Bhaswar Bhattacharya: Inference in Ising Models

(Work with Sumit Mukherjee)

The Ising spin glass is a one-parameter exponential family model for binary data with quadratic sufficient statistic. In this paper, we show that given a single realization from this model, the maximum pseudolikelihood estimate (MPLE) of the natural parameter is $\sqrt{a_N}$ consistent at a point whenever the log-partition function has order a_N in a neighborhood of that point. This gives consistency rates of the MPLE for ferromagnetic Ising models on general weighted graphs in all regimes, extending results of Chatterjee (2007) where only $\sqrt N$-consistency of the MPLE was shown. It is also shown that consistent testing, and hence estimation, is impossible in the high temperature phase in ferromagnetic Ising models on a converging sequence of weighted

graphs, which includes the Curie-Weiss model. In this regime, the sufficient statistic is distributed as a weighted sum of independent

χ^2_1 random variables, and the asymptotic power of the most powerful test is determined.

Barbara Bravi: Inference for dynamics of continuous variables: the Extended Plefka Expansion with hidden nodes

We consider the problem of a subnetwork of observed nodes embedded into a larger bulk of unknown (i.e. hidden) nodes, where the aim is to infer these hidden states given information about the

subnetwork dynamics. The biochemical networks underlying many cellular and metabolic processes are important realizations of such a scenario as typically one is interested in reconstructing the time evolution of unobserved chemical concentrations starting from the experimentally more accessible ones. As a paradigmatic model we study the stochastic linear dynamics of continuous degrees of freedom interacting via random Gaussian couplings. The resulting joint distribution is known to be Gaussian and this allows us to fully characterize the posterior statistics of the hidden nodes. In particular the equal-time hidden-to-hidden correlation – conditioned on observations - gives the expected error when the hidden time courses are predicted based on the observations. We study it in the stationary regime and in the infinite network size limit by resorting to a novel dynamical mean field approximation, the Extended Plefka Expansion, that is based on a path integral description of the stochastic dynamics. We analyze the phase diagram in the space of the relevant parameters, namely the ratio between the numbers of observed and hidden nodes, the degree of symmetry of the interactions and the relative amplitudes of the hidden-to-hidden and hidden-to-observed couplings with respect to the decay constant of the internal hidden dynamics. We assess in particular how the interplay of such structural properties of the system may affect the accuracy of the prediction by identifying critical regions for the inference error, i.e. parameters values for which the error would diverge.