Constrained Variational Bayesian Approximation for Parameter Estimation in Diffusion Processes.

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Abstract. Stochastic differential equations (SDEs) have been used extensively in modeling phenomena that exhibit intrinsic randomness or unknown components. To tackle these problems a range of different methods have been employed based on the Kalman filter and Monte Carlo approaches. An alternative is based on a variational treatment of the inference problem. Recently, a variational Bayesian algorithm has been proposed for inference in diffusion processes that can be used for both state and parameter estimation. In this paper we propose a new approach that is based on a radial basis function (RBF) reparameterisation of this variational approximation algorithm. We focus on estimating the (hyper-) parameters in the drift and diffusion of the stochastic differential equation considered. The new RBF approach is fast and shows great robustness and stability. Here we validate our method on a multidimensional (40 variable Lorentz) dynamical system and compare our results with a state of the art ensemble Kalman filter and a recently reported Markov Chain Monte Carlo based algorithm. We compare the asymptotic behaviour of the algorithms as the observation density increases, and discuss the reasons for the empirically observed differences in performance of the methods.

Keywords: RBF approximation; Variational Inference; Stochastic Differential Equations; Diffusion Processes; Parameter Estimation.

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