UPPSALA UNIVERSITY
Department of Mathematics
Örjan Stenflo

Markov Processes
1MS012

Markov Processes, Spring semester 2024

Teacher:

Örjan Stenflo, office 74108 Ångström.

Literature:

Gregory F. Lawler, Introduction to Stochastic Processes, Second edition, Chapman and Hall, 2006. (Ch. 1–3, 7.1–7.3, 8.1–8.3, 8.8)

Lecture notes with additional material and exercises will be available in Studium.

Other useful references:

P. Bremaud, Markov Chains. Gibbs fields, Monte Carlo simulation, and Queues, Second Edition, Springer 2020.

G.R. Grimmett, D.R. Stirzaker, Probability and Random Processes, Fourth edition, Oxford University Press, 2020.

O. Häggström, Finite Markov Chains and Algorithmic Applications, Cambridge University Press, 2002.

J. Norris, Markov Chains, Cambridge University Press, 1997.

D. Stirzaker, Stochastic Processes Models, Oxford University Press, 2005.

Examination: Written exam (max 35 points)+ project (max 5 points)+ assignments (max 3 bonuspoints).

Written exam: March 13, 2024
June 11 2024 (resit) (preliminary date)
August 2024 (resit)

Project: Short survey paper (4-6 pages) aimed at fellow students on a topic (free of choice) within the theory of Markov chains. The paper should be submitted electronically (in pdf form) no later than February 28 and should also be presented in class in a talk (on March 5 or March 6). The project gives up to a total of 5 points (paper 2p, presentation 2p, attending all presentations 1p) added to the result of the written exam on March 13. Group work (2-3 persons/group). Deadline for selecting topic: February 22.

Assignments: Three sets of assignment problems will be handed out during the course. Non-compulsory. Assignments will be marked and give up to a total of 3

bonuspoints added to the result of the written exam and project. (Bonus points are only valid at the first exam on March 13.)

Assignments	Out	Due
Assignment 1	Jan 23	Jan 31
Assignment 2	Feb 5	Feb 14
Assignment 3	Feb 19	Feb 27

For grade 5 the requirement is a total of at least 32 points, for grade 4 at least 25 points and the limit to pass (grade 3) is a total of 18 points.

Course information: Course plan, lecture notes, assignments, exercises etc. can be downloaded from Studium:

https://login.studium.uu.se/

Exercises and Problems

"Basic exercises" and "Extra problems" can be downloaded from Studium.

See the lecture notes for suggested exercises and problems from Lawler's book.

Preliminary plan

L: Lecture. **E**: Exercises.

Moment	Date	Contents (with suggested basic exercises and extra problems)
L1	15/1	Introduction, Stochastic processes
L2	17/1	Markov chains in discrete time, examples, Chapman-Kolmogorov equations. Basic exercises: 1–7.
L3	18/1	Classification and structure. Extra problems: A1, A2.
L4	19/1	First-step analysis and hitting times. Basic exercises: 11,14, Extra problems: a2, A2, A4, B1.
L5	22/1	Markov chains in the long run, Stationary distributions. Basic exercises: 8-10, 12-16, Extra problems: a1.
L6	23/1	Convergence theorem, Branching processes. Extra problems: a3.
L7	24/1	Simulation of Markov chains, fractals. Basic exercises: 17.
E1	**24/1**	**Exercises**
L8	29/1	Reversible Markov chains, Markov chain Monte Carlo. Extra problems: b2.
L9	31/1	More on MCMC methods, Propp-Wilson's perfect sampling method, Extra problems: b1.
L10	1/2	Continuous time Markov chains, Basic exercises: 18, 20
L11	5/2	Forwards and backwards equations, examples, Basic exercises: 19, Extra problems: c2.
E2	**5/2**	**Exercises**
L12	7/2	Classification. Basic exercises: 21-22, 27, Extra problems: b3, B3, B4,
L13	12/2	Birth and death processes, Basic exercises: 23-26, 28, Extra problems: c1, B2.
L14	15/2	Applications
E3	**15/2**	**Exercises**
L15	19/2	Introduction to Brownian motion, Basic exercises: 29-32, Extra problems: c3.
L16	21/2	Forward and Backward equations, Diffusion processes
L17	22/2	Brownian bridge, geometric Brownian motion, Reflection principle
E4	**22/2**	**Exercises**
L18	4/3	Repetition
L19	5/3	Project presentations
L20	6/3	Project presentations
L21	8/3	Repetition