OPTIMAL SENSOR PLACEMENT WITH SPARSITY

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We address the problem of identifying parameters of a physical process, described by a system of elliptic partial differential equations, from previously collected experimental data. In many applications, data is scarcely available and polluted by measurement errors. To obtain reliable estimates of the parameters, this uncertainty in the measurements has to be taken into account in the design of the underlying experiment. To this purpose, we formulate an optimal design problem based on the asymptotic covariance matrix of a least-squares estimator for the parameters, which depends on the number, position, and quality of the measurement sensors. The measurement setup is modeled by a sum of Dirac-delta functions on the spatial experimental domain, which corresponds to a finite number of pointwise measurements of the PDE solutions. We present a function space analysis of the problem formulation and discuss structural properties of optimal measurement designs. For the algorithmic solution, a class of accelerated conditional gradient methods is derived, which exploits the sparsity of the solutions to the design problem. A discrete approximation of the continuous problem based on a variational discretisation with finite elements is considered and numerical results are presented.