Quantum Random Number Generator for Monte Carlo Simulations

Why it matters

Monte Carlo simulations are an essential part of the modern financial services and insurance industries. They are used across a wide range of tasks such as risk management, portfolio optimisation, pricing complex financial instruments and actuarial assessment. The quality and efficiency of these simulations have a tremendous direct impact on the bottom line of organisations operating in those sectors, affecting both their budgets and their ability to make correct decisions. Unfortunately, the current approach to enable Monte Carlo simulations is inefficient and ineffective. The core of these simulations is the generation of truly random samples to be able to model uncertain events, however, this is a task that the current state-of-the-art in computing hardware is ill-suited for.

Quantum Dice's solution

All "random" numbers on a computer are currently generated by pseudo-random number generators (PRNGs): these are deterministic algorithms and, therefore, only provide random-looking patterns rather than true randomness. As opposed to algorithms, which have their own problems when it comes to the quality and reliability of randomness, quantum physical processes are intrinsically unpredictable based on the underpinning laws of physics. We have pioneered a high-speed, reliable, and highly optimised architecture for randomness generation using quantum photonics. Our quantum random number generator (QRNG) leverages integrated photonics, along with our proprietary methods for generating reliable randomness from the quantum behaviour of photonic processes, to enable true randomness for simulations. Not only does our patented solution mitigate any risks associated with choosing a weak PRNG, but we have further demonstrated significant advantages of our quantum randomness source compared to industry-standard pseudo-randomness in both serial and parallel computing, leading to a substantial reduction in computing steps for Monte Carlo simulations.

Business advantages

Our high-quality randomness source offers the following performance advantages:

1. More accurate predictions and estimates in modelling

Better quality of random numbers leads to improved accuracy:

Together with STFC Hartree, we assessed the effect of various random number sources on the results of Monte Carlo simulations and confirmed that the QRNG leads to estimates and simulation results that are closer to the true (analytical) solution than the industry-standard PRNG.

This is because the QRNG offers a better dispersion of values, indicating a tendency towards more randomness: for instance, it samples the underlying solution space more uniformly, closely matching theoretical expectations.

2. Cost savings due to reduced simulation computations

The QRNG reaches convergence in fewer computational steps than the PRNG. Our results demonstrate a reduction in sample size by 15-20%. A reduction of sample size directly relates to a reduced simulation time and, thus, cost and energy savings.

Ultimately, truly random sampling significantly affects how we estimate risk, capture uncertain events, and predict costs and trading. If the underlying random shocks, random fluctuations, and unpredictable scenarios are modelled with true randomness, the outcomes of the corresponding simulation lead to a quantitatively better result and more efficient time-to-convergence. This allows improved – and faster – decision-making to save costs and avoid loss of revenue.

Product offerings

Quantum Dice offers three ways to access true quantum randomness for simulations, all combining best-in-class quality and the highest generation speed:

Ultra-portable and fast plug-in PCIe extension card suitable for a single user.

High-performance, ultra-fast 19-inch server rack ideally suited for on-premise deployment in computing clusters.

Entropy-as-a-service cloud solution.

Our solutions, whether on-premises or cloud-based, come with all necessary drivers and libraries, making it easy for analysts and developers to integrate high-quality randomness into their existing systems. To allow seamless adoption without changes to the simulation code, we provide the appropriate software interface to integrate Quantum Dice's randomness generation into the software packages used in stochastic modelling and simulations.

The supported environments are Windows and Linux operating systems for C++ and Python implementations. The stream of random bits can be transformed into any distributions of random numbers specified in the C++ programming language standard, directly using the C++ standard libraries. The quantum random numbers can thus be sampled from all distributions standardised in the C++ library (e.g. uniform, normal, Bernoulli, binomial, negative binomial, geometric, Poisson, exponential, Gamma, Weibull, extreme value, lognormal, chi-squared, Cauchy, Fisher-F, Student-T, discrete, piecewise constant and piecewise linear).

GET IN TOUCH

Get in touch at **simulations@quantum-dice.com** to book an initial trial of our solution and see how much it can improve your business operations.

www.quantum-dice.com