Random time steps geometric integrators of ordinary differential equations for uncertainty quantification of numerical errors

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Abstract:

We introduce a probabilistic integrator for ordinary differential equations (ODEs) based on randomised time steps [1]. The random perturbation that is introduced allows to build a probability measure on the numerical solution and thus to provide an uncertainty quantification of the error. Convergence of this probability measure towards the true solution is studied both in strong and weak sense.

Unlike an additive random perturbation, randomising the time steps guarantees the conservation of some geometric properties of deterministic Runge-Kutta methods, hence improving the robustness of the probabilistic solution.

Probabilistic methods for differential equations allow for a substantial qualitative improvement of the solution of Bayesian inverse problems. Hence, we show how to incorporate our probabilistic integrator in this framework, providing examples of inverse problems based on Hamiltonian systems.

References

[1] A. Abdulle and G. Garegnani, *Random time step probabilistic methods for uncertainty quantification in chaotic and geometric numerical integration*, Submitted for publication (2018).