SMSTC: Probability (2018-19)

Foundations of Probability (Semester 1)

i. Fundamentals: probability spaces, σ-algebras, probability measures, conditioning and independence (lectures 1-2)
ii. Random variables & their distributions, important special distributions (lectures 3-5)
iii. Convergence and limit theorems (lectures 6-7)
iv. Conditional expectation and martingales (lectures 8-9)
v. Renewal theory (lecture 10)

Stochastic Processes (Semester 2)

i. Markov chains and processes, Poisson processes (lectures 1-3)
ii. Applications, including connections to statistics and graph theory (lectures 4-6)
iii. Brownian motion and stochastic calculus (lectures 7-10)

Assessment

Each module is assessed by two assignments, with provisional deadlines on:

- Foundations of Probability: 20 November 2018 and 8 January 2019
- Stochastic Processes: 19 February 2019 and 2 April 2019

Assignments will be set at least two weeks before the deadline. Solutions for (at least) one assignment per module should be produced using LaTeX.

Prerequisites

Both courses will assume basic undergraduate-level knowledge of mathematical analysis, linear algebra and combinatorics. In addition, Stochastic Processes will assume probability theory, either at undergraduate level or from Foundations of Probability.

Background and Further Reading

- G. Grimmett and D. Stirzaker (2001). *Probability and Random Processes* (3 ed.). Oxford University Press.
    - A very readable introduction to probability theory and stochastic processes, without the measure-theoretic abstraction.
- D. Williams (1991). *Probability with Martingales.* Cambridge University Press.
    - A lively account of (approximately) the topics covered in Foundations of Probability.
- J. R. Norris (1997). *Markov Chains.* Cambridge University Press.
    - A very readable introduction to the Markovian processes that are at the heart of the Stochastic Processes module.

SMSTC: Statistics (2018-19)

Regression and Simulation Methods (Semester 1)

i. Introduction to R

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ii. Linear models
iii. Likelihood and optimisation
iv. Generalised linear models
v. Simulation and bootstrapping
vi. Case study

Important: The first five sessions of Regression and Simulation methods cover material which is a standard part of many undergraduate curricula, although it is recognised that the material may be new to some. A flexible form of delivery allows participants to study different parts of this material at a speed and depth which is appropriate to their previous experience. So, **the first five sessions of this module will be delivered through audio and PDF files supplied on the SMSTC website. There will be no videoconference sessions until session 6 (13 November 2018)**, when the style of delivery will revert to the usual videoconferencing lecture. However, during the first five weeks there will be local tutorials to support the learning of the material. This is likely to focus largely on the exercises, but there should also be an opportunity to discuss the lecture material if that would be useful.

Modern regression and Bayesian Methods (Semester 2)

i. Random effects models
ii. Modern regression
iii. Bayesian methods
iv. Markov chain Monte Carlo
v. Case study

Assessment

Regression and Simulation Methods: One written assignment (based on the final five lectures), deadline in early January 2019. The assignment will be available by mid-December.

Modern Regression and Bayesian Methods: Two written assignments, one after each block of five lectures. Assignments will be available at least two weeks before the deadline.

Prerequisites

Both courses assume basic concepts in probability (elementary probability distributions), statistics (ideas of estimation, confidence intervals, hypothesis testing), calculus and linear algebra. In addition, Modern Regression and Bayesian Methods will assume knowledge from Regression and Simulation Methods, or its equivalent.

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