



# STAT683

## Introduction to Probability

S2 Day 2016

*Dept of Statistics*

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#### Disclaimer

Macquarie University has taken all reasonable measures to ensure the information in this publication is accurate and up-to-date. However, the information may change or become out-dated as a result of change in University policies, procedures or rules. The University reserves the right to make changes to any information in this publication without notice. Users of this publication are advised to check the website version of this publication [or the relevant faculty or department] before acting on any information in this publication.

## General Information

Unit convenor and teaching staff

Unit Convenor

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AHH, Level 2

Friday, 12-2pm

Lecturer

Nino Kordzakhia

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AHH, Level 2

Tuesday, 12-1pm, 2-3pm

Credit points

4

Prerequisites

Admission to MAppStat or GradDipAppStat

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:

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.

Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## 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](mailto: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://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/policy.html)

[http://www.mq.edu.au/policy/docs/disruption\\_studies/procedure.html](http://www.mq.edu.au/policy/docs/disruption_studies/procedure.html)

## Assessment Tasks

Name	Weighting	Due
<u>Tutorial assessment</u>	10%	Weeks 3 and 9

Name	Weighting	Due
<u>Test 1</u>	10%	Week 4 lecture
<u>Simulation project 1</u>	10%	Week 6
<u>Test 2</u>	10%	Week 10
<u>Simulation project 2</u>	10%	Week 12
<u>Final Examination</u>	50%	University Examination Period

## Tutorial assessment

Due: **Weeks 3 and 9**

Weighting: **10%**

In weeks 3 and 9, students will be required to submit the tutorial work via iLearn. Students will be given a week to complete the tasks. Students should solve the problems and submit their solutions via iLearn as Microsoft Word (.doc or .docx) or Adobe Portable Document Format (.pdf) files. Hand-written solutions are not encouraged, but may be scanned to create pdf documents. The tutorial works are equally weighted and together worth 10% of the unit assessment.

On successful completion you will 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.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## 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:

- 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.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## Simulation project 1

Due: **Week 6**

Weighting: **10%**

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

On successful completion you will 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).

- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## Test 2

Due: **Week 10**

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:

- 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).
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## 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:

- 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.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## Final Examination

Due: **University Examination Period**

Weighting: **50%**

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>)

On successful completion you will 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.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## **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., Mendenhall W. Scheaffer. Mathematical Statistics with Applications (4th,5th or 6th Editions) QA276 .M426 2002
- Kinney, J.J. (1997) Probability - An Introduction with Statistical Applications, John Wiley and Sons QA273.K493/1997
- Scheaffer R.L. (1994) Introduction to Probability and Its Applications, (2nd Edition) Duxbury Press, QA273.S357
- Sincich,T., Levine, D.M., Stephan, D. (1999) Practical statistics by example using Microsoft Excel QA276.12 .S554

Copies of these books are held in the Reserve section of the library.



## Technology Used and Required

### **iLearn**

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

Students are free to attend one 1-hour tutorial a week. Students must submit their work on iLearn before the due date indicated in the assessment page on iLearn.

### **Additional Exercises**

Additional exercises will also be made available on iLearn. It is expected that students will attempt all the 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
W4	Moments. 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	Important Continuous Distributions: Uniform, Exponential.
	<b>Mid-semester break</b>
W8	Normal distribution.
W9	Normal distribution (cont).
W10	More Continuous Distributions: Gamma and Beta Distributions. Chebyshev's Theorem
W11	Joint Distributions: Discrete and Continuous cases.
W12	Sampling Distributions.
W13	Introduction to Markov Chains. States, Transition probabilities, State vectors, Equilibrium, Absorbing States

## 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](http://mq.edu.au/policy/docs/academic_honesty/policy.html)

**New Assessment Policy in effect from Session 2 2016** [http://mq.edu.au/policy/docs/assessment/policy\\_2016.html](http://mq.edu.au/policy/docs/assessment/policy_2016.html). For more information visit [http://students.mq.edu.au/events/2016/07/19/new\\_assessment\\_policy\\_in\\_place\\_from\\_session\\_2/](http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/)

Assessment Policy prior to Session 2 2016 <http://mq.edu.au/policy/docs/assessment/policy.html>

Grading Policy prior to Session 2 2016 <http://mq.edu.au/policy/docs/grading/policy.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](http://www.mq.edu.au/policy/docs/complaint_management/procedure.html)

Disruption to Studies Policy [http://www.mq.edu.au/policy/docs/disruption\\_studies/policy.html](http://www.mq.edu.au/policy/docs/disruption_studies/policy.html) *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

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/](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](http://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](http://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](http://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/](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

### Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

#### Assessment tasks

- Simulation project 1
- Simulation project 2

### Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

#### Assessment tasks

- Simulation project 1
- Simulation project 2

### 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

- Describe a probabilistic model for an experiment. Calculate probability and conditional probability of an event. Have a deep understanding of the independence of events.
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- 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.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## Assessment tasks

- Tutorial assessment
- 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

- 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.
- A solid understanding a Markov Chain (MC), a stationary distribution of MC. Interpretation of MCs with absorbing states.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## Assessment tasks

- Tutorial assessment
- 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 outcomes

- Be able to generate random data. Be able to organise and summarise any random data. Determine whether a particular model fits random data.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to solve complex problems in a creative way.

## **Assessment tasks**

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

## **Effective Communication**

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

## **Assessment tasks**

- Simulation project 1
- Simulation project 2

## **Changes from Previous Offering**

In addition to Microsoft Excel, the statistical software R will also be used.