Probability, Distribution Theory and Inference

LECTURERS: RICHARD PYMAR & SWATI CHANDNA

`https://moodle.bbk.ac.uk/course/view.php?id=28456`

Office Hours
We are happy to meet with students outside the normal lecture sessions by appointment or to schedule telephone calls/appointments – please arrange this in advance via email (`r.pymar@bbk.ac.uk`, `s.chandna@bbk.ac.uk`).

Aims
To provide a solid grounding in the fundamentals of random variables and their distributions, together with an introduction to probability theory and the convergence of sequences and sums of random variables.

To cover the theory underlying modern statistics and to provide a solid grounding in mathematical statistics and the principles of statistical inference.

Teaching
Autumn Term Weeks 1-5 and 7-11: Fridays between 6 and 9 p.m. - Room 541 in the Birkbeck Main Building. Week 6 is a reading week with no lecture.

Module Outline

- Sample Space, σ-Field and Probability Measure.
  Conditional probability, Bayes' Theorem and Statistical Independence.
  Random Variables and Distribution Function.

- Discrete and Continuous Random Variables with Examples.
  Expectation, Variances and Moments.

- Joint distribution functions and Statistical Independence.
  Conditional Distributions and Conditional Expectations
  Distribution of functions of random variables.

- Generating function: Probability and Moment Generating Function, Characteristic Function.
  Limit Theorem: Weak law of large Numbers and Central limit theorem.

- Multivariate Normal Distribution and Sampling distributions.

- The Likelihood Function and Sufficiency

- Point Estimation and the Method of Maximum Likelihood

- Minimum Variance Unbiased Estimation

- Tests of Hypotheses

- The Bayesian Approach to Statistical Inference

Assessment

Coursework:
The first assignment, on *Probability and Distribution Theory*, will be handed out in week 5; the second assignment, on *Inference*, will be handed out in week 11. Each assignment will be worth 5% of the final mark for the *Probability and Stochastic Modelling* module. Assignments covering other aspects of the module (Markov Chains, Time Series) collectively contribute a further 10% of the final mark for the module.

Exam:
The exam paper will have 6 questions in total: 3 in section A and 3 in section B – you will be required to answer 2 questions from each section.

Section A will comprise one question on *Probability and Distribution Theory*, another on *Inference*, and a third question on either *Probability and Distribution Theory* or *Inference*.

Section B will comprise one question on *Markov Chains* and two on *Time Series*.

Unassessed homework:
Exercises will be handed out for each part of the syllabus and solutions will be provided.

You should make every effort to keep up with the unassessed homework to give yourself plenty of practice for this theoretical course.

Recommended Texts
Grimmett G R and Stirzaker D R, *Probability and Random Processes*, Oxford University Press (3rd Edition), 2001.
Ross S M, *First Course in Probability*, MacMillan (6th Edition), 2001.
Ross S M, *Introduction to Probability Models*, Academic Press (8th Edition), 2002.
Tuckwell H C, *Elementary Applications of Probability Theory*, Chapman and Hall, 1995.
Casella A and Berger R L, *Statistical Inference*, Duxbury (2nd Edition), 2002.
Cox D R and Hinkley D V, *Theoretical Statistics*, Chapman & Hall/CRC, 1979.
Gaithwaite P.H, Joliffe I T & Jones B, *Statistical Inference*, OUP (2nd Edition), 2002.
Young G A & Smith R L, *Essentials of Statistical Inference*, Cambridge University Press, 2005.
Later editions of the above books would be more than fine also.

Books for more Probability Theory
Williams D, *Probability with martingales*, Cambridge University Press, 1991.
Rosenthal J, *A first look at rigorous probability theory*, World Scientific Publishing Co. Pte. Ltd. (2nd Edition), 2006.
Billingsley P, *Probability and measure*, John Wiley & Sons, Inc. (3rd Edition), 1995.
Billingsley P, *Convergence of probability measures*, John Wiley & Sons, Inc. (2nd Edition), 1999.