ST230-10 Mathematical Statistics

26/27

Department
Statistics
Level
Undergraduate Level 2
Module leader
Elke Thonnes
Credit value
10
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

To provide a systematic introduction to major ideas of statistical inference, with an emphasis on likelihood methods of modelling, estimation, and testing.

Pre-requisites:

- ST228 Mathematical Methods for Statistics and Probability, and
- ST229 Probability for Mathematical Statistics.

This module is core for students with their home department in Statistics.

It is **not** available to other students, for whom ST232/ST233 Introduction to Mathematical Statistics or ST352 Introduction to Mathematical Statistics (for Finalists) is provided as an alternative.

Leads To: many ST3 and ST4 modules.

Module web page

Module aims

To provide a systematic introduction to major ideas of statistical inference, with an emphasis on the mathematical underpinnings of modelling using likelihoods, and on model selection and

testing.

A good understanding of these ideas is crucial preparation for further investigation of applied and methodological statistics, machine learning, and the core statistical aspects of data science.

The module will consolidate the initial understanding developed in the first-year common core for Statistics students.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

This module continues the systematic study of the theory of mathematical statistics.

1. The notion of a parametrized statistical model for data.
2. The definition of likelihood and examples of using it to compare possible parameter values.
3. Parameter estimates and in particular maximum likelihood estimates. Examples including estimated means and variances for Gaussian variables.
4. The notion of estimator and its sampling distribution; interval estimation. Examples of calculating sampling distributions.
5. Frequentist approaches to model comparison and selection; hypothesis testing and p-values.
6. The Bayesian approach to statistical inference; concepts of prior, posterior, conjugacy.
7. Bayesian estimators and credible intervals, posterior predictive checking.
8. Bayesian model selection.

Learning outcomes

By the end of the module, students should be able to:

- describe the main notions of statistical inference including a (parametrized) statistical model, an estimator and its sampling distribution, and hypothesis tests; and to understand their uses and limitations.
- calculate maximum likelihood estimators in a variety of examples.
- use likelihood ratios to compare models and to design hypothesis tests in a variety of examples.
- derive properties of sampling distributions of estimators in a variety of examples.
- compare models using methods of model selection in both a frequentist and Bayesian setting.
- communicate solutions to problems accurately with structured and coherent arguments.

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Subject specific skills

- Select and apply appropriate mathematical and/or statistical techniques.
- Create structured and coherent arguments communicating them in written form.
- Construct and develop logical mathematical arguments with clear identification of assumptions and conclusions.

Transferable skills

- Written communication skills: Students complete written assessments that require precise and unambiguous communication in the manner and style expected in mathematical sciences.
- Verbal communication skills: Students are encouraged to discuss and debate formative assessment and lecture material within small-group tutorials sessions. Students can continually discuss specific aspects of the module with the module leader. This is facilitated by statistics staff office hours.
- Problem-solving skills: The module requires students to solve problems with complex solutions and this requirement is embedded in the module’s assessment.

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (20%)
Seminars	5 sessions of 1 hour (5%)
Tutorials	5 sessions of 1 hour (5%)
Private study	60 hours (60%)
Assessment	10 hours (10%)
Total	100 hours

Private study description

Weekly revision of lecture notes and materials, wider reading and practice exercises, working on problem sets and preparing for examination.

Other activity description

Revision support.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D2

	Weighting	Study time	Eligible for self-certification
In term assessment	10%	8 hours	No

There will be approximately weekly problem sets. Each problem set will contain a number of individual questions based on the material delivered in the lectures. Problem sheets are supported by seminars, including both analytical and computational tasks. Assessment is based on solutions to the problems and engagement with in-class problems.

The preparation and completion time noted below refers to the amount of time in hours that a well-prepared student who has attended lectures and carried out an appropriate amount of independent study on the material could expect to spend on this assessment.

Centrally-timetabled examination (On-campus)	90%	2 hours	No

You will be required to answer all questions on this examination paper.
The study time noted refers to the length of the exam in hours.

- Students may use a calculator
- Answerbook Pink (12 page)

Assessment group R2

	Weighting	Study time	Eligible for self-certification
In-person Examination - Resit	100%		No

You will be required to answer all questions on this examination paper.

- Students may use a calculator
- Answerbook Pink (12 page)

Feedback on assessment

Individual feedback will be provided on problem sheets by class tutors.

Cohort level feedback will be provided for the examination.

Students are actively encouraged to make use of office hours to build up their understanding, and to view all their interactions with lecturers and class tutors as feedback.

Past exam papers for ST230

Availability

Anti-requisite modules

If you take this module, you cannot also take:

- ST352-15 Introduction to Mathematical Statistics (for Finalists)
- ST232-15 Introduction to Mathematical Statistics
- ST233-15 Introduction to Mathematical Statistics

Courses

This module is Core for:

- USTA-G302 Undergraduate Data Science
  - Year 2 of G302 Data Science
  - Year 2 of G302 Data Science
- Year 2 of USTA-G304 Undergraduate Data Science (MSci)
- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
  - Year 2 of G30A Master of Maths, Op.Res, Stats & Economics (Actuarial and Financial Mathematics Stream)
  - Year 2 of G30J Master of Maths, Op.Res, Stats & Economics (Data Analysis Stream)
  - Year 2 of G30B Master of Maths, Op.Res, Stats & Economics (Econometrics and Mathematical Economics Stream)
  - Year 2 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
  - Year 2 of G30C Master of Maths, Op.Res, Stats & Economics (Operational Research and Statistics Stream)
  - Year 2 of G30D Master of Maths, Op.Res, Stats & Economics (Statistics with Mathematics Stream)
  - Year 2 of G300 Mathematics, Operational Research, Statistics and Economics
  - Year 2 of G300 Mathematics, Operational Research, Statistics and Economics
  - Year 2 of G300 Mathematics, Operational Research, Statistics and Economics
- Year 2 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
  - Year 2 of GG14 Mathematics and Statistics
  - Year 2 of GG14 Mathematics and Statistics
- USTA-Y602 Undergraduate Mathematics,Operational Research,Statistics and Economics
  - Year 2 of Y602 Mathematics,Operational Research,Stats,Economics
  - Year 2 of Y602 Mathematics,Operational Research,Stats,Economics