Bayesian Identification for non-Gaussian Parameters

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Abstract

Inverse problems and identification procedures are known to lead to ill-posed problems in the sense of Hadamard when considered in a deterministic setting. In a probabilistic Bayesian setting, on the other hand, they are well-posed. In the simplest setting of a linear system and Gaussian randomness this leads to the well-known Kalman Filter (KF) procedures. They are also the simplest kind of linear Bayesian updates. Extensions to nonlinear or non-Gaussian settings which are based on linearisation like the extended Kalman Filter (EKF) are only of limited applicability. Without linearisation, they invariably involve some kind of sampling, e.g. in the form of ensemble Kalman Filter (EnKF), particle filters, or Markov chain Monte Carlo (MCMC) methods.

In this talk the probabilistic identification problem is cast in a functional approximation setting - the best known of which is the polynomial chaos expansion (PCE) - and the linear Bayes form of updating. In this way the identification process can be carried out completely deterministically. In the case where the original problem was a deterministic identification task the Bayes procedure additionally provides a quantification of the remaining uncertainty. However, the method can be also used as an identification procedure in an originally (frequent) probabilistic setting. Here are given numerical examples of both.

Keywords: minimum squared error estimate, minimum variance estimate, polynomial chaos expansion, linear Bayesian update, Kalman filter