MIE1622H – Computational Finance and Risk Management

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Course title: Computational Finance and Risk Management (MIE1622H)

Course description: The objective of the course is to examine the construction of computational algorithms in solving financial problems, such as risk-aware decision-making, asset pricing, portfolio optimization and hedging. Considerable attention is devoted to the application of computational and programming techniques to financial, investment and risk management problems. Materials in this course are quantitative and computational in nature as well as analytical. Topics include mean-variance portfolio optimization, simulation (Monte Carlo) methods, scenario-based risk optimization, hedging, uncertainty modeling, asset pricing, simulating stochastic processes, and numerical solutions of differential equations. Matlab is the primary computational and modeling software used in this course, we also briefly describe other programming environments such as R, Python and C/C++ used in financial engineering. Practical aspects of financial and risk modeling, which are used by industry practitioners, are emphasized.

Lectures: Monday, 6:00pm-9:00pm, MC 254 (first lecture is on January 6)
Office Hours: After the lecture or by appointment
Teaching Assistants: TBA

Course Outline

Introduction
1. Important finance and statistics concepts
2. Computational finance with Matlab

Simulation Modeling
1. Introduction to simulation modeling
2. Generating random numbers
3. Monte Carlo simulations
4. Introduction to asset pricing by simulation
5. Factor models

Quantitative Risk Management
1. Risk measures, moment-based and tail-based risk
2. Market, credit, liquidity and operational risks
3. Economic and regulatory capital, capital requirements under Basel II-III accord
4. Credit risk modeling

Optimization Modeling
1. Portfolio selection and portfolio optimization in practice
   a) mean-variance optimization
   b) multi-objective optimization, computing efficient frontiers
   c) benchmarks, tracking error minimization
   d) incorporating transaction costs and taxes
2. Risk budgeting

3. Scenario-based risk optimization
4. Optimization under uncertainty
   a) robust parameter estimation
   b) portfolio resampling
   c) regularized optimization
   d) robust portfolio optimization

Asset Pricing
1. Modeling dynamics of asset prices
2. Binomial lattices
3. Random walk models
4. Stochastic processes
5. Derivatives pricing
   a) Black-Scholes model
   b) option pricing by Monte Carlo methods

Assignments, Exams and Grading

Assignment #1, #2, #3, #4 **(15% each)**
Midterm Test **(10%)**
Final Exam **(20%)**
In-Class Presentation **(10%)**

If a student gets less than 50% mark at the Final Exam, her/his course mark will be reduced one letter grade down. E.g., a student got 13 pts (Assg 1) + 14 pts (Assg 2) + 14 pts (Assg 3) + 14 pts (Assg 4) + 9 pts (Midterm Test) + 8 pts (In-Class Presentation) + 9 pts (Final Exam) = 81 pts that corresponds to A- course mark, but because a student got 9 pts out of 20 pts at the Final Exam (less than 50%), the course mark will be reduced from A- to B+.

Course Materials and Readings

Suggested
- **Simulation and Optimization in Finance: Modeling with MATLAB, @Risk, or VBA** by D. Pachamanova and F. Fabozzi, 2010
  http://www.amazon.com/Simulation-Optimization-Finance-Website-Modeling/dp/0470371897/

Optional
- **Risk Management and Financial Institutions** (3rd Edition) by J. Hull, 2012
  http://www.amazon.com/Management-Financial-Institutions-Wiley-Finance/dp/1118269039/
- **Numerical Methods in Finance and Economics: A MATLAB-Based Introduction** (2nd Edition) by P. Brandimarte, 2006
  http://www.amazon.com/Numerical-Methods-Finance-Economics-MATLAB-Based/dp/0471745030/
- **Introduction to Computational Finance and Financial Econometrics** by E. Zivot, 2012
  http://faculty.washington.edu/ezivot/econ424/424notes.htm