STAT411

Generalised Linear Models

S2 Evening 2015

Dept of Statistics

Contents

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General Information

Unit convenor and teaching staff
Convenor
Ian Marschner
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AHH Level 2
10.00am Wednesday

Lecturer
Thomas Fung
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AHH Level 2
2.00-4.00pm Thursday

Credit points
3

Prerequisites
39cp including (STAT272(P) or STAT306(P) or STAT371(P))

Corequisites

Co-badged status
STAT411 is co-taught with STAT711 and STAT811

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 disciplines such as biology, actuarial studies 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 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

In order to pass the unit, students need to perform satisfactorily on all components of assessment (assignments and examination).

Assignment submission Assignments must be submitted electronically through the iLearn website.

Extensions and penalties Extensions to assignments is at the discretion of the lecturers. It is the responsibility of the student to prove that there has been unavoidable disruption. Marks will be deducted for late submissions in the absence of an approved extension.

Examination There will be a 2-hour sit-down examination. 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.

Assessment Tasks

Name	Weighting	Due
Assignment 1	20%	August 27
Assignment 2	20%	October 8
Assignment 3	30%	November 5
Exam	30%	S2 exam period

Assignment 1

Due: **August 27**
Weighting: **20%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS 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: **October 8**
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: **November 5**
Weighting: **30%**

On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS 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: **30%**

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On successful completion you will be able to:

- Formulate a generalized linear model; estimate the parameters using SAS 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: Thursday 6-8pm, E5A 110

Tutorial: Thursday 8-9pm, E4B 118

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. SAS manual, available in the SAS help menu.

Some references to texts on Generalized Linear Models using SAS are given on http://www.stats ci.org/glm/books.html

Recommended web sites

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

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

TECHNOLOGY USED

Software

We will be using the software SAS version 9.3. If you require the software for your home computer, we will supply you with a fully working version (with one year's licence). You can also access SAS remotely using the iLab application. Please see separate handout concerning this.

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 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
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	No lecture (public holiday)
9	Logistic regression contd; Zero-inflated models; Generalized additive models
10	Regression models for ordinal and categorical responses
11	Correlated data: Models for longitudinal data, and other data structures in which there is clustering or correlation between observations
12	Correlated data
13	Correlated data

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

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 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

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

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

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

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

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

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

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 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
- Exam

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should

have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

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

- Assignment 3