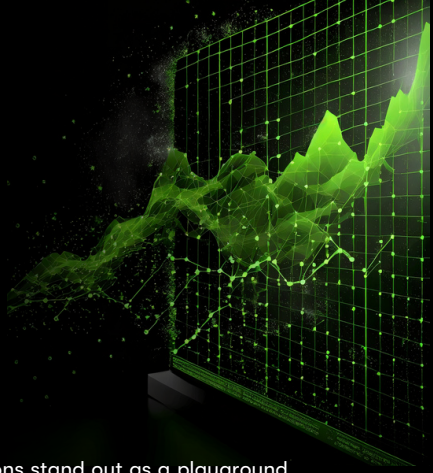
From research to business value

CIRDAN CAPITAL

CASE STUDY



Towards Quantum-enhanced Exotic Options Trading: Increasing pricing speed and computational efficiency

In the fast-paced world of financial markets, exotic options stand out as a playground for the daring and the innovative. With their customized payoffs and intricate structures, they offer the potential for extraordinary returns, while also presenting risks and challenges. Pricing is a particularly demanding task, due to complex variables and ever-changing market conditions influencing the performance of these financial instruments. Therefore, optimal decision-making and computational efficiency are key for faster, more accurate, and more efficient pricing of exotic options. Working with the London-based investment bank Cirdan Capital, we demonstrated a significant value creation potential by accelerating the pricing of exotic options (such as multi-asset autocallable options), leveraging a proprietary approach based on Tensor Networks.

Key Takeaway

Using a proprietary approach to price exotic options, Terra Quantum's Tensor Networks based algorithms, which can run on classical compute infrastructure today, were able to showcase a pricing speedup of up to 75% compared to the industry standard Monte Carlo methods, while getting to the desired level of accuracy for the options price. This speed-up also enables traders and risk managers to better understand their risk positions faster, while reducing the spend on cloud compute as well.

The Problem

Exotic options such as these do not have analytical, closed form solutions and their price typically needs to be determined by methods that utilize Monte Carlo simulations. Such Monte Carlo simulations are very widely used across the Financial Services industry and while they are key for critical tasks such as exotic options pricing, they are extremely complex and incur significant and often expensive cloud compute usage.

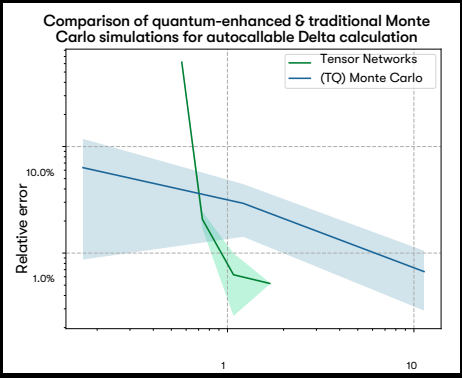
Results

75% **Improvement in speed of pricing exotic options and related Greeks.**

75% **Reduction in computing power needed for pricing exotic options & related Greeks.**

The Approach

To solve the challenge, we identified a quicker algorithmic method to price exotic options, based on Tensor Networks. The performance speedup in the options price calculation was performed on equivalent compute infrastructure for both the industry benchmark and Terra Quantum's software approach. For a large trading bank pricing multiple option types on a regular basis, the speedier pricing process suggests a reduction of compute costs of several millions of dollars per year would be possible in one of the scenarios considered.



This figure illustrates the result of up to 75% speedup in calculating the price of exotic options such as autocallables, identified for Cirdan Capital. The speed-up was identified in calculating Greeks as well, with improved computational efficiency for both.

As our approach is based on Tensor Networks, the solution quality will improve significantly as underlying quantum hardware matures.

Tensor Networks

Tensor Networks are a new approach to linear algebra emerging from quantum physics for very efficient solutions to high-dimensional problems, relying on decomposing a huge tensor into a product of smaller ones. Since Tensor Network possess a logarithmic complexity similar to quantum algorithms, Terra Quantum has been employing them for generating speed-up and cost savings for complex systems across industries.

Conclusion

As the Terra Quantum approach gets powered by large scale quantum computing hardware, this speed up and computing cost savings are expected to further increase significantly. In addition to the price calculation speed up, the Terra Quantum solution is also able to improve the speed and computational efficiency of calculating the associated risk parameters, often referred to as the 'Greeks'.

Our Tensor Networks approach can deliver not only business value through more informed intra-day trading decisions, but also compute cost efficiencies.

> Speeding up options pricing can enable trading desks in volatile markets to assess their risks faster by valuing their books more often during the day, resulting in better identification of intra-day market imbalances, while also reducing their computational costs significantly.
>
> - Antonio de Negri, the CEO of Cirdan Capital