Efficiency of micro-macro acceleration for scale-separated stochastic differential equations

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Many stochastic systems in nature have an inherent time-scale separation, while we are typically only interested in the evolution of some well-chosen macroscopic state variables on long time scales. Here, we investigate a new micro-macro acceleration algorithm for such multiscale systems when the model is a stiff stochastic differential equation.

The proposed algorithm interleaves short bursts of stochastic microscopic simulation with extrapolation of the macroscopic states over a larger time interval. .Since the extrapolation step is larger than the step size of the explicit inner microscopic time integrator, the method is expected to provide a gain in computational efficiency. The drawback is an increased time discretization error.

For slow-fast SDEs, it is often also possible to derive an approximate macroscopic model for the non-stiff variable in the limit of infinite time-scale separation. This approximate model however induces a modelling error when the separation is finite. Our results show that the micro-macro acceleration method can attain a lower error than the approximate macroscopic model, while increasing efficiency with respect to the microscopic simulation.