

Syllabus for Stochastic Methods + Lab

(CO18-110221 and CO18-110222)

Fall Semester 2018

Up-to-date course information can be found on the course website
http://math.jacobs-university.de/petrat/teaching/2018_fall_stochastic_methods/

1 Official Course Description

This course is a first hands-on introduction to stochastic modeling. Examples will mostly come from the area of Financial Mathematics, so that this course plays a central role in the education of students interested in Quantitative Finance and Mathematical Economics. Topics include binomial tree models, discrete Brownian paths, stochastic ODEs, Monte-Carlo methods, finite differences solutions for the Black-Scholes equation, and an introduction to time series analysis, parameter estimation, and calibration. Students will program and explore all basic techniques in a numerical programming environment and apply these algorithms to real data whenever possible

2 Contact Information

Instructor: Prof. Sören Petrat
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3 Time and Place

Thu 15:45 – 17:00, East Hall 4
Fri 08:15 – 09:30, 09:45 – 11:00, East Hall 4
First class: September 6, 2018; last class: December 7, 2018

4 Textbooks

The class material is similar to the following book:

- Lyuu - Financial Engineering and Computation - Principles, Mathematics, Algorithms (Cambridge University Press).

Also, some material is similar to

- Etheridge - A Course in Financial Mathematics (Cambridge University Press),

which is, however, more mathematically involved than this class.

5 Homework Assignment

Each week on Thursday (with exceptions) there will be a homework assignment. The homework assignments have to be uploaded individually on each student's own branch on the bitbucket server via git (details are announced in class). The due date is one week after the class, i.e., usually the Thursday after the sheet is available. On this day, the homework has to be uploaded before class begins. Homeworks that are handed in late are downgraded to 75% of the original score. Note: It is encouraged to discuss the exercise sheets with your classmates (e.g., discuss how to come up with the solution or what the right way of approaching the problem is). On the other hand, the solutions must be written down and handed in individually! Copying the solutions from somebody else is a violation of Academic Integrity!

6 Exams

There will be a final take-home exam.

7 Grading

The final grade is weighted as follows:

Homework: 80%

Final take-home exam: 20%

Note: The grade for Stochastic Methods and the grade for Stochastic Methods Lab are the same.

8 Tentative Class Schedule

| Session | Date | Topic |
|---------|--------|--|
| 1 | Sep 6 | Organization, Introduction to Scientific Python, Introduction to git |
| 2 | Sep 7 | Basics of financial math |
| 3 | Sep 13 | Bonds |
| 4 | Sep 14 | Bonds |
| 5 | Sep 20 | Immunization |
| 6 | Sep 21 | Options |
| 7 | Sep 27 | Binomial tree method |
| 8 | Sep 28 | Binomial tree method |
| 9 | Oct 4 | Binomial tree method |
| 10 | Oct 5 | Black-Scholes formula |
| 11 | Oct 11 | Brownian Motion, Geometric Brownian Motion |
| 12 | Oct 12 | Stochastic Integrals |
| 13 | Oct 18 | Stochastic Differential Equations |
| 14 | Oct 19 | Weak and strong convergence |
| 15 | Oct 25 | Ito Lemma |
| 16 | Oct 26 | Black-Scholes SPDE |
| 17 | Nov 1 | Finite difference approximation, stability |
| 18 | Nov 2 | Time Series, autocorrelation |
| 19 | Nov 8 | Time Series |
| 20 | Nov 9 | Time Series |
| 21 | Nov 15 | Time Series |
| 22 | Nov 16 | Application to stock data |
| 23 | Nov 22 | Application to stock data |
| 24 | Nov 23 | Stochastic Resonance, Ornstein-Uhlenbeck process, Fokker-Planck equation |
| 25 | Nov 29 | TBA |
| 26 | Nov 30 | TBA |
| 27 | Dec 6 | TBA |
| 28 | Dec 7 | TBA |