Probability and Random Processes

Contact Information

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Course Objectives

This module aims at providing a basic knowledge of probability theory and random processes suitable for students in engineering, Computer Science, and Mathematics. The module provides students with basic skills needed for formulating real-world problems dealing with randomness and probability in mathematical language, and methods for applying a toolkit to solve these problems. Mathematical rigor is used where appropriate. A more advanced treatment of the subject is deferred to the third-year module Stochastic Processes.

The lecture comprises the following topics

• Brief review of number systems, elementary functions, and their graphs

• Outcomes, Events & Sample Space. Combinatorial probability.

• Conditional probability and Bayes' formula.

• Binomials & Poisson-Approximation

• Random Variables, distribution and density functions.

• Independence of random variables.

• Conditional Distributions and Densities.

• Transformation of random variables.

• Joint distribution of random variables and their transformations.

• Expected Values & Moments, Covariance.

- High dimensional probability: Chebyshev and Chernoff bounds.
- Moment Generating Functions & Characteristic Functions.
- The Central limit theorem.
- Random Vectors & Moments, Covariance matrix, Decorrelation.
- Multivariate normal distribution.
- Markov chains, stationary distributions.

Homework

There will be 8 homework for this course. You can find Problem sets on the course page. The grade will be calculated based on the top 6 grades. Late homework will not be accepted. You are encouraged to work in groups, but each class participants has to write the homework by themselves. You are encouraged to use books or internet resources, but do not search for the problems appearing on the assignments.

Final exam

The final exam is based on all the topics discussed in class during this semester. The exam period is in the range 90-120 minutes. The exam is structure as follows:

Question type	Points
Conceptual multiple choice and true-false questions	30
Computational myltiple choice and true-false questions	30
Seen problems (similar to homework problems)	20
Unseen problems	20

Grade Policies

The grade in this class is fully based on the performance in the final exam. The bonus points collected by doing homework and Moodle quizzes can raise your grade by up to 0.66 points. The bonus points will only be added if the final grade is at least 45.

The Code Of Academic Integrity

Rules and regulations found in The Code Of Academic Integrity apply to this class.

Syllabus Change Policy

This syllabus is only a guide for the course and is subject to change with advanced notice.

This syllabus is only intended as guidance for class participants. In particular, it is subject to modification in case needs arise.
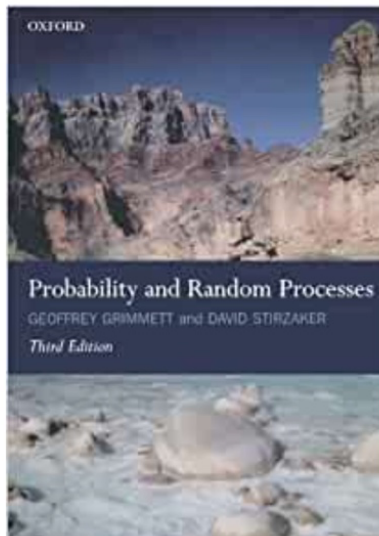
Textbooks
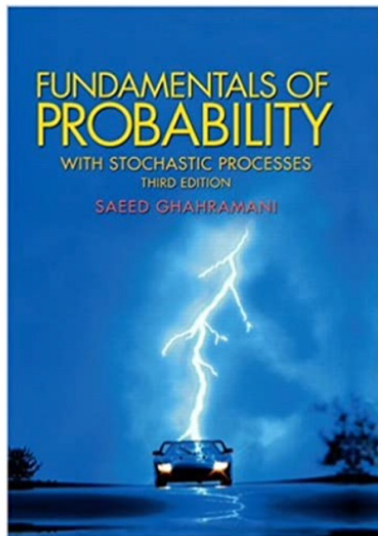
Fundamentals of probability.
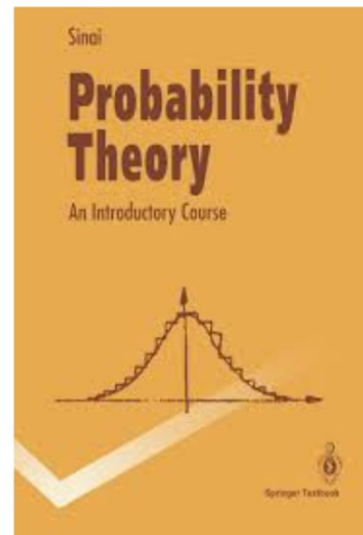
S. Ghahramani

Large set of exericsees

Probability and random processe.

G. Grimmet and D.Stirzacker.

Large set of exercises

Additional topics

Probability theory

Ya. Sinai

More advenced

Additional topics

Course schedule

1	Fri, 2. Sep. 2022	Basica ideas of probability		
2	Wed, 7. Sep. 2022	Pascal's equiprobabable model, sample space		
3	Fri, 9. Sep. 2022	Counting, Birthday paradox		
4	Wed, 14. Sep. 2022	Inclusion and exclusion	PS 1 Posted	
5	Fri, 16. Sep. 2022	Geometric probability		
6	Wed, 21. Sep. 2022	Conditional probability, independence		
7	Fri, 23. Sep. 2022	Bayes' formula	PS 2 posted	PS 1 due
8	Wed, 28. Sep. 2022	Random variables, discrete random variables, distribution		
9	Fri, 30. Sep. 2022	Properties of distribution function, continuous random variables		
	Wed, 5. Oct. 2022	Research day; class does not meet		
10	Fri, 7. Oct. 2022	Important classes of random variables	PS 3 posted	PS 2 due
	Wed, 12. Oct. 2022	Practice Exam		
	Fri, 14. Oct. 2022	Discussion of Practice exam		
11	Wed, 19. Oct. 2022	Expectation and variance for discrete random variables		
12	Fri, 21. Oct. 2022	Properties of expectation, applications	PS4 posted	PS3 due
13	Wed, 26. Oct. 2022	Expectation and variance for continuous random variables		
14	Fri, 28. Oct. 2022	Joint distribution, marginals, independence of random variables		
15	Wed, 2. Nov. 2022	Properties of independent s random variable, covariance	PS 5 posted	PS4 due
16	Fri, 4. Nov. 2022	Joint density for continuous random variables		
17	Wed, 9. Nov. 2022	Conditional distribution and conditional expectation		
18	Fri, 11. Nov. 2022	Conditional density functions		
19	Wed, 16. Nov. 2022	Concentration inequalities, the law of large numbers	PS6 posted	PS5 due
20	Fri, 18. Nov. 2022	The central limit theorem and applications		
21	Wed, 23. Nov. 2022	Practice Exam II		
22	Fri, 25. Nov. 2022	Markov property, Markov chains, examples	PS7 posted	PS6 due
23	Wed, 30. Nov. 2022	Computation with Markov chains, long term behavior		
24	Fri, 2. Dec. 2022	Stationary distribution for Markov chains	PS 8 posted	
25	Wed, 7. Dec. 2022	Review		PS7 due