STAT711

Generalized Linear Models

S2 Evening 2019

Dept of Mathematics and Statistics

Contents

General Information

Unit convenor and teaching staff
Convenor
Gillian Heller
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12 WW 7.25
Tuesday 10-12

Lecturer
Thomas Fung
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12 WW 6.26
Tuesday 3 - 5pm

Credit points
4

Prerequisites
Admission to MRes

Corequisites
STAT710

Co-badged status
STAT811 is co-taught with STAT711

Unit description
This unit starts with the classical normal linear regression model. The family of generalized linear models is then introduced and maximum likelihood estimators are derived. Models for counted responses, binary responses, continuous non-normal responses and categorical responses; and models for correlated responses, both normal and non-normal, and generalised additive models, are studied. Zero-inflated models are also considered. All models and methods are illustrated using data sets from disciplines such as biology, actuarial studies and medicine.

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:

Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model selection; and interpret the model parameters.

Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.

Carry out in-depth graphical data exploration, and perform appropriate data transformations.

Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.

Formulate and estimate a generalized additive model.

Write a well-structured technical report on statistical analysis performed.

Write a report on statistical analysis performed, for a non-statistical audience.

General Assessment Information

ASSIGNMENT SUBMISSION: Assignment submission will be online through the iLearn page, by the given due date and time.

Submit assignments online via the appropriate assignment link on 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.

- Assignment submission is via iLearn. You should upload this as a single scanned PDF file.
- Please note the quick guide on how to upload your assignments provided on the iLearn page.
- Please make sure that each page in your uploaded assignment corresponds to only one A4 page (do not upload an A3 page worth of content as an A4 page in landscape). If you are using an app like Clear Scanner, please make sure that the photos you are using are clear and shadow-free.
- It is your responsibility to make sure your assignment submission is legible.
- If there are technical obstructions to your submitting online, please email us to let us know.

You may submit as often as required prior to the due date/time. 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 assignments or assessments must be submitted by the official due date and time. No marks will be given to 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. It is in your interests to make frequent submissions of your partially completed work. Note that later submissions completely replace any earlier submission, and so

only the final submission made before the due date will be marked.

Examination There will be a two-hour sit-down examination. You will be permitted to bring an A4 sheet of notes, handwritten or typed, on both sides, into the examination. The sit-down examination will be timetabled in the official University examination timetable.

FINAL EXAM POLICY: examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is, the final day of the official examination period. The only excuse for not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these special circumstances, you may apply for special consideration via ask.mq.edu.au.

SUPPLEMENTARY EXAMINATIONS:

IMPORTANT: 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. If you apply for special consideration, you must give the supplementary examination priority over any other pre-existing commitments, as such commitments will not usually be considered an acceptable basis for a second application for special consideration. Please ensure you are familiar with the policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (https://bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification sometime in the week prior to the exam with the exact date and time of their supplementary examination.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	20%	No	19 August
Assignment 2	20%	No	30 September
Assignment 3	20%	No	28 October
Final examination	40%	No	Examination period

Assignment 1

Due: **19 August**
Weighting: **20%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model selection; and interpret the model parameters.

- Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Assignment 2

Due: **30 September**
Weighting: **20%**

On successful completion you will be able to:

- Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.
- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Assignment 3

Due: **28 October**
Weighting: **20%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model selection; and interpret the model parameters.
- Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Formulate and estimate a model for correlated data, using random effects or generalized

estimating equations, as appropriate; interpret the model parameters.
- Formulate and estimate a generalized additive model.
- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Final examination

Due: **Examination period**
Weighting: **40%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model selection; and interpret the model parameters.
- Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.
- Formulate and estimate a generalized additive model.
- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Delivery and Resources

Lectures and SGTAs are at the following times:

Lecture: Tuesday 6-8pm, 9 Wally's Walk (E6A) - 133 Tutorial Rm

SGTA: Tuesday 8-9pm, 6 Eastern Rd (E4B) - 118 Faculty PC Lab.

SGTAs will run from week 1 to week 12.

Course notes: Course notes are available on iLearn, prior to the lecture. SGTA solutions are posted on iLearn.

Required and recommended resources

There is no prescribed text for this unit. The following are useful references:

1. Fahrmeir, L., Kneib, T., Lang, S. and Marx, B. (2013). **Regression: Models, Methods and Applications**, Springer.

2. Faraway, J. J. (2016). **Extending the linear model with R: generalized linear, mixed effects and nonparametric regression models**. CRC Press.
3. De Jong, P. and Heller, G.Z. (2008). **Generalized Linear Models for Insurance Data**, Cambridge University Press.
4. Wood, Simon N. (2017). **Generalized additive models: an introduction with R,** 2nd edition**.** CRC Press.
5. Stasinopoulos M. D., Rigby R. A., Heller G. Z., Voudouris V., De Bastiani F. (2017). **Flexible Regression and Smoothing: Using GAMLSS in R**. CRC Press.
6. Dobson, A. J. and Barnett, A. G. (2018). **An Introduction to Generalized Linear Models**, 4th edition, Chapman & Hall.
7. Lindsey, J.K. (1997). **Applying Generalized Linear Models**, Springer.
8. McCullagh, P. and Nelder, J.A. (1989). **Generalized Linear Models**, 2nd edition, Chapman & Hall.

Recommended web sites

A comprehensive list of online resources for self-learning R, is given on iLearn.

www.gamlss.com

www.statsci.org/glm/

en.wikipedia.org/wiki/Generalized_linear_model

Technology used

We will be using R, which is freely downloadable from the CRAN website. We recommend use of the RStudio interface, also freely downloadable.

iLearn

We will be using iLearn for posting of course notes, assignments, solutions and data sets, and online discussions. You are encouraged to use the forums for discussions on the course material. Remember that if you are confused about something, the chances are that other students are also confused. Everybody benefits from the discussions, and you should not be embarrassed to admit that you do not understand a concept.

Audio recordings of lectures

Audio recordings of the lectures (Echo) will be available on the iLearn site.

Unit Schedule

Week	Topics	
1	The classical normal linear model	
2	Introduction to GLMs: The framework of generalized linear models is introduced, and the theory behind maximum likelihood estimation of the parameters started.	
3	Maximum likelihood estimation of the parameters; Poisson regression for count data	
4	Inference; comparison of models The deviance as a measure of fit; hypothesis testing	Assn 1 due
5	Model checking: Definition of residuals in GLMs; checking for violation of model assumptions	
6	Model selection; overdispersion: Selection of models via AIC; the phenomenon of overdispersion; compound Poisson models to overcome it; the negative binomial model for counts	
7	Binary responses: logistic regression	
	Session 2 Break	
8	Logistic regression contd; Zero-inflated models; Generalized additive models	Assn 2 due
9	Regression models for ordinal and categorical responses	
10	Correlated data: Models for longitudinal data, and other data structures in which there is clustering or correlation between observations	
11	Correlated data	
12	Correlated data	Assn 3 due
13	No lecture	

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). 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). 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 (https://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 - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Learning outcomes

- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Final examination

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

- Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model

selection; and interpret the model parameters.
- Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.
- Formulate and estimate a generalized additive model.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- 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

- Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model selection; and interpret the model parameters.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.
- Formulate and estimate a generalized additive model.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- 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

- Formulate a generalized linear model; estimate the parameters using R or other appropriate statistical software; perform diagnostic model checking; perform model selection; and interpret the model parameters.
- Carry out in-depth graphical data exploration, and perform appropriate data transformations.
- Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.
- Formulate and estimate a generalized additive model.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Final examination

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcomes

- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3

- Final examination

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues

This graduate capability is supported by:

Learning outcomes

- Write a well-structured technical report on statistical analysis performed.
- Write a report on statistical analysis performed, for a non-statistical audience.

Assessment task

- Final examination

Changes from Previous Offering

- Emphasis in computing will change from SAS to R.
- The take-home examination has been replaced by a sit-down examination.

Changes since First Published

Date	Description
30/07/2019	Lecture venue changed to accommodate larger numbers.