Stability and Super-resolution of MUSIC and ESPRIT for Multi-snapshot Spectral Estimation

Speaker: Zengying Zhu (Fudan University)

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Advisor: Weiguo Gao (Fudan University)

Abstract: This talk is concerned with the spectral estimation problem of estimating the locations of a fixed number of point sources given multiple snapshots of Fourier measurements collected by a uniform array of sensors. We prove novel stability bounds for MUSIC and ESPRIT as a function of the noise standard deviation, number of snapshots, source amplitudes, and support. Our most general result is a perturbation bound of the signal space in terms of the minimum singular value of Fourier matrices. When the point sources are located in several separated clumps, we provide an explicit upper bound of the noise-space correlation perturbation error in MUSIC and the support error in ESPRIT in terms of a Super-Resolution Factor (SRF). The upper bound for ESPRIT is then compared with a new Cramér-Rao lower bound for the clumps model. As a result, we show that ESPRIT is comparable to that of the optimal unbiased estimator(s) in terms of the dependence on noise, number of snapshots and SRF. As a byproduct of our analysis, we discover several fundamental differences between the single-snapshot and multi-snapshot problems. Joint work with Weilin Li, Weiguo Gao and Wenjing Liao.