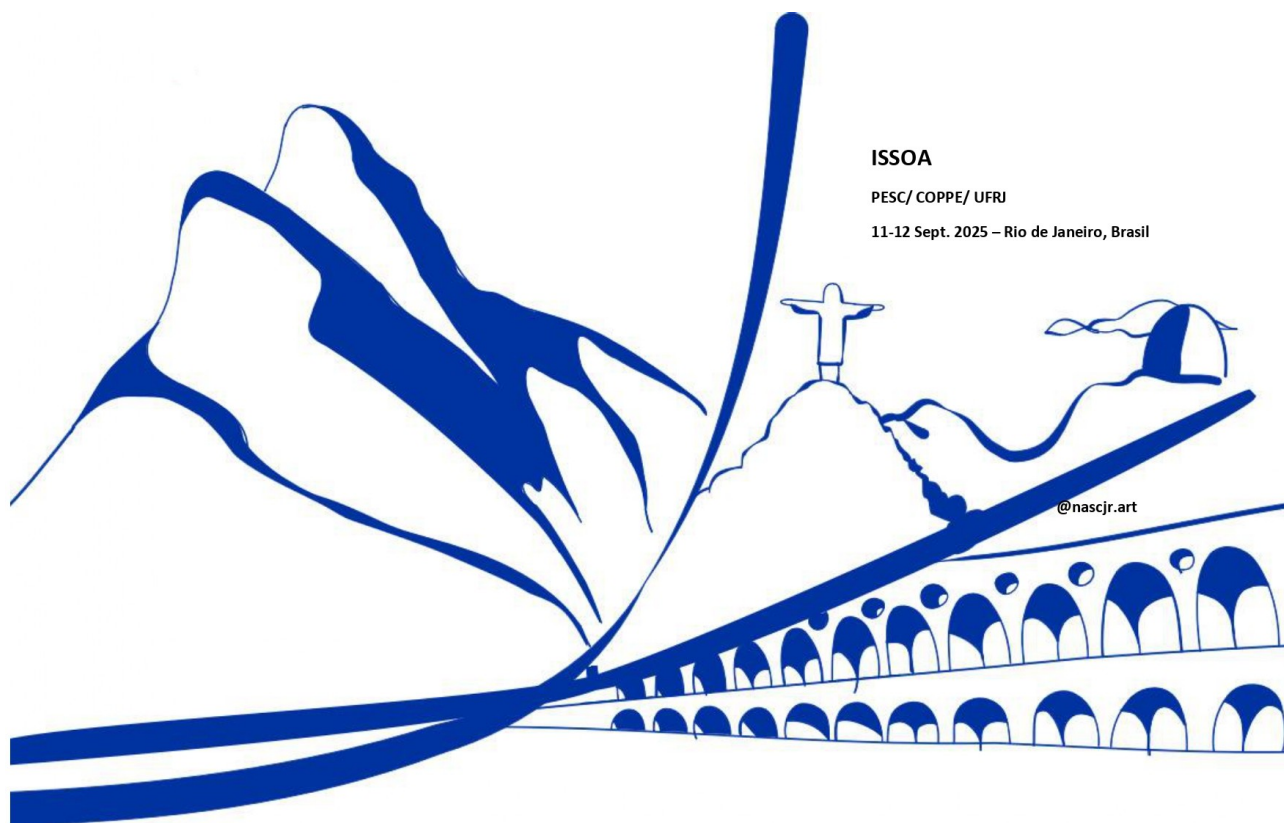




ISSOA

PESC/ COPPE/ UFRJ

11-12 Sept. 2025 – Rio de Janeiro, Brasil

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International Seminar on Smoothing Optimization Algorithms

em homenagem a
[Adilson Elias Xavier](#)

Quarenta e três anos da Técnica de Suavização
Hiperbólica no Brasil

11th – 12th Setembro 2025

Sessão Especial em Memória de

[*José Herskovits Norman*](#)

Feasible Direction Interior Point Algorithm
(FDIPA e FAIPA)

COPPE-Programa de Engenharia de Sistemas e
Computação (PESC)

e

Instituto de Matemática

Universidade Federal do Rio de Janeiro
Brasil

1 Local

Avenida Horácio Macedo, 2030, sala G-122
Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa de Engenharia-Centro de Tecnologia (COPPE), UFRJ - Cidade Universitária.

2 Organizadores

- Nelson Maculan, PESC/IM/COPPE/UFRJ, Brazil.
- Jano Moreira de Souza, PESC/COPPE/UFRJ, Brazil.
- Lennin Mallma Ramirez, PESC/COPPE/UFRJ, Brazil.

3 Comité Científico

- Nelson Maculan, UFRJ, Brasil.
- Paulo Roberto Oliveira, UFRJ, Brasil.
- Lennin Mallma Ramirez, UFRJ, Brasil.
- Benar Fux Svaiter, IMPA, Brasil.
- Philippe Michelon, Avignon Université, França.

4 Comité Organizador

- Nelson Maculan, UFRJ, Brasil.
- Grigori Chapiro, UFJF, Brasil.
- Argimiro Resende Secchi, UFRJ, Brasil.
- Vinicius Layter Xavier, UERJ, Brasil.
- Jéssica Richards Nascimento, UFRJ, Brasil.
- Igor Pereira dos Santos Pereira, UFRJ, Brasil.
- Renan Vicente Pinto, UFRJ, Brasil.
- Lennin Mallma Ramirez, UFRJ, Brasil.

5 Palestrantes Convidados

- Adil Bagirov, FUA, Australia.
- André Luiz Diniz, CEPEL, Brasil.
- Argimiro Resende Secchi, UFRJ, Brasil.
- Carlile Lavor, UNICAMP, Brasil.
- Emilio Vilches, UOH, Chile.
- Ernesto J.G. Birgin, USP, Brasil.
- Grigori Chapiro, UFJF, Brasil.
- Orizon Pereira Ferreira, UFG, Brasil.

6 Conferência

- Amit Bhaya, UFRJ, Brasil.

- Otto Corrêa Rotunno Filho, UFRJ, Brasil.

7 Sessão Especial: em memória de José Herskovits Norman

- Jean-Rodolphe Roche, Université de Lorraine, França.
- Juan Pablo Luna, UFRJ, Brasil.
- Nelson Maculan, UFRJ, Brasil.
- Nestor Alberto Zouain Pereira, UFRJ, Brasil.
- Sandro Rodrigues Mazorche, UFJF, Brasil.

Secretária

- Patrícia Siqueira Leal, COPPE/UFRJ.
- Eliah Alves Costa, COPPE/UFRJ.

Este evento foi patrocinado por:

- CNPq, CAPES, FAPERJ, FAPEMIG e COPPETEC.

8 Resumos

Adil Bagirov

Centre for Smart Analytics, Institute of Innovation, Science and Sustainability,
Federation University Australia, Ballarat, Victoria, Australia

Title: *Smoothing Techniques in Nonsmooth Optimization and Applications*

Abstract:

In this talk, we discuss different approaches for smoothing nonsmooth functions. We consider the local smoothing techniques which approximate the function in some neighbourhood of a point of nondifferentiability and global smoothing techniques which approximate the function in the whole domain. The relationships between gradients of smoothed functions and subdifferentials and ϵ -subdifferentials (when a function is convex) of the nonsmooth function are discussed. We present numerical results using some illustrative examples. Finally, we consider application of smoothing techniques to solve some problems in machine learning, including partitional clustering and clusterwise linear regression problems.

André Luiz Diniz

Cepel, Brazil

Title: *The value of smooth optimization in optimal power generation problems*

Abstract:

Optimal power generation problems are usually modeled with linear or mixed-integer linear functions, not only due to higher performance of LP and MILP commercial solvers as compared to NLP and MINLP solution strategies, but also because some decomposition algorithms, such as stochastic dual dynamic programming (SDDP), are better suitable for affine problems. In this sense, nonconvex nonlinear constraints such as the hydro production function and power losses in transmission lines are usually approximated with piecewise linear inequalities, under some conditions. However, the use of smooth optimization tends to provide better behaved solutions in both primal variables, in terms of operation profile of hydro and thermal plants over time, and dual variables, such as water values and energy prices, in terms of stability. This talk aims to discuss the above aspects, as well as to evaluate the trade-off between a better quality in representing the real cost functions / constraints and the computational cost in solving the related problems.

Argimiro Resende Secchi
PEQ/COPPE/UFRJ

Title: *Real-Time Optimization: Advances and Challenges*

Abstract:

Real-Time Optimization (RTO), particularly in its dynamic form (D-RTO), is essential for integrating modeling, control, and decision-making in modern industrial processes. This talk explores key advances in dynamic optimization, covering numerical methods, model-based formulations, and applications across chemical engineering systems. D-RTO enables optimal trajectory tracking under transient conditions and frequent disturbances while improving economic performance and operational safety. Treatment of constraints are also addressed, including multi-objective optimization and strategies that incorporate hyperbolic relaxations to handle infeasibilities and ensure smooth optimization under strict operational limits. The presentation also discusses approaches for hybrid modeling, uncertainty handling, and online model adaptation to mitigate plant-model mismatch. Despite the significant progress, challenges persist in computational scalability, model maintenance, and the real-time infrastructure needed for large-scale applications. The talk concludes with future perspectives for D-RTO in the context of digitalization and Industry 4.0.

Carlile Lavor
University of Campinas (UNICAMP), Brazil

Title: *A Geometric Framework Beyond Euclidean Space for Molecular Optimization*

Abstract:

Molecular geometry optimization plays a central role in computational chemistry, relying heavily on the efficient computation of interatomic distances and their derivatives. This talk presents a novel geometric framework based on a non-Euclidean model of the 3D space, designed to improve the performance of energy minimization algorithms by simplifying distance and derivative calculations.

Emilio Vilches
Universidad de O'Higgins, Chile

Title: *Approximating Probability Functions for Chance-Constrained Optimization*

Abstract:

Optimization problems with uncertainty in the constraints arise in many applications. A common approach is to use probability functions to model feasibility under randomness. However, these functions are often nonsmooth, which complicates optimization. To address this, we propose a regularization based on the Moreau envelope applied to a scalarization of the underlying inequality system. We show that the regularized function becomes smooth and converges, in a variational sense, to the original probability function. This guarantees that, under suitable conditions, solutions to the regularized problems approximate those of the original problem. Applications include joint, semidefinite, and robust chance-constrained optimization.

Ernesto G. Birgin

Department of Computer Science, Institute of Mathematics and Statistics, University of São Paulo, Brazil

Title: *A tour through selected numerical optimization methods presented by a graphical representation of the problems they can solve*

Abstract:

This talk focuses on the development of numerical optimization methods. Over the past few decades, we have developed methods for unconstrained minimization, minimization with linear constraints, minimization in convex sets, and minimization with general constraints, to name a few. Typically, when a new method is developed, its performance is compared with existing methods. In other cases, we use problems with special characteristics to illustrate the mechanism or advantages of the proposed method. Many of our works consider geometrically interpretable problems, whose solutions can be illustrated with figures. In this lecture, we will take a trip through some of the optimization methods we have developed over the last two decades, inverting the usual order of presentation by using pictures as a guide instead of presenting formulas, methods, or theorems.

Grigori Chapiro

Laboratório de Matemática Aplicada (LAMAP) da Universidade Federal de Juiz de Fora, Brazil

Title: *Applications of the Interior-point Algorithm for (Mixed) Complementarity Nonlinear Problems*

Abstract:

Nonlinear complementarity and mixed complementarity problems arise in mathematical models describing several applications in Engineering, Economics, and different branches of Physics. José Herskovits developed a robust and efficient Feasible Directions interior-point Algorithm for nonlinear complementarity problems. In a joint work, we extended it to mixed nonlinear complementarity problems. At each iteration, the algorithm finds a feasible direction with respect to the region defined by the inequality conditions, which is also a monotonic descent direction for the potential function. Then, an approximate line search along this direction is performed in order to define the next iteration.

The algorithm is applied to several examples, including a system of nonlinear differential equations describing an in situ combustion model, and the elastic-plastic torsion problem encountered in the field of Solid Mechanics.

References:

1. An interior point algorithm for mixed complementarity nonlinear problems AER Gutierrez, SR Mazonche, J Herskovits, G Chapiro Journal of Optimization Theory and Applications 175 (2), 432-449
2. Numerical solution of a class of moving boundary problems with a nonlinear complementarity approach G Chapiro, AER Gutierrez, J Herskovits, SR Mazonche, WS Pereira Journal of Optimization Theory and Applications 168 (2), 534-550

Orizon Pereira Ferreira

Federal University of Goiás (UFG)

Institute of Mathematics and Statistics-IME/UFG, Brazil

Title: *Constraint qualifications and augmented Lagrangian method on Riemannian manifolds*

Abstract:

Recent developments in nonlinear programming in the Euclidean context are formulated for optimization on Riemannian manifolds, encompassing both equality and inequality constraints. While unconstrained optimization problems on manifolds have been extensively studied, the treatment of constrained scenarios has only recently gained attention. The current work aims to fill this gap by incorporating the latest advancements in nonlinear programming. Several well-established constraint qualifications adapted from the Euclidean domain are introduced, ensuring the global convergence of augmented Lagrangian methods without necessitating the boundedness of Lagrange multipliers. Furthermore, the convergence of the dual sequence under a weak constraint qualification is established. Central to the approach are sequential optimality conditions, a robust framework utilized in this context. While primarily focused on optimization on Riemannian manifolds, the present study also serves as a comprehensive review of key constraint qualifications and the global convergence theory of cutting-edge augmented Lagrangian methods in the Euclidean context.

Sandro Rodrigues Mazorche

Universidade Federal de Juiz de Fora, Brazil

Title: *FDIPA no tempo da COVID-19*

Abstract:

O FDIPA (Feasible Direction Interior Point Algorithm) foi introduzido em 1982 no artigo “A two-stage feasible direction algorithm including variable metric techniques for non-linear optimization problems”, tornando-se um dos primeiros métodos de pontos interiores para otimização não linear. Essa abordagem inovadora permitiu resolver problemas complexos em engenharia e matemática aplicada. Nesta apresentação, será demonstrado como o FDIPA foi adaptado para calibrar o Modelo SIR na versão fracionária, a fim de obter os parâmetros que melhor ajustam a curva de infectados durante a Pandemia de COVID-19 no ano de 2020.

Juan Pablo Luna

Programa de Engenharia de Produção, COPPE, UFRJ, Brazil

Title: *Regularized Equilibrium Problems with Equilibrium Constraints with Application to Energy Markets*

Abstract:

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.

Amit Bhaya

Department of Electrical Engineering, COPPE/UFRJ
Rio de Janeiro-RJ, Brazil

Title: *One step ahead control and its applications*

Abstract:

This talk focuses on one step ahead optimal control in discrete time. This class of optimal control problems allows a transcription of the optimal control problem for a dynamical system with control and exogenous inputs to a mathematical programming problem. The transcription is computationally cheap, because of the one step horizon, which recedes as the control computation advances. Prediction of the exogenous input is also simplified. This approach is seen to be applicable to a wide range of problems, and examples from inventory control, opinion dynamics games and cash balance problems will be presented.

Otto Corrêa Rotunno Filho

Laboratory of Water Resources and Environmental Studies (LABH2O),
Civil Engineering Program, Alberto Luiz Coimbra Institute for Postgraduate
Studies and Research in Engineering-COPPE, Federal University of Rio
de Janeiro, CEP 21945-970, Rio de Janeiro-RJ, Brazil

Title: *Challenges and Opportunities in Water Monitoring: The Hyperbolic Smoothing Approach for Automatic Calibration of Rainfall-Runoff Models*

Abstract:

Rainfall-runoff modelling continues to be a challenge for hydrologists. There has been a great effort in mathematical modelling coupled with experimental work during the last six decades in order to better understand the behaviour of nature. Hydrologic processes can be analysed on the basis of the equations of hydraulics and soil physics, but the high degree of variability in a catchment of any size poses serious problems of parameter specification and parameter estimation. Due to threshold structures commonly occurring in conceptual rainfall-runoff models, the associated mathematical optimization problems have the significant characteristic of being strongly non-differentiable. In order to face this enormous task, the hyperbolic smoothing technique represents an alternative still to be better explored and investigated regarding automatic parameter calibration of rainfall-runoff models. The resolution method proposed adopts a smoothing strategy using a special C^∞ differentiable class function. The final estimation solution is obtained by solving a sequence of differentiable subproblems which gradually approach the original conceptual problem.

Keywords: Hydrological Modeling, Rainfall-runoff models; Automatic calibration; Hyperbolic smoothing method

Adilson Elias Xavier

PESC/COPPE/UFRJ, Brazil

Title: *Solving Large Problems of the Literature with Incremental Accelerated Hyperbolic Smoothing Clustering Method*

Abstract:

This article considers the minimum sum-of-squares clustering problem. The mathematical modelling of this problem leads to a min-sum-min formulation which, in addition to its intrinsic bi-level nature, has the significant characteristic of being nondifferentiable. To overcome these difficulties, the proposed resolution method, called Hyperbolic Smoothing, adopts a smoothing strategy which engenders an unconstrained C^∞ differentiable problem. The proposed algorithm applies also a partition of the set of observations into two non-overlapping groups: “data in frontier” and “data in gravitational regions”, which drastically simplify the computational tasks. Moreover, the article introduces a novel incremental procedure to produce good starting points. Results of numerical experiments on some of the largest canonical test instances show the good performance of the algorithm.

9 Biografias Curtas

9.1 Uma biografia de Adilson Elias Xavier, por Vinicius Layter Xavier

Professor do PESC-COPPE da linha Otimização , com interesse em Programação Linear , Programação Não-Linear, Análise de Agrupamentos, Classificação , Recobrimento, Problemas de Localização , Logística, Modelos Hidrológicos e Implementação de Softwares Matemáticos.

Tem como tema de pesquisa central três técnicas: **Penalização Hiperbólica**, **Lagrangeano Hiperbólico** e **Suavização Hiperbólica**.

Desenvolveu o método da “Penalização Hiperbólica”, há cerca de 35 anos, tendo por objetivo a resolução do problema geral da programação não-linear sujeito a restrições de desigualdade. O método trabalha com uma função que apresenta a singular característica de possuir perfeita continuidade em suas derivadas, de qualquer ordem, em todo o domínio dos reais, ou seja, é de classe C^∞ em todo domínio real. O método “Lagrangeano Hiperbólico” é resultado da exploração teórica das ligações entre o método da Penalização Hiperbólica e a Função Lagrangeana. A técnica de “Suavização Hiperbólica” basicamente consiste na utilização da função penalidade hiperbólica para efetuar a transformação de Problemas de Programação Não-Diferenciáveis em problemas completamente diferenciáveis (classe C^∞). Destarte, torna-se possível a utilização de técnicas de minimização irrestrita consagradamente mais poderosas, que se utilizam das informações das derivadas de primeira e segunda ordem. A técnica de Suavização Hiperbólica foi originalmente utilizada na Calibração Automática de Modelos Hidrológicos. Atualmente, tem sido utilizada com resultados inauditos na resolução de uma ampla classe de Problemas de Programação Não- Diferenciáveis como: Minimax, Clustering, Facility Location, Hub Location, Covering 2D e 3D, Distance Geometry e Packing. Complementarmente, tem se dedicado ao desenvolvimento de aplicações para: Petrobras, CEPEL, Eletrobras, ONS, Furnas, Embratel e Secretaria Saúde Estado RJ.

9.2 Uma biografia de José Herskovits Norman, por Grigori Chapiro e Sandro Rodrigues Mazorche

O Professor José Herskovits foi um destacado pesquisador e educador na área de Engenharia Mecânica e Otimização, com uma brilhante carreira acadêmica. Graduado em Engenharia Industrial pela Universidade da República do Uruguai (1972), mestre em Engenharia Mecânica pela UFRJ (1976) e doutor em Matemáticas da Decisão pela Université de Paris IX (1982), atuou como Professor Titular no Programa de Engenharia Mecânica da COPPE/UFRJ desde 1977 até 2017 e de 2017/2023 foi Professor Colaborador Voluntário e Pesquisador Visitante Emérito. Desenvolveu técnicas pioneiras em otimização, como Algoritmo de Ponto Interior por Direções/Arcos Viáveis (FDIPA e FAIPA), aplicadas em problemas não lineares, semidefinidos e de complementaridade (FDA-NCP e FAA-NCP), amplamente utilizadas pela comunidade científica e industrial. Ele foi autor de 73 artigos em periódicos internacionais, 145 trabalhos em conferências, 10 capítulos de livros e editor de 10 livros, além de ter orientado 19 teses de doutorado e 28 dissertações de mestrado. Com uma atuação internacional relevante, Herskovits foi professor visitante em mais de 15 universidades estrangeiras, incluindo instituições na França, Portugal, Uruguai e Coreia do Sul, e colaborou com indústrias como Dassault Aviation, Renault, Petrobras e EMBRA-Tel. Participou ativamente da organização de conferências científicas, destacando-se a série EngOpt (Conferência Internacional em Otimização em Engenharia), e integrou comitês editoriais de revistas como Latin American Journal of Solids and Structures, Engineering Optimization e Structural and Multidisciplinary Optimization. Reconhecido por sua contribuição à ciência, foi bolsista do Programa Cientista do Nosso Estado da FAPERJ e bolsista de produtividade do CNPq, consolidando-se como uma referência em otimização estrutural e mecânica nacional e internacional. A técnica desenvolvida por José Herskovits que originou o FDIPA (Feasible Direction Interior Point Algorithm) teve seu início durante seu doutorado na Université de Paris IX (Dauphine) onde destacamos o artigo de 1982: “A two-stage feasible direction algorithm including variable metric techniques for non-linear optimization problems”. Esse trabalho marcou o desenvolvimento de um dos primeiros métodos de pontos interiores para problemas de otimização não linear, uma abordagem inovadora que permitia a solução de problemas complexos de engenharia e matemática aplicada. O FDIPA, em particular, tornou-se uma referência na área por sua eficiência em garantir viabilidade e convergência em problemas de otimização com restrições, sendo amplamente adotado tanto no meio acadêmico quanto no setor produtivo. O algoritmo foi aprimorado ao longo dos anos, dando origem a variações como o FAIPA (Feasible Arc Interior Point Algorithm), que ampliou sua aplicabilidade para problemas de otimização não diferenciável, semidefinida e de complementaridade não linear. Essas contribuições consolidaram Herskovits como um pioneiro na área de otimização estrutural, com impacto significativo em aplicações práticas, como projetos aeronáuticos, automotivos e de energia, além de influenciar gerações de pesquisadores e profissionais da área.

10 Fotografias do Seminário



Fig. 1 Amit Bhaya, UFRJ, Brasil



Fig. 2 Argimiro R. Secchi, UFRJ, Brasil



Fig. 3 André L. Diniz, CEPEL, Brasil



Fig. 4 Orizon P. Ferreira, UFG, Brasil



Fig. 5 Otto C. Rotunno F., UFRJ, Brasil



Fig. 6 Emilio Vilches, UOP, Chile



Fig. 7 Ernesto Birgin, USP, Brasil



Fig. 8 Jean-Rodolphe Roche, Université de Lorraine, França



Fig. 9 Juan Pablo Luna, UFRJ, Brasil



Fig. 10 Nestor A. Zouain P., UFRJ, Brasil



Fig. 11 Sandro Rodrigues Mazorche, UFJF, Brasil



Fig. 12 Grigori Chapiro, UFJF, Brasil



Fig. 13 Carlile Lavor, UNICAMP, Brasil



Fig. 14 Adil Bagirov, FUA, Austrália



Fig. 15 Professores: Adil Bagirov e Adilson E. Xavier



Fig. 16 Prof. Adilson E. Xavier



Fig. 17 Professores: A. Bagirov e N. Maculan



Fig. 18 O Prof. Nelson Maculan conduz todas as palestras nos dois dias do seminário



Fig. 19 Fotografia de Grupo