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Optimal experimental design with correlation data

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A major problem within the field of aeroacoustics is determining the distribution of an aeroacoustic source, such as an airplane engine, given pressure measurements on external microphone arrays. Taking a Bayesian view and modeling the source as fundamentally random with zero mean leads to the problem of determining the covariance of the random source.

While this can be recovered from correlations of pressure measurements, the consequent dimensionality increase is significant when the dimension of the observations is large. Accordingly, we study optimal experimental design for correlation data, with the goal of determining the optimal, sparse sensor placement prior to conducting any real-world experiments.

Specifically, we investigate A-optimal designs, that is, designs that minimize the average posterior covariance in the reconstruction. Building on the work presented in [1] for the case of deterministic sources with non-correlated data, we moreover present algorithmic treatment of the design problem for the random source problem in aeroacoustics and other PDE-based applications, involving low-rank approximation of correlated forward operators.

[1] A. Alexanderian, Optimal experimental design for infinite-dimensional Bayesian inverse problems governed by PDEs: a review, Inverse Problems, 37(2021), 043001.

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