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Broadcasting with Random Matrices

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Konstantinos Zampetakis and Charilaos Efthymiou

Abstract: Motivated by the theory of spin-glasses in physics, we study the so-called reconstruction problem for the related distributions on the tree, and on the sparse random graph G(n,d/n).

Both cases, reduce naturally to studying broadcasting models on the tree, where each edge has its own broadcasting matrix and this matrix is drawn independently from a predefined distribution. In this context, we study the effect of the configuration at the root to that of the vertices at distance h, as h\to\infty.

We establish the reconstruction threshold for the cases where the broadcasting matrices give rise to symmetric, 2-spin Gibbs distributions. This threshold seems to be a natural extension of the well-known Kesten-Stigum bound which arise in the classic version of the reconstruction problem.

Our results imply, as a special case, the reconstruction threshold for the well-known Edward-Anderson model of spin-glasses on the tree.

Also, we extend our analysis to the setting of the Galton-Watson tree, and the random graph G(n,d/n), where we establish the corresponding thresholds. Interestingly, for the Edward-Anderson model on the random graph, we show that the replica symmetry breaking phase transition, established in [Guerra and Toninelli:2004], coincides with the reconstruction threshold.

Compared to the classical Gibbs distributions, the spin-glasses have a lot of unique features. In that respect, their study calls for new ideas, e.g., here we introducing novel estimators for the reconstruction problem etc. Furthermore, note that the main technical challenge in the analysis is the presence of (too) many levels of randomness. We manage to circumvent this problem by utilising recent tools coming from the analysis of Markov chains.

Presenter: ZAMPETAKIS, Konstantinos

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