Minissimpósio “Métodos Computacionais de Otimização”

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1 Objetivos

O minissimpósio em Métodos Computacionais de Otimização tem como objetivo divulgar para a comunidade de matemática aplicada a pesquisa em alto nível desenvolvida por pesquisadores e pesquisadoras da área de otimização contínua no Brasil. Além disso, pretende-se que o minissimpósio propicie um ambiente de discussão entre participantes de diferentes regiões do país com o intuito de fomentar novas colaborações.

2 Descrição

A área de Otimização Contínua estuda o problema de minimizar uma função real a várias variáveis reais (função objetivo) dadas restrições sob as variáveis de entrada. Isto é,

$$\text{Minimizar } f(x), \text{ sujeito a } x \in \Omega,$$

onde $f\colon \mathbb{R}^n \to \mathbb{R}$ e $\Omega \subseteq \mathbb{R}^n$. Tipicamente o conjunto viável Ω é descrito por restrições de igualdade e desigualdade. Um número incontável de problemas práticos é modelado desta forma, desde problemas de energia, de economia, de engenharia, química, etc, até problemas nas áreas de ciências sociais. Particularmente com o avanço das ferramentes computacionais, modelos mais realistas e que portanto fazem uso de toda a generalidade acima (isto é, sem hipóteses de linearidade ou de convexidade sob as funções que definem o problema) tem sido propostos. Um exemplo de destacado sucesso são as aplicações pioneiros de técnicas de aprendizado de máquina que necessitam a resolução de problemas de otimização complexos e não convexos (em particular, técnicas de *deep learning*). Neste minissimpósio trazemos 14 palestrantes de diferentes regiões do país, a maioria deles pesquisadores consolidados em suas respectivas áreas, para palestras de 15 a 20 minutos, totalizando 4h de duração.

3 Palestrantes

1. Daiana Oliveira dos Santos (UNIFESP)
2. Luiz Rafael dos Santos (UFSC)
3. Diaulas S. Marcondes (USP)
4. Roger Behling (UFSC)
5. Juan Pablo Luna (UFRJ)
6. Evelin H. M. Krulikovski (UFPR)
7. Max L. N. Gonçalves (UFG)
8. Mauricio Romero Sicre (UFBA)
9. Orizon P. Ferreira (UFG)
10. Jefferson D. G. Melo (UFG)
11. Vitaliano Amaral (UFPI)

12. Mariana da Rosa (Unicamp)
13. Leandro Prudente (UFG)
14. Marina Geremia (IFSC)

4 Programação

Horário	**Dia 1**	**Dia 2**
00:00 - 00:20	Leandro Prudente	Vitaliano Amaral
00:20 - 00:40	Max Gonçalves	Orizon Ferreira
00:40 - 01:00	Jefferson Melo	Mariana da Rosa
01:00 - 01:20	Evelin Krulikovski	Juan Pablo Luna
01:20 - 01:40	Marina Geremia	Diaulas Marcondes
01:40 - 02:00	Roger Behling	Mauricio Sicre
	L. Rafael Santos	Daiana Santos

5 Resumos

1. Daiana Oliveira dos Santos

   Optimality Conditions for Nonlinear Second-Order Cone Programming and Symmetric Cone Programming

   Nonlinear symmetric cone programming (NSCP) generalizes important optimization problems such as nonlinear programming, nonlinear semi-definite programming and nonlinear second-order cone programming (NSOCP). In this work, we present two new optimality conditions for NSCP without constraint qualifications, which implies the Karush–Kuhn–Tucker conditions under a condition weaker than Robinson's constraint qualification. In addition, we show the relationship of both optimality conditions in the context of NSOCP, where we also present an augmented Lagrangian method with global convergence to a KKT point under a condition weaker than Robinson's constraint qualification.

2. Luiz Rafael dos Santos

   A successive centralized circumcentered-reflection method for the convex feasibility problem

   In this paper, we present a successive centralization process for the circumcentered-reflection method with several control sequences for solving the convex feasibility problem in Euclidean space. Assuming that a standard error bound holds, we prove the linear convergence of the method with the most violated constraint control sequence. Moreover, under additional smoothness assumptions on the target sets, we establish the superlinear convergence. Numerical experiments confirm the efficiency of our method.

3. Diaulas S. Marcondes

   Active-set Newton-MR methods for nonconvex optimization problems with bound constraints

   Resumo: In this work we present active-set methods for the minimization of nonconvex twice continuously differentiable functions with bound constraints. Within the faces, descent methods with Armijo line search are employed with approximated Newton directions obtained by the Minimum Residual (MINRES) method. To leave the faces, we investigate the use of the Spectral Projected Gradient (SPG) method, and also the use of a variant of a Cubic Regularization of the Newton's method tailored to bound constrained problems. When the objective function has

Lipschitz continuous gradient, we show that the method based on SPG takes needs no more than $\mathcal{O}(n\epsilon^{-2})$ calls to the oracle to find ϵ-approximate stationary points. If, additionally, the objective function has Lipschitz continuous Hessian, we show that the method based on the cubic regularization method needs no more than $\mathcal{O}\left(n\epsilon^{-3/2}\right)$ calls to the oracle to achieve the same goal. We also report numerical experiments comparing the proposed methods against existing active-set methods. The results illustrate the potential benefits of using MINRES instead of Conjugate Gradient (CG) method for approximating Newton directions within the faces.

4. Roger Behling

   Computing the completely positive factorization via alternating minimization

   In this article, we propose a novel alternating minimization scheme for finding completely positive factorizations. In each iteration, our method splits the original factorization problem into two optimization subproblems, the first one being a orthogonal procrustes problem, which is taken over the orthogoal group, and the second one over the set of entrywise positive matrices. We present both a convergence analysis of the method and favorable numerical results.

5. Juan Pablo Luna (UFRJ)

   Regularized Equilibrium Problems with Equilibrium Constraints with Application to Energy Markets

   Equilibrium problems with equilibrium constraints are appropriate modeling formulations in a number of important areas, such as energy markets, transportation planning, and logistics. These models often correspond to bilevel games, in which certain dual variables, representing the equilibrium price, play a fundamental role. We consider multileader single-follower equilibrium problems having a linear program in the lower level. Because in this setting the lower-level response to the leaders' decisions may not be unique, the game formulation becomes ill-posed. We resolve possible ambiguities by considering a sequence of bilevel equilibrium problems, endowed with a special regularization term. We prove convergence of the approximating scheme. Our technique proves useful numerically over several instances related to energy markets. When using PATH to solve the corresponding mixed-complementarity formulations, we exhibit that, in the given context, the regularization approach computes a genuine equilibrium price almost always, while without regularization the outcome is quite the opposite.

6. Evelin H. M. Krulikovski

   Derivative-free optimization approach for structured symmetric matrices with fixed eigenvalues

   A Derivative-Free Optimization (DFO) model is developed and analyzed for solving inverse structured symmetric matrix problems for which the eigenvalues are given. Some (zero and nonzero) entries are pre assigned and cannot be changed, and some others should be nonzero but their value is not given. The rest of the entries are completely free. The obtained matrix must satisfy these requirements and its eigenvalues must be the given ones. This specialized inverse eigenvalue problem appears in several applications and 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 model requires computing the eigenvalues of a symmetric matrix to evaluate the non-differentiable objective function. We propose derivative-free optimization schemes, specifically the well-known directional direct search method DDS and its global variant GLODS. We discuss their convergence properties which are based on the fact that the objective function is Lipschitz continuous. In addition, we also explore the potential benefits of using some well-established heuristic strategies that can be seen as natural competitors to the deterministic derivative-free schemes DDS and GLODS. We present some preliminary numerical results that demonstrate the effectiveness of our deterministic DFO proposals in a variety of possible scenarios.

7. Max L.N. Gonçalves

   An away-step Frank–Wolfe algorithm for constrained multiobjective optimization

   In this paper, we propose and analyze an away-step Frank–Wolfe algorithm designed for solving multiobjective optimization problems over polytopes. We prove that each limit point of the sequence generated by the algorithm is a weak Pareto optimal solution. Furthermore, under additional conditions, we show linear convergence of the whole sequence to a Pareto optimal solution. Numerical examples illustrate a promising performance of the proposed algorithm in problems where the multiobjective Frank–Wolfe convergence rate is only sublinear.

8. Mauricio Romero Sicre

   A Projective Splitting Method for Monotone Inclusions: Iteration-Complexity and Application to conic optimization

   In this work we propose an inexact projective splitting method to solve the problem of finding a zero of a sum of maximal monotone operators. We perform convergence and complexity analyses of the method by viewing it as an inertial variant of an inexact proximal point method proposed by Solodov and Svaiter in 2001. For the proposed method, we establish convergence rates and complexity bounds We apply the proposed method to a conic optimization problem.

9. Orizon P. Ferreira

   Constraint Qualifications and Strong Global Convergence Properties of an Augmented Lagrangian Method on Riemannian Manifolds

   In the past several years, augmented Lagrangian methods have been successfully applied to several classes of nonconvex optimization problems, inspiring new developments in both theory and practice. In this paper 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. In this paper 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. The paper can also be read with the Euclidean context in mind, 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.

10. Jefferson D. G. Melo

    Improved convergence rates for the multiobjective Frank-Wolfe method

    In this talk, we analyze the convergence rates of the Frank-Wolfe method for solving convex constrained multiobjective optimization. We establish improved convergence rates under different assumptions on the objective function, the feasible set, and the localization of the limit point of the sequence generated by the method. We show that the method can achieve linear convergence rates in terms of a merit function under certain scenarios. Additionally, we explore enhanced convergence rates with respect to an optimality measure. Finally, we provide some examples to illustrate the convergence rates and the set of assumptions.

11. Vitaliano Amaral

    Um método do tipo ponto proximal com regularização quadratica para a minimização de uma composição de funções

    Discutiremos uma versão do método ponto proximal para resolver um problema de otimização composto pela soma de três funções: a primeira é uma função própria e semicontínua inferior, a segunda é continuamente diferenciável com gradiente Hölder contínuo, e a terceira é uma função convexa que pode ser não diferenciável. Esse tipo de problema surge em diversas aplicações práticas, mas é desafiador devido à presença de não convexidade e não suavidade. Para lidar com essas dificuldades, propomos um algoritmo baseado no método gradiente proximal, que combina uma aproximação quadrática do termo diferenciável, uma aproximação linear do termo convexo e um termo não convexo.

O método proposto apresenta complexidade compatível com a dos métodos já estabelecidos na teoria da otimização. Além disso, apresentamos exemplos numéricos que ilustram os resultados teóricos e a eficiência prática do algoritmo.

12. Mariana da Rosa

    Advances in constant-rank type constraint qualifications

    It is well known that constant rank-type constraint qualifications (CQs) imply the Mangasarian-Fromovitz CQ (MFCQ) after a suitable local reparametrization of the feasible set, which involves eliminating redundancies (remove and/or transform inequality constraints into equalities) without changing the feasible set locally. This technique has been mainly used to study the similarities between well-known CQs from the literature. In this talk, we present a different perspective by introducing a type of reparametrization that itself constitutes a CQ. Additionally, we propose a relaxed version of the constant rank of the subspace component (CRSC) CQ, called constrained CRSC, which preserves the relevant geometric properties of CRSC, is linked to reparametrizations to MFCQ, and also ensures local error bound condition.

13. Leandro Prudente

    A Proximal Gradient method with an explicit line search for multiobjective optimization

    We present a proximal gradient method for solving convex multiobjective optimization problems, where each objective function is the sum of two convex functions, with one assumed to be continuously differentiable. The algorithm incorporates a backtracking line search procedure that requires solving only one proximal subproblem per iteration, and is exclusively applied to the differentiable part of the objective functions. Under mild assumptions, we show that the sequence generated by the method converges to a weakly Pareto optimal point of the problem. Additionally, we establish an iteration complexity bound by showing that the method finds an ε-approximate weakly Pareto point in at most $\mathcal{O}(1/\varepsilon)$ iterations.

14. Marina Geremia

    Um Algoritmo de Decomposição ADMM Inexato com Erro Relativo para Otimização Convexa com Efeitos Inerciais

    Este trabalho foi desenvolvido em colaboração com o Professor Maicon Marques Alves e propõe uma nova versão inexata com erro relativo do método dos multiplicadores de direção alternada (ADMM) para otimização convexa. Demonstramos a convergência assintótica do nosso algoritmo principal, bem como as complexidades iterativas pontuais e ergódicas para os resíduos. Além disso, ilustramos a eficácia do algoritmo por meio de experimentos numéricos.