, and test problems from published computational reports.

Global Optimization

Reiner Horst 2013-11-11

The main contents and character of the monograph did not change with respect to the first edition. However, within most chapters we incorporated quite a number of modifications which take into account the recent development of the field, the very valuable suggestions and comments we received from numerous colleagues and students as well as our own experience while using the book. Some errors and misprints in the first edition are also corrected. Reiner Horst May 1992

Preface to the First Edition

The enormous practical need for solving global optimization problems coupled with a rapidly advancing computer technology has allowed one to consider problems which a few years age would have been considered computationally intractable. As a consequence, we are seeing the creation of a large and increasing number of diverse algorithms for solving a wide variety of multie xtremal global optimization problems. The goal of this book is to systematically clarify and unify these diverse approaches in order to provide insight into the underlying concepts and their pro perties. Aside from a coherent view of the field much new material is presented.

Deterministic Global Optimization

Yaroslav D. Sergeyev 2017-06-16

This book begins with a concentrated introduction into deterministic global optimization and moves forward to present new original results from the authors who are well known experts in the field. Multie xtremal continuous problems that have an unknown structure with Lipschitz objective functions and functions having the first Lipschitz derivatives defined over hyperintervals are examined. A class of algorithms using several Lipschitz constants is introduced which has its origins in the DIRECT (Dividing RECTangles) method. This new class is based on an efficient strategy that is applied for the search domain partitioning. In addition a survey on derivative free methods and methods using the first derivatives is given for both one-dimensional and multi-dimensional cases. Non-smooth and smooth minorants and acceleration techniques that can speed up several classes of global optimization methods with examples of applications and problems arising in numerical testing of global optimization algorithms are discussed. Theoretical considerations are illustrated through engineering applications. Extensive numerical testing of algorithms described in this book stretches the likelihood of establishing a link between mathematicians and practitioners. The authors conclude by describing applications and a generator of random cases of test functions with known local and global minima that is used in more than 40 countries of the world. This title serves as a starting point for students, researchers, engineers, and other professionals in operations research, management science, computer science, engineering, economics, environmental sciences, industrial and applied mathematics to obtain an overview of deterministic global optimization.

Global Optimization

János D. Pintér 2006-10-13

Optimization models based on a nonlinear systems description often possess multiple local optima. The objective of Global Optimization (GO) is to find the best possible solution of multie xtremal problems. This volume illustrates the applicability of GO modeling techniques and solution strategies to real-world problems. Coverage extends to a broad range of applications, from agroecosystem management to robot design. Proposed solutions encompass a range of practical and viable methods.

Global Optimization Using Interval Analysis

Eldon Hansen 2003-12-19

Employing a closed set-theoretic foundation for interval computations, Global Optimization Using Interval Analysis simplifies algorithm construction and increases generality of interval arithmetic. This Second Edition contains an up-to-date discussion of interval methods for solving systems of nonlinear equations and global optimization problems. It expands and improves various aspects of its forerunner and features significant new discussions, such as those on the use of consistency methods to enhance algorithm performance. Provided algorithms are guaranteed to find and bound all solutions to these problems despite bounded errors in data, in approximations, and from use of rounded arithmetic.

Deterministic Global Optimization

Christodoulos A. Floudas 2013-03-09

The vast majority of important applications in science, engineering and applied science are characterized by the existence of multiple minima and maxima, as well as first, second and higher order saddle points. The area of Deterministic Global Optimization introduces theoretical, algorithmic and computational ad-vaunces that (i) address the computation and characterization of global minima and maxima, (ii) determine valid lower and upper bounds on the global minima and maxima, and (iii) address the enclosure of all solutions of nonlinear constrained systems of equations. Global optimization applications are widespread in all disciplines and they range from atomic or molecular level to process and product level.
representations. The primary goal of this book is three-fold: first, to introduce the reader to the basics of deterministic global optimization; second, to present important theoretical and algorithmic advances for several classes of mathematical problems that include nonconvex and bilinear, problems, signomial problems, general twice differentiable nonlinear problems, mixed integer nonlinear problems, and the enclosure of all solutions of nonlinear constrained systems of equations; and third, to tie the theory and methods together with a variety of important applications.

Developments in Global Optimization Immanuel M. Bomze 2013-03-14 In recent years global optimization has found applications in many interesting areas of science and technology including molecular biology, chemical equilibrium problems, medical imaging and networks. The collection of papers in this book indicates the diverse applicability of global optimization. Furthermore, various theoretical, algorithmic, and computational studies are presented. Audience: All researchers and students working in mathematical programming.

Stochastic and Global Optimization G. Demyda 2006-04-11 In the paper we propose a model of tax incentives optimization for invest-ment projects with a help of the mechanism of accelerated depreciation. Unlike the tax holidays which influence on effective income tax rate, accelerated -precipitation affects on taxable income. In modern economic practice the state actively uses this potential, which is connected with the attraction of the investment, the formation of many projects, and the expansion of the investment in new enterprises. In order to attract the potential investor the state decides to use a mechanism of accelerated tax depreciation. The fol- lowing 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 he will maximize the advantage at economic environment the investor chooses 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 maxim- ization of 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.

Stochastic Adaptive Search for Global Optimization Z.B. Zabinsky 2013-11-27 The field of global optimization has been developing at a rapid pace. There is a journal devoted to the topic, as well as many publications and notable books discussing various aspects of global optimization. This book is intended to complement these other publications with a focus on stochastic methods for global optimization. Stochastic methods, such as simulated annealing and genetic algorithms, are gaining in popularity among practitioners and engineers because they are relatively easy to program on a computer and may be used to solve a broad class of global optimization problems. However, the theoretical performance of these stochastic methods is not well understood. In this book, an attempt is made to describe the theoretical properties of several stochastic search methods. Such a theoretical understanding may allow us to better predict algorithm performance and ultimately design new and improved algorithms. This book consolidates a collection of papers on the analysis and development of stochastic adaptive search. The first chapter introduces random search methods. Chapters 2–6 describe the theoretical analysis of a progression of algorithms. A main result is that the expected number of iterations required for pure stochastic algorithms to be self-contained introduction, a reference for the techniques, and a guide to the literature rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905.

Optimization in Action János D. Pintér 2013-03-14 in science, engineering and economics, decision problems are frequently modelled by optimizing the value of a (primary) objective function under stated feasibility constraints. In many cases of practical relevance, the optimization problem structure does not warrant the global optimality of local solutions; hence, it is natural to search for the globally best solution(s). Global Optimization in Action provides a comprehensive discussion of adaptive partition strategies to solve global optimization problems under very general structural requirements. A unified approach to numerous known algorithms makes possible straightforward generalizations and extensions, leading to efficient computer-implemented systems. A considerable part of the book is devoted to applications, including some generic problems from numerical analysis, and several case studies in environmental systems analysis and management. The book is essentially self-contained and is based on the author’s research, in cooperation (on applications) with a number of colleagues. Audience: Professors, students, researchers and other professionals in the fields of operations research, management science, industrial and applied mathematics, computer science, engineering, economics and the environmental sciences.

Global Optimization in Engineering Design Ignacio E. Grossmann 2013-04-17 Mathematical Programming has been of significant interest and relevance in engineering, an area that is very rich in challenging optimization problems. In many cases, many design and operational problems give rise to nonlinear and mixed integer nonlinear optimization problems whose modeling and solution is often nontrivial. Furthermore, with the increased computational power and development of advanced analysis (e.g., process simulators, finite element packages) and modeling systems (e.g., GAMS, AMPL, SPEEDUP, ASCEND, gPROMS), the size and complexity of engineering optimization models is rapidly increasing. While the application of efficient local solvers (nonlinear programming algorithms) has become widespread, a major limitation is that there is often no guarantee that the solutions that are generated correspond to global optima. In some cases finding a local solution might be adequate, but it is likely to mean incurring a significant cost penalty, or even worse, getting an incorrect solution to a physical problem. Thus, the need for finding global optima in engineering is a very real one. It is the purpose of this monograph to present recent developments of the techniques and applications of deterministic approaches to global optimization in engineering. The present monograph is heavily represented by chemical engineering, and to a large extent this is no accident. The reason is that mathematical programming is an active and vibrant area of research in chemical engineering. This trend has existed for about 15 years.

Stochastic Global Optimization Methods and Applications to Chemical, Biochemical, Pharmaceutical and Environmental Processes. Ch. Venkatwarl 2011-18 Stochastic global optimization methods and applications to chemical, biochemical, pharmaceutical and environmental processes presents various algorithms that include the genetic algorithm, simulated annealing, differential evolution, ant colony optimization, tabu search, particle swarm optimization, artificial bee colony optimization, and cuckoo search algorithms. The design and analysis of these algorithms is studied in detail. This is the result of the best efforts of the authors and, of course, the conference brought together an interdisciplinary group of the most active developers of algorithms for global optimization in order to focus the attention of the mathematical programming community on the unsolved problems and diverse algorithms addressed by this field. The main subjects addressed at the conference were advances in deterministic and stochastic methods for global optimization, parallel algorithms for global optimization, methods for solving global optimization problems, and applications of methods for solving global optimization problems. The book presents various classical, stochastic, evolutionary, and artificial intelligence optimization algorithms for the solution of real-life problems concerning health care, biology, chemistry, engineering, and environmental engineering processes. The book is self-contained and is based on the author’s research, in cooperation (on applications) with a number of colleagues. Audience: Professors, students, researchers and other professionals in the fields of scientific computing, management science, industrial and applied mathematics, computer science, engineering, economics and the environmental sciences.

Recent Advances in Global Optimization Christodoulos A. Floudas 2014-07-14 This book will present the papers delivered at the first U.S. conference devoted exclusively to global optimization and will provide a valuable resource for students and professionals. Held at Princeton University in May 1991, the conference brought together an interdisciplinary group of the most active developers of algorithms for global optimization in order to focus the attention of the mathematical programming community on the unsolved problems and diverse algorithms addressed by this field. The main subjects addressed at the conference were advances in deterministic and stochastic methods for global optimization, parallel algorithms for global optimization, methods for solving global optimization problems, and applications of methods for solving global optimization problems. The book provides a comprehensive survey of the state of the art in global optimization research and practice, and serves as a valuable reference for researchers and practitioners in the field.


Rigorous Global Search: Continuous Problems R. Baker Kearfott 2013-03-09 This work grew out of several years of research, graduate seminars and talks on the subject. It was motivated by a desire to make the technology accessible to those who most needed it or could most use it. It is meant to be a self-contained introduction, a reference for the techniques, and a guide to the literature for the underlying theory. It contains pointers to fertile areas for future research. It also serves as an introductory documentation for a Fortran 90 software package for nonlinear systems and global optimization.

Models and Algorithms for Global Optimization Amo Törn 2007-04-08 The research on Antazilénkos has focused on developing models for global optimization, implementing and investigating the corresponding algorithms, and applying those algorithms to practical problems. This volume, dedicated to Professor Antazilénkos on the occasion of his 60th birthday, contains new survey papers in which researchers from the field present various models and algorithms for solving global optimization problems.

Global Optimization with Non-Convex Constraints Roman G. Strongin 2013-11-09 Everything should be made as simple as possible, but not simpler. (Albert Einstein, Readers Digest, 1977) The modern practice of creating technical systems and technological processes of high efficiency besides the employment of new principles, new materials, new physical effects and other new solutions (which is very traditional and plays the key role in the selection of the general structure of the object to be designed) also includes the choice of the best combination for the set of parameters (geometrical sizes, electrical and strength characteristics, etc.) concretizing this general structure, because the Variation of these parameters (with the structure or linkage being already set defined) can essentially affect the objective performance indexes. The mathematical tools for choosing these best combinations are exactly what this book about. With the advent of computers and the computer-aided design the pro babilities of the selected variants are usually performed not for the real examples (this may require some very expensive building of sample op tions and of the special...
installations to test them), but by the analysis of the corresponding mathematical models. The sophistication of the mathematical models for the objects to be designed, which is the natural consequence of the raising complexity of these objects, greatly complicates the objective performance analysis. Today, the main (and very often the only) available instrument for such an analysis is computer-aided simulation of an object’s behavior, based on numerical experiments with its mathematical model.

Numerical Software Verification-Alessandro Abate 2017-07-11 This book constitutes the proceedings of the 10th International Workshop on Numerical Software Verification, NSV 2017, held in Heidelberg, Germany, in July 2017 - colocated with the International Workshop on Formal Methods for Rigorous Systems Engineering of Cyber-Physical Systems, RISE4CPS 2017, a one-to-one, invited-only event. The 3 full papers presented together with 3 short papers, 2 keynote abstracts and 4 invited abstracts were carefully reviewed and selected from numerous submissions. The NSV 2017 workshop is dedicated to the development of logical and mathematical techniques for the reasoning about programmability and reliability.

Encyclopedia of Optimization-Christodoulos A. Floudas 2009-09-04 The goal of the Encyclopedia of Optimization is to introduce the reader to a complete set of topics that show the spectrum of research, the richness of ideas, and the breadth of applications that has come from this field. The second edition builds on the success of the former edition with more than 150 completely new entries, designed to ensure that the reference addresses recent areas where optimization theories and techniques have advanced. Particularly heavy attention resulted in health science and transportation, with entries such as “Algorithms for Genomics,” “Optimization and Radiotherapy Treatment Design,” and “Crew Scheduling.”

Advances in Convex Analysis and Global Optimization-Nicolas Hadjisavvas 2013-12-01 There has been much recent progress in global optimization algo rithms for nonsmooth and discrete problems from both a theoretical and a practical perspective. Convex analysis plays a fun damental role in the analysis and development of global optimization algorithms. This is due essentially to the fact that virtually all nonconvex optimization problems can be described using differences of convex functions and differences of convex sets. A conference on Convex Analysis and Global Optimization was held during June 5-9, 2000 at Pythagorion, Samos, Greece. The conference was honoring the memory of C. Caratheodory (1873-1950) and was en dorsed by the Mathematical Programming Society (MPS) and by the Society for Industry and Applied Mathematics (SIAM) Activity Group in Optimization. The conference was sponsored by the European Union (through the ERFAC/ERP program), the Department of Mathematics of the University of the Aegean, and the University of the Aegean. The conference was supported by the General Secretariat of Research and Techno logy of Greece, by the Ministry of Education of Greece, and several local Greek government agencies and companies. This volume contains a select set of refereed papers based on invited and contributed talks presented at the conference. The two themes of convexity and global optimization pervade this book. The conference provided a forum for researchers working on different aspects of convexity and global optimization to present their recent discoveries, and to interact with people working on complementary aspects of mathematical programming.

Numerical Solutions of Realistic Nonlinear Phenomena-A. Tenreiro Machado 2020-02-19 This collection covers new aspects of numerical methods in applied mathematics, engineering, and health sciences. It provides recent theoretical developments and new techniques based on optimization theory, partial differential equations (PDEs), mathematical modeling and fractional calculus that can be used to model and understand complex behavior in natural phenomena. Specific topics covered in detail include new numerical methods for nonlinear partial differential equations, global optimization, unconstrained optimization, detection of HV-Protease, modelling with new fractional operators, analysis of biological models, and stochastic modeling.

Introduction to Global Optimization-Horst 2008-12-31 A textbook for an undergraduate course in mathematical programming for students with a knowledge of elementary real analysis, linear algebra, and classical numerical programming (simple techniques). Focuses on the computation and characterization of global optima of nonlinear functions, rather than the locally optimal solutions addressed by most books on optimization. Incorporates the theoretical, algorithmic, and computational advances of the past three decades that help solve globally multi-extreme problems in the mathematical modeling of real world systems. Annotation copyright by Book News, Inc., Portland, OR.

Mathematical Optimization Terminology-Andre A. Keller 2017-11-10 Mathematical Optimization Terminology: A Comprehensive Glossary of Terms is a practical book with the essential formulations, illustrative examples, real-world applications and main references on the topic. This book helps readers gain a more practical understanding of optimization, enabling them to apply it to their algorithms. This book also addresses the need for a practical publication that introduces these concepts and techniques. Discusses real-world applications of optimization and how it can be used in algorithms. Explains the essential formulations of optimization in mathematics. Covers a more practical approach to optimization.

Introduction to Global Optimization Exploiting Space-Filling Curves-Yaroslav D. Sergeyev 2013-08-13 Introduction to Global Optimization Exploiting Space Filling Curves provides an overview of classical and new results pertaining to the usage of space filling curves in global optimization. The authors look at the concept of a family of derivative-free numerical algorithms applying space-filling curves to reduce the dimensionality of the global optimization problem, along with a number of unconventional ideas, such as adaptive strategies for estimating Lipschitz constant, balancing global and local information to accelerate the search. Convergence conditions of the described algorithms are studied in depth and theoretical considerations are illustrated through numerical examples. This work also contains a code for implementing space-filling curves that can be used for constructing new global optimization algorithms. Basic ideas from this text can be applied to a number of problems including problems with multilevel and partially defined constraints and non-redundant parallel computations can be organized. Professors, students, researchers, engineers, and other professionals in the fields of pure mathematics, nonlinear sciences studying fractals, operations research, management science, industrial and applied mathematics, computer science, engineering, economics, and the environmental sciences will find this title useful.

Parallel Computing in Optimization-A. Migdalas 2013-12-01 During the last three decades, breakthroughs in computer technology have made a tremendous impact on optimization. In particular, parallel computing has made it possible to solve larger and computationally more difficult prob lems. This volume contains mainly lecture notes from a Nordic Summer School held at the Linköping Institute of Technology, Sweden in August 1995. In order to make the book more complete, a few authors were invited to contribute chapters that were not part of the course on this first occasion. The purpose of this Nordic course in advanced studies was three-fold. One goal was to introduce the students to the new achievements in a new and very active field, bring them close to world leading researchers, and strengthen their competence in an area with internationally explosive rate of growth. A second goal was to strengthen the bonds between students from different Nordic countries, and to encourage collaboration and joint research ventures over the borders. In this respect, the course built further on the achievements of the “Nordic Network in Mathematical Programming”, which has been running during the last three years with the support of the Nordic Council for Advanced Studies (NorFA). The final goal was to produce literature on the particular subject, which would be available to both the participating students and to the students of the "next generation".

Handbook of Parallel Computing and Statistics-Ericos John Kontoghiorghes 2005-12-21 Technological improvements continue to push back the frontier of processor speed in modern computers. Unfortunately, the computational intensity demanded by modern research problems grows even faster. Parallel computing has emerged as the most successful bridge to this computational gap, and many popular solutions have emerged based on its concepts.

Numerical Methods and Optimization-Éric Walter 2014-07-22 Initial training in pure and applied sciences tends to present problem-solving as the process of elaborating explicit closed-form solutions from basic principles, and then using these solutions in numerical applications. This approach is only applicable to very limited classes of problems that are simple enough for such closed-form solutions to exist. Unfortunately, most real-life problems are too complex to be amenable to this type of treatment. Numerical Methods - a Consumer Guide presents methods for dealing with them. Shifting the paradigm from formal calculus to numerical computation, the text makes it possible for the reader to discover how to escape the dictatorship of those particular cases that are simple enough to be formally solved, and to use the huge range of software packages available to apply such solutions to various problems.
Global Optimization and Constraint Satisfaction  Christophe Jermann  2005-05-24 This book constitutes the thoroughly refereed post-proceedings of the Second International Workshop on Global Optimization and Constraint Satisfaction, COCOS 2003, held in Lausanne, Switzerland in November 2003. The 13 revised full papers presented were carefully selected and went through two rounds of reviewing and improvement. The papers are devoted to theoretical, algorithmic, and application-oriented issues in global constrained optimization and constraint satisfaction; they are organized in topical sections on constraint satisfaction problems, global optimization, and applications.

Fuzzy Sets Based Heuristics for Optimization  José-Luis Verdegay  2012-11-03 The aim of this volume is to show how Fuzzy Sets and Systems can help to provide robust and adaptive heuristic optimization algorithms in a variety of situations. The book presents the state of the art and gives a broad overview on the real practical applications that Fuzzy Sets, based on heuristic algorithms, have.

Lectures on Global Optimization  Panos M. Pardalos  2009 A large number of mathematical models in many diverse areas of science and engineering have lead to the formulation of optimization problems where the best solution (globally optimal) is needed. Due to the interdisciplinary nature of global optimization, there has been astonishing progress in this field during the last few decades. Many powerful computational algorithms and new theoretical developments have been introduced to solve a spectrum of hard problems in several disciplines. This book covers a small subset of recent important topics in global optimization with emphasis on recent theoretical developments and scientific applications. The chapters are based on the talks presented at the workshop on 'Global Optimization: Methods and Applications' that was held at the Fields Institute from May 11-12, 2007. The target audience includes graduate students in mathematics, engineering, and sciences, academic researchers, as well as practitioners, who use global optimization for their specific needs and applications.

New Computer Methods For Global Optimization

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