Unbiased and Multilevel Methods for a Class of Diffusions Partially Observed via Marked Point Processes

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In this talk we consider the filtering problem associated to partially observed diffusions, with observations following a marked point process. In the model, the data form a point process with observation times that have its intensity driven by a diffusion, with the associated marks also depending upon the diffusion process. We assume that one must resort to time-discretizing the diffusion process and develop particle and multilevel particle filters to recursively approximate the filter. In particular, we prove that our multilevel particle filter can achieve a mean square error (MSE) of $\mathcal{O}(\epsilon^2)$ ($\epsilon > 0$ and arbitrary) with a cost of $\mathcal{O}(\epsilon^{-2.5})$ versus using a particle filter which has a cost of $\mathcal{O}(\epsilon^{-3})$ to achieve the same MSE. We then show how this methodology can be extended to give unbiased (that is with no time-discretization error) estimators of the filter, which are proved to have finite variance and with high-probability have finite cost. Finally, we extend our methodology to the problem of online static-parameter estimation.