Structured approximate Bayesian inference for models with complex likelihoods

Khaled Ouafi

Morgan Stanley Investment Management, London, UK
kouafi@assets-management.ms.com

May 18, 2013

Abstract

We consider the problem of approximate Bayesian parameter inference in non-linear state space models with intractable likelihoods. Sequential Monte Carlo with approximate Bayesian computations (SMC-ABC) is an approach to approximate the likelihood in this type of models. However, such approximations can be noisy and computationally costly which hinders efficient implementations using standard methods based on optimisation and statistical simulation. We propose a novel method based on the combination of Gaussian process optimisation (GPO) and SMC-ABC to create a Laplace approximation of the intractable posterior. The properties of the resulting GPO-ABC method are studied using stochastic volatility (SV) models with both synthetic and real-world data. We conclude that the algorithm enjoys: good accuracy comparable to particle Markov chain Monte Carlo with a significant reduction in computational cost and better robustness to noise in the estimates compared with a gradient-based optimisation algorithm. Finally, we make use of GPO-ABC to estimate the Value-at-Risk for a portfolio using a copula model with SV models for the margins.

Keywords — Bayesian inference, approximate Bayesian Computations, Gaussian process optimisation, sequential Monte Carlo, α-stable distributions.