מכון ויצמן למדע

THE WEIZMANN INSTITUTE OF SCIENCE

FACULTY OF MATHEMATICS AND COMPUTER SCIENCE

Machine Learning and Statistics Seminar

Room 1 ,Ziskind Building
on Wednesday, Dec 30, 2015
at 11:15

Joint Mathematical Analysis and Applications & Machine Learning and Statistics seminar

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Efficient algorithms for large scale parameter estimation

Abstract:

Parameter estimation is performed by fitting data measurements to a model using Bayesian statistics, assuming additional prior information. The estimation requires a numerical solution of large scale optimization problem, whose objective traditionally includes data fidelity and regularization terms. In this talk I will present numerical solution methods for two such estimation problems.

In the first part of the talk I will concentrate on parameter estimation of physical models, obtained by solving optimization problems that are constrained by partial differential equations (PDEs). I will focus on my recent work on 3D Full Waveform Inversion, which arises in seismic exploration of oil and gas reservoirs, earth sub-surface mapping, ultrasound imaging and more. I will demonstrate how to computationally treat this inverse problem, and improve its solution by using travel time tomography in a joint inversion framework. This includes efficient algorithms for the solution of the Helmholtz and eikonal equations (the two associated PDEs), and a parallel software framework for applying these algorithms for the joint inversion using a Gauss Newton algorithm.

In the second part of the talk, I will consider the estimation of large scale sparse inverse covariance matrices of multivariate Gaussian distribution. Such matrices are often used to characterize and analyze data measurements in fields that range from machine learning, signal processing and computational biology. To estimate these matrices, an l1 regularized log-determinant optimization problem needs to be solved. I will present a block-coordinate descent algorithm that can efficiently solve this problem at large scales with low memory footprint, and a multilevel acceleration framework that is suitable for general sparse optimization problems. These algorithms can be used as a tool for enriching inverse problems by "learning" appropriate prior information, adopting an empirical Bayesian framework.