# CIM course "Numerical methods in stochastic modelling and simulations" (7.5hp)

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## Overview

The course covers (1) a brief introduction to the theory of stochastic differential equations (SDEs) and a slightly more involved discussion on numerical solutions thereof, (2) Markov Chain Monte Carlo methods and in particular discrete state space models of the Ising type, and (3) parameter inference in SDEs. Notably, some methods studied in (1) and (2) are combined in the problems discussed in (3).

**The course will be given for the first time during the spring 2016.**

## Description of the course

The course is divided into three parts, comprising 2.5hp each. All parts end with a 'miniproject' to be submitted in the form of a written report.

**Part 1** SDE: basic teory specifically aiming at introducing those context used in Numerical analysis, like existence/uniqueness and tools and results in obtaining *a priori* bounds (approximately §1–5 in Øksendal's book). Numerical methods for SDEs: methods for discretization, strong/weak convergence, transformation methods, SDEs with jumps, exact simulation of SDEs (part of the material is found in Part IV–VI of Kloeden and Platen's book).

*Miniproject:* convergence of numerical methods for SDEs.

**Part 2** Monte Carlo methods for Ising-type models, variance reduction, quasi-MC and randomized quasi-MC, and continuous-time Markov chains. Material from the book by Newman and Barkema will be used here.

*Miniproject:* Monte Carlo simulation of an Ising model, transient dynamics and estimation of macroscopic quantities.

**Part 3** Parameter estimation for SDEs (likelihood-based), analytic solution of conditioned probability in short times (papers by Sahalia and Elerian).

*Miniproject:* Estimation of parameters through Markov chain Monte Carlo in a switch-diffusion modell. "Shadowing" of parameters.

There will be one introductory lecture (2 hours), $3 \times 2$ hour lectures, 3 miniprojects reported back in written, and an additional lecture where a more liberal extra part on one of the projects is presented to the other students.