

DIMENSION-INDEPENDENT LIKELIHOOD INFORMED MCMC

TIANGANG CUI¹, KODY J.H. LAW² AND YOUSSEF M. MARZOUK³

¹MIT
Aero-Astro Dept., Cambridge, MA, USA
E-mail address and URL

²KAUST
SRI-UQ, Thuwal, Saudi Arabia
E-mail address and URL

³MIT
Aero-Astro Dept., Cambridge, MA, USA
E-mail address and URL

Key words: Bayesian inverse problem, MCMC, Langevin equation, Elliptic PDE, SDE, SPDE

Abstract. Many Bayesian inference problems require exploring the posterior distribution of high-dimensional parameters that, in principle, can be described as functions. This work introduces a family of Markov chain Monte Carlo (MCMC) samplers that can adapt to the particular structure of a posterior distribution over functions. Two distinct lines of research intersect in the methods developed here. First, we introduce a general class of operator-weighted proposal distributions that are well defined on function space, such that the performance of the resulting MCMC samplers is independent of the discretization of the function. Second, by exploiting local Hessian information and any associated low-dimensional structure in the change from prior to posterior distributions, we develop an inhomogeneous discretization scheme for the Langevin stochastic differential equation that yields operator-weighted proposals adapted to the non-Gaussian structure of the posterior. The resulting dimension-independent and likelihood-informed (DILI) MCMC samplers may be useful for a large class of high-dimensional problems where the target probability measure has a density with respect to a Gaussian reference measure. Two nonlinear inverse problems are used to demonstrate the efficiency of these DILI samplers: an elliptic PDE coefficient inverse problem and path reconstruction in a conditioned diffusion.

REFERENCES

- [1] Cui, T., Law, K.J.H., and Marzouk, Y.M. *Dimension-independent likelihood-informed MCMC*. Submitted.
- [2] Law, K.J.H. *Proposals Which Speedup Function Space MCMC*. Journal of Computational and Applied Mathematics, 262, 127-138 (2014).