STOCHASTIC ANALYSIS FOR JUMP PROCESSES

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Course Description

The aim of this course is to introduce stochastic processes with jumps, develop the stochastic calculus for these processes and provide a comprehensive understanding of their structure and properties.

The first part of the course will be devoted to the study of Lévy processes. Lévy processes are natural generalizations of Brownian motion, since they are processes with independent and stationary increments. Contrary to Brownian motion though their sample paths can have jumps.

There are several applications of Lévy processes and more general processes with jumps in different fields of research, for example: in mathematical finance and insurance mathematics, in mathematical biology, in physics and in telecommunications. We will motivate the study of jump processes from some applications, and analyze the effect of modeling certain phenomena by such processes.

The second part of this course will be devoted to the study of stochastic analysis for Lévy processes and general semimartingales.

Some key points of the course will be:

- infinitely divisible laws and their relation to Lévy processes,
- the Lévy-Itô decomposition of the path of a Lévy process,
- Poisson random measures and analysis of the Lévy measure,
- stochastic integration and Itô's formula for general semimartingales,
- measure transformations and Girsanov's theorem,
- stochastic differential equations driven by jump processes,
- Markov property of the solution, semigroups and generators.

Prerequisites

This course is aimed at students with an understanding of probability theory and continuous time stochastic processes, as taught e.g. in the courses "Probability Theory I & II", "Stochastic Analysis" and "Financial Mathematics II".

Literature

- D. Applebaum: *Lévy Processes and Stochastic Calculus*. Cambridge University Press, 2004.
- J. Jacod and A. N. Shiryaev: *Limit Theorems for Stochastic Processes* (2nd ed.). Springer, 2003.
- A. Kyprianou: *Introductory Lectures on Fluctuations of Lévy Processes with Applications*. Springer, 2006.

- Ph. Protter: *Stochastic Integration and Differential Equations* (3rd ed.). Springer, 2004.
- K. Sato: *Lévy Processes and Infinitely Divisible Distributions*. Cambridge University Press, 1999.

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