AMSC 808F: NUMERICAL METHODS IN MATHEMATICAL FINANCE

Fall 2013, MWF 1:00—1:50

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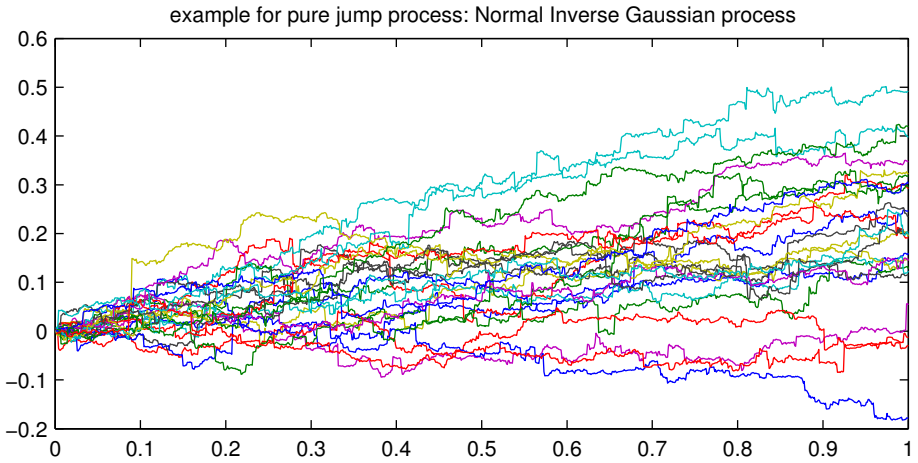

Mathematical finance models risky assets such as stocks by stochastic processes. A key question is the correct pricing of financial products based on stocks (such as options). Traditionally models based on Brownian motion were used for stock prices, but I will also discuss more general models with jump processes.

The option prices can be obtained as expectations, and we are interested in efficient methods to compute them. This can be done by

- Monte-Carlo methods based on simulation with random numbers
- deterministic methods based on solving parabolic differential equations

I will mainly consider the second approach which leads to challenging computational problems, in particular for problems involving many stocks, or American options.

Introduction to Option Pricing: Starting with a discrete model, I will introduce the basic concepts of options and no-arbitrage pricing.

Brownian motion vs. jump processes: The **Black-Scholes model** uses Brownian motion for modelling stock prices. However, it became apparent that a better fit to reality can be obtained by replacing Brownian motion with more general **Lévy processes** which allow jumps.

Monte-Carlo simulation: The stock price is the solution of a stochastic differential equation (SDE). I will give an **introduction to Monte Carlo methods** and then discuss **numerical methods for SDEs** driven either by Brownian motion or by jump processes.

PDE methods: The option price is the solution of a parabolic initial value problem. We will discuss **finite difference** and **finite element methods** for the approximation. In the case of jump processes this will involve the solution of **integral equations**. This will be the main part of the course.

Prerequisites Some basic knowledge of probability, elliptic and parabolic PDEs, and option pricing is helpful. I will explain all concepts in class, but I will use results about stochastic processes and PDEs without proofs.

Homework and Grading Policy We will use Matlab to implement the discussed methods, I will make some m-files available. The homeworks will have both theoretical and Matlab problems.

The grade will be based on homeworks (70%) and a final exam (30%).