Algorithmic trading

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Course : 15 hours - TP : 0 hours

Objectives

The aim of this course is to introduce students to the various modeling issues associated with high frequency trading. In particular, the course will focus on taking into account execution costs and market impact in the construction of optimal execution strategies for large orders (the so-called optimal execution problem). From a mathematical point of view, the course will make extensive use of the notions of optimisation and optimal control (stochastic or not). Practical illustrations will be presented.

Main learning outcomes of the course: at the end of the course, the student will have been familiarized with the problems of high frequency trading. He will know the main block crossing modes as well as the models used. On the mathematical level, he will have deepened his knowledge of deterministic and stochastic optimization, and will have acquired new knowledge in the field of statistics on high-frequency data.

Outline

- Introduction to stock markets : financial markets operating (order books, different types of orders, competition between platforms, dark pools, ...) optimal execution problematic, utility expectation criterion, CARA functions and mean-variance criteria.
- Almgren-Chriss model in discrete time : trading curves that invoke only elementary optimization tools.
- The continuous time Almgren-Chriss model: quadratic execution costs and linear permanent market impact ; then the general case with more realistic execution costs (Euler Lagrange equation and Hamiltonian systems in a general framework).
- Pricing of a block trade by indifference, value of liquidity (Hamilton-Jacobi equations and viscosity solutions).
- S - POV - Target Close – VWAP : Implementation Shortfall (IS), orders POV, orders Target Close and orders VWAP.
- Market impact models : permanent, temporary, transient. Dynamic arbitrages and compatible models.
- Estimation of market impacts, of execution costs and other high-frequency statistics.
- No-execution risk : stochastic optimization for dark pools and limit orders.

Bibliography

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- Bardi, Capuzzo-Dolcetta, Optimal Control and Viscosity Solutions of Hamilton-Jacobi-Bellman Equations.
- Guéant, Optimal execution and block trade pricing: a general framework, working paper.
- Rockafellar, Conjugate Convex Functions in Optimal Control and the Calculus of Variations, J. of Math. Anal. Appli., 1970.