

ECE Special Seminar



Spectral Method and Regularized MLE Are Both Optimal for Top-K Ranking

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[Energy and Information
Systems Seminar](#)

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Abstract:

This talk is concerned with the problem of top-K ranking from pairwise comparisons. Given a collection of n items and a few pairwise binary comparisons across them, one wishes to identify the set of K items that receive the highest ranks. To tackle this problem, we adopt the logistic parametric model — the Bradley-Terry-Luce model, where each item is assigned a latent preference score, and where the outcome of each pairwise comparison depends solely on the relative scores of the two items involved. Recent works have made significant progress towards characterizing the performance (e.g. the mean square error for estimating the scores) of several classical methods, including the spectral method and the maximum likelihood estimator (MLE). However, where they stand regarding top-K ranking remains unsettled.

We demonstrate that under a random sampling model, the spectral method alone, or the regularized MLE alone, is minimax optimal in terms of the sample complexity—the number of paired comparisons needed to ensure exact top-K identification. This is accomplished via optimal control of the entrywise error of the score estimates. We complement our theoretical studies by numerical experiments, confirming that both methods yield low entrywise errors for estimating the underlying scores. Our theory is established based on a novel leave-one-out trick, which proves effective for analyzing both iterative and non-iterative optimization procedures. Along the way, we derive an elementary eigenvector perturbation bound for probability transition matrices, which parallels the Davis-Kahan theorem for symmetric matrices.

Bio:

Cong Ma is a third year PhD candidate in the Department of Operations Research and Financial Engineering at Princeton University under the supervision of Prof. Yuxin Chen and Prof. Jianqing Fan. Prior to attending Princeton University, he received his bachelor's degree in Electrical Engineering from Tsinghua University in 2015. He is broadly interested in machine learning, high dimensional statistics, convex and nonconvex optimization as well as their applications to neuroscience.

SEMINAR NOTES: (LIGHT REFRESHMENTS SERVED)