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# WELL-POSED BAYESIAN GEOMETRIC INVERSE PROBLEMS ARISING IN SUBSURFACE FLOW

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Optimal management in subsurface applications involves decision-making under uncertainty that arises from the lack of direct information concerning geologic properties of the subsurface. A common strategy to reduce this uncertainty and obtain a better characterization of the subsurface is to solve the inverse problem of finding estimates of the geologic properties given observational flow data. In this talk we present the application of the infinite-dimensional Bayesian framework described in [5] for the solution to geometric inverse problems that arise in subsurface flow. In particular, we are interested in determining the permeability of the subsurface from pressure measurements, within the framework of an incompressible single-phase Darcy flow [3] .

Our application of the Bayesian framework incorporates prior knowledge in terms of geometric features relevant to the characterization of the geologic properties of the subsurface. More concretely, we consider parameterizations of the permeability that have been previously used to characterize multiple geologic facies including the potential locations of faults as well as geometric features such as channels typical of fluvial environments [4, 2]. These prior models of the permeability lead to the estimation of a finite number of unknown parameters determining the geometry, together with a finite number of functions representing the permeability on each one of the geologic facies defined by the geometry.

In this talk we discuss key aspects of the rigorous application of the Bayesian framework, namely the proof of the existence of the resulting Bayesian posterior and its continuity in the Hellinger and total variation metrics, with respect to observational data. In addition, we discuss novel MCMC methods in which prior-reversible proposals are defined, leading to an acceptance probability determined purely by the likelihood (or model-data mismatch) hence having clear physical interpretation; this builds on similar algorithms developed in the case of Gaussian priors in [1]. Finally some numerical examples are presented demonstrating the feasibility of the methodology.

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