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Fundamental limits in structured PCA, and how to reach them

Speaker

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Abstract

I will present recent results concerning the Bayesian estimation of low-rank matrices corrupted by structured noise, namely rotational-invariant noise with generic spectrum. Using the replica method we drive the optimal performance limit by exploiting the low-rank structure of signal, which allows for a reduction of the model to an effective quadratic model of the Ising type.

Secondly, we show that the Approximate Message Passing (AMP) algorithm currently proposed in the literature for Bayesian estimation is sub-optimal. We explain the reason for this sub-optimality and then deduce an optimal Bayesian AMP algorithm with a rigorous state evolution matching the replica prediction. Surprisingly, despite the seemingly strong hypothesis of rotational-invariance for the noise, our theory and proposed AMP work very well for real data coming from various application domains due to strong universality properties.

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