STAT 598F
Financial modeling with jump processes
TTh 12:00 - 1:15, Rec 315
Purdue University, Spring 2009

Instructor: *José Enrique Figueroa-López*

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- Office hours: F 1:30 - 3:30 p.m. or by appointment.
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Prerequisites: Stat 519/MA 519 or equivalent. MA 515/Stat 540 or concurrent enrollment.

Primary Audience: MS Students in Statistics, Mathematics and Management who are working towards the Computational Finance Specialization. Ph.D. students with good background in stochastic processes, and with interest in quantitative finance.

Course Description:

Levy processes, or more generally Poisson point processes, have become important building blocks in modern financial modeling either as a natural substitute of Brownian motion or as one source of randomness driving the dynamics of asset prices. This course will cover the tools necessary to extend the most fundamental theorems of mathematical finance as well as to perform statistical inference on these processes. Thus, the course is intended for students with strong interest in computational finance or for Ph.D. students whose research area involves Poisson point processes or stochastic processes, and want to learn about applications in mathematical finance. The following topics will be covered:

(1) Properties, definitions, and simulation of Poisson random measures and Lévy processes

(2) Asset price modeling via Lévy processes and statistical estimation based on maximum likelihood, spectral methods, and other nonparametric methods.

(3) Stochastic calculus for jump processes and stochastic differential equations, including numerical solutions and simulation.

(4) Arbitrage-free option pricing in exponential Lévy models via risk-neutral and integro-partial differential equation representations

(5) Model calibration and inverse problems

(6) The problem of optimal partial hedging and super-replication

(7) Portfolio optimization and other stochastic control problems

The emphasis of the course is on the concepts and methods leaving aside the technicalities and replacing them with heuristic arguments whenever is possible. In particular, the mathematical and probabilistic tools will be covered along the way as they are needed.

Grading and attendance policy:

Evaluation is through assignments, both theoretical and computational, and a final project which will be chosen by the students (with the instructor's guidance and approval) according to their specific interest and background. NO LATE homework will be accepted without a valid justification. *Important note*: ATTENDANCE IS EXPECTED. Justified absence must be notified to the instructor with anticipation.

Bibliographical material: Lectures will cover excerpts from the instructor's notes and from the following books:

- **[CT]** *Financial modeling with jump processes* by R. Cont and P. Tankov.

  Monograph that covers a very wide range of topics on the theory and financial applications of Lévy processes at an elementary level in a rather extensive way. Many of our topics will summarize and unify excerpts from this book.

- **[Sh]** *Stochastic Calculus for Finance Vol. II* by S. Shreve, 1st Edition.

  Chapter 11 contains a concise and elementary presentation of jump processes and option pricing, including stochastic calculus (at least for finite-activity jump processes).

- **[S]** *Lévy process and infinitely divisible distributions* by Ken-Iti Sato. Cambridge, 1999.

  This is one of the bibles in Lévy process containing all formal mathematical proofs of the classical results. There is no or little discussion about financial applications and stochastic calculus for jump processes.

- **[A]** *Lévy processes and stochastic calculus* by D. Applebaum, Cambridge, 2004.

  Monograph on stochastic calculus for semimartingales driven by Lévy processes from a more mathematical perspective.

I hope you will enjoy this course. Have a nice semester.