DISSERTATION DEFENSE

XINTONG WANG

Computational Modeling and Design of Financial Markets: Towards Manipulation-Resistant and Expressive Markets

Monday, December 21, 2020
2:00 PM
[Virtual](#)

ABSTRACT: Electronic trading platforms have transformed the financial market landscape, supporting automation of trading and dissemination of information. With high volumes of data streaming at high velocity, market participants use algorithms to assist almost every aspect of their decision-making: they learn market state, identify opportunities to trade, and express increasingly diverse and nuanced preferences. This growing automation motivates a reconsideration of market designs. This dissertation focuses on the design of (1) manipulation-resistant markets that facilitate learning genuine market supply and demand, and (2) expressive markets that facilitate delivering preferences in greater detail and flexibility. Advance towards each may contribute to efficient resource allocation and information aggregation.

Manipulation-Resistant Markets. Spoofing refers to the practice of submitting spurious orders to deceive others about supply and demand. To understand its effects, this dissertation develops an agent-based model of manipulating prices in limit-order markets, and demonstrates the effectiveness of spoofing against approximate-equilibrium traders. Built on this model, a cloaking mechanism is designed to deter manipulation via strategic disclosure of the order book; variations of the learning-based trading strategy are explored to reasonably compromise effectiveness in non-manipulated markets for robustness against manipulation.

Regulators who deploy detection algorithms to catch manipulation face the challenge that an adversary may obfuscate strategy to evade. This dissertation proposes an adversarial learning framework to proactively reason about how a manipulator might mask behavior. Evasion is represented by a generative model, trained by augmenting manipulation order streams with examples of normal trading. The framework generates adapted manipulation order streams that mimic benign trading patterns and appear qualitatively different from prescribed manipulation strategies.

Expressive Markets. Financial options are contracts that specify the right to buy or sell an underlying asset at a strike price in the future. Standard exchanges offer options of predetermined strike values and trade them independently, even for those written on the same asset. This dissertation proposes a mechanism to match orders on options related to the same asset, supporting trade of any custom strike. Combinatorial financial options—contracts that define future trades of any linear combination of underlying assets—are introduced to enable the expression of demand based on predicted correlations among assets. Optimal clearing of such markets is coNP-hard, and a heuristic algorithm is proposed to find optimal matches via iterative constraint generation.

Prediction markets that support betting on ranges (e.g., on the price of S&P 500) offer predetermined intervals at a fixed resolution, limiting the ability to elicit fine-grained information. The logarithmic market scoring rule (LMSR) used in this setting presents two limitations that prevent its scaling to large outcome spaces: (1) operations run in time linear in the number of outcomes, and (2) loss suffered by the market can grow unbounded. By embedding the modularity properties of LMSR into a binary tree, this dissertation shows that operations can be expedited to logarithmic time. A constant worst-case loss can be achieved by designing a liquidity scheme for intervals at different resolutions.

CHAIR: Prof. Michael Wellman