GEOMETRICALLY DEVELOPED STOCHASTIC DYNAMICS AND APPLICATIONS

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ABSTRACT

In this talk, we consider and explore a method for developing the flows of stochastic dynamical systems, posed as Ito's stochastic differential equations, on a Riemannian manifold identified through a suitably constructed metric. The framework used for the stochastic development, viz. an orthonormal frame bundle that relates a vector on the tangent space of the manifold to its counterpart in the Euclidean space of the same dimension, is the same as that used for developing a standard Brownian motion on the manifold. Mainly drawing upon some aspects of the energetics so as to constrain the flow according to any known or prescribed conditions, we show how to expediently arrive at a suitable metric, thus briefly demonstrating the application of the method to a broad range of problems of general scientific interest. These include simulations of Brownian dynamics trapped in a potential well, a numerical integration scheme that reproduces the linear increase in the mean energy of conservative dynamical systems under additive noise and non-convex optimization. Of specific interest in this talk is our geometrically inspired approach for non-convex optimization problems, wherein we exploit stochastically developed Langevin dynamics with and without multiplicative (state-dependent) noises. The simplicity of the method and the sharp contrast in its performance vis-à-vis the correspondent Euclidean schemes in our numerical work provide a compelling evidence to its potential.