Application of Randomised QMC for Option Pricing and Greeks

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In many financial applications Quasi Monte Carlo (QMC) based on Sobol' low-discrepancy sequences (LDS) outperforms Monte Carlo showing faster and more stable convergence. However, unlike MC QMC lacks a practical error estimate. Randomized QMC (RQMC) method combines the best of two methods. Application of scrambled LDS allows to compute confidence intervals around the estimated value, providing a practical error bound. Randomization of Sobol' LDS is applied for computation of Asian options and Greeks using hyperbolic local volatility model. RQMC demonstrated the superior performance over standard QMC showing increased convergence rates and providing practical error bounds around the estimated values. Efficiency of RQMC strongly depends on the scrambling methods. We recommend using Sobol' LDS with Owen's scrambling. Application of effective dimension reduction techniques such as the Brownian bridge or PCA is critical to dramatically improve the efficiency of QMC and RQMC methods.

Global Sensitivity Analysis (GSA) is a very powerful tool in the analysis of complex models. It offers a comprehensive approach to model analysis in many fields including finance [1]. We apply the variance-based method based on Sobol' indices for comparison and explanation the differences in performances of different schemes. GSA fully explains superior performance of the Brownian bridge and PCA schemes in terms of the reduced effective dimensions. Some findings from this study were presented in [2].

[1] Kucherenko, S., & Shah, N. (2007) The Importance of being Global. Application of Global Sensitivity Analysis in Monte Carlo option Pricing, Wilmott, July, 82-91.

[2] Kucherenko, S., & Hok, J. (2023) The Importance of Being Scrambled: Supercharged Quasi Monte Carlo, Journal of Risk 26(1), 1–20, 2023.