STAT7150

Bayesian Data Analysis

Session 1, In person-scheduled-weekday, North Ryde 2022

School of Mathematical and Physical Sciences

Contents

General Information

Unit convenor and teaching staff
Houying Zhu
houying.zhu@mq.edu.au

Benoit Liquet-Weiland
benoit.liquet-weiland@mq.edu.au

Credit points
10

Prerequisites
Admission to MRes and (STAT710 or STAT7310)

Corequisites

Co-badged status

Unit description
This unit introduces main concepts and methods of Bayesian analysis with a clear comparison with frequentist statistical methods. Both single-parameter and multi-parameter models are derived. Bayesian computation techniques and Bayesian regression models, which include linear, GLM and hierarchical models, are studied in the unit. This unit highlights and exploits computational aspects of Bayesian data analysis including Markov Chain Monte Carlo (MCMC) methods (Gibbs sampling, Hastings-Metropolis) using the latest computational tools.

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:

ULO1: Explain and communicate to a non-expert audience the fundamentals of the Bayesian approach to Statistics

ULO2: Construct conjugate families of prior distributions for common sampling distributions

ULO3: Formulate and carry out Bayesian inference procedures such as point and interval estimation and hypothesis testing, for common sampling distributions

ULO4: Develop, analytically describe, and implement both single and multiparameter

probability models in the Bayesian framework

ULO5: Solve real world problems using Bayesian Methods and state-of-art software tools

ULO6: Design hierarchical models exploiting Markov chain Monte Carlo (MCMC) simulation methods, and apply them to common statistical models including Generalised Linear Models

General Assessment Information

Assignment Submission: Assignment submission will be online through the iLearn page. A personalised cover sheet is not required with online submissions. Read the submission statement carefully before accepting it as there are substantial penalties for making a false declaration. Please note that each submission will completely replace any previous submissions. It is in your interests to make frequent submissions of your partially completed work as insurance against technical or other problems near the submission deadline.

Late Submission of Work: All assessment tasks must be submitted by the official due date and time. Should these assessments be missed due to illness or misadventure, students should apply for special consideration. In the case of a late submission for a non-timed assessment (e.g. an assignment), if special consideration has NOT been granted, a consistent penalty will be applied for the late submission as follows. A 12-hour grace period will be given after which the following deductions will be applied to the awarded assessment mark; 12 to 24 hours late = 10% deduction; for each day thereafter, an additional 10% per day or part thereof will be applied until five days beyond the due date. After this time (including weekends and/or public holidays), a mark of zero (0) will be given. Timed assessment tasks (e.g. test, examination) do not fall under these rules.

Assessment Tasks

Name	Weighting	Hurdle	Due
Report 1	30%	No	Week 5
Report 2	30%	No	Week 8
Report 3	30%	No	Week 12
Media presentation	10%	No	Week 13

Report 1

Assessment Type [1]: Quantitative analysis task
Indicative Time on Task [2]: 20 hours
Due: **Week 5**
Weighting: **30%**

The report will focus mainly on the material covered in Lecture Weeks 1-3.

On successful completion you will be able to:

- Explain and communicate to a non-expert audience the fundamentals of the Bayesian approach to Statistics
- Construct conjugate families of prior distributions for common sampling distributions
- Formulate and carry out Bayesian inference procedures such as point and interval estimation and hypothesis testing, for common sampling distributions

Report 2

Assessment Type [1]: Quantitative analysis task
Indicative Time on Task [2]: 20 hours
Due: **Week 8**
Weighting: **30%**

The report will focus mainly on the material covered in Lecture Weeks 4-6.

On successful completion you will be able to:

- Explain and communicate to a non-expert audience the fundamentals of the Bayesian approach to Statistics
- Construct conjugate families of prior distributions for common sampling distributions
- Formulate and carry out Bayesian inference procedures such as point and interval estimation and hypothesis testing, for common sampling distributions
- Develop, analytically describe, and implement both single and multiparameter probability models in the Bayesian framework
- Solve real world problems using Bayesian Methods and state-of-art software tools

Report 3

Assessment Type [1]: Quantitative analysis task
Indicative Time on Task [2]: 20 hours
Due: **Week 12**
Weighting: **30%**

The report will focus mainly on the material covered in Lecture Weeks 7-10.

On successful completion you will be able to:

- Explain and communicate to a non-expert audience the fundamentals of the Bayesian approach to Statistics
- Construct conjugate families of prior distributions for common sampling distributions
- Formulate and carry out Bayesian inference procedures such as point and interval estimation and hypothesis testing, for common sampling distributions
- Develop, analytically describe, and implement both single and multiparameter probability models in the Bayesian framework
- Solve real world problems using Bayesian Methods and state-of-art software tools
- Design hierarchical models exploiting Markov chain Monte Carlo (MCMC) simulation methods, and apply them to common statistical models including Generalised Linear Models

Media presentation

Assessment Type [1]: Media presentation
Indicative Time on Task [2]: 13 hours
Due: **Week 13**
Weighting: **10%**

Students are required to produce a media presentation demonstrating a unit topic of their choice. This demonstration needs to be a brief and accessible to other students that haven't studied the specific topic but have similar Mathematics/Statistics background.

On successful completion you will be able to:

- Explain and communicate to a non-expert audience the fundamentals of the Bayesian approach to Statistics
- Construct conjugate families of prior distributions for common sampling distributions
- Formulate and carry out Bayesian inference procedures such as point and interval estimation and hypothesis testing, for common sampling distributions
- Develop, analytically describe, and implement both single and multiparameter probability models in the Bayesian framework
- Solve real world problems using Bayesian Methods and state-of-art software tools
- Design hierarchical models exploiting Markov chain Monte Carlo (MCMC) simulation methods, and apply them to common statistical models including Generalised Linear

Models

[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

Lectures and SGTAs

The unit is delivered by lectures (2 hours per week, starting in Week 1) and SGTAs (1 hour per week, starting in Week 2). All teaching materials will be available on iLearn. SGTA solutions will be available on iLearn at the end of the week. Please refer to the iLearn page for more details.

The important message to off-shore students: Off-shore students must email the convenor as soon as possible to discuss study options.

Computing and Software

R and Rstudio: These are freely available to download from the Web, and they will be used for data analysis in this unit.

Recommended text

- Peter Hoff, *A First Course in Bayesian Statistical Methods.* Springer Texts in Statistics, Springer, 2009.
- Reich, Brian J. and Ghosh Sujit K. *Bayesian Statistical Methods.* Chapman and Hall/ CRC, 2019.
- Lambert B. *A Student's Guide to Bayesian Statistics.* SAGE Publications Ltd, 2018.
- Kruschke JK. *Doing Bayesian Data Analysis: A Tutorial with R, JAGS and Stan.* Academic Press/Elsevier, 2015.
- McElreath R. *Statistical Rethinking: A Bayesian Course with Examples in R and Stan.* CRC Press/Taylor and Francis/Chapman and Hall, 2016.
- Gelman A, Carlin JB, Stern HS, Dunson DB, Vehtari A, Rubin DB. *Bayesian Data Analysis (3rd Edition)*. CRC Press/Taylor and Francis/Chapman and Hall, 2014.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). 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
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/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

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

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

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

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.