Sequential Monte Carlo Using Differential Evolution Particle Filtering

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Sequential Monte Carlo (SMC) approaches are increasingly being used to estimate sequences of probability distributions of model parameters and states when new or real-time data are becoming available. These methods, also called particle filters, involve substantial computational effort yet exhibit the desirable properties to properly treat uncertainty, determine the information content of experimental data, and to check whether model parameters are stationary or time-varying. Such diagnostics help quantify model structural errors, determine optimal experimental design strategies, and provide meaningful estimates of model predictive error. In this talk I will present a DiffeRential Evolution particle filter (DEPF) that is especially designed to maintain diversity of particles during filter evolution. As main building block DEPF uses the DREAM adaptive MCMC scheme presented in Vrugt et al. (2008, 2009), yet implements recursive likelihood updating to facilitate posterior tracking of model parameters and states. Benchmark results show that DEPF (1) Requires far fewer particles than conventional SMC approaches to work well, speeding up convergence to limiting parameter and state distributions, (2) Maintains adequate particle diversity during all stages of filter evolution, and (3) is embarrassingly parallel. This novel filter is especially designed to solve complex, high-dimensional problems, pertinent to geophysical inverse problems.