Applied Mathematics Seminar

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

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Dynamical consistency and adaptivity for stochastic systems

We consider the use of adaptive timestepping to allow strong explicit Euler-Maruyama discretisations to reproduce the dynamical properties of two classes of nonlinear stochastic differential equations (SDEs) with non-negative, non-globally Lipschitz coefficients.

First we will examine a class of SDEs whose solutions may display a tendency towards explosive growth, but where the existence of a global strong solution ensured by a sufficiently intense and nonlinear diffusion coefficient. We construct an adaptive timestepping strategy which responds to both drift and diffusion and which closely reproduces the a.s. asymptotic stability and instability of the equilibrium, as well as ensuring the positivity of solutions with arbitrarily high probability.

Second, we introduce an explicit adaptive Euler method for the approximate solution of the Cox-Ingersoll-Ross short rate model, the diffusion coefficient of which has unbounded gradient in the vicinity of zero. We propose a hybrid method which relies upon a class of path-bounded timestepping strategies and which invokes a backstop method in the event that the timestep becomes too small, or to prevent solutions from overshooting zero and becoming negative. As well as proving strong convergence of solutions, we can provide estimates, both theoretical and numerical, on the probability that the method requires the backstop to preserve the positivity of the original model.

We will demonstrate the relative performance of this adaptive hybrid approach via numerical examples.

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