Bayesian Inference for Discretely Observed Stochastic Partial Differential Equations

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This talk concerns the estimation of model parameters θ for a discretely observed, semi-linear stochastic partial differential equation (SPDE). When observations of the associated process X are sparse, both space and/or time, such the statistical problem becomes notoriously difficult due to intractable likelihoods.

From a computational Bayesian viewpoint, this can be considered a *missing data problem*, in which case a natural solution is the *data augmentation algorithm.*

In its simplest form, it is a Gibbs sampler that iterates between updating the missing path segments of X and parameters θ. This solution faces two key challenges: Firstly, a careless implementation of the data augmentation algorithm leads to reducible Markov chains.

Secondly, the Gibbs sampler requires proposals of the missing path, i.e. an infinite dimensional diffusion bridge. As these are in general intractable, computational efficiency of the algorithm relies on 'good' proposals that closely resemble the true path conditioned on the observations.

These challenges are known from the finite dimensional case and have been investigated in the past twenty years. In this talk I will present current progress of lifting previous solutions from the finite to the infinite dimensional case. Particular attention will be paid to the construction of 'guided processes' for the simulation of infinite dimensional diffusion bridges, based on previous work by [1]. This requires a solid understanding of such bridge processes - an open problem that has so far received surprisingly little attention, with few exceptions such as the linear case ([2]).

The performance of the proposed solutions will be presented in numerical experiments. This talk is based on a project with Frank van der Meulen and Aad van der Vaart.

References

[1] Frank van der Meulen and Moritz Schauer, Bayesian estimation of discretely observed multi-dimensional diffusion processes using guided proposals, *Electronic Journal of Statistics*, 11(1), (2017) 2358-2306.

[2] B. Goldys and B. Maslowski,The ornstein-uhlenbeck bridge and applications to markov semi-groups, *Stochastic Processes and their Applications*, 118(10), (2008), 1738-1767.