Alternatives to delta functions in Monte Carlo based Uncertainty Quantification

Sahani Pathiraja
University of New South Wales, Australia
s.pathiraja@unsw.edu.au

In many tasks such as uncertainty quantification, high dimensional integration and Bayesian inference, it is necessary to generate samples from some underlying distribution and/or compute expectation functionals. Monte Carlo or particle-based methods are a well-established, foundational tool for such tasks, largely due to their flexible simulation-based structure. This foundational idea has spurred the development of popular approaches including Ensemble Kalman methods, sequential Monte Carlo, Markov Chain Monte Carlo, control type particle filters and particle based variational inference. However, Monte Carlo based techniques are often inefficient in high dimensions, in representing distributional tails and non-Gaussian characteristics as well as in complex time-dependent systems. This is in part due to the reliance on points (i.e. delta functions) to approximate distributions. In this talk I will explore various sampling techniques that make use of alternatives to delta functions, e.g. the suite of Gaussian mixture type filters as well as kernel-based particle flow methods. Their performance characteristics will be examined both analytically and numerically compared to corresponding approaches that make use of standard Monte Carlo.