Department of Mathematical and Computer Sciences

From Prediction to Prescription - Design in Inversion

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Friday, November 6th, 3:00 p.m. Chauvenet Hall 143

Inverse problems emerge frequently in science and engineering. In particular, these problems play a noteworthy role in the fields of biomedical and geophysical imaging, spanning a broad range of clinical, functional and operational applications. Many of these problems are classified as ill-posed, which implies that a naïve attempt to resolve these problems may yield non-unique solutions. In order to overcome the intrinsic ill-posed nature of these problems, two independent and yet complementary avenues can be considered. One way is by improving the experimental design. As a result, more discriminating information can be extracted already within the data acquisition process, and therefore, solution ambiguity is partly diminished. Another way of enhancing the fidelity of the obtained solutions is by imposition of a-priori information through regularization. Traditionally, the mathematical interpretation of a-priori knowledge is considerably subjective. Thus, a way to mathematically prescribe more objective a-priori information is essential. In this talk, a generic optimal experimental design framework for non-linear, ill-posed problems is presented. In addition, an implicit regularization learning method is introduced. Both approaches promote the use of sparsity constraints in empirical Bayesian risk minimization schemes. The statistical merit and computational considerations are discussed, and the effectiveness of the methods is demonstrated for neuroimaging and geosciences applications.

Bio: Lior conducted his PhD studies in UCL, London with Simon Arridge and David Holder, where he worked on the development of innovative medical imaging techniques. Later, Dr. Horesh visited Eldad Haber in Emory University, where he investigated some of the fundamental aspects of inverse problems and large-scale modeling, covering problems like regularization learning, optimal experimental design and OcTree-based adaptive mesh refinement. Currently, serves as a senior research scientist at the Mathematical Sciences department of IBM Watson research center, NY. His recent research is addresses numerical modeling and inversion of large-scale geophysical and environmentally related problems.