STAT411

Generalised Linear Models

E2 2012

Statistics

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
Gillian Heller
gillian.heller@mq.edu.au
Contact via gillian.heller@mq.edu.au
E4A 533
Thursday 12-2 pm

Credit points
3

Prerequisites
STAT371(P) or STAT271(P) or STAT306(P)

Corequisites

Co-badged status
Co-badged with 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:

Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity

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.

Assessment Tasks

Name	Weighting	Due
Assignment 1	15%	20 August
Assignment 2	15%	8 October
Assignment 3	15%	29 October
Take-home examination	30%	20 November
Examination	25%	TBA

Assignment 1

Due: **20 August**
Weighting: **15%**

Assignment submission

Assignments should be submitted to the lecturer, by 6pm on the due date. On-campus students are expected to submit assignments at the lecture; distance students should email or mail them.

Extensions and penalties

Extensions to assignments is at the discretion of the lecturer. 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.

On successful completion you will be able to:

- Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity
- 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: **8 October**
Weighting: **15%**

On successful completion you will be able to:

- Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity
- 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 3

Due: **29 October**
Weighting: **15%**

On successful completion you will be able to:

- Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity
- 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 examination

Due: **20 November**
Weighting: **30%**

You will have four days to complete the take-home examination. The timing of the take-home examination will be determined in class, once the draft University timetable has been published. (A tentative due date of 20 November has been published.)

On successful completion you will be able to:

- Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity
- 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.

Examination

Due: **TBA**
Weighting: **25%**

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 sit-down examination.*

Please note that students who have not performed satisfactorily in the assignments, will not be permitted to sit either the sit-down or the take-home examination. Any student who is to be excluded from the examinations, will be notified in writing of this after the due date of the last assignment.
The sit-down examination will be timetabled in the official University examination timetable. The University Examination 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 at: http://www.exams.mq.edu.au/exam/

The only exception to not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to consider applying for Special Consideration. Information about unavoidable disruption and the special consideration process is available at: http://web.science.mq.edu.au/new_and_current_students/undergrad/admin_central/

A supplementary examination will only be granted if a student has satisfactory coursework**.** If a Supplementary Examination is granted as a result of the Special Consideration process, the examination will be scheduled after the conclusion of the official examination period.

Note that there is a University policy regarding requests for Special Consideration for examinations and the granting of supplementary examinations, which can be found at: http://www.mq.edu.au/policy/docs/special_consideration/policy.html.

You are advised that it is Macquarie University policy not to set early 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.

On successful completion you will be able to:

- Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity
- 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

Textbooks

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.

The first four texts are on 3-day loan. Some references to texts on Generalized Linear Models using SAS 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_models

TECHNOLOGY USED

Software

We will be using the software SAS version 9.2, which is available in the computer labs in E4B. Should you need your own version of SAS, you can obtain a fully working version (with one year's licence). 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 will be available on the iLearn site, the day after the lecture is delivered.

Course notes are available on iLearn, prior to the lecture. Students should print the notes and bring them to lectures.

Unit Schedule

Lecture: Monday 6-8pm, E4B 306

Tutorial: Monday 8-9pm, E4B 306

Students are expected to attend lectures and tutorials weekly.

Lecture and assessment timetable

Week	Date	Assessment
1	30 July	
2	6 August	Assignment 1 handed out
3	13 August	
4	20 August	Assignment 1 handed in

5	27 August	
6	3 September	Assignment 2 handed out
7	10 September	
Mid-semester break		
8	1 October	No lecture (public holiday)
9	8 October	Assignment 2 handed in
10	15 October	Assignment 3 handed out
11	22 October	
12	29 October	Assignment 3 handed in
13	5 November	
	20 November	Take-home exam due

Topics covered

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
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

Learning and Teaching Activities

Weekly lectures and tutorials

The unit is taught as one 3-hour block per week in the computer lab consisting of one 2-hour lecture and one 1-hour tutorial. Students are expected to read the lectures notes before the lecture, will be asked to participate actively to the unit and to study on a weekly basis.

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://www.mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://www.mq.edu.au/policy/docs/assessment/policy.html

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

Special Consideration Policy http://www.mq.edu.au/policy/docs/special_consideration/policy.html

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Of interest to students are the policies and associated procedures on:

- Assessment
- Feedback and unit evaluation
- Special consideration
- Appeal Against Final Grade Policy / Procedures / Guidelines

- Academic honesty

You should, in particular, familiarise yourself with University policy on **academic honesty:** http://www.mq.edu.au/policy/docs/academic_honesty/policy.html . Academic honesty is an integral part of the core values and principles contained in the Macquarie University Ethics Statement: http://www.mq.edu.au/ethics/ethic-statement-final.html. Its fundamental principle is that all staff and students act with integrity in the creation, development, application and use of ideas and information. Penalties may include a deduction of marks, failure in the unit, and/or referral to the University Discipline Committee.

Student Support

Macquarie University provides a range of Academic Student Support Services. Details of these services can be accessed at: http://students.mq.edu.au/support/.

UniWISE provides:

- Online learning resources and academic skills workshops http://www.mq.edu.au/learning_skills/
- Personal assistance with your learning & study related questions.
- The Learning Help Desk is located in the Library foyer (level 2).
- Online and on-campus orientation events run by Mentors@Macquarie.

Student Services and Support

Students with a disability are encouraged to contact the Disability Support Unit who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

Details of these services can be accessed at http://www.student.mq.edu.au/ses/.

IT Help

If you wish to receive IT help, we would be glad to assist you at 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 and it outlines what can be done.

Graduate Capabilities

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 outcome

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

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

- Critical scientific thinking; analytical skills; applied statistical skills; ability to diagnose and resolve problems; scientific integrity
- 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.

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.