STAT7111

Generalized Linear Models

Session 2, In person-scheduled-weekday, North Ryde 2024

School of Mathematical and Physical Sciences

Contents

General Information

Unit convenor and teaching staff
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Credit points
10

Prerequisites
Admission to MRes

Corequisites

Co-badged status
STAT8111

Unit description
The family of generalized linear models is introduced. Models for counted responses, binary responses, continuous non-normal and categorical responses and models for correlated responses, both normal and non-normal, and generalized additive models are studied. This unit also offers students the opportunity to develop an understanding in survival analysis for analysing time-to-event data. All models and methods are illustrated using datasets from disciplines such as actuarial studies, biology, biostatistics 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:

ULO1: Formulate a Generalized Linear Model and derive its maximum likelihood estimators.

ULO2: Interrogate research questions by exploring data graphically, applying appropriate data cleaning and modelling techniques, appraising underlying model assumptions and goodness of fit and modifying the analysis if required.

ULO3: Investigate competing models by performing model selection and hypothesis tests.

ULO4: Modify a generalized liner model to incorporate nonlinear forms of the predictors and use random effects or generalized estimating equations to model correlated data.

ULO5: Select the appropriate statistical software to create model outputs, interpret and synthesise the analysis results and communicate effectively with other researchers and stakeholders.

ULO6: Demonstrate a solid understanding of survival data by identifying and applying correct models such as the Cox proportional hazards model.

General Assessment Information

Requirements to Pass this Unit

To pass this unit you must:

- Achieve a total mark equal to or greater than 50%.

Hurdle Assessments

There is no Hurdle Assessment.

Late Assessment Submission Penalty

Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark) will be applied each day a written assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of 0 will be awarded even if the assessment is submitted. Submission time for all written assessments is set at 11:55 pm. A 1-hour grace period is provided to students who experience a technical concern.

For any late submission of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, students need to submit an application for Special Consideration.

Assessments where Late Submissions will be accepted.

In this unit late submissions will be accepted as follows:

- Assignment 1 – YES, Standard Late Penalty applies;
- Assignment 2 – YES, Standard Late Penalty applies;
- Case study/analysis – YES, Standard Late Penalty applies.

- Final Exam – NO, unless Special Consideration is granted.

Special Consideration

The Special Consideration Policy aims to support students who have been impacted by short-term circumstances or events that are serious, unavoidable and significantly disruptive, and which may affect their performance in assessment. If you experience circumstances or events that affect your ability to complete the written assessments in this unit on time, please inform the convenor and submit a Special Consideration request through ask.mq.edu.au.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	10%	No	Week 5
Assignment 2	10%	No	Week 9
Case study/analysis	40%	No	Week 12
Final Exam	40%	No	Formal Examination Period

Assignment 1

Assessment Type [1]: Quantitative analysis task
Indicative Time on Task [2]: 10 hours
Due: **Week 5**
Weighting: **10%**

Assignment

On successful completion you will be able to:

- Formulate a Generalized Linear Model and derive its maximum likelihood estimators.
- Interrogate research questions by exploring data graphically, applying appropriate data cleaning and modelling techniques, appraising underlying model assumptions and goodness of fit and modifying the analysis if required.
- Investigate competing models by performing model selection and hypothesis tests.

Assignment 2

Assessment Type [1]: Quantitative analysis task
Indicative Time on Task [2]: 10 hours
Due: **Week 9**

Weighting: **10%**

Assignment

On successful completion you will be able to:
- Formulate a Generalized Linear Model and derive its maximum likelihood estimators.
- Interrogate research questions by exploring data graphically, applying appropriate data cleaning and modelling techniques, appraising underlying model assumptions and goodness of fit and modifying the analysis if required.
- Investigate competing models by performing model selection and hypothesis tests.
- Modify a generalized liner model to incorporate nonlinear forms of the predictors and use random effects or generalized estimating equations to model correlated data.
- Select the appropriate statistical software to create model outputs, interpret and synthesise the analysis results and communicate effectively with other researchers and stakeholders.

Case study/analysis

Assessment Type [1]: Case study/analysis
Indicative Time on Task [2]: 20 hours
Due: **Week 12**
Weighting: **40%**

Authentic case study that required some data cleaning

On successful completion you will be able to:
- Formulate a Generalized Linear Model and derive its maximum likelihood estimators.
- Interrogate research questions by exploring data graphically, applying appropriate data cleaning and modelling techniques, appraising underlying model assumptions and goodness of fit and modifying the analysis if required.
- Investigate competing models by performing model selection and hypothesis tests.
- Modify a generalized liner model to incorporate nonlinear forms of the predictors and use random effects or generalized estimating equations to model correlated data.
- Select the appropriate statistical software to create model outputs, interpret and synthesise the analysis results and communicate effectively with other researchers and

stakeholders.

- Demonstrate a solid understanding of survival data by identifying and applying correct models such as the Cox proportional hazards model.

Final Exam

Assessment Type [1]: Examination
Indicative Time on Task [2]: 2 hours
Due: **Formal Examination Period**
Weighting: **40%**

Formal invigilated examination testing the learning outcomes of the unit.

On successful completion you will be able to:

- Formulate a Generalized Linear Model and derive its maximum likelihood estimators.
- Interrogate research questions by exploring data graphically, applying appropriate data cleaning and modelling techniques, appraising underlying model assumptions and goodness of fit and modifying the analysis if required.
- Investigate competing models by performing model selection and hypothesis tests.
- Modify a generalized liner model to incorporate nonlinear forms of the predictors and use random effects or generalized estimating equations to model correlated data.
- Demonstrate a solid understanding of survival data by identifying and applying correct models such as the Cox proportional hazards model.

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[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

Classes

Lectures (beginning in Week 1): There is one two-hour lectures each week.

SGTA classes (beginning in Week 2): Students must register in and attend one one-hour class per week.

The timetable for classes can be found on the University website at: https://publish.mq.edu.au

Enrolment can be managed using eStudent at: https://students.mq.edu.au/support/technology/systems/estudent

Suggested textbooks

The following textbook is useful as supplementary resources, for additional questions and explanations. They are available from the Macquarie University library:

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.

Technology Used and Required

This subject requires the use of the following computer software:

- R: R is a free statistical software package. Access and installation instructions may be found at: https://www.r-project.org/
- RStudio: RStudio is an open source tool that is used to manage and present work performed using R. Access and installation instructions may be found at https://rstudio.com/products/rstudio/download/
- LaTeX: LaTeX is a free mathematical typesetting program. You should use this to help to typeset your assignment. Access and installation instructions may be found at: https://www.latex-project.org/get/

Communication

We will communicate with you via your university email or through announcements on iLearn. Queries to convenors can either be placed on the iLearn discussion forum or sent to your lecturers from your university email address.

COVID Information

For the latest information on the University's response to COVID-19, please refer to the Coronavirus infection page on the Macquarie website: https://www.mq.edu.au/about/coronavirus-faqs. Remember to check this page regularly in case the information and requirements change during semester. If there are any changes to this unit in relation to COVID, these will be communicated via iLearn.

Unit Schedule

This is a draft schedule and is subjected to change.

Week	Topics	
1	The classical normal linear model	
2	Introduction to GLMs: The framework of generalized linear models and the theory behind maximum likelihood estimation of the parameters; Poisson and Gamma regression	
3	Inference; Comparison of models; Deviance as a measure of fit; Hypothesis testing	
4	Model checking: Definition of residuals in GLMs; checking for violation of model assumptions; Model selection; Model building strategy	
5	Overdispersion; The negative binomial model for counts	Assignment 1 due
6	Binary responses: logistic regression	
7	Zero-inflated models; Generalized additive models (GAMs)	
8	Regression models for ordinal and nominal responses	
	Session 2 Break	
9	Correlated data - Generalized linear mixed models (GLMMs)	Assignment 2 due
10	Correlated data - the Generalized estimating equation (GEE) approach; Generalized Additive Models for Location, Scale and Shape (GAMLSS)	
11	Introduction to time to event data and survival analysis; censoring and truncation; nonparametric estimators for various survival quantities	
12	Estimation and inference using parametric and semi-parametric survival models	Case study/ analysis due
13	Revision	

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 Advocacy provides independent advice on MQ policies, procedures, and processes

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.

Changes from Previous Offering

We highly appreciate student feedback as it helps us enhance our unit offerings continually. Therefore, we encourage students to provide constructive feedback through various channels, such as student surveys, direct communication with teaching staff, or by utilising the FSE

Student Experience & Feedback link available on the iLearn page.

Following recommendations from the ACS and TEQSA accreditation processes, we have added a case study/analysis and a final exam to the assessment structure. Additionally, two weeks of survival analysis content have been incorporated, while some of the Generalized Linear Models (GLM) content has been condensed and simplified to enhance clarity and focus.

Changes since First Published

Date	Description
26/07/2024	Updated Changes from Previous Offering.

Unit information based on version 2024.01 of the Handbook