

Special Lecture Computational Intelligence and System II

Tokyo Institute of Technology, 2015

Stochastic Processes for Statistical and Engineering Applications

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Classes. 13:20–14:50, June 3, 10, 17, 24; July 1, 8, 15.

Description of the course. Measurements and estimates of events evolved with time are subjects of intensive investigations in statistics and engineering research. Their underlying mathematical models involve a local martingale $M(t)$ and its martingale transform $H(t)dM(t)$, which unifies various aspects of stochastic processes developed for different applications. In this short course we intend to introduce foundations and properties of one dimensional stochastic processes and their martingale framework, but we will omit some of the necessary details of stochastic integrals and differentials. Instead, we stay focused on the operational aspect of stochastic processes, that is, how to manipulate or solve them. We still begin with basic concept of probability and distribution, and present an idea of Brownian motion from scratch. After being acquainted with Brownian motion fairly well, we will introduce stochastic differential equations (SDE's) and their applications in statistics and engineering problems.

I taught this subject as a graduate course at Tennessee Technological University, aiming mostly at engineering graduate students for whom I assume no background in probability theory and statistics.

Tentative schedule.

- Week 1: Basic concept in probability, and an introduction to Brownian motion.
- Week 2: An introduction to SDE and Ito calculus.
- Week 3: More examples of SDE and their solutions.
- Week 4: Filtration and martingale in stochastic processes.
- Week 5: Expectation, variance, and asymptotic properties of martingale transform.
- Week 6: An introduction to filtering problems and the mechanism of Kalman-Bucy filter.
- Week 7: Further discussion on filtering problems: Girsanov's theorem and Bayes formula.

Organization, assignment and grading. Lectures will be given in English. Attendance is required (which is a main factor determining the course grade), but no particular assignment has been planned. However, problems will be introduced from the topics, and correspondence with the lecturer regarding these problems is encouraged (possibly between the class meetings electronically).