Mathematics > Probability

Levy area logistic expansion and simulation

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We present a new representation for the Levy chordal area for a two-dimensional Wiener process conditioned on its endpoints. This is based on an infinite weighted sum of Logistic random variables. We develop a numerical simulation algorithm for the Levy area based on truncating this series and simulating the tail by a suitable Normal random variable. We show how to improve the efficiency of the algorithm by approximating higher order terms, which are large sums of independent identically distributed Logistic random variables, by two separate methods: using a suitable Normal approximation and, sampling directly from the fixed density function for the logarithm of the product of decimal magnitudes of independent identically distributed Exponential random variables. To implement a strong Milstein numerical integrator for a stochastic differential equation driven by a multi-dimensional Wiener process, we must maintain a local mean-square error of order the cube of the stepsize. To achieve this prescribed accuracy, the latter two Levy area sampling methods we propose, reduce the number of uniform random variables required to be sampled over each timestep, a measure of the complexity, from reciprocal square-root complexity to logarithmic complexity.

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