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Contribution - Implicit Update for Large-Scale Inversion under GP prior

DS algorithms with a view towards Machine Learning and Artifical Intelligence

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Abstract

We present an almost matrix-free update method for posterior Gaussian process distributions under sequential observations of linear functionals. By introducing a novel implicit representation of the posterior covariance matrix, we are able to extract posterior covariance information on large grids and to provide a framework for sequential data assimilation when covariance matrices cannot fit in memory.

This is useful in Bayesian linear inverse problems with Gaussian priors, where the matrices involved grow quadratically in the number of elements in the discretization grid, creating memory bottlenecks when inverting on fine-grained discretizations.

We illustrate our method by applying it to an excursion set recovery task arising from a gravimetric inverse problem on Stromboli volcano. In this setting, we demonstrate computation and sequential updating of exact posterior mean and covariance at resolutions finer than what state-of-the-art techniques can handle and showcase how the proposed framework enables implementing large-scale probabilistic excursion set estimation and also deriving efficient experimental design strategies tailored to this goal.

Joint work with David Ginsbourger (Univ. Bern) and Niklas Linde (Univ. Lausanne).