Title: Big Data in Finance: Modeling of Limit Order Books.

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Big data has now become a driver of model building and analysis in a number of areas, including finance. In this talk we show how to deal with big data arising in electronic markets for algorithmic and high-frequency (milliseconds) trading that contain two types of orders, limit orders and market orders. More than half of the markets in today's highly competitive and relentlessly fast-paced financial world now use a limit order book (LOB) mechanism to facilitate trade.
R. Cont and A. de Larrard (SIAM J. on Finan. Math., 2013) introduced a Markovian stochastic model for the dynamics of a LOB and computed various quantities of interest such as the probability of a price increase or the diffusion limit of the price process. In this talk, we consider several extensions of their model suggested by empirical observations. One of them is to extend their framework to 1) arbitrary distributions for book events inter-arrival times (possibly non-exponential) and 2) both the nature of a new book event and its corresponding inter-arrival time depend on the nature of the previous book event (not independent). The dynamics of the bid and ask queues are modeled by Markov renewal process and the mid-prices - by a semi-Markov process. We justify and illustrate the approach by calibrating our model to the five stocks, Amazon, Apple, Google, Intel, Microsoft, on June 21st, 2012 (Lobster data), to the 15 stocks from Deutsche Boerse Group (September 23d, 2013), and to Cisco asset (November 3d, 2014). As in Cont & de Larrard, the bid-ask spread remains constant equal to one tick and all orders have the same size. Different quantities of interest and diffusion limit are obtained. The second extension is associated with the case when the price changes are not fixed at one tick. And the third one is related to the case with arbitrary number of states for the price changes. For both cases the justification, diffusion limits, implementations and numerical results are presented for different LOB data: Lobster data, and Cisco, Facebook, Intel, Liberty Global, Liberty Interactive, Microsoft, Vodafone from 2014/11/03 to 2014/11/07. (The talk is based on two research papers written with my ex-students: Nelson Vadori (JP Morgan, NY), Julia Schmidt and Katharina Cera (TUM, Munich, Germany), and Tyler Hofmeister (Oxford)).