Contribution ID: **103** Type: **not specified**

Chebyshev and tensor cross interpolation for Monte-Carlo-based option sensitivities

Monday, 25 August 2025 15:35 (20 minutes)

High dimensionality is one of the key challenge in mathematical finance, where option pricing and sensitivity computations must be both accurate and real-time. Finite-difference Monte Carlo methods often suffer numerical instability, especially for second-order derivatives (a.k.a. Gamma). Chebyshev-interpolation can stabilize sensitivities, but it suffers from the curse of dimensionality as input parameters increase.
We handle this high dimensions by compressing tensorized Chebyshev coefficients using Tensor Cross Interpolation (TCI). Addressing interpolation nature of TCI, we fix the Monte Carlo seed to suppress sampling noise of MC. From the resultant compressed chebyshev coefficients, we compute first- and second-order sensitivities.
We validate our method on three benchmarks—a noisy sine function; an Asian-barrier option; and a European basket option under a multi-asset Black–Scholes model. we discuss how exploiting low-rank structure of option price gives better accuracy and computational time compared to conventional Monte Carlo method.

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Session Classification: Contributed talks

Track Classification: Invited talk