STAT711

Generalized Linear Models

S2 Evening 2017

Dept of Statistics

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General Information

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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 generalized additive models, are studied. All models and methods are illustrated using data sets from scientific disciplines such as biology, marine science and medicine. SAS software is used.

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 SAS, 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 Assignments should be submitted electronically on iLearn, by the given due date and time.

Please note that the Turnitin tool will be used for assignment submission. This tool detects similarities between submitted assignments and identifies plagiarism.

Extensions and penalties Extensions to assignments are at the discretion of the unit coordinator. It is the responsibility of the student to prove that there has been unavoidable disruption. In the absence of an approved extension, the penalty for late assignments will be 5% of earned mark per day, up to maximum of 50%.

Examination There will be a two-hour sit-down examination, and a take-home examination which you have four days to complete. You will be permitted to bring an A4 sheet of notes, handwritten or typed, on both sides, into the sit-down examination. The sit-down examination will be timetabled in the official University examination timetable. The timing of the take-home examination will be determined in class, once the draft University timetable has been published. A tentative hand-in date of 20 November has been set.

Supplementary examinations will be held in the week 11 - 15 December. Should you be granted a supplementary examination, you will be required to be available at the specified time in

that week.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	15%	No	21 August
Assignment 2	15%	No	2 October
Assignment 3	15%	No	30 October
Take home exam	30%	No	20 November (tentative date)
Exam	25%	No	S2 exam period

Assignment 1

Due: **21 August**
Weighting: **15%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS, 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: **2 October**
Weighting: **15%**

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: **30 October**
Weighting: **15%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS, 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.

Take home exam

Due: **20 November (tentative date)**
Weighting: **30%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS, 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.

Exam

Due: **S2 exam period**
Weighting: **25%**

-

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS, 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.

Delivery and Resources

Lectures and tutorials are at the following times:

Lecture: Tuesday 6-8pm, E3B 218

Tutorial: Tuesday 8-9pm, 6 Eastern Rd (E4B) 306 Faculty PC Lab

External students are expected to study the course notes and attempt the tutorials, weekly. They are also welcome to optionally attend the weekly lectures and tutorials:

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

Required and recommended resources

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

1. McCullagh, P. and Nelder, J.A. (1989). **Generalized Linear Models**, 2nd edition, Chapman

& Hall.

2. Dobson, A. J. and Barnett, A. G. (2008). **An Introduction to Generalized Linear Models**, 3rd edition, Chapman & Hall.

3. De Jong, P. and Heller, G.Z. (2008). **Generalized Linear Models for Insurance Data**, Cambridge University Press.

4. Lindsey, J.K. (1997). **Applying Generalized Linear Models**, Springer.

5. Faraway, J. J. (2016). **Extending the linear model with R: generalized linear, mixed effects and nonparametric regression models**. CRC Press.

6. Stasinopoulos MD, Rigby RA, Heller GZ, Voudouris V, De Bastiani F (2017). **Flexible Regression and Smoothing: Using GAMLSS in R**. CRC Press.

7. Wood, Simon N. (2017). **Generalized additive models: an introduction with R,** 2nd edition**.** CRC Press.

Some references to texts on Generalized Linear Models are given on http://www.statsci.org/glm/books.html

Recommended web sites

http://www.statsci.org/glm/

http://en.wikipedia.org/wiki/Generalized_linear_model

TECHNOLOGY USED

SAS Software

- We will be using SAS version 9.4. This is accessed via iLab, in the computer labs and outside the University.
- On your own computer, it is also possible to access SAS via SASUniversityEdition.
    - Follow the instructions at http://www.sas.com/en_us/software/university-edition/download-software.html You will need to install VirtualBox or VMware software, on which SAS will run. You will also need to set up a SAS user profile. This works on Windows and OS platforms and needs a 64-bit machine.
- SAS technical advice is available here: SAS Academic support; HP support site; Dell support site; Lenovo Support site

R software

We will be providing R code in the notes, as an alternative to SAS. R 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	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

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
- Take home exam

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 SAS, 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
- Take home exam
- Exam

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 SAS, 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
- Take home exam
- Exam

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 SAS, 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
- Take home exam
- Exam

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
- Take home exam
- Exam

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

- Take home exam

Changes since First Published

Date	Description
28/07/2017	Lecture venue updated