



STAT806

Statistical Inference

S1 Day 2019

Dept of Mathematics and Statistics

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General Information

Unit convenor and teaching staff

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Credit points

4

Prerequisites

Corequisites

((Admission to MAppStat or GradDipAppStat or Msc) and (MATH604 and STAT670 and STAT680 and STAT683)) or (admission to MActPrac)

Co-badged status

Unit description

This unit provides an introduction to likelihood-based statistical inference. After a brief discussion of the multivariable calculus concepts needed, students will study (multivariate) change of variable, the likelihood function and maximum likelihood estimation, using examples from a range of distributions. The theory of estimation and hypothesis testing will be discussed, including most powerful tests, large sample theory, the sufficiency principle, the likelihood ratio principle, and sequential probability ratio tests.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at <https://www.mq.edu.au/study/calendar-of-dates>

Learning Outcomes

On successful completion of this unit, you will be able to:

Have a deep and integrated understanding of the foundation concepts in probability and

statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.

Be able to summarise data using appropriate statistical analysis, descriptive statistics and graphical presentation.

Apply appropriate statistical models/methods and relevant analyses for various types of data, and interpret the results.

Describe and apply the principles of statistical inference including point estimators, confidence intervals and hypothesis testing.

General Assessment Information

IMPORTANT: If you apply for Special Consideration for the final examination, you must make yourself available for the Supplementary Examination as organised by the Faculty of Science & Engineering.

If you are not available at that time, there is no guarantee that an additional examination time will be offered. Specific examination dates and times will be determined at a later date.

LATE SUBMISSION OF WORK: All assignments and assessment tasks must be submitted by the official due date and time.

No marks will be given for late work unless an extension has been granted following a successful application for Special Consideration.

Please contact the unit convenor for advice as soon as you become aware that you may have difficulty meeting any of the assignment deadlines.

Assessment Tasks

Name	Weighting	Hurdle	Due
<u>iLearn Quiz</u>	5%	No	Week 5
<u>Test</u>	20%	No	Week 7
<u>Assignment</u>	15%	No	Week 11
<u>Final examination</u>	60%	No	University Examination Period

iLearn Quiz

Due: **Week 5**

Weighting: **5%**

The iLearn quiz will become available in Week 4 and due in Week 5. The duration of the quiz will be 1 hour.

On successful completion you will be able to:

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.

Test

Due: **Week 7**

Weighting: **20%**

There will be a mid-semester test of 50 minutes duration held during the first lecture of week 7. Students are permitted to take in to the test one sheet of A4 paper containing the student's personal summary. One or both sides of the sheet may be used. The material thereon must be in the student's own handwriting (scanned copies are not permitted) and not typed.

On successful completion you will be able to:

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.

Assignment

Due: **Week 11**

Weighting: **15%**

There will be an assignment due in week 11.

No marks will be given for late work unless an extension has been granted following a successful application for Special Consideration.

On successful completion you will be able to:

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.
- Be able to summarise data using appropriate statistical analysis, descriptive statistics and graphical presentation.
- Apply appropriate statistical models/methods and relevant analyses for various types of data, and interpret the results.
- Describe and apply the principles of statistical inference including point estimators,

confidence intervals and hypothesis testing.

Final examination

Due: **University Examination Period**

Weighting: **60%**

The duration of the final examination is three (3) hours plus ten minutes' reading time. An electronic calculator and two A4 sheets of paper (written on one or both sides) may be taken in to the exam room. All material thereon must be in the student's own handwriting (scanned copies are not permitted) and not typed.

You are expected to present yourself for examination at the time and place designated in the University examination timetable, which will be available at <https://timetables.mq.edu.au>.

Only documented illness or unavoidable disruption may be used as reasons for not sitting an examination at the designated time. In these circumstances you should apply for special consideration via ask.mq.edu.au.

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the interval between the regular exam period and the start of the next session. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the Special Consideration Policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

On successful completion you will be able to:

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.
- Be able to summarise data using appropriate statistical analysis, descriptive statistics and graphical presentation.
- Apply appropriate statistical models/methods and relevant analyses for various types of data, and interpret the results.
- Describe and apply the principles of statistical inference including point estimators, confidence intervals and hypothesis testing.

Delivery and Resources

Technologies used and required

All unit materials, including administrative updates, lecture notes, and assignments, will be posted on the Unit website on iLearn. The web address is <https://ilearn.mq.edu.au>. The R software (freely available online) will be used in the unit.

Students will attend three hours of lectures per week starting in week 1 and one 1-hour small group teaching activity (SGTA) per week starting week 2. The notes shown in lectures will be available on iLearn before the lecture is given, but note that corrections may be made after the lecture. SGTA exercises will be set weekly and will be available on iLearn before the SGTA. Students are expected to have attempted all questions before the SGTA. A plan of the topics to be covered is at the end of this document.

Required and Recommended texts and/or materials

There is no required textbook for this unit. Students may benefit from having access to the following background reference for additional reading and problems:

“Mathematical Statistics with Applications” W Mendenhall, D Wackerly and R Scheaffer (6th or 7th edition) - library call number is QA276.M426.

The following books may also be useful background references:

ROSS, S. A First Course in Probability (QA273.R83)

SCHEAFFER, R. L. Introduction to Probability and Its Applications (QA273.S357)

SMITH, P. J. Into Statistics (QA276.S615)

FREUND, J. E. Mathematical Statistics (QA276.F692)

HOEL, P. Introduction to Mathematical Statistics (QA276.H57)

HOGG, R.V. & TANIS, E.A. Probability and Statistical Inference (QA273.H694)

LARSON, H. Introduction to Probability Theory and Statistical Inference (QA273.L352)

SPIEGEL, M.R., SRINIVASAN, J. & SCHILLER, J.J. Schaum's outline of theory and problems of probability and statistics (QA273.25.S64)

WALPOLE, R.E. & MYERS, R.H. Probability and Statistics for Engineers and Scientists (TA340.W35)

HOGG, R.V. & CRAIG, A.T. Introduction to Mathematical Statistics (QA276.H59)

At least one copy of each of these is available in the Library, and extra copies may be available on the shelves for borrowing purposes.

It should be understood that there are variations in notation (and even in definition) from one reference book to another, and that the lecture material alone defines recommended notation. Note that all lecture notes will be available in pdf form on the Unit website on iLearn before the

lecture. You are required to print out your own copy and bring this to lectures.

Unit Schedule

TOPIC	MATERIAL COVERED
1	Sample space, events. Axioms of probability, conditional probability. Bayes Theorem.
2	Random variables and probability distributions. Standard discrete and continuous distributions and their key characteristics. The Poisson process.
3	Expected values (discrete and continuous) and their properties. Measures of variation. Quantiles. Moments (raw and central). Interpretation of moments (skewness, kurtosis etc.).
4	Sums of independent random variables. Discrete and continuous convolutions with applications. Transformations (monotonic and non-monotonic) of continuous random variables. Transformation of a continuous random variable to one with a uniform distribution, with applications to simulation.
5	Probability generating functions and moment generating functions with properties and applications. The moment generating function of a sum of independent random variables. The Central Limit Theorem and applications.
6	Multivariate (particularly bivariate) random variable theory (continuous and discrete). Marginal and conditional distributions and expectations. Covariance and correlation.
7	Exploratory data analysis including measures of association and principal component analysis.
8	Random sampling and sampling distributions.
9	Point estimators and their properties. MLEs and asymptotic results and bootstrapping.
10	Interval estimators, their properties.
11	Hypothesis testing, including likelihood ratios and goodness of fit.

Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central \(https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central\)](https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- [Academic Appeals Policy](#)
- [Academic Integrity Policy](#)
- [Academic Progression Policy](#)
- [Assessment Policy](#)
- [Fitness to Practice Procedure](#)
- [Grade Appeal Policy](#)

- [Complaint Management Procedure for Students and Members of the Public](#)
- [Special Consideration Policy](#) (**Note:** *The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.*)

Undergraduate students seeking more policy resources can visit the [Student Policy Gateway](https://students.mq.edu.au/support/study/student-policy-gateway) (<https://students.mq.edu.au/support/study/student-policy-gateway>). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit [Policy Central](http://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central) (<http://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central>).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: <https://students.mq.edu.au/study/getting-started/student-conduct>

Results

Results published on platform other than [eStudent](#), (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in [eStudent](#). For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit <http://students.mq.edu.au/support/>

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- [Workshops](#)
- [StudyWise](#)
- [Academic Integrity Module for Students](#)
- [Ask a Learning Adviser](#)

Student Services and Support

Students with a disability are encouraged to contact the [Disability Service](#) who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the [Acceptable Use of IT Resources Policy](#). The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.
- Be able to summarise data using appropriate statistical analysis, descriptive statistics and graphical presentation.
- Apply appropriate statistical models/methods and relevant analyses for various types of data, and interpret the results.
- Describe and apply the principles of statistical inference including point estimators, confidence intervals and hypothesis testing.

Assessment tasks

- iLearn Quiz
- Test
- Assignment
- Final examination

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.
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- Describe and apply the principles of statistical inference including point estimators, confidence intervals and hypothesis testing.

Assessment tasks

- iLearn Quiz
- Test
- Assignment
- Final examination

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- Have a deep and integrated understanding of the foundation concepts in probability and statistics, including random variables and distributions, independence, joint and conditional distributions, expectations, generating functions, distributions of sums of independent random variables and the Central Limit Theorem.
- Be able to summarise data using appropriate statistical analysis, descriptive statistics and graphical presentation.
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Assessment tasks

- iLearn Quiz
- Test
- Assignment
- Final examination

Changes from Previous Offering

The unit has been redeveloped in order to cover the syllabus of Actuarial Statistics 1 (CS1), the Institute and Faculty of Actuaries.