

# Syllabus for Stochastic Methods + Lab

(CO18-110221 and CO18-110222)

Fall Semester 2019  
Syllabus as of August 30, 2019

Up-to-date course information can be found on the course website  
[http://math.jacobs-university.de/petrat/teaching/2019\\_fall\\_stochastic\\_methods/](http://math.jacobs-university.de/petrat/teaching/2019_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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Office: Research I, room 112  
TA: Tuba Masur ([g.masur@jacobs-university.de](mailto:g.masur@jacobs-university.de))

## 3 Time and Place

Mon 14:15 – 15:30, room tba  
Mon 15:45 – 17:00 (Lab), room tba  
Thu 14:15 – 15:30, room tba  
First class: September 2, 2019; last class: December 5, 2019

## 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 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 it has been handed out, and will always be announced on the website. 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!

Note that only the best 8 out of 11 homework sheets are used to compute the homework grade. This also means that there will be no extensions of homework submission deadlines and no excuses from the homework obligation, with the only exception of illness that lasts longer than a week.

## 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%

Notes:

- The grade for Stochastic Methods and the grade for Stochastic Methods Lab are the same for students taking both the class and the lab.
- For student who only take the class and not the lab component only the best 5 out of 11 homework sheets are used to compute the homework grade.

## 8 Tentative Class Schedule

Session	Date	Topic
1	Sep 2	Organization, Introduction to Scientific Python, Introduction to git
2	Sep 5	Basics of financial math
3	Sep 9	Bonds
4	Sep 12	Bonds
5	Sep 16	Immunization
6	Sep 19	Options
7	Sep 23	Binomial tree method
8	Sep 26	Binomial tree method
9	Sep 30	Binomial tree method
	Oct 3	<b>German Unity Day</b>
10	Oct 7	Black-Scholes formula
11	Oct 10	Brownian Motion, Geometric Brownian Motion
12	Oct 14	Stochastic Integrals
13	Oct 17	Stochastic Differential Equations
14	Oct 21	Stochastic Differential Equations
15	Oct 24	Weak and strong convergence
16	Oct 28	Ito Lemma
	Oct 31	<b>Reformation Day</b>
17	Nov 4	Black-Scholes SPDE
18	Nov 7	Finite difference approximation, stability
19	Nov 11	Time Series, autocorrelation
20	Nov 14	Time Series
21	Nov 18	Time Series
22	Nov 21	Time Series
23	Nov 25	Application to stock data
24	Nov 28	Application to stock data
25	Dec 2	Stochastic Resonance, Ornstein-Uhlenbeck process, Fokker-Planck equation
26	Dec 5	Discussion of final project