STAT683

Introduction to Probability

S1 Day 2017

Dept of Statistics

Contents

General Information

Unit convenor and teaching staff Unit Convenor Georgy Sofronov georgy.sofronov@mq.edu.au Contact via georgy.sofronov@mq.edu.au Friday, 12-2pm
Credit points 4
Prerequisites Admission to MAppStat or GradDipAppStat or MSc
Corequisites STAT670
Co-badged status This unit is co-taught with STAT273.
Unit description This unit consolidates and expands upon the material on probability introduced in STAT670. The emphasis is on the understanding of probability concepts and their application. Examples are taken from areas as diverse as biology, medicine, finance, sport, and the social and physical sciences. Topics include: the foundations of probability; probability models and their properties; some commonly used statistical distributions; relationships and association between variables; distribution of functions of random variables and sample statistics; approximations including the central limit theorem; and an introduction to the behaviour of random processes. Simulation is used to demonstrate many of these concepts.

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:

> Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.

Have a solid understanding of the difference between discrete and continuous random variables.

For discrete or continuous random variables be able to calculate probabilities of events, their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.

Have a deep knowledge of a bivariate probability distribution, joint, marginal, conditional probabilities and covariance. Have a solid understanding of a bivariate Normal distribution.

Understand limit theorems: the Law of Large Numbers (LLN) and the Central Limit Theorem (CLT).

Be able to generate random data. Be able to organise and summarise any random data. Determine whether a particular model fits random data.

A solid understanding a Markov Chain (MC), a stationary distribution of MC. Interpretation of MCs with absorbing states.

General Assessment Information

On-time submission of the assessment tasks is compulsory. Late submission will not be accepted unless satisfactory documentation outlining illness or misadventure is submitted via ask.mq.edu.au. Information about the Disruption to Studies policy and procedure is available at:

http://students.mq.edu.au/student_admin/exams/disruption_to_studies/

http://www.mq.edu.au/policy/docs/disruption_studies/policy.html

http://www.mq.edu.au/policy/docs/disruption_studies/procedure.html

Assessment Tasks

Name	Weighting	Hurdle	Due
Test 1	10%	No	Week 4 lecture
Simulation project 1	10%	No	Week 7
Test 2	10%	No	Week 10 lecture
Simulation project 2	10%	No	Week 12
Final Examination	60%	No	University Examination Period

Test 1

Due: **Week 4 lecture**
Weighting: **10%**

You are allowed to bring in one A4 page of handwritten notes, written on both sides. All necessary statistical tables and formulae will be provided. An electronic calculator is essential. Non-programmable calculators with no text-retrieval capacity are allowed in the tests or exam.

On successful completion you will be able to:

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.
- For discrete or continuous random variables be able to calculate probabilities of events, their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.

Simulation project 1

Due: **Week 7**
Weighting: **10%**

Students will be given one week to complete the Simulation project.

On successful completion you will be able to:

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.
- For discrete or continuous random variables be able to calculate probabilities of events, their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.
- Understand limit theorems: the Law of Large Numbers (LLN) and the Central Limit

Theorem (CLT).

- Be able to generate random data. Be able to organise and summarise any random data. Determine whether a particular model fits random data.

Test 2

Due: **Week 10 lecture**
Weighting: **10%**

You are allowed to bring in one A4 page of handwritten notes, written on both sides. All necessary statistical tables and formulae will be provided. An electronic calculator is essential. Non-programmable calculators with no text-retrieval capacity are allowed in the tests or exam.

On successful completion you will be able to:

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.
- For discrete or continuous random variables be able to calculate probabilities of events, their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.
- Understand limit theorems: the Law of Large Numbers (LLN) and the Central Limit Theorem (CLT).

Simulation project 2

Due: **Week 12**
Weighting: **10%**

Students will be given one week to complete the Simulation project.

On successful completion you will be able to:

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.

- For discrete or continuous random variables be able to calculate probabilities of events, their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.
- Have a deep knowledge of a bivariate probability distribution, joint, marginal, conditional probabilities and covariance. Have a solid understanding of a bivariate Normal distribution.
- Understand limit theorems: the Law of Large Numbers (LLN) and the Central Limit Theorem (CLT).
- Be able to generate random data. Be able to organise and summarise any random data. Determine whether a particular model fits random data.

Final Examination

Due: **University Examination Period**
Weighting: **60%**

The examination will be of 3 hours duration with 10 minutes reading time.

For the Final examination you are allowed to bring in one A4 page of handwritten notes, written on both sides. All necessary statistical tables and formulae will be provided.

An electronic calculator is essential and will be required. Non-programmable calculators with no text-retrieval capacity are allowed in the tests or exam.

You are expected to present yourself for examination at the time and place designated in the University Examination Timetable. The timetable will be available in Draft form approximately eight weeks before the commencement of the examinations and in Final form approximately four weeks before the commencement of the examinations (http://www.exams.mq.edu.au)

If you apply for Disruption to Study for your final examination, you must make yourself available for the week of July 24 – 28, 2017. If you are not available at that time, there is no guarantee an additional examination time will be offered. Specific examination dates and times will be determined at a later date.

On successful completion you will be able to:

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.
- For discrete or continuous random variables be able to calculate probabilities of events,

their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.

- Have a deep knowledge of a bivariate probability distribution, joint, marginal, conditional probabilities and covariance. Have a solid understanding of a bivariate Normal distribution.
- Understand limit theorems: the Law of Large Numbers (LLN) and the Central Limit Theorem (CLT).
- Be able to generate random data. Be able to organise and summarise any random data. Determine whether a particular model fits random data.
- A solid understanding a Markov Chain (MC), a stationary distribution of MC. Interpretation of MCs with absorbing states.

Delivery and Resources

Classes

STAT683 is delivered by lectures and tutorials.

The timetable for classes can be found on the University web site at:

http://www.timetables.mq.edu.au

Required and Recommended Texts and/or Materials

There is no set textbook for this subject. Lecture notes will be available from iLearn at least the night before the lecture. Students should read the lecture notes before the lecture. All teaching materials will be available via iLearn.

References that may be useful

- Wackerly, D. D., Mendenhall, W., Scheaffer, R. L. Mathematical Statistics with Applications (4th,5th, 6th or 7th Editions)
- Ross, S. A First Course in Probability, Pearson (5th, 6th, 7th, 9th or 9th Editions)
- Ward, M. D. and Gundlach, E. (2016) Introduction to Probability, W. H. Freeman and Company
- Kinney, J.J. (1997) Probability - An Introduction with Statistical Applications, John Wiley and Sons
- Scheaffer R.L. (1994) Introduction to Probability and Its Applications, (2nd Edition) Duxbury Press
- Sincich,T., Levine, D.M., Stephan, D. (1999) Practical Statistics by Example using

Microsoft Excel

Technology Used and Required

iLearn

There will be an iLearn site for this unit where weekly information, online discussions, lecture notes, iLectures, practice exercises and solutions will be posted.

Students are required to login to iLearn using their Student ID Number and myMQ Portal Password (note, information about how to get hold of your password is provided by the weblink http://ilearn.mq.edu.au).

The website for the iLearn login is https://ilearn.mq.edu.au/login/MQ/. You can only access the material if you are enrolled in the unit.

Software

We will be using Microsoft Office for Windows (especially Excel), R and Wolfram Alpha, freely available online.

Audio/Video recordings of lectures will be available on iLearn soon after the lecture is delivered.

Course notes are available on iLearn before the lecture. Students should familiarise themselves with the notes before the lecture and bring a copy (in paper or electronic form) to class.

Teaching and Learning Strategy

Lectures

Lectures begin in Week 1. STAT683 students should attend 3 hours per week. The lecture notes must be brought to the lectures each week. These will be available on iLearn the night before the lecture.

Tutorials

Tutorials begin in Week 2 and are based on work from the previous week's lecture. The aim of tutorials is to apply techniques learnt in lectures to solve problems using a statistical package. The material is available on iLearn.

Additional Exercises

Additional exercises may also be made available on iLearn. It is expected that students will attempt all questions. The exercises will not be discussed during the tutorial, although some may be discussed during the lectures. A solution will be made available on the website.

Unit Schedule

WEEK	LECTURE TOPIC

W1	Experiments, sample spaces, Probability Rules, Permutations and Combinations
W2	Conditional Probability. Independence, Bayes' Theorem
W3	Random Variables. Probability Functions, Discrete Probability Distributions, Cumulative Distribution functions, Expected value and Variance. Moments.
W4	Important Discrete Distributions: Bernoulli, Binomial, Geometric and Poisson.
W5	Moment generating functions. More Discrete Distributions: Negative Binomial and Hypergeometric.
W6	Introduction to Continuous random variables. Cumulative distribution function.
W7	Continuous Distributions: Uniform, Exponential.
	Mid-semester break
W8	Normal distribution.
W9	Continuous Distributions: Gamma and Beta Distributions. Chebyshev's Theorem.
W10	Sampling Distributions.
W11	Joint Distributions: Discrete and Continuous cases.
W12	Introduction to Markov Chains. States, Transition probabilities, State vectors, Equilibrium, Absorbing States
W13	Revision.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy_2016.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy (in effect until Dec 4th, 2017): http://www.mq.edu.au/policy/docs/disruption_studies/policy.html

Special Consideration Policy (in effect from Dec 4th, 2017): https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policies/special-consideration

In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/

Results

Results shown in *iLearn*, 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.

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

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

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.
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Assessment tasks

- Test 1
- Simulation project 1
- Test 2

- Simulation project 2
- Final Examination

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Be able to describe a probabilistic model for an experiment, calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
- Have a solid understanding of the difference between discrete and continuous random variables.
- For discrete or continuous random variables be able to calculate probabilities of events, their expected values and variances. Graph the probability distributions or probability density functions and the cumulative distribution functions. Using moment generating functions for finding of moments of random variables. Generate random numbers from distributions and use these numbers for solving probability problems.
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Assessment tasks

- Test 1
- Simulation project 1
- Test 2
- Simulation project 2
- Final Examination

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcome

- Be able to generate random data. Be able to organise and summarise any random data. Determine whether a particular model fits random data.

Assessment tasks

- Simulation project 1
- Simulation project 2
- Final Examination