UNIVERSITY OF LONDON

Course information 2024-25

ST1215 Introduction to Mathematical Statistics

General information

MODULE LEVEL: 4

CREDIT: 30

NOTIONAL STUDY TIME: 300 hours

MODE: Locally Taught, Independent Learner Route and Online Taught

Summary

The course provides a precise and accurate treatment of probability, distribution theory and statistical inference at the introductory level.

Conditions

Please refer to the relevant programme structure in the EMFSS Programme Regulations to check:

- where this course can be placed on your degree structure; and
- details of prerequisites and corequisites for this course.

You should also refer to the Exclusions list in the EMFSS Programme Regulations to check if any exclusions apply for this course.

Aims and objectives

The course provides a precise and accurate treatment of introductory probability and distribution theory, statistical ideas, methods and techniques. Topics covered are data visualisation and descriptive statistics, probability theory, random variables, common distributions of random variables, multivariate random variables, sampling distributions of statistics, point estimation, interval estimation, hypothesis testing, analysis of variance (ANOVA) and linear regression.

Learning outcomes

At the end of this half course, and having completed the Recommended reading and activities, students should be able to:

- compute probabilities of events, including for univariate and multivariate random variables
- apply and be competent users of standard statistical operators and be able to recall a variety of well-known probability distributions and their respective moments
- derive estimators of unknown parameters using method of moments, least squares and maximum likelihood estimation techniques, and analyse the statistical properties of estimators
- explain the fundamentals of statistical inference and develop the ability to formulate the hypothesis of interest, derive the necessary tools to test this hypothesis and interpret the results in a number of different settings
- be familiar with the fundamental concepts of statistical modelling, with an emphasis on analysis of variance and linear regression models be familiar with the fundamental concepts of statistical modelling, with an emphasis on analysis of variance models.
- demonstrate understanding that statistical techniques are based on assumptions and the plausibility of such assumptions must be investigated when analysing real problems.

Employability skills

Below are the three most relevant employability skills that students acquire by undertaking this course which can be conveyed to future prospective employers:

1. Complex problem-solving
2. Decision making
3. Communication

Essential reading

A comprehensive subject guide will provide all the essential reading this course. A recommended textbook for additional exposition and practice problems is:

Larsen, R.J. and M.J. Marx (2017) An Introduction to Mathematical Statistics and Its Applications, Pearson Education, 6th edition.

Assessment

This course is assessed by a three-hour and fifteen-minute closed-book written examination (80%) and a sixty-minute Multiple Choice Question assessment (20%). The Multiple Choice Question assessment will examine students' knowledge on Chapters 1 – 5 of the Subject Guide (Locally Taught and Independent Learner students) and up to an including unit 5 (Online Taught students).

Syllabus

Data visualisation and descriptive statistics: Basics of data visualisation; Common measures of central tendency and dispersion.

Probability theory: Set theory: the basics; Axiomatic definition of probability; Classical probability and counting rules; Conditional probability and Bayes' theorem.

Random variables: Discrete random variables and their properties; Continuous random variables and their properties.

Common distributions of random variables: Common discrete distributions; Common continuous distributions.

Multivariate random variables: Joint probability functions; Marginal distributions; Conditional distributions; Covariance and correlation; Independent random variables; Sums and products of random variables.

Sampling distributions of statistics: Random samples; Statistics and their sampling distributions; Sampling distribution of a statistic; Sample mean from a normal population; The central limit theorem; Some common sampling distributions; Prelude to statistical inference.

Point estimation: Estimation criteria: bias, variance and mean squared error; Method of moments estimation; Least squares estimation; Maximum likelihood estimation; Asymptotic distribution of maximum likelihood estimators.

Interval estimation: Interval estimation for means of normal distributions; Approximate confidence intervals; Use of the chi-squared distribution; Interval estimation for variances of normal distributions.

Hypothesis testing: Setting p-value, significance level, test statistic; t tests; General approach to statistical tests; Two type of error; Tests for variances of normal distributions; Comparing two normal means with paired observations; Comparing two normal means; Tests for correlation coefficients; Tests for the ratio of two normal variances.

Analysis of variance: One-way analysis of variance; Two-way analysis of variance.

Linear regression: Simple linear regression; Inference for parameters in normal regression models; Regression ANOVA; Confidence intervals for E(y); Prediction intervals for y; Multiple linear regression models.