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On NASDAQ Order Book dynamics: New problems for the control field

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Abstract:

The NASDAQ is an electronic stock market which is run entirely by high-speed computers. With this as context, the main objectives of this tutorial are as follows: First Objective: To demonstrate that NASDAQ order book dynamics provide a rich source of many new research problems of a control-theoretic nature. Second Objective: To provide context and motivation driving new order book research in the control area by presenting a review of the critical issues and results in the finance literature. Third Objective: To provide a detailed explanation of order book "mechanics" and a review of existing literature providing the basis for state space and simulation models. Fourth Objective: To describe some specific new examples of Order Book Control Problems that are amenable to solution using the tools and expertise of our community. This includes control problems involving regulation in volatile markets, stock-price manipulation and robustness issues arising from dynamic model uncertainty. Fifth Objective: To provide broader context for the research based on the role of the order book in a larger financial network, the tutorial includes a review of some existing results in the area of Network Identification which are relevant to areas being surveyed. When traders submit their orders, either to a broker or directly to the exchange, entries are made into the NASDAQ order book which evolves over time. The state of the order book consists of two lists: one for the buyers and one for the sellers. On the buy side, at a fixed moment in time, the i -th entry is an ordered pair (N_i, p_i) which is interpreted as follows: Buyer i is willing to buy N_i shares provided the price paid is p_i or less. This is called a limit order. Similarly, on the sell side (N_i, p_i) denotes the willingness of Seller i to sell N_i shares provided the price received is p_i or more. The order engine is basically an algorithm in software matching buyers and sellers dynamically over time.

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