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(Deep) Learning to Predict Complex Market Dynamics

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Financial markets are data-rich systems where prices and their dynamics emerge from the continuous interaction of many agents. In this talk, I present a framework that combines deep learning with ideas from statistical physics to understand and predict short-term price movements in modern electronic markets. At the core of this framework is the Limit Order Book (LOB)—a high-frequency, tabular data structure that reflects the evolving state of supply and demand. From a machine learning perspective, modelling LOBs poses a significant challenge, sharing many of the difficulties seen in deep learning on tabular data, where standard architectures often underperform compared to simpler models. Yet, the fine-grained and structured nature of LOB data offers unique opportunities to uncover latent patterns not easily accessible through traditional approaches.

Using data from NASDAQ-traded stocks, we examine how microstructural features—such as tick size and liquidity—influence predictability, and we evaluate models not only by their statistical accuracy, but by the feasibility of trading strategies they enable. Finally, I introduce a hybrid approach that augments deep learning with network-based representations of LOBs, capturing spatial and temporal dependencies across price levels. This perspective, inspired by statistical physics and complex systems theory, sheds light on how information flows and decays in high-frequency markets. Moreover, the proposed methodology is general and may be applied to other structured, dynamical systems beyond finance.

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