UNIVERSITY OF TRIESTE

Department of Mathematics, Informatics and Geosciences

PhD Course

ON

Computational Techniques in Modern Optimization: From Interior Point Methods to Machine Learning and AI

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Abstract

This course will address practical methods of modern optimization and their applications. It will cover (briefly) interior point methods for linear and quadratic programming including the aspects of their efficient implementation. The success of the latter is based on the ability to cleverly exploit sparse matrix techniques in the linear algebra operations.

Several applications of optimization algorithms in data science will also be discussed: classification problems arising in statistics and machine learning, inverse problems in statistics and signal and image processing, unconstrained optimization problems arising in AI.

Jacek Gondzio is a Full Professor in Optimization at the School of Maths of the University of Edinburgh.

His research interests include the theory and implementation of large scale optimization methods.

He is an expert in Interior Point methods for linear, quadratic, nonlinear and semidefinite programming, cutting plane methods for convex nondifferentiable optimization and column generation approaches for combinatorial optimization.

He has authored or co-authored more than 100 papers published in international peer-reviewed scientific journals.

Schedule:

Tuesday 8 October: 14-16
Wednesday 9 October:14-16
Thursday 10 October: 14-16
Friday 11 October: 10-12

Content

Lectures 1 and 2
Mathematical background of optimization: unconstrained and constrained optimization, convexity and duality; Convex sets and functions; Lagrangian and Wolfe's duality.

Lectures 3 and 4
Interior point methods for linear and quadratic programming; IPM framework: logarithmic barrier, optimality conditions, Newton method; Self-concordant barriers, worst-case complexity of IPMs.

Lectures 5 and 6
Computational aspects of interior point methods: KKT systems, Cholesky factorization, exploiting sparsity; Exploiting structure in very large scale computations.

Lectures 7 and 8
Several applications of optimization: Classification with Support Vector Machines, Inverse problems arising in statistics and signal and image processing, Using Stochastic Gradient to train Neural Networks.