Sensor Selection for Bayesian Inverse Problems and Data Assimilation via Dimension Reduction

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In numerical simulations, mathematical models, such as partial differential equations, are widely used to predict the behavior of a physical system. However, any model can only provide an approximation to the underlying physics, and can be subject to a variety of model errors, such as uncertainties in the geometry or loading. Variational Data Assimilation and Bayesian Inversion can be used to improve state and parameter predictions through the incorporation of measurement data. As experimental data can be expensive, sensors need to be chosen carefully to gain the most information.

In this talk, we first consider a variational approach to linear model corrections and identify an observability coefficient that describes the connection between numerical stability and sensor positions. We introduce an algorithm that exploits a reduced order approximation of the forward model's solution manifold to iteratively choose sensors to improve the observability coefficient. We then expand the setting to hyper-parameterized linear Bayesian inverse problems and draw connections to optimal experimental design criteria.