Statistics and Data Science Seminar

Improved Shrinkage Prediction under a Spiked Covariance Structure

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Abstract: We develop a novel shrinkage rule for prediction in a high-dimensional non-exchangeable hierarchical Gaussian model with an unknown spiked covariance structure. We propose a family of commutative priors for the mean parameter, governed by a power hyper-parameter, which encompasses from perfect independence to highly dependent scenarios. Corresponding to popular loss functions such as quadratic, generalized absolute, and linex losses, these prior models induce a wide class of shrinkage predictors that involve quadratic forms of smooth functions of the unknown covariance. By using uniformly consistent estimators of these quadratic forms, we propose an efficient procedure for evaluating these predictors which outperforms factor model based direct plug-in approaches. We further improve our predictors by introspecting possible reduction in their variability through a novel coordinate-wise shrinkage policy that only uses covariance level information and can be adaptively tuned using the sample eigen structure. We extend our methodology to aggregation based prescriptive analysis of generic multidimensional linear functionals of the predictors that arise in many contemporary applications involving forecasting decisions on portfolios or combined predictions from dis-aggregative level data. We propose an easy-to-implement functional substitution method for predicting linearly aggregative targets and establish asymptotic optimality of our proposed procedure. We present simulation experiments as well as real data examples illustrating the efficacy of the proposed method.

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