III Congresso Brasileiro de Jovens Pesquisadores
em Matemática Pura, Aplicada e Estatística

Curitiba, December 12-14, 2018

Session: Otimização Contínua

Organized by Douglas Soares Gonçalves (Universidade Federal de Santa Catarina)
and Roger Behling (Universidade Federal de Santa Catarina)

Schedule

Wednesday, December 12

9:00 - 9:30	Opening
9:30 - 10:30	Plenary talk 1
10:30 - 11:00	Coffee break
11:00 - 11:30	Priscila Savulski Ferreira (UTFPR) *O problema de complementaridade linear e o método de pivotamento em blocos principais*
11:30 - 12:00	Juliano De Bem Francisco (UFSC) *Non-monotone inexact restoration method for minimization on Stiefel manifold*
12:00 - 13:30	Lunch
13:30 - 14:30	Plenary talk 2
14:40 - 15:10	Juan Pablo Luna (UFRJ) *Analysis of EPEC Models for Power Markets*
15:10 - 15:40	Felipe Fidalgo (UFSC) *Um método dividir-e-conquistar para um Problema de Geometria de Distâncias*
15:40 - 16:10	Majela Pentón Machado (UFBA) *Métodos inexatos de subgradiente proximal*
16:10 - 16:40	Lucas Eduardo Azevedo Simões (Unicamp) *Sampling methods for constrained nonsmooth optimization*
16:40 - 17:10	Coffee break
17:10 - 18:40	Round Table

Thursday, December 13

9:00 - 10:00	Plenary talk 3
10:00 - 10:30	Coffee break
10:30 - 11:00	Thadeu Alves Senne (UNIFESP) *Nonlinear systems arising from topology optimization of structures under geometrical nonlinearities*
11:00 - 11:30	Douglas Gonçalves (UFSC) *Local convergence analysis of the Levenberg-Marquardt framework for nonzero- residue nonlinear least-squares problems under an error bound condition*
11:30 - 12:00	Roger Behling (UFSC) *A special complementarity function revisited hereditary*
12:00 - 13:30	Lunch
13:30 - 14:30	Plenary talk 4
14:40 - 15:10	José Alberto Ramos Flor (UFPR) *On the Complexity analysis for a class of sparse optimization problems over polyhedron*
15:10 - 15:40	Max Leandro Nobre Gonçalves (UFG) *A partially inexact generalized alternating direction method of multipliers and its iteration-complexity analysis*
15:40 - 16:10	Luís Felipe Bueno (UNIFESP) *On the complexity analysis of an Inexact Restoration method*
16:10 - 16:40	Geovani Nunes Grapiglia (UFPR) *A refined worst-case complexity analysis for non-monotone line searches*
16:40 - 17:10	Coffee break
17:10 - 17:40	Glaydston De Carvalho Bento (UFG) *An Approach on Proximal Methods for Vector Optimization*
17:40-18:10	Leandro Da Fonseca Prudente (UFG) *A Wolfe line search algorithm for vector optimization*
18:10-18:40	Leonardo Delarmelina Secchin (UFES) *Uma condição sequencial de otimalidade associada à quasinormalidade, e suas consequências algorítmicas*
20:00 - 0:00	Social dinner

Friday, December 14

9:00 - 10:00	Plenary talk 5
10:00 - 10:30	Coffee break
10:30 - 10:00	Reinier Díaz Millán (IFG) *A projection algorithm for non-monotone variational inequalities*
11:00 - 11:30	Luiz-Rafael Santos (UFSC) *AN INTERIOR POINT METHOD WITH NO CENTRALITY PARAMETER*
11:30 - 12:00	Roberto Antonio Cordeiro Prata (UFAM) *Operações com Números Fuzzy F-correlacionados*
12:00 - 13:30	Lunch
13:30 - 14:30	Plenary talk 6
14:40 - 15:10	Evelin Heringer Manoel Krulikovski (UFPR) *ANÁLISE TEÓRICA DE MÁQUINAS DE VETORES SUPORTE*
16:40 - 17:10	Coffee break
17:10 - 18:40	Assembly

Abstracts

1. *Speaker:* **Priscila Savulski Ferreira**
Affiliation: UTFPR
Title: ***O problema de complementaridade linear e o método de pivotamento em blocos principais***

O problema de complementaridade linear consiste em, dados $Q \in \mathbb{R}^{n\times n}$ e $c \in \mathbb{R}^n$, encontrar um par $(x, \omega) \in \mathbb{R}^{2n}$ tal que

$$\begin{aligned} &Qx + c = \omega, \\ &x \circ \omega = 0, \\ &x \geq 0,\ \omega \geq 0, \end{aligned}$$

sendo $x \circ \omega := (x_1\omega_1, \ldots, x_n\omega_n) \in \mathbb{R}^n$. Este problema tem uma vasta gama de aplicações em ciência e tecnologia aplicada, por exemplo, em análise sócio-econômica, teoria dos jogos, modelos de equilíbrio espacial, problemas de análise elastoplástica em mecânica e modelagem de energia.

O método de pivotamento em blocos principais (BPP), Lemke em 1965, é um dos algoritmos pioneiros desenvolvidos para este tipo de problema. Estes algoritmos geralmente possuem um excelente desempenho na prática quando Q é uma matriz simétrica definida positiva de grande porte, no entanto não possue convergência garantida.

Verificamos que os algoritmos de conjuntos ativos apresentados em Hungerlander 2014 e Kunisch 2003 podem ser vistos como algoritmos BPP. Apresentamos um algoritmo em duas fases: uma fase de viabilidade, que visa obter um ponto viável, e outra de complementaridade. Testes numéricos comprovam a grande eficiência desses algoritmos na prática e a lentidão do algoritmo proposto em Judice 1994, quando iterações do tipo Murty são utilizadas.

Para finalizar, utilizamos estes algoritmos como um método para resolver problemas de decomposição em matrizes não negativas, problemas decorrentes do desenvolvimento tecnológico, principalmente devido ao processamento e transmissão de grandes quantidades de dados. Como segunda aplicação, mostramos que os algoritmos apresentados anteriormente podem ser aplicados no Algoritmo de Gradiente Projetado Precondicionado. .

2. *Speaker:* **Juliano de Bem Francisco**
Affiliation: Universidade Federal de Santa Catarina
Title: ***Non-monotone inexact restoration method for minimization on Stiefel manifold***

We consider the problem of minimizing a differentiable functional restricted to the set of nxp matrices with orthonormal columns, also called Stiefel manifold. We present an algorithm based on a non-monotone variation of the inexact restoration method for nonlinear programming problem along with its implementation details. For the restoration phase we employ the well-known Cayley transform for bringing the computed point back to the feasible set (i.e., the restoration phase is exact), which leads to a SVD-free scheme. Under standard assumptions we prove that any limit point of the sequence generated by our algorithm is a stationary point. A numerical comparison with a well established

algorithm is presented and it shows that our approach is reliable and efficient in a wide class of problems.

3. *Speaker:* **Juan Pablo Luna**
Affiliation: UFRJ/COPPE/PEP
Title: ***Analysis of EPEC Models for Power Markets***

A usual equilibrium model in power markets is to consider a leader-follower problem in which the top level involves multiple power producers bidding prices and generation levels. At the bottom level, common to each producer, there is an independent system operator (ISO) that takes all the bids from producers and minimizes the total operation costs, subject to capacity and other bounds on production. As such, the system being modeled in an equilibrium problem with equilibrium constraints (EPEC). We show that already in their simplest instances, such models suffer from two serious drawbacks, related to:

- the existence of many equilibria, which harm the algorithmic solution (cycles), and
- equilibrium prices that can take values above the bids, even for the most expensive dispatched producer.

To address these issues, we propose a dual regularization for the ISO problem, that has an enlightening interpretation in economical terms.

4. *Speaker:* **Felipe Fidalgo**
Affiliation: UFSC
Title: ***Um método dividir-e-conquistar para um Problema de Geometria de Distâncias***

O Problema de Geometria de Distâncias (PGD) é um problema inverso que busca encontrar conformações para um grafo em um espaço métrico que minimizam a função soma das diferenças quadráticas entre a norma da diferença das posições encontradas (ao quadrado) e os valores de distâncias conhecidos (ao quadrado). Neste trabalho, apresentamos uma maneira que usa simetrias inerentes ao problema no espaço Euclidiano tridimensional em uma estrutura divide-and-conquer para resolver o problema.

5. *Speaker:* **Majela Pentón Machado**
Affiliation: UFBA
Title: ***Métodos inexatos de subgradiente proximal***

Apresentamos versões inexatas do método de subgradiente proximal para minimizar a soma de duas funções convexas (não necessariamente diferenciáveis). Os algoritmos envolvem, em cada iteração, avaliações inexatas do operador proximal e subgradientes aproximados das funções (o ϵ-subgradiente).

Analisamos as propriedades de convergência e taxa de convergência destes métodos. Este é um trabalho em colaboração com Reinier Díaz.

6. *Speaker:* **Lucas Eduardo Azevedo Simões**
Affiliation: Universidade Estadual de Campinas
Title: ***Sampling methods for constrained nonsmooth optimization***

Recently, optimization problems involving nonsmooth functions have gained more attention from the optimization community. Pursuing this perspective, a method known as Gradient Sampling (GS) was developed for the solution of unconstrained problems. As a natural extension, a new GS method, based on the exact penalization approach and some SQP ideas, was elaborated for solving nonsmooth problems subjected to nonsmooth constraints. In this talk, we propose a new sampling-like method for constrained nonsmooth optimization problems. As its main feature, a new penalty function is used, which allows the user to have a stronger control over the infeasibility of the iterates than the usual exact penalty strategy. We also present illustrative numerical results to show the main advantages of our approach.

7. *Speaker:* **Thadeu Alves Senne**
Affiliation: UNIFESP
Title: ***Nonlinear systems arising from topology optimization of structures under geometrical nonlinearities***

One of the most common problems in topology optimization consists in minimizing the compliance of a structure, subject to its static equilibrium conditions and to a limited volume of material prescribed. Some structures are under geometrical nonlinearities, meaning that the material used to construct it has a nonlinear relation between deformations and displacements. In this case, to compute the objective function, it is necessary to solve a nonlinear system of equations (associated with the static equilibrium conditions of the structure), usually solved using the Newton's method. In this work, we present a strategy applied in this method with the aim of obtaining an approximate solution of these nonlinear systems in a cheaper way, and we will show some preliminary results. In a previous work of the author, this analysis was done considering a linear material, that has a linear relation between deformations and displacements.

8. *Speaker:* **Douglas Gonçalves**
Affiliation: UFSC
Title: ***Local convergence analysis of the Levenberg-Marquardt framework for nonzero-residue nonlinear least-squares problems under an error bound condition***

The Levenberg-Marquardt method (LM) is widely used for solving nonlinear systems of equations, as well as nonlinear least-squares problems. In this paper, we consider local convergence issues of the

LM method when applied to nonzero-residue nonlinear least-squares problems under an error bound condition, which is weaker than requiring full-rank of the Jacobian in a neighborhood of a stationary point. Differently from the zero-residue case, the choice of the LM parameter is shown to be dictated by (i) the behavior of the rank of the Jacobian, and (ii) a combined measure of nonlinearity and residue size in a neighborhood of the set of (possibly non-isolated) stationary points of the sum of squares function.

9. *Speaker:* **Roger Behling**
Affiliation: Universidade Federal de Santa Catarina
Title: ***A special complementarity fucntion revisited***

Recently, a local framework of Newton-type methods for constrained systems of equations has been developed. Applied to the solution of Karush–Kuhn–Tucker (KKT) systems, the framework enables local quadratic convergence under conditions that allow nonisolated and degenerate KKT points. This result is based on a reformulation of the KKT conditions as a constrained piecewise smooth system of equations. It is an open question whether a comparable result can be achieved for other (not piecewise smooth) reformulations. It will be shown that this is possible if the KKT system is reformulated by means of the Fischer–Burmeister complementarity function under conditions that allow degenerate KKT points and nonisolated Lagrange multipliers. To this end, novel constrained Levenberg–Marquardt subproblems are introduced. They allow significantly longer steps for updating the multipliers. Based on this, a convergence rate of at least 1.5 is shown.

10. *Speaker:* **Jose Alberto Ramos Flor**
Affiliation: Universidade Federal de Parana (UFPR)
Title: ***On the Complexity analysis for a class of sparse optimization problems over polyhedron***

Sparse optimization is an important machine learning tool, useful for extracting information for a massive data with certain characteristics. Furthermore, such optimization problems arise commonly in image restoration, signal processing and variable selection, etc. In this talk, we review optimality conditions, complexity analysis results and numerical methods for sparse minimization problems.

11. *Speaker:* **Max Leandro Nobre Gonçalves**
Affiliation: Universidade Federal de Goiás
Title: ***A partially inexact generalized alternating direction method of multipliers and its iteration-complexity analysis***

In this talk, we will present the complexity analysis of a version partially inexact of the alternating direction method of multipliers for computing approximate solution of a linearly constrained convex optimization problem. Some numerical tests for the proposed method will also be illustrated.

12. *Speaker:* **Luís Felipe Bueno**
Affiliation: UNIFESP
Title: ***On the complexity analysis of an Inexact Restoration method***

In recent years, there has been an increase in interest in the analysis of the complexity of nonlinear optimization algorithms. For constrained optimization, there are few results on algorithm complexity. Notable references on this subject deal with simple constraints or do not present an affordable algorithm. Inexact Restoration (IR) methods deal with feasibility and optimality in different phases and therefore can explore specific characteristics of the constraints or the objective function in the corresponding phase. In this work we present an IR algorithm that in the first phase searches for a more feasible point using a first order method with complexity of epsilon to the power minus two to solve a box constrained least squares problem. In the second phase, another first-order method with the same complexity is used, but it deals with linear constraints. Combining these ideas, we obtain a practical first order IR method for which we present a theory of complexity of the same order for nonlinear optimization with general constraints.

13. *Speaker:* **Geovani Nunes Grapiglia**
Affiliation: Universidade Federal do Paraná
Title: ***A refined worst-case complexity analysis for non-monotone line searches***

A non-monotone line search framework has been proposed by Sachs and Sachs (Control Cybern 40: 1059-1075, 2011) for smooth unconstrained op- timization problems, generalizing several non-monotone stepsize rules. More recently, worst-case complexity bounds to achieve approximate first-order opti- mality were proved by Grapiglia and Sachs (Comput Optim Appl 68: 555-577, 2017) for this framework under the assumption that the sequence of param- eters that control the non-monotonicity is summable. In this talk, we relax this assumption in various ways and provide complexity estimates for the resulting non-monotone schemes. New non-monotone stepsize rules are obtained for which preliminary numerical results are also reported.

14. *Speaker:* **Glaydston de Carvalho Bento**
Affiliation: UFG
Title: ***An Approach on Proximal Methods for Vector Optimization***

In this talk, will be presented an approach on proximal point methods for vector optimization. The main proposals and results already achieved in this direction will be presented. In particular, it is explored an optimality condition, for multiobjective problems, which allowed us to consider the method without any assumption of convexity over the constraint sets that determine the vectorial improvement steps.

15. *Speaker:* **Leandro da Fonseca Prudente**
Affiliation: UFG
Title: ***A Wolfe line search algorithm for vector optimization***

In a recent paper, Lucambio Pérez and Prudente extended the Wolfe conditions for the vector-valued optimization. In this talk, we will present a line search algorithm for finding a step-size satisfying the strong Wolfe conditions in the vector optimization setting. Well definiteness and finite termination results will be presented. We will discuss practical aspects related to the algorithm and present some numerical experiments illustrating its applicability.

16. *Speaker:* **Leonardo Delarmelina Secchin**
Affiliation: UFES
Title: ***Uma condição sequencial de otimalidade associada à quasinormalidade, e suas consequências algorítmicas***

Provamos que o método de Lagrangiano aumentado tipo PHR converge a pontos KKT sob quasinormalidade, uma condição de qualificação associada à teoria de penalidade externa. Para este fim, uma nova condição sequencial de otimalidade para otimização com restrições, chamada PAKKT, foi definida. Esta nova condição leva em consideração os sinais dos multiplicadores, constituindo-se em uma contrapartida sequencial adequada às chamadas condições de Fritz-John melhoradas, propostas por Hestenes e extensivamente tratadas por Bertsekas. Fornecemos também uma nova condição de qualificação, associada a PAKKT, estritamente menos exigente que quasinormalidade e a recente noção de cone continuidade. Generalizamos assim resultados anteriores sobre a convergência do método considerado.

17. *Speaker:* **Reinier Díaz Millán**
Affiliation: Instituto Federal de Goiás
Title: ***A projection algorithm for non-monotone variational inequalities***

We introduce a projection-type algorithm for solving the variational inequality problem for point-to-set operators, and establish its convergence properties. Namely, we assume that the operator T in the variational inequality is continuous in the point-to-set sense, i.e., inner- and outer-semicontinuous. Under the assumption that the dual solution set is not empty, we prove that our method converges to a solution of the variational inequality. Instead of the monotonicity assumption, we require the non-emptiness of the solution set of the dual formulation of the variational inequality. We provide numerical experiments illustrating the behavior of our iterates. Moreover, we compare our new method with a recent similar one.

18. *Speaker:* **Luiz-Rafael Santos**
Affiliation: Universidade Federal de Santa Catarina
Title: ***AN INTERIOR POINT METHOD WITH NO CENTRALITY PARAMETER***

We propose an interior point method that iteratively solves the KKT system that arises from a Quadratic Programming problem based on an approximation of the 2nd order information and on a trust region, defined by a set of polynomials constraints. This method makes no use of central path wathsoever, that is, is non-homotopic, rather uses a weight on the correction direction that is chosen on an optimal manner, such that, at each iteration, the residual of the KKT system has its maximal reduction.

19. *Speaker:* **ROBERTO ANTONIO CORDEIRO PRATA**
Affiliation: UFAM
Title: ***Operações com Números Fuzzy F-correlacionados***

Neste trabalho, nossa proposta é discorrer sobre os números fuzzy f-correlacionados, no qual generalizamos o conceito de números fuzzy completamente correlacionados . Que no nosso caso, a formulação foi feita através de uma função monótona e injetora. Serão também apresentadas algumas propriedades estatísticas para números fuzzy f-correlacionados.

20. *Speaker:* **Evelin Heringer Manoel Krulikovski**
Affiliation: UFPR
Title: ***ANÁLISE TEÓRICA DE MÁQUINAS DE VETORES SUPORTE***

O objetivo geral deste trabalho foi realizar um estudo teórico sobre Máquinas de Vetores Suporte (SVM), que inclui relatar justificativas para o uso de tal técnica e exibir sua interpretação geométrica e perspectiva analítica. Para aplicar a técnica em problemas de classificação, buscamos fundamentar matematicamente sua utilização, visto que envolve um problema de programação quadrática, convexa e com restrições. Para a análise da técnica, utilizamos a teoria de dualidade Lagrangiana, que notamos facilitar os cálculos e a análise das soluções. Além disso, reescrevemos resultados que usam ponto de sela, sem precisar deste conceito. Estabelecemos algumas implicações e exibimos alguns contraexemplos, para mostrar que certos resultados decorrentes da técnica SVM encontrados na literatura não são precisos.