# STAT683

## Introduction to Probability

S1 External 2015

*Dept of Statistics*

## Contents

# General Information

Unit convenor and teaching staff
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Credit points
4

Prerequisites
Admission to MAppStat or GradDipAppStat

Corequisites
STAT670

Co-badged status

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:

Master understanding of fundamentals of probability theory.

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

Have a deep understanding of the difference between theoretical and empirical probability.

For various discrete and continuous random variables be able to calculate relevant probabilities, their expected values and variances. Generate/simulate random numbers from a distribution using inverse distribution function method. Solve probability problems using simulation.
For bivariate (discrete or continuous) random variables find the joint distribution, marginal and conditional probabilities. Covariance.
Understanding of homogeneous Markov Chains and finding its stationary distribution if such distribution exists. Interpretation of Markov Chains with absorbing states.
Be able to organise and summarize random data; Determine whether random data fits a particular model; Be able to simulate random numbers from probability distributions either using pre-existing functions/tools or by the method of inversion; Be able to organise and summarise random data; Determine whether random data fits a particular model and obtain estimates of the model parameters; Be able to find probabilities, expected values etc, using an appropriate statistical package for exploratory data analysis.
Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to identify and solve problems using probabilistic methods.

# Assessment Tasks

| Name | Weighting | Due |
|---|---|---|
| Tutorial work | 10% | Weekly |
| Test 2 | 10% | Week 7 |
| Test 1 | 10% | Week 3 |
| Assignment | 10% | Week 10 |
| Simulation Project | 10% | Week 12 |
| Final Examination | 50% | University exam timetable |

## Tutorial work

Due: **Weekly**
Weighting: **10%**

In weeks 2 to 12 you are required to submit the tutorial work via iLearn. Students will be given a week to complete the task. The cut-off date will be announced on iLearn. Tutorial works are equally weighted and together worth 10% of the unit assessment.

On successful completion you will be able to:

- Master understanding of fundamentals of probability theory.
- Have a deep understanding of the difference between discrete and continuous random variables.
- Have a deep understanding of the difference between theoretical and empirical probability.
- For bivariate (discrete or continuous) random variables find the joint distribution, marginal and conditional probabilities. Covariance.
- Be able to organise and summarize random data; Determine whether random data fits a particular model; Be able to simulate random numbers from probability distributions either using pre-existing functions/tools or by the method of inversion; Be able to organise and summarise random data; Determine whether random data fits a particular model and obtain estimates of the model parameters; Be able to find probabilities, expected values etc, using an appropriate statistical package for exploratory data analysis.

## Test 2

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

Test 2 will be held in the lecture. You are permitted ONE A4 page of paper containing reference material handwritten on both sides.

On successful completion you will be able to:

- Have a deep understanding of the difference between discrete and continuous random variables.
- For various discrete and continuous random variables be able to calculate relevant probabilities, their expected values and variances. Generate/simulate random numbers from a distribution using inverse distribution function method. Solve probability problems using simulation.

## Test 1

Due: **Week 3**
Weighting: **10%**

Test 1 will be held in the lecture.  You are permitted ONE A4 page of paper containing reference material handwritten on both sides.

On successful completion you will be able to:

- Master understanding of fundamentals of probability theory.
- Have a deep understanding of the difference between theoretical and empirical probability.
- For various discrete and continuous random variables be able to calculate relevant probabilities, their expected values and variances. Generate/simulate random numbers from a distribution using inverse distribution function method. Solve probability problems using simulation.

## Assignment

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

The Assignment will be administered via iLearn.

**Extension requests for assessments**

No extensions will be granted. Students who have not submitted assessment tasks on time will be awarded a mark of 0 for the task, except for cases in which an application for special consideration is made and approved.

On successful completion you will be able to:

- Have a deep understanding of the difference between discrete and continuous random variables.
- For bivariate (discrete or continuous) random variables find the joint distribution, marginal and conditional probabilities. Covariance.
- Understanding of homogeneous Markov Chains and finding its stationary distribution if such distribution exists. Interpretation of Markov Chains with absorbing states.

## Simulation Project

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

Simulation Project will take place in Week 12 during the tutorial time.

On successful completion you will be able to:

- Have a deep understanding of the difference between theoretical and empirical probability.
- For bivariate (discrete or continuous) random variables find the joint distribution, marginal and conditional probabilities. Covariance.

- Be able to organise and summarize random data; Determine whether random data fits a particular model; Be able to simulate random numbers from probability distributions either using pre-existing functions/tools or by the method of inversion; Be able to organise and summarise random data; Determine whether random data fits a particular model and obtain estimates of the model parameters; Be able to find probabilities, expected values etc, using an appropriate statistical package for exploratory data analysis.

## Final Examination

Due: **University exam timetable**
Weighting: **50%**

A three-hour final examination for this unit will be held during the University Examination period.

You are permitted ONE A4 page of paper containing reference material handwritten on both sides. The pages will not be returned after the end of the final examination.

Calculators will be needed but must not be of the text/programmable type.

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 via

http://exams.mq.edu.au/

The Macquarie University Final Examination policy details can be viewed at

http://www.mq.edu.au/policy/docs/examination/policy.htm

On successful completion you will be able to:

- For bivariate (discrete or continuous) random variables find the joint distribution, marginal and conditional probabilities. Covariance.
- Understanding of homogeneous Markov Chains and finding its stationary distribution if such distribution exists. Interpretation of Markov Chains with absorbing states.
- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to identify and solve problems using probabilistic methods.

# Delivery and Resources

**Classes**

Students will attend three 1-hour lectures and one 1-hour tutorial per week.

Tutorials start in the second week of Session 1.

The timetable for classes can be found at

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

**iLearn**

All unit related materials, lecture notes, tutorials, additional exercises, the assignment and administrative updates, will be posted on the unit website on iLearn at

https://ilearn.mq.edu.au/login/MQ/ . The lecture notes will be made available on iLearn before the lecture.

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. Solutions to exercises will be made available on iLearn.

**Software**

Microsoft Office will be used in this unit.

The link to online answer engine Wolfram Alpha is available for verifying results of your calculations:

http://www.wolframalpha.com/

**Required and Recommended Texts and/or Materials**

There is not the textbook set for this unit.

Recommended references include:

- Wackerly, D., Mendenhall W. Scheaffer. Mathematical Statistics with Applications (4th,5thor 6thEditions) QA276 .M426 2002
- Kinney, J.J. (1997) Probability - An Introduction with Statistical Applications, John Wiley and Sons QA273.K493/1997
- Scheaffer R.L. (2010) Introduction to Probability and Its Applications, (3rd Edition) Duxbury Press, *QA273 .S357* 2010
- Sincich,T., Levine, D.M., Stephan, D. (1999) Practical statistics by example using Microsoft Excel, QA276.12 .S554

# Unit Schedule

| Weeks | Lecture Topics |
|---|---|
| W1 | Experiments, Sample Spaces, Probability Rules, Permutations and Combinations, Theoretical vs. Empirical probability |

| | |
|---|---|
| **W2**<br>Tutorials start | Conditional Probability, Independence, Bayes' Theorem |
| **W3** | Random Variables, Probability Functions, Discrete Probability Distributions, Cumulative Distribution functions, Expected value and Standard Deviation |
| **W4** | Discrete Distributions: Bernoulli, Binomial, Geometric, Poisson. |
| **W5** | Discrete Distributions cont.: Negative Binomial and Hypergeometric.<br>Introduction to Continuous random variables |
| **W6** | *Good Friday Public Holiday (3/4/15)* |
| ***Mid –session break: 3/4/15-19/4/15*** | |
| **W7** | Cumulative distribution function, Functions of Random Variables, Sampling distributions, Uniform and Exponential Distributions |
| **W8** | Normal Distribution Model checking, Central Limit Theorem, Normal Approximations |
| **W9** | Gamma Distributions, Beta Distributions, Tchebysheff's Theorem |
| **W10** | Chi-squared Distribution, Distribution of sample variance, F-Distribution, Test for Equality of Variance, t- Distribution, Distribution of sample mean (σ unknown) |
| **W11** | Joint Distributions: Discrete and Continuous cases. |
| **W12** | Joint Distributions: Discrete and Continuous cases. Introduction to Markov Chains States, Transition probabilities, State vectors, Equilibrium, Absorbing States |
| **W13** | Review |

# Learning and Teaching Activities

## Discipline Specific nowledge 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 o 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.

## Critical, Analytical and Integrative Thinking

e 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 aninformation technology literacy.

## 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 confidency to take the initiative in doing so, within awareness of their own limitations.

## 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.

## Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

# 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.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

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

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy 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/

## 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://informatics.mq.edu.au/help/.

When using the University's IT, you must adhere to the Acceptable Use 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:

### Learning outcome

- For bivariate (discrete or continuous) random variables find the joint distribution, marginal and conditional probabilities. Covariance.

### Assessment tasks

- Tutorial work
- Assignment
- Simulation Project
- Final Examination

## 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:

### Learning outcome

- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to identify and solve problems using probabilistic methods.

### Assessment task

- Final Examination

## Commitment to Continuous Learning

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## Assessment tasks

- Tutorial work
- Test 2
- Test 1
- Assignment

- Simulation Project
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### Assessment tasks

- Tutorial work
- Test 2
- Test 1
- Assignment
- Simulation Project

## 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:

### Learning outcome

- Students will build their knowledge starting from the basic idea of probability. At the end, they will be able to identify and solve problems using probabilistic methods.

### Assessment task

- Final Examination

## Changes from Previous Offering

There is no change made from previous offering.