BIG DATA & ALGORITHMIC FINANCE

Emmanuel GOBET
Professor, Ecole polytechnique

Emmanuel Gobet graduated from Ecole Polytechnique - Paris in 1995, he got a PhD degree in probability at University Paris Diderot. He took different academic positions at University Pierre et Marie Curie, Grenoble Institute of Technology and he is currently Professor at Ecole Polytechnique. He is an expert in Monte Carlo simulations, Machine learning and data science, extremes, risk management, stochastic modelling with applications in Climate change, Energy, Finance. He has written more than 100 papers in international journals and 3 books. He is the scientific leader of the Chair Stress Test, between BNPP Paris and Ecole Polytechnique. He is the IP Paris Pedagogy Coordination Director at Hi!PARIS, the center for Artificial Intelligence and Data Science at Institut polytechnique de Paris and HEC. He is also a Scientific Advisor to Kaiko, a major digital finance data provider.

THOROUGH MATHEMATICAL MODELING AND ANALYSIS OF UNISWAP V3

Emmanuel GOBET, Mnacho ECHENIM, and Anne-Claire MAURICE.

Automated Market Makers have emerged quite recently, and Uniswap is one of the most widely used platforms (it covers 96% of the available pools as of today). This protocol is chal- lenging from a quantitative point of view, as it allows participants to choose where they wish to concentrate liquidity. There has been an increasing number of research papers on Uniswap v3 but often, these articles use heuristics or approximations that can be far from reality: for instance, the liquidity in the pool is sometimes assumed to be constant over time, which con- tradicts the mechanism of the protocol. The objectives of this work are fourfold: first, to revisit Uniswap v3's principles in detail (starting from the open source code) to build an unambiguous knowledge base. Second, to analyze the Impermanent Loss of a liquidity provider by detailing its evolution, with no assumption on the swap trades or liquidity events that occur over the time period. Third, we introduce the notion of a liquidity curve. For each curve, we can con- struct a payoff at a given maturity, net of fees. Conversely, we show how any concave payoff can be synthetized by an initial liquidity curve and some tokens outside the pool; this paves the way for using Uniswap v3 to create options. Fourth, we analyze the behavior of collected fees without any simplifying hypothesis (like a constant liquidity or zero Spot-Pool spread) un- der the mild assumption that the pool price follows a general Ito price dynamic. The value of the collected fees then coincides with an integral of call and put prices. Our derivations are supported by graphical illustrations and experiments.

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