XIV
BRAZILIAN
WORKSHOP
ON CONTINUOUS
OPTIMIZATION

NOTEBOOK OF ABSTRACTS

AND

OTHER RELEVANT INFORMATION

School of Applied Mathematics of Fundação Getúlio Vargas, Rio de Janeiro, Brazil

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PLENNARY TALKS

Current work in the development of augmented Lagrangian software and applications

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Abstract

Our Augmented Lagrangian method Algencan was introduced about two decades ago. Since then, its computational implementation and asymptotic convergence theory have been updated and strengthened several times, and complexity results have been presented. In 2020, a completely new implementation of Algencan was developed for the case where second derivatives are available and matrix factorizations are affordable. We are currently revising the version of Algencan that uses only first-order derivatives and does not perform factorizations. In this talk we will report on the current state of this development. Recent applications of Algencan will also be presented.

First and zeroth-order implementations of the regularized Newton method with lazy approximated Hessians

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Abstract

In this work, we develop first-order (Hessian-free) and zeroth-order (derivative-free) implementations of the Cubically regularized Newton method for solving general non-convex optimization problems. For that, we employ finite difference approximations of the derivatives. We use a special adaptive search procedure in our algorithms, which simultaneously fits both the regularization constant and the parameters of the finite difference approximations. It makes our schemes free from the need to know the actual Lipschitz constants. Additionally, we equip our algorithms with the lazy Hessian update that reuse a previously computed Hessian approximation matrix for several iterations. Specifically, we prove the global complexity bound of $O\left(n^{1/2}\varepsilon^{-3/2}\right)$ function and gradient evaluations for our new Hessian-free method, and a bound of $O\left(n^{3/2}\varepsilon^{-3/2}\right)$ function evaluations for the derivative-free method, where n is the dimension of the problem and ε is the desired accuracy for the gradient norm. These complexity bounds significantly improve the previously known ones in terms of the joint dependence on n and ε, for the first-order and zeroth-order non-convex optimization.

PLENNARY TALKS

On theory and practice of augmented Lagrangian methods

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Abstract

In this talk, we present recent developments concerning the safeguarded augmented Lagrangian method for general non-convex smooth optimization. In particular, we will discuss weak conditions that guarantee boundedness of the sequence of dual approximations and the practical implications of this phenomenon, including the application of a scaled stopping criterion for the subproblems. Extensions to other classes of problems will be discussed, as well.

A Riemannian convex bundle method

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Abstract

Bundle methods are versatile algorithms to solve non-smooth, convex and non-convex optimization problems in vector spaces. In this presentation, we introduce a bundle method to solve convex, non-smooth optimization problems on Riemannian manifolds. Each step of our method is based on a model that involves the convex hull of previously collected and parallely transported subgradients. This generalizes the dual form of classical bundle subproblems in Euclidean space. We prove that, under mild conditions, the convex bundle method converges to a minimizer. Numerical examples implemented using the Julia package manopt.jl illustrate the performance of the method compared to the subgradient method, the cyclic proximal point, as well as the proximal bundle algorithm.

New Perspectives on Deriving Compact Extended Formulations for Optimization Problems with Indicator Variables

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Abstract

Applications in statistics and data sciences require modeling an inherit sparsity as well as structural relationships among variables and often lead to NP-Hard nonconvex problems. Sparsity and structural relations in such problems are usually modeled by introducing indicator (binary) variables associated with the original continuous variables and enforcing complementarity relations between them. We consider optimization problems with convex objective functions of the continuous variables and arbitrary constraints on their associated indicators, and study the resulting conic

mixed-binary sets with complementarity restrictions. For such sets, by studying the recessive directions and also utilizing perspective functions, we provide a practical framework to derive compact, ideal, and conic-representable extended formulations. The size of our extended formulation depends on the "rank" of the function and the presence of sign restrictions. Moreover, our techniques highlight that the complexity of the convex hull characterizations of these conic mixed-binary sets with complementarity restrictions hinges solely on the complexity of the convex hull characterization of a set defined by only the indicator variables. This then enables us to take advantage of the extensive research on convex hull descriptions of binary sets and related sophisticated optimization software. In addition, our results unify and generalize previous results established for special cases, e.g., perspective reformulation for separable functions, non-separable rank-one functions, or low-rank quadratic functions optimized over domains with combinatorial constraints on indicator variables and possibly sign constraints on continuous variables. On the computational side, we illustrate the effectiveness of our approach on sparse structured logistic regression problems.

This is joint work with Soroosh Shafieezadeh-Abadeh.

Algorithms in generalized convexity

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Abstract

In generalized convexity, the duality product is replaced by a coupling c, the Fenchel conjugacy by the c-conjugacy associated with the coupling c, closed convex functions by c-convex functions (functions that are equal to their c-biconjugates), and subdifferentials by c-subdifferentials. The field of generalized convexity has mostly been the subject of theoretical works and, more rarely, of algorithmic ones. The talk is organized in three parts. First, we provide background on so-called couplings and Fenchel-Moreau conjugates, with a special focus on what we call one-sided linear (OSL) couplings. Then, we review (surprising) results about the l0 pseudonorm. We present the OSL E-Capra coupling, and we show that the l0 pseudonorm is E-Capra-convex. We deduce that l0 coincides, on the unit sphere, with a proper convex lsc function --- that we call the l0-cup and that we describe. We also deduce that l0 is a kind of convex-composite function as the composition of the convex function l0-cup with the (nonsmooth at the origin) radial projection. Second, we detail the E-Capra-subdifferential of the l0 pseudonorm, and we discuss the difficulty in using it to tackle the Fermat rule in sparse optimization problems. We also sketch E-Capra-duality in the Rockafellar perturbation-duality framework, and the possibility to design sparsity-inducing regularizers. Third, we enlarge the focus and we outline a possible research program to design algorithms based on generalized convexity: how to define Bregman distances, proximal operators and deduce possible algorithms (e.g. c-proximal gradient method, c-mirror descent).

This is a joint work with Jean-Philippe Chancelier and Seta Rakotomandimby.

PLENNARY TALKS

Worst case complexity bounds for linesearch-type derivative-free algorithms

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Abstract

In this talk we show that derivative free algorithms which are based on a linesearch-type extrapolation technique with sufficient decrease have the same worst case complexity proved for direct search methods. Furthermore, thanks to the linesearch approach with sufficient decrease, they also have the property that the number of iterations (in the worst case) for which the norm of the gradient is above a given threshold is of the order of ε^{-2}. This last property considerably enriches the worst case analysis of derivative-free algorithm and, to the best of our knowledge, is new in this context. It is worth noticing that the property characterizes the behavior of the derivative-free algorithm better than the usual complexity result. Indeed, typical complexity results gives the number of iteration required to drive the norm of the gradient below a prefixed tolerance for the first time. If we let the method run, the norm of the gradient might well rise above the tolerance again. The property we prove indicates that the total number of iterations with a gradient norm above a specified tolerance is bounded by a constant that depends on ε^{-2}.

This is a joint work with A. Brilli, M. Kimiaei and S. Lucidi.

Random algorithms for problems with large number of constraints

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Abstract

Optimization problems with a large number of constraints are emerging in many application domains such as optimal control, reinforcement learning, statistical learning, and artificial intelligence, in general. The challenges posed by the size of the problems in these applications resulted in prolific research in the context of optimization theory and algorithms. Many refinements and accelerations of various (mainly) first-order methods have been proposed and studied, majority of which solves a penalized re-formulation of the original problem in order to cope with the large number of constraints. While the main focus has been on the penalized variants, not much has been done about re-thinking the whole approach to these problems. This talk will focus on a different viewpoint and discuss the optimization methods that use randomization and penalty approaches to deal with a large number of constraints. The performance and efficiency of such algorithms will be addressed, as well as some auxiliary theory that supports the development of such methods.

PLENNARY TALKS

Optimization schemes on manifolds for structured matrices with fixed eigenvalues

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Abstract

Several manifold optimization schemes are presented and analyzed for solving inverse structured symmetric matrix problems with prescribed spectrum. Some entries in the desired matrix are assigned in advance and cannot be altered, and some others should be nonzero. The rest of the entries are free. The reconstructed matrix must satisfy these requirements and its eigenvalues must be the given ones. This inverse eigenvalue problem is related to the problem of determining the graph, with weights on the undirected edges, of the matrix associated with its sparse pattern. Our optimization schemes are based on considering the eigenvector matrix as the only unknown and moving iteratively on the manifold of orthogonal matrices, forcing the additional structural requirements through a change of variables and a convenient differentiable objective function in the space of square matrices. We propose Riemannian gradient-type methods combined with either a penalization or an augmented Lagrangian strategy, and two different well-known retractions. We also present a block alternating technique that takes advantage of a proper separation of variables. Convergence properties of the penalty alternating approach are established. Finally, we present initial numerical results to demonstrate the effectiveness of our proposals.

The spectral proximal gradient method and new applications

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Abstract

The spectral proximal gradient method is an accelerated variation of the proximal gradient algorithm that uses second-order information of the data captured by the spectral stepsize from Barzilai-Borwein-Raydan. We will present a brief survey of its historical development, theortical properties, and main convergence results. Afterward, we will dive into some applications in areas like projection onto the intersection of convex sets, low-rank plus sparse decomposition of matrices, l_0-regularized support vector machines, and full wave inversion in Geophysics.

PLENNARY TALKS

Some recent proposals for nonconvex optimization

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Abstract

The talk will consider two recent proposals for the optimization of nonconvex functions in continuous variables. The first is a new variant of Newton's method for unconstrained problems, that alternates between regularized Newton and negative curvature steps in an iteration-dependent subspace. In most cases, the Hessian matrix is regularized with the square root of the current gradient and an additional term taking moderate negative curvature into account, a negative curvature step being taken only exceptionally. Practical variants are proposed where the subspaces are chosen to be the full space, or Krylov subspaces. In the first case, the proposed method only requires the solution of a single linear system at nearly all iterations. We establish that at most $O\left(|log\varepsilon|\varepsilon^{-3/2}\right)$ evaluations of the problem's objective function and derivatives are needed for the algorithm in the new class to obtain an ε-approximate first-order minimizer, and at most $O\left(|log\varepsilon|\varepsilon^{-3}\right)$ to obtain a second-order one. In a second part, a brief survey of new OFFO methods (ie methods where the objective function is never evaluated) will be presented, covering both new twists for first-order methods and a higher-order variant.

This work is co-authored with S. Gratton and S. Jerad.

Difference of weakly convex algorithm for bilevel programs with applications in hyperparameter selection

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Abstract

A bilevel programming problem is a sequence of two optimization problems where the constraint region of the upper level problem is determined implicitly by the solution set to the lower level problem. It can be used to model a two-level hierarchical system where the two decision makers have different objectives and make their decisions on different levels of hierarchy. Recently more and more applications including those in machine learning have been modelled as bilevel optimization problems. In this work, we present a difference of weakly convex algorithm for solving bilevel programs and study its theoretical and numerical properties. This nontrivial class of bilevel programs provides a powerful modelling framework for dealing with applications arising from hyperparameter selection in machine learning. We demonstrate the performance of our algorithms to some classes of hyperparameter selection problems such as those in elastic net, sparse group lasso, and RBF kernel support vector machine.

CONTRIBUTED TALKS

Variants of the A-HPE and large-step A-HPE algorithms for strongly convex problems with applications to accelerated high-order tensor methods

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Keywords: Convex optimization, strongly convex, accelerated methods, proximal-point algorithm, high-order tensor methods

Abstract

For solving strongly convex optimization problems, we propose and study the global convergence of variants of the accelerated hybrid proximal extragradient (A-HPE) and large-step A-HPE algorithms of Monteiro and Svaiter (2013). We prove *linear* and *superlinear* $O\left(k^{-k\left(\frac{p-1}{p+1}\right)}\right)$ global rates for the proposed variants of the A-HPE and large-step A-HPE methods, respectively. The parameter $p \geq 2$ appears in the (high-order) large-step condition of the new large-step A-HPE algorithm. We apply our results to high-order tensor methods, obtaining a new inexact (relative-error) tensor method for (smooth) strongly convex optimization with iteration-complexity $O\left(k^{-k\left(\frac{p-1}{p+1}\right)}\right)$. In particular, for $p=2$, we obtain an inexact proximal-Newton algorithm with fast global $O\left(k^{-k/3}\right)$ convergence rate.

Weak notions of nondegeneracy in nonlinear semidefinite programming

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Keywords: constraint qualifications, nonlinear semidefinite programming, nondegeneracy condition

Abstract

The constraint nondegeneracy condition is one of the most relevant and useful constraint qualifications in nonlinear semidefinite programming. It can be characterized in terms of any fixed orthonormal basis of the, let us say, n-dimensional kernel of the constraint matrix, by the linear independence of a set of $n(n+1)/2$ derivative vectors. We show that this linear independence requirement can be equivalently formulated in a smaller set, of n derivative vectors, by considering all orthonormal bases of the kernel instead. This allows us to identify that not all bases are relevant for a constraint qualification to be defined, giving rise to a strictly weaker variant of nondegeneracy related to the global convergence of an external penalty method. We use some of these ideas to revisit an approach of Forsgren (Math. Program. 88, 105–128, 2000) for exploiting the sparsity

structure of a transformation of the constraints to define a constraint qualification, which led us to develop another relaxed notion of nondegeneracy using a simpler transformation. If the zeros of the derivatives of the constraint function at a given point are considered, instead of the zeros of the function themselves in a neighborhood of that point, we obtain an even weaker constraint qualification that connects Forsgren's condition and ours.

Solution concepts for interval-valued optimization problems via combined gradient based algorithm

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Keywords: Interval-valued programming, Gradient-based methods, complexity analysis,

Abstract

The talk will focus on an innovative method for solving interval-valued optimization problems that makes use of blended gradient techniques. In order to enable a more comprehensive exploration of the solution space, our method combines standard gradient-based optimization techniques with interval arithmetic. We will investigate the application of gradient information for each interval-valued objective function in this talk's first part, keeping in mind the particular structure of the problem. A subsequence that converges to the problem's local Pareto point is produced in the second part, assuming that the objective function's gradient is linearly independent. Additionally, in order to demonstrate the algorithm's effectiveness, the discussion will go over the numerical findings. The proposed approach determines the most effective solutions within intervals and gauges resilience, which can help decision-makers arrive at sound decisions in uncertain situations.

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CONTRIBUTED TALKS

Circumcentric directions of cones

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Keywords: cone, circumcenter, convex feasibility

Abstract

Generalized circumcenters have been recently introduced and employed to speed up classical projection-type methods for solving feasibility problems. In this work, circumcenters are enforced in a new setting; they are proven to provide inward directions to sets given by convex inequalities. In particular, we show that circumcentric directions of finitely generated cones belong to the interior of their polars. We also derive a measure of interiorness of the circumcentric direction, which then provides a special cone of search directions, all being feasible to the convex region under consideration.

Bibliography

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On the Finite Convergence of Alternating Projections

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Keywords: Infeasibility, Error bound, Finite convergence, Alternating projection

Abstract

In this talk, we combine two ingredients in order to get a rather surprising result on one of the most studied, elegant and powerful tools for solving convex feasibility problems, the method of alternating projections (MAP). Going back to names such as Kaczmarz and von Neumann, MAP has the ability to track a pair of points realizing the minimum distance between two given closed convex sets. Unfortunately, MAP may suffer from arbitrarily slow convergence, and sublinear rates are essentially only surpassed in the presence of some Lipschitzian error bound, which is our first ingredient. The second one is a seemingly unfavorable and unexpected condition, namely, infeasibility. For two non-intersecting closed convex sets satisfying an error bound, we establish finite convergence of MAP. In particular, MAP converges in finitely many steps when applied to a polyhedron and a hyperplane in the case in which they have empty intersection. Furthermore, the greater the distance between the target sets, the fewer iterations MAP needs to find the best approximation pair. Insightful examples and further theoretical and algorithmic discussions accompany our results, including the investigation of finite termination of other projection methods.

This joint work with Roger Behling and Luiz-Rafael Santos is detailed further in [1].

Bibliography
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An approach to Busemann functions in Optimization

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Keywords: Busemann functions, Hadamard manifolds, equilibrium problems

Abstract

It is known that Busemann functions are smooth convex functions with a constant norm gradient. In a recent contribution, we have proven that any affine function is constant in a complete and connected Riemannian manifold of negative Ricci curvature on some open set. In particular, any affine function is constant in Hadamard manifolds of negative sectional curvature. Our study ensures that Busemann functions are suitable to cover the absence of non-constant affine functions in Hadamard manifolds of negative sectional curvature. We highlight contributions from both theoretical and algorithmic perspectives achieved through Busemann functions, including among other thinks, the introduction of a Fenchel-type conjugate represented as the supremum of convex functions, as well as of the resolvent associate to equilibrium problems on Hadamard manifold. The main advantage of using this resolvent is that the term performing regularization is a convex function in general Hadamard manifolds, allowing us to explore the asymptotic behavior of the proximal point method to solve equilibrium problems. For more details see [1, 2].

Bibliography
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[2] G.C. Bento, J.X. Cruz Neto and I.D.L. Melo. Fenchel Conjugate via Busemann Function on Hadamard Manifolds. Applied Mathematics & Optimization 88(3), 83-102, 2023.

Progressive Hedging decomposition applied to the scheduling of LNG nominations for a Brazilian thermal power plant

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Keywords: Progressive Hedging, Stochastic Programming, Mixed Integer Linear Programming

Abstract

Energy supply contracts signed by thermoelectric power plants (UTEs) in Brazil include compensation for both actual production and available capacity, aiming to remunerate fuel and investment. The goal of achieving optimal operation is motivated by the desire to maximize revenue through efficiency improvements while avoiding financial penalties outlined in contractual clauses. For example, power generators may strategically stockpile fuel to evade fines for unavailability. The operational policy that maximizes the agent's net income can be strengthened through the use of a mathematical programming model that addresses uncertainties in both the plant's operation and its fuel supply process. This presentation outlines the development of a stochastic mathematical programming model designed to tackle the operational challenges of a thermoelectric power plant responsible for allocating its LNG (Liquefied Natural Gas) loads transported by LNGCs (Liquefied Natural Gas Carriers). The LNG supplies storage tanks in a FSRU (Flonating Storage Regasification Unit), enabling the fuel to be regasified and supplied to interconnected thermoelectric plants. The model also considers additional elements such as onshore LNG tanks, connections to the gas pipeline network, and gas trading, making the program adaptable and conducive to evaluating potential investments in existing plants and projects in the planning stages. In terms of problem modeling, we employ the mixed-integer linear stochastic optimization paradigm. Nonlinearities in the process are addressed through a combination of linearizations and integer variables. Uncertainties are modeled using specialized decision trees known as multi-branch trees. Consequently, the final model is extensive and computationally intricate. The solution strategy is based on the decomposition principle and utilizes the Progressive-Hedging algorithm, compatible with free and commercial mathematical programming packages. One of the main objectives of this presentation is to provide a practical guide on the strategies used to make the Progressive Hedging decomposition of a very large Mixed Integer Linear Programming Model feasible in a production-ready tool. We will focus on strategies to enforce the consensus of state variables and heuristics to get good viable solutions in for the MILPs in less time. In conclusion, the presentation will share key insights into optimal operation under diverse market and weather conditions, along with illustrative examples of operation in each scenario, if operators follow the model's decisions. These insights empower decision-makers with a more accurate alignment of expectations, potentially leading to increased efficiency for the generator's business.

A Jacobi-type Newton method for Nash equilibrium problems with descent guarantees

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Abstract

A common strategy for solving an unconstrained two-player Nash equilibrium problem with continuous variables is applying Newton's method to the system obtained by the corresponding first-order necessary optimality conditions. However, when taking into account the game dynamics, it is not clear what is the goal of each player assuming they are taking their current decision following Newton's iterates. In this presentation, we provide an interpretation for Newton's iterate

as follows: instead of minimizing the quadratic approximation of the objective functions parameterized by the other player current decision (the Jacobi-type strategy), we show that the Newton iterate follows this approach but with the objective function parameterized by a prediction of the other player action. This interpretation allows us to present a new Newtonian algorithm where a backtracking procedure is introduced in order to guarantee that the computed Newtonian directions, for each player, are descent directions for the corresponding parameterized functions. Thus, besides favoring global convergence, our algorithm also favors true minimizers instead of maximizers or saddle points, unlike the standard Newton method, which does not consider the minimization structure of the problem in the non-convex case. Thus, our method is more robust compared to other Jacobi-type strategies or the pure Newtonian approach, which is corroborated by our numerical experiments. We also present a proof of the well-definiteness of the algorithm under some standard assumptions, together with a preliminary analysis of its convergence properties taking into account the game dynamics.

Dual SDDP for Risk-averse problems

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Keywords: Risk-averse problems, Stochastic Dual Dynamic Programming

Abstract

Risk-averse multistage stochastic programs appear in multiple areas, and Stochastic Dual Dynamic Programming (SDDP) is a well-known algorithm to solve such problems under time-independence assumptions. However, SDDP produces only a sequence of increasing (and converging) lower bounds. In the risk-neutral setting, it is possible to produce a Monte-Carlo estimate for the cost of the resulting policy, which yields a statistical upper bound. This, however, is not available in the risk-averse setting, due to the nested risk measures. We show how to derive a dual formulation for these problems and apply an SDDP algorithm, leading to converging and deterministic upper bounds for risk-averse problems.

Mixed-Integer Programming Techniques for the Minimum Sum-of-Squares Clustering Problem

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Keywords: Minimum sum-of-squares clustering, Global optimization, Mixed-integer nonlinear optimization

Abstract

The minimum sum-of-squares clustering is a very important problem in the context of data mining and machine learning, with many applications in, e.g., medicine or social sciences. However, it is known to be NP-hard in all relevant cases and notoriously hard to be solved to global optimality in practice. We develop and test different tailored mixed-integer programming techniques to improve the performance of state-of-the-art MINLP solvers when applied to the problem—among them are cutting planes, propagation techniques, branching rules, or primal heuristics. Our extensive numerical study shows that our techniques significantly improve the performance of the open-source MINLP solver SCIP. We now solve many instances that are not solvable without our techniques and we obtain much smaller gaps for those instances that can still not be solved to global optimality.

Constraint qualifications and strong global convergence properties of an augmented Lagrangian method on Riemannian manifolds

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Keywords: constraint qualifications, global convergence, augmented Lagrangian methods, Riemannian manifolds.

Abstract

In the past years, augmented Lagrangian methods have been successfully applied to several classes of non-convex optimization problems, inspiring new developments in both theory and practice. In this talk we bring most of these recent developments from nonlinear programming to the context of optimization on Riemannian manifolds, including equality and inequality constraints. Many research have been conducted on optimization problems on manifolds, however only recently the treatment of the constrained case has been considered. We propose to bridge this gap with respect to the most recent developments in nonlinear programming. In particular, we formulate several well known constraint qualifications from the Euclidean context which are sufficient for guaranteeing global convergence of augmented Lagrangian methods, without requiring boundedness of the set of Lagrange multipliers. Convergence of the dual sequence can also be assured under a weak constraint qualification. The theory presented is based on so-called sequential optimality conditions, which is a powerful tool used in this context. This presentation can also be approached from the perspective of Euclidean context, serving as a review of the most relevant constraint qualifications and global convergence theory of state-of-the-art augmented Lagrangian methods for nonlinear programming.

CONTRIBUTED TALKS

LieDetect: Detection of representation orbits of compact Lie groups from point clouds

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Abstract

We noticed that in Machine Learning there is a long history of interest in detecting actions of groups. For instance, identifying symmetries of the special Euclidean group SE(n) has been tackled since the 1980s for planar data, and more recently for 3D objects. Other Lie groups have also been studied, Abelian or not. Once the information of acting Lie groups is determined, it can be used to increase the efficiency of other inference and machine learning tasks, through the use of equivariant algorithms. However, the methods of representation detection found in the literature do not address the question of estimating the exact representation type, that is, its decomposition into irreducible representations. Indeed, the representation is often found through its Lie algebra, which is approximated as if it were a linear subspace. Consequently, the information regarding the commutators is not exact, and the approximation may not be stable by Lie bracket. In this work, we tackle the question of projecting onto the closest Lie algebra, as raised in [1], by employing tools from optimization on matrix manifolds. Namely, the manifolds involved are the Stiefel and Grassmannian of Lie subalgebras. We propose a careful analysis of our algorithm, allowing to obtain precise theoretical guarantees for convergence. By bridging the gap between compact Lie groups representations and symmetry detection in practice, our algorithm allows the reconstruction of the orbits, and the identification of the group that generates the action. The proposed algorithm is general for any compact Lie group, but we implement it and focus specifically on SO(2), Td, SU(2), and SO(3). We illustrate its accuracy in the context of three data science problems, including image analysis, harmonic analysis and classical mechanics systems. (Code and prepint are available in https://github.com/HLovisiEnnes/LieDetect and https://arxiv.org/abs/2309.03086).

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On projection mappings and the gradient projection method on hyperbolic space forms

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Keywords: Gradient projection method, κ-hyperbolic space form, Convex set, Projection

Abstract

This talk examines the gradient projection method as a solution approach for constrained optimization problems in κ-hyperbolic space forms, particularly for potentially non-convex objective functions. We consider both constant and backtracking step sizes in our analysis. Our studies are based on the hyperboloid model, commonly referred to as the Lorentz model. In our

investigation, we present several innovative properties of the intrinsic κ-projection into convex sets of κ-hyperbolic space forms. These properties are crucial for analyzing the method and also hold independent significance. We discuss the relationship between the intrinsic κ-projection and the Euclidean orthogonal projection, as well as the Lorentz projection. Moreover, we provide formulas for the intrinsic κ-projection into specific convex sets, using the Euclidean orthogonal projection and the Lorentz projection. Regarding the convergence results of the gradient projection method, we establish two main findings. Firstly, we demonstrate that every accumulation point of the sequence generated by the method with backtracking step sizes is a stationary point for the given problem. Secondly, assuming the Lipschitz continuity of the gradient of the objective function, we show that each accumulation point of the sequence generated by the gradient projection method with a constant step size is also a stationary point. Additionally, we provide an iteration complexity bound that characterizes the number of iterations needed to achieve a suitable measure of stationarity for both step sizes. Finally, we explore the properties of the constrained Fermat-Weber problem, demonstrating that the sequence generated by the gradient projection method converges to its unique solution.

Numerical studies on continuous approximations of a cone in an augmented Lagrangian method for nonlinear conic optimization

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Keywords: nonlinear conic optimization, augmented Lagrangian method, copositive programming

Abstract

We are interested in practically solving a nonlinear conic programming (NCP) problem stated as

$$(NCP) \quad \begin{cases} \text{minimize} \;\; f(x) \\ \text{subject to} \;\; g(x) \in \mathrm{K} \end{cases}$$

where $f: R^n \to R$ and $g: R^n \to E$ are continuously differentiable functions, E is a finite-dimensional vector space with an inner product, and $K \subseteq E$ is a closed convex cone. Particular cases when $f(x)$ and $g(x)$ are convex functions and K is the semidefinite symmetric matrix cone or the second-order cone can be solved efficiently [1, 4]; or when $f(x)$ is a linear function and K is the copositive cone has a better treatment [3]. Recently, Andreani et al. [2] extended a sequential optimality condition from nonlinear programming [5] to the NCP. In this study, we propose a variant of these methods, which satisfies these conditions based on an augmented Lagrangian method with continuous approximations of K. In particular, we consider an implementation with a polyhedral approximation K^k of the copositive cone K, which compensates the numerous expensive projection onto K^k per iteration required by these methods. Numerical results confirm our finding on some small examples.

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A multicut approach to compute upper bounds for risk-averse SDDP

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Keywords: SDDP, CVaR, Multicut, Brazil, Power Systems, Risk

Abstract

Stochastic Dual Dynamic Programming (SDDP) is a widely used and fundamental algorithm for solving multistage stochastic optimization problems. Although SDDP has been frequently applied to solve risk-averse models with the Conditional Value-at-Risk (CVaR), it is known that the estimation of upper bounds is a methodological challenge, and many methods are computationally intensive. In practice, this leaves most SDDP implementations without a practical and clear stopping criterion. In this paper, we propose using the information already contained in a multicut formulation of SDDP to solve this problem with a simple and computationally efficient methodology. The multicut version of SDDP, in contrast with the typical average cut, preserves the information about which scenarios give rise to the worst costs, thus contributing to the CVaR value. We use this fact to modify the standard sampling method on the forward step so the average of multiple paths approximates the nested CVaR cost. We highlight that minimal changes are required in the SDDP algorithm and there is no additional computational burden for a fixed number of iterations. We present multiple case studies to empirically demonstrate the effectiveness of the method. First, we use a small hydrothermal dispatch test case, in which we can write the deterministic equivalent of the entire scenario tree to show that the method perfectly computes the correct objective values. Then, we present results using a standard approximation of the Brazilian operation problem and a real hydrothermal dispatch case based on data from Colombia. Our numerical experiments showed that this method consistently calculates upper bounds higher than lower bounds for those risk-averse problems and that lower bounds are improved thanks to the better exploration of the scenarios tree.

CONTRIBUTED TALKS

Semi-norm regularized Gauss-Newton for non-zero residue nonlinear least-squares: convergence analysis and applications

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Keywords: Gauss-Newton methods, nonlinear least-squares problems, regularization matrices

Abstract

We analyze a class of regularized Gauss-Newton (Levenberg-Marquardt) methods, where the regularization term can be a semi-norm, for non-zero residue nonlinear least-squares problems. Local quadratic convergence to the set of stationary points of the least-squares function is established under an error bound condition. Global convergence is also obtained with a line-search scheme. Numerical experiments on ill-posed nonlinear inverse problems illustrate that a suitable choice of the regularization matrix defining the semi-norm can lead to better approximate solutions than the classic approaches.

Subsampled cubic regularization method for finite-sum minimization

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Keywords: Cubic regularization method, Finite-sum minim Braization, Iteration-complexity analysis

Abstract

In this talk, we discuss and analyze a subsampled Cubic Regularization Method (CRM) for solving finite-sum optimization problems. The new method uses random subsampling techniques to approximate the functions, gradients and Hessians in order to reduce the overall computational cost of the CRM. Under suitable hypotheses, first- and second-order iteration-complexity bounds and global convergence analyses are presented. We also discuss the local convergence properties of the method. Numerical experiments are presented to illustrate the performance of the proposed scheme.

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Inexact FISTA-like methods with backtracking and applications

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Keywords: inexact proximal point, line search, inverse problems

Abstract

Consider the following optimization problem

$$min_{x \in R^n} \{ f(x) + g(Kx) + h(x) \} \quad (1)$$

with $f : R^n \to R$ convex and L_f-smooth, i.e., differentiable with L_f-Lipschitz continuous gradient, $K \in R^{m \times n}$, $g : R^m \to R$ and $h : R^n \to (-\infty, \infty]$ proper, convex and closed functions. Assume further that the proximal point operators of g and h have closed form. Several inverse problems may be written in the form of (1) by the variational regularization strategy. Since g and h are not assumed to be differentiable, problem (1) allows fully non smooth models by setting $f = 0$. For example, the discrete linear inverse problem $Ax = b$, with $A \in R^{m \times n}$ and $b \in R^m$, in which x is expected to be sparse, may be modeled with $f = 0, K = A, g(y) = \|y - b\|_1$, and $h(x) = \lambda \|x\|_1$, with $\lambda > 0$ a regularization parameter. Besides, constraints are supported considering h as an indicator function. The computational cost of FISTA-like methods to solve (1) amounts to evaluating ∇f and $\text{prox}_{\rho(g \circ K + h)}$, with $\rho > 0$, iteratively. We suppose that ∇f has a non prohibitively expensive closed form, but $\text{prox}_{\rho(g \circ K + h)}$ cannot be evaluated exactly, which leads to inexact evaluations. Estimating this inexactness to preserve convergence results of exact versions of FISTA has been addressed in the literature. In a recent paper [1], a relative error rule was established. Nonetheless, the inherent step sizes depend on the parameter L_f, which narrows down its applicability. In this work, part of the master's dissertation of the first author, we proposed line search strategies analogue to exact FISTA whenever the relative error rule is used. Other than preserving the complexity of the exact algorithms in the inexact case, we provided monotone and nonmonotone step-size strategies in which the step-size sequence is convergent, implying that the additional cost due to functional evaluation vanishes. Also, a practical way of applying the relative error rule to evaluate $\text{prox}_{\rho(g \circ K + h)}$ was proposed, in which the Fenchel duality theory is used to construct the dual problem associated with the proximal point evaluation. The resulting problem was, in turn, addressed with an exact FISTA-like method, considering the relative error rule as the termination criteria. In experimental results, the proposed monotone step-size strategy replicated the behavior of the original algorithm in [1] without any knowledge of L_f and the proposed nonmonotone step-size strategy was able to select step sizes around five times larger than the two aforementioned algorithms without a significant cost raise due to additional functional and gradient evaluations.

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Efficient updates to matrix factorization

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Keywords: Algorithm, factorization, update

Abstract

Let $Ax=b$ be a matrix system. There are plenty of manners to find the solution to the system and the factorization of A is one of them. The two most known methods to factorize a matrix are LU factorization and QR factorization. Both of them consist in factorizing A into two matrices, leading to the solution of two linear systems. Solving these systems, instead of the original, is an easier task. Another advantage of the factorization is the capability of modifying A, exchanging a column in the case of the LU, or adding a positive number to the main diagonal in the QR, and still being able to find the solution of the system with no need of calculating the factorization again. In these work, the two updating forms were studied and implemented using Julia language. The algorithms are quite efficient as they have low running time and low memory cost. Mainly, the QR update was computed in such manner to gain even better results.

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A second order system with asymptotically vanishing and Hessian-driven damping terms attached to a monotone inclusion problem

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Keywords: monotone equation, Nesterov's accelerated gradient method, convergence rates, convergence of trajectories

Abstract

Given a real Hilbert space H and a continuous and monotone operator V defined on H, we study the asymptotic properties of the trajectories $z(t)$ generated by a second order dynamical system attached to the monotone inclusion problem $V(z)=0$: as the time variable t approaches infinity, we show that $z(t)$ converges weakly to a zero of V. Adding to the already large family of Nesterov-type accelerated systems, and related to the (fOGDA) dynamics studied in [2], our system features an asymptotically vanishing damping together with a Hessian-driven damping term. Convergence rates

to zero are derived for the norm of $V(z(t))$ as well as for the gap function associated to the system. These rates are directly influenced by two parameters: a time rescaling function which fulfills a certain growth condition, and a number r in [0, 1] linked to the damping terms. Through a particular choice for V, we establish a connection with linearly constrained convex optimization. More precisely, we recover a variant of the (TRIALS) dynamics studied in [1] and [3]. A temporal discretization of the dynamical system gives rise to an implicit algorithm which reproduces the convergence rates of the continuous case. Under appropriate assumptions, the iterates converge weakly to a zero of V.

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Multi-Objective Optimization Problem: A case study to analyse the Productivity in Cultivation of Major Rabi Crops in India

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Keywords: Multi-Objective Optimization, NSGA-III, cultivation, optimal solution

Abstract

In this contributed talk, the basic concept of Multi-Objective Optimization and Non-dominated Sorting Genetic Algorithm (NSGA-III) will be elaborated. The study focuses on analysing the productivity of a many objective optimization problem of major Rabi crops in India using NSGA-III algorithm. The challenge is predominantly formulated based on some actual data, encompassing the area and production quantities of 7 major Rabi crops in 18 states of India for the year 2020-21. The problem involves generating a population of solutions using Vogel approximation inspired random initialization followed by NSGA-III procedure. The obtained results in the form of Pareto optimal solutions are compared with the actual data of production quantities and area of cultivation for each state and each Rabi crop cultivated in 2020-21 using graphical illustrations.

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CONTRIBUTED TALKS

A hybrid direct search and projected simplex gradient method for convex constrained minimization

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Keywords: Derivative-free Optimization, Convex Constrained Optimization, Directional Direct Search, Spectral Projected Gradient, Simplex Gradient, Dykstra's Algorithm

Abstract

We propose a new Derivative-free Optimization (DFO) approach for solving convex constrained minimization problems. The feasible set is assumed to be the non empty intersection of a finite collection of closed convex sets, such that the projection onto each of these individual convex sets is simple and inexpensive to compute. Our iterative approach alternates between steps that use Directional Direct Search (DDS), considering an adequate set of poll directions, and a Spectral Projected Gradient (SPG) method, in which the real gradient is replaced by a simplex gradient, under a DFO approach. In the SPG steps, if the convex feasible set is a simple set, then a direct projection is computed. If the feasible set is the intersection of finitely many convex simple sets, then Dykstra's alternating projection method is applied. Convergence properties are established under standard assumptions usually associated to DFO methods. Some preliminary numerical experiments are reported to illustrate the performance of the proposed algorithm, in particular by comparing it with a classical DDS method. Our results indicate that the hybrid algorithm is a robust and effective approach for derivative-free convex constrained optimization.

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On the minimization of the sum of two nonconvex functions with applications

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Keywords: Nonconvex optimization, Nonsmooth optimization, proximal-gradient algorithms

Abstract
We study the problem of minimizing the sum of two nonconvex functions in which one of them is nonconvex and nondifferentiable and the other is differentiable with Lipschitz continuous gradient

(and possible nonconvex too). By assuming that the nondifferentiable and nonconvex function is strongly quasiconvex in the sense of Polyak [3], we provide new necessary optimality conditions for a point to be a local minimizer of the problem and, as a consequence, we provide new information regarding the convergence of the sequence generated by the Proximal Gradient algorithm under the usual Kurdyka-Lojasewiecz property. Finally, two applications in nonconvex mathematical programming are given; new information for the particular case of DC (difference of convex) programming problems and also for strongly quasiconvex mathematical programming problems.

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Branch-and-bound for D-Optimality with fast local search and variable-bound tightening

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Keywords: branch-and-bound algorithm, D-optimality problem

Abstract

We develop a branch-and-bound algorithm for the D-optimality problem, a central problem in statistical design theory, based on two convex relaxations, employing variable-bound tightening and fast local-search procedures, testing our ideas on randomly-generated test problems.

A finitely convergent circumcenter method for the convex feasibility problem

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Keywords: circumcenter method, convex feasibility problem, projection onto sets

Abstract

In this talk, we present a variant of the circumcenter method for the Convex Feasibility Problem (CFP), ensuring finite convergence under a Slater assumption. The method replaces exact projections onto the convex sets with projections onto separating halfspaces, perturbed by positive exogenous parameters that decrease to zero along the iterations. If the perturbation parameters decrease slowly enough, such as the terms of a diverging series, finite convergence is achieved. To the best of our knowledge, this is the first circumcenter method for CFP that guarantees finite convergence.

CONTRIBUTED TALKS

A projected subgradient method for the computation of adapted metrics for dynamical systems

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Keywords: Nonlinear systems, singular value optimization, optimization on manifolds, sub-gradient algorithm, adapted metrics, dimension estimates, restoration entropy

Abstract

In this talk, we extend a recently established subgradient method for the computation of Riemannian metrics that optimizes certain singular value functions associated with dynamical systems. This extension is threefold. First, we introduce a projected subgradient method which results in Riemannian metrics whose parameters are confined to a compact convex set and we can thus prove that a minimizer exists; second, we allow inexact subgradients and study the effect of the errors on the computed metrics; and third, we analyze the subgradient algorithm for three different choices of step sizes: constant, exogenous and Polyak.

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Proximal Gradient Method for Multiobjective Optimization

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Keywords: Proximal Gradient Method, Multiobjective Optimization, Convergence

Abstract
In this talk, we will analyze the convergence properties of a proximal gradient method for solving nonsmooth composite multiobjective optimization problems. We will discuss the asymptotic convergence and the iteration-complexity of this scheme in order to obtain an approximate stationary solution.

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CONTRIBUTED TALKS

A stochastic optimization model for the sugarcane production chain with focus on biofuels

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Keywords: Stochastic programming, Benders decomposition, Decarbonization, Biofuels

Abstract

Recent years have seen a growing global concern regarding the adverse effects of fossil fuel consumption and dependence on the environment and energy security, and the urgent need to transition towards sustainable and low-carbon energy sources. As a result, significant attention has been directed towards renewable energy such as hydropower, solar and wind. However, utilizing biomass derived from organic materials such as plants, wood, agricultural waste, and dedicated energy crops, as a renewable energy source holds a lot of potential for decarbonizing the energy sector and mitigating greenhouse gas emissions. One particularly noteworthy source of biomass for energy production is sugarcane. With its abundance, high energy content, and efficient conversion into biofuels, sugarcane holds considerable potential as a renewable energy feedstock. Building upon the rich potential of sugarcane as a renewable energy feedstock, a crucial step in harnessing its benefits lies in strategically optimizing its production chain. In this context, a stochastic optimization model will be developed to determine investments in industrial plants that produce sugarcane products, along with their operation, with the aim of maximizing revenue through sales. The two-stage model will account for uncertainty by incorporating scenarios for sugarcane plantation production and bioproduct prices. The first stage involves defining investments in each industrial plant, thus determining their processing capacities. The relationship between investments and capacities is modeled as a concave exponential function, represented as a piecewise linear function that requires integer variables. The second stage involves determining the quantity of each product that will be produced and sold, given the capacities of each plant and the scenarios for prices and production. To efficiently solve the resulting large-scale stochastic program, Benders decomposition is applied. This optimization model is applied using realistic data, considering Brazil's specific context. The parameters and scenarios used in the model are tailored to reflect the nuances of the sugarcane industry within the Brazilian landscape. By incorporating accurate and region-specific information, the model aims to provide insights and strategies that are directly applicable to the dynamic challenges and opportunities present in the Brazilian sugarcane sector.

Principles of Noisy Nonlinear Optimization

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Abstract

In many applications of nonlinear optimization, the objective function and constraints contain noise. This could be the result of stochastic simulation, lower precision computer arithmetic or "computational noise" (a concept that will be discussed in detail). Classical algorithms typically fail in this case, and the goal of this talk is to present 4 design principles to help redesign deterministic methods to be noise tolerant. We illustrate the application of our principles on the solution of an optimal design problem in which the constraints are given by the discretization of differential equations.

On the worst-case complexity analysis of line-search methods on manifolds

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Keywords: Riemannian optimization, non-monotone line search, worst-case complexity, global convergence

Abstract

In this talk, we consider the problem of minimizing a smooth cost function on a Riemannian manifold and motivate the problem with several applications, including matrix completion problems [2], image segmentation [4], symplectic eigenvalue computation [3], among others. Riemannian line-search methods [1] are frequently used to iteratively solve this kind of problem. Our goal is to study the number of iterations necessary for this class of algorithms to obtain an ε-approximated stationary point. Particularly, we prove that, under a regularity Lipschitz-type condition on the pullbacks of the cost function to the tangent spaces of the manifold and other mild assumptions, the Riemannian non-monotone line-search schemes generates points with Riemannian gradient norm smaller than ε in $O(\varepsilon^{-2})$ iterations. Our analysis includes a wide variety of known non-monotone strategies existing in the literature. In addition, we establish the global convergence for this family of methods. The bounds obtained in our study agree with the bounds known for line-search methods in the unconstrained nonlinear optimization case, generalizing previous knowledge.

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About obtaining complementary approximate Karush-Kuhn-Tucker conditions and algorithmic applications

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Keyword: weighted complementary approximate Karush-Kuhn-Tucker

Abstract

We present the weighted complementary approximate Karush-Kuhn-Tucker (WCAKKT) optimality condition. Under the analyticity of the algebraic description of the feasible set, and relying on a desingularization result, the new condition is proven to guarantee the complementary approximate Karush-Kuhn-Tucker (CAKKT) conditions. It is an optimality condition satisfied by successful algorithms. It is verified not only by the safeguarded augmented Lagrangian method, but also by the

Inexact Restoration method, inverse and logarithmic barrier method, and by a penalty algorithm for non-smooth and constrained optimization. A notable feature of WCAKKT conditions is that they capture the algebraic elements of a desingularization result necessary to obtain CAKKT sequences. Due to its generality and strength, the new condition can help illuminate the practical performance of algorithms in generating CAKKT sequences.

A quasi-Newton method with Wolfe line searches for multiobjective optimization

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Keywords: Multiobjective optimization, Pareto optimality, quasi-Newton methods, BFGS method, Wolfe line search

Abstract

In this talk, we propose a quasi-Newton BFGS method with Wolfe line searches for multi-objective optimization problems. The algorithm is well defined even for nonconvex problems. Global convergence and R-linear convergence to a Pareto optimal point are established for strongly convex problems. In the local convergence analysis, if the objective functions are locally strongly convex with Lipschitz continuous Hessians, the rate of convergence is Q-superlinear. In this respect, our method exactly mimics the classical BFGS method for single-criterion optimization.

On second-order conditions for degenerate optimization problems

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Keywords: geometrical constraints mathematical programs, optimality conditions

Abstract

In this talk, we discuss necessary and sufficient optimality conditions for mathematical programs with geometrical constraints in the degenerated case where the Robinson condition fails. We will use tools from p-regularity theory to derive first and second-order optimality conditions. We will also perform sensitivity analysis of the value function for the parametric case.

CONTRIBUTED TALKS

Sparse optimization via cardinality constraints

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Keywords: Nonlinear programming, cardinality constraints, minimax problems

Abstract

The subject of this talk is linked to nonlinear programming, and related to the computational and theoretical aspects of cardinality problems. We study the concept of cardinality in a different perspective in which, instead of replacing the original problem by an augmented problem, we introduce a binary variable that evaluate how many nonzero components the vector can have and where these nonzero components are alocated. More precisely, we replace the cardinality constraint of the original problem with simple constraints of the type $x_I = 0$, where the set of indices I varies over a finite spectrum. So, applying duality to the inner problem and relating minmax with maxmin, we obtain a tractable problem, establishing theoretical and computational results.

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An inertial degenerate preconditioned HPE method for solving the monotone inclusion problem: complexity analysis and applications

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Keywords: monotone inclusion problem, degenerate preconditioners, relative hybrid error criteria

Abstract

The proximal point method (PPM) is a classical method for solving the monotone inclusion problem, i.e., finding a zero of a maximal monotone operator. Since its appearance, several features have been incorporated to this method in order to improve its applicability and convergence properties, such as, the relative hybrid error criteria proposed by Solodov and Svaiter to devise inexact variants (hybrid proximal extragradient (HPE) methods); using inertial techniques to improve its practical efficiency; and the introduction of degenerate preconditioners in order to expand the range of applicability of the PPM. In this work, we incorporate the three features mentioned above to develop an inertial degenerate preconditioned HPE method for solving the monotone inclusion problem. For the resulting algorithm, we perform convergence and complexity analyses. We apply these results to study inexact inertial variants of some splitting methods for solving the monotone inclusion problem.

CONTRIBUTED TALKS

On the penalty parameter in Augmented Lagrangian methods

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Keywords: Augmented Lagrangian methods

Abstract

Augmented Lagrangian methods are effective tools for solving optimization problems with general constraints. One of the drawbacks, however, is the excessive increase of the penalty parameter, which can generate numerical instabilities, especially in problems not convex. One of the strategies that aim to minimize this problem is the use of exact penalties. However, the usual exact penalty functions are not differentiable, which in practice makes it difficult to use competitive algorithms. In this work, we briefly discuss some exact penalty functions and present a new result that, with weaker hypotheses than those presented in the literature, allows keeping the penalty parameter limited.

Strong global convergence properties of an Augmented Lagrangian method for symmetric cones

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Keywords: nonlinear symmetric cone programming, sequential optimality conditions

Abstract

Sequential optimality conditions have played a major role in proving stronger global convergence results for numerical algorithms used in nonlinear programming. Several extensions have been described in conic contexts, leading to many open questions. In this talk, we will present new sequential optimality conditions for nonlinear symmetric cone programming. Stronger results are obtained by exploiting the rich algebraic structure of the problem.

Basis pursuit by infeasible alternating projections

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Keywords: Basis pursuit, Inconsistency Alternating Projections, Compressed Sensing.

Abstract

Basis pursuit [4] is the problem of finding a vector with smallest l_1 -norm among the solutions of a given linear system of equations, that is, the problem of solving

$$(BP) \quad \min \|x\|_1 \quad \text{s.t.} \quad Ax = b,$$

where $A \in R^{m\times n}$ with $m \leq n$ has full row rank. It is a famous convex relaxation of what the literature refers to as sparse affine feasibility (SAF) problem, in which sparse solutions to undetermined systems are sought. Problem SAF is a fundamental problem in Compressed Sensing (CS), which is a technique for recovering sparse signals from incomplete measurements. While SAF is known to be NP-hard, there are some instances where the solution of BP and SAF coincide [3]. The importance of basis pursuit led to a great deal of research devoted to the development of effective methods for solving it, mainly for large-scale problems. There are several methods for solving BP. One can think, for instance, in recasting it as a linear program (LP) and applying to the reformulation any standard LP solver [3]. In turn, we tackle BP in its very original form with a scheme that uses alternating projections [1] in its subproblems. These subproblems are designed to be inconsistent in the sense that they relate to two non-touching sets. Quite recently, inconsistency coming from infeasibility has been seen to work in favor of alternating projections and correspondent convergence rates [2]. In our work, this feature is now suitably enforced in a new and numerically competitive method for solving the basis pursuit problem [5].

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Scaled-PAKKT sequential optimality condition for multiobjective problems and its application to an Augmented Lagrangian method

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Keywords: multiobjective problem, sequential optimality condition, augmented Lagrangian method

Abstract

Based on the recently introduced Scaled Positive Approximate Karush-Kuhn-Tucker condition for single objective problems, we derive a sequential necessary optimality condition for multiobjective problems with equality and inequality constraints as well as additional abstract set constraints which hold without any additional assumptions. These necessary sequential optimality conditions for multiobjective problems are subject to the same requirements as ordinary (pointwise) optimization conditions: we show that the updated Scaled Positive Approximate Karush-Kuhn-Tucker condition is necessary for a local weak Pareto point to the problem. Furthermore, we propose a variant of the

classical augmented Lagrangian method for multiobjective problems. Our theoretical framework does not require any scalarization. We also discuss the convergence properties of our algorithm with regard to feasibility and global optimality without any convexity assumption. Finally, some numerical results are given to illustrate the practical viability of the method.

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On extended notions of Lagrange multipliers and the boundedness of dual sequences generated by augmented Lagrangian methods

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Keywords: optimality conditions, quasi-normality constraint qualification, augmented Lagrangian methods

Abstract

The Fritz-John (FJ) and KKT conditions are fundamental tools for characterizing minimizers and form the basis of almost all methods for constrained optimization. Since their respective seminal works, FJ/KKT conditions have been enhanced by adding extra necessary conditions. Such an extension was initially proposed by Hestenes in the 1970s and later extensively studied by Bertsekas and collaborators. We revisit enhanced KKT stationarity for standard (smooth) nonlinear programming. We argue that every KKT point satisfies the usual enhanced versions found in the literature; therefore, enhanced KKT stationarity only concerns the Lagrange multipliers. We then analyse some properties of the corresponding multipliers under the quasi-normality (QN) constraint qualification. Also, based on the enhanced optimality, we introduce a very mild relaxation of QN that ensures that the sequence of approximate Lagrange multipliers generated by the (safeguarded quadratic penalty-like) augmented Lagrangian method remains bounded. This helps to elucidate the practical effectiveness of the algorithm.

Convergence properties of proximal point iterations in Hilbert spaces

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Keywords: Proximal point method, Strong convergence, Projection methods

Abstract
In this talk, we aim to study the convergence properties of the proximal point algorithm and its variants in infinite dimensional spaces with respect to some classical problems. To this end, we analyse the proximal point method for finding zeros of maximal monotone operators, as in [1]. It is well known that the classical proximal point algorithm converges only weakly to a solution under very mild assumptions, [2, 3]. We show a technique to force strong convergence of the classical proximal point method and some of its variants, [4, 5, 6]. Strong convergence is achieved by combining proximal point iterations with simple projection steps onto the intersection of two halfspaces. Such a scheme is also used in other methods in the related literature.

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Proximal contractions and its applications to engineering and science through minimization problems

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Keywords: Proximal contractions, Best proximity point, Nonlinear problems

Abstract
The talk's primary focus is to showcase the ways that various proximal contractions are capable of solving minimization problems, along with how these contractions may be used in a wide range of engineering and science disciplines. We will look at significant recent contributions by researchers, particularly those that address nonlinear problems involving proximal contractions. The second part covers a number of best proximity point results that are used as minimization solutions to the problem. Some creative examples and computer simulations are then included. Additionally, this talk discusses some recent applications of metric fixed-point theory for functional equations that deal with dynamical, boundary value, concentration, and other problems.

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Low Order-Value Derivative-free optimization

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Keywords: low order-value optimization, trust-region derivative-free algorithms

Abstract
Low Order-Value Optimization (LOVO) problems consist on minimizing the minimum among a finite number of functions. Several applications for this kind of problems exist, such as robust adjustment of models in the presence of outliers and pattern detection. In this talk, we present a trust-region derivative-free algorithm for solving LOVO problems, where the evaluation of each function is very expensive and we do not have access to its derivatives. Convergence, complexity and promising numerical experiments also are discussed.

DC algorithms and image denoising

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Keywords: image noise removal, difference of two convex functions optmization

Abstract
The recent advances in imaging systems have steadily improved the quality of images for the last several decades. However, image degradation is unavoidable due to the many factors affecting the image acquisition process. Image denoising, which aims to reconstruct a high-quality image from its degraded observation, is a classical yet still very active research area. One of the most commonly used models for image noise removal is the Total Variation (TV) model. So far, researchers have already proposed various methods for decreasing noise, and hence, each method has its own advantages and disadvantages. In this work, we discuss how to apply Difference of Convex (DC) algorithms for image denoising based on non-convex TV models.

Application-Driven Learning: A Closed-Loop Prediction and Optimization Approach Applied to Dynamic Reserves and Demand Forecasting

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Keywords: Application-driven learning, closed-loop prediction and optimization, bilevel optimization, forecast, power-systems operation

Abstract

In many industry applications, forecasting and optimization models play key roles in decision-making. However, these two processes are generally modeled as two sequential steps with no feedback, following an open-loop approach. This is particularly true in the electricity sector, where it is common for system operators to use an open-loop forecast-decision approach together with ad hoc actions to determine an adequate level of reserves, in face of uncertain renewable generation and demand. Such ad hoc procedures lack technical formalism and transparency to minimize operating and reliability costs. Motivated by these shortcomings, in this work we present a new closed-loop framework, named application-driven learning, in which the best forecasting model is defined according to a given application cost function. We consider applications in which the decision-making process is driven by an optimization scheme fed by a multivariate point forecast. Our estimation method is introduced as a bilevel optimization problem. We present our general methodology and prove, under mild conditions, that the solution converges to the best estimator regarding the expected cost of the selected application. Then, we propose two solution methods: an exact method based on the KKT conditions of the second-level problems and a scalable heuristic approach suitable for decomposition. While the proposed methodology, in its general form, can be used to achieve better pointwise forecasts for applications that can be modeled by two-stage problems, the focus of this talk is on the problem of defining dynamic reserve requirements and conditional load forecasts in power system operations. In this context, we offer an alternative scientifically grounded approach to current ad hoc procedures implemented in industry practices such as load-forecast biasing. We test the proposed methodology under real data and large-scale realistic systems with thousands of buses. Our results show that the proposed methodology is scalable and consistently performs better than the standard open-loop approach.

Sample average approximation: localization, random constraints and heavier-tails

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Keywords: sample average approximation, stochastic optimization

Abstract

We revisit the sample average approximation (SAA) technique in stochastic optimization. “Localization” has proven to be a valuable tool in the Statistical Learning literature as it allows sharp risk bounds regarding the problem geometry: bounds that depend only on the vicinity of the solution set. Localized bounds seem to be much less exploited in the stochastic optimization literature, including the case of random constraints and possible "heavier tails". In this work, we combine an adaptation of Talagrand’s “generic chaining” bound for sub-Gaussian processes, “localization” arguments, and the use of standard conditions in Optimization (metric regularity, Slater-type conditions) to control fluctuations of the feasible set and obtain localized bounds for stochastic optimization.

SUGGESTED RESTAURANTS

Salsalito

Praia de Botafogo 228, Stores 117 to 119 — Botafogo

Good self-service restaurant

Broz

Marquês de Abrantes Street, 216 — Flamengo

Nice Brazilian barbecue

Garagem

Jorn. Orlando Dantas Street, 43 — Botafogo

Usually, there's a waiting line before 1 pm, but the service is quick

Food Court at Botafogo Praia mall

Praia de Botafogo, 400 - Botafogo

Several options from fast food to Japanese cuisine

Miako

Farani Street, 20 — Botafogo

Traditional Japanese food

Arte SESC Bistrô

R. Marquês de Abrantes, 99 — Flamengo

Gourmet restaurant at an affordable price

Mizu

Farani Street, 16 — Botafogo

Mexican and Japanese food

Verde Vício

Visconde de Ouro Preto Street, 47 — Botafogo

Healthy food restaurant

Port's Self Lanchonete

Marquês de Abrantes Street, 214 — Botafogo

Cheaper self-service option