Probabilistic Computing for Arbitrage Detection

Quantum Dice Challenge 2025 – Team 23 (Entropica)

The global sports betting market is valued at roughly $100 bn/year and is rapidly growing through live betting. Studies of European football markets indicate that approximately one-fifth of matches present risk-free profit opportunities across bookmakers and exchanges, yielding an average of 1-2% per trade. Hence, this is a problem of integrity and profitability, as well as a technical curiosity.

Who benefits and why. Our system targets licensed sportsbooks, betting exchanges, and market integrity providers. These firms must (i) maintain a fair market, (ii) prevent coordinated exploitation attacks, and (iii) reduce losses during rapid odds shifts. Identifying and mitigating a fraction of high-confidence arbitrage positions before execution represents millions of dollars per year in value saved. Proprietary or in-house trading teams could also utilise the same engine to detect and capitalise on mispriced odds.

What we are building. We propose an arbitrage detection layer based on *probabilistic computing*. Rather than relying on market scanning with predetermined rules or a machine learning model that rates a user after their trade is placed, we will directly model the market and optimise for opportunity.

To do so, each odd will be a probabilistic node or vertex, with weighted edges that capture correlations between markets and events. A network of stochastic units, "p-bits" evolves towards low-energy states, thus representing an optimised space of odds. Such configurations would hence be immediately detected for action or defence.

Why this is different.

- **Speed.** Optimising a set of trades in vast network is a complex combinatorial optimisation problem; here, research shows that appropriately applied probabilistic computing can provide a significant speed-up over classical algorithms.
- **Accuracy.** Along with improved efficiency, research shows that probabilistic annealing methods have achieved higher accuracy than classical counterparts, ensuring more arbitrage opportunities are spotted, and at a faster pace.
- **Adaptivity.** As events occur and odds shift, the network will rebalance automatically without any need for retraining or manual thresholds.

What it replaces. As it stands, operators employ a complex mix of procedures that involve dynamic pricing based on real-time data feeds, bet flow analytics, predetermined rules and thresholds, as well as manual supervision in case of sudden events. Many fraud detection companies have also partnered with sports betting conglomerates to spot and counter any attempted risk-free profiteering. All of these processes are reactive in nature. Our approach will be structural and proactive: it checks if the market, in its current state, is optimal or not, and will fix any inconsistencies immediately.

How it would be deployed. The system integrates alongside existing odds management, either as a low-latency API or as a directly connected system for high-volume exchanges, and continuously running as a co-processor for real-time surveillance.

Commercial impact. When looking at the financials of a company like Flutter, a betting conglomerate, we can estimate that, based on revenue, average commissions collected, payouts issued and more, they see over $100 billion / year in turnover. Preventing around 0.5% leakage through our optimisation model would protect $500 million every year. As such, a software subscription or stand-alone add-on product priced at hundreds of thousands of dollars would be a rational decision from an operator's perspective. Hence, if technical performance can be demonstrated, this gives a clear path to commercial deployment.

Why this matters beyond betting. The same core question "does this market configuration contain a risk-free opportunity?" is quintessential in market-making, derivatives pricing, and exchange surveillance in finance. A fast probabilistic search engine for structural mispricing is valuable on both sides; this helps honest venues defend themselves and shows pricing teams exactly where opportunities lie.