

Statistics Department

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The correlated pseudo-marginal method

Friday, May 19th, 4:00 PM in Science Center 705

Abstract: The pseudo-marginal algorithm is a popular variant of the Metropolis--Hastings scheme which allows us to sample asymptotically from a target probability density when we are only able to estimate an unnormalized version of this target unbiasedly. It has found numerous applications in Bayesian statistics as there are many scenarios where the likelihood function is intractable but can be estimated unbiasedly using Monte Carlo samples. For a fixed computing time, it has been shown in several recent contributions that an efficient implementation of the pseudo-marginal method requires the variance of the log-likelihood ratio estimator appearing in the acceptance probability of the algorithm to be of order 1, which in turn requires scaling the number of Monte Carlo samples linearly with the number of data points. We propose a modification of the pseudo-marginal algorithm, termed the correlated pseudo-marginal algorithm, which is based on a novel log-likelihood ratio estimator computed using the difference of two positively correlated log-likelihood estimators. This approach allows us to scale the number of Monte Carlo samples sub-linearly with the number of data points. A non-standard weak convergence analysis of the method will be presented as well as its limitations in the asymptotic analysis of the performance of the algorithm. In our numerical examples, the efficiency of computations is increased relative to the pseudo-marginal by up to several orders of magnitude for large datasets. (joint work A. Doucet and M. K. Pitt).