# STAT411

Generalised Linear Models

S2 Evening 2013

Statistics

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General Information

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

Unit Convenor
Ian Marschner
ian.marschner@mq.edu.au
Contact via ian.marschner@mq.edu.au
E4A 540
11am Wednesday

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 http://students.mq.edu.au/student_admin/enrolmentguide/academicdates/
Learning Outcomes

1. 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.
2. Derive the maximum likelihood estimators for a generalized linear model, and test hypotheses.
3. Carry out in-depth graphical data exploration, and perform appropriate data transformations.
4. Formulate and estimate a model for correlated data, using random effects or generalized estimating equations, as appropriate; interpret the model parameters.
5. Formulate and estimate a generalized additive model.
6. Write a well-structured technical report on statistical analysis performed.
7. Write a report on statistical analysis performed, for a non-statistical audience.

Assessment Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
</tr>
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<tbody>
<tr>
<td>Assignment 1</td>
<td>15%</td>
<td>August 22</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>15%</td>
<td>October 3</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>15%</td>
<td>October 31</td>
</tr>
<tr>
<td>Take home exam</td>
<td>30%</td>
<td>November 22</td>
</tr>
<tr>
<td>Exam</td>
<td>25%</td>
<td>S2 exam period</td>
</tr>
</tbody>
</table>

Assignment 1

Due: **August 22**
Weighting: **15%**

This Assessment Task relates to the following 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.
• 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 3
Weighting: 15%

This Assessment Task relates to the following Learning Outcomes:
• 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: October 31
Weighting: 15%

This Assessment Task relates to the following Learning Outcomes:
• 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: November 22
Weighting: 30%

This Assessment Task relates to the following 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.

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%**

This Assessment Task relates to the following 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.

**Delivery and Resources**

**Lecture:** Thursday 6-8pm, E4B 316

**Tutorial:** Thursday 8-9pm, E4B 214

**Course notes:** Course notes are available on iLearn, prior to the lecture.

Students are expected to attend lectures and tutorials weekly. They should print the notes and bring them to lectures.

**Changes from previous years:** there are no major changes from previous years.

**Required and recommended resources**

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

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

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). 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, the day after the lecture is delivered.
## Unit Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>The classical normal linear model</td>
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<tr>
<td>2</td>
<td>Introduction to GLMs: The framework of generalized linear models is introduced, and the theory behind maximum likelihood estimation of the parameters started.</td>
</tr>
<tr>
<td>3</td>
<td>Maximum likelihood estimation of the parameters; Poisson regression for count data</td>
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<tr>
<td>4</td>
<td>Inference; comparison of models The deviance as a measure of fit; hypothesis testing</td>
</tr>
<tr>
<td>5</td>
<td>Model checking: Definition of residuals in glms; checking for violation of model assumptions</td>
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<tr>
<td>6</td>
<td>Model selection; overdispersion: Selection of models via AIC; the phenomenon of overdispersion; compound Poisson models to overcome it; the negative binomial model for counts</td>
</tr>
<tr>
<td>7</td>
<td>Binary responses: logistic regression</td>
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<tr>
<td>8</td>
<td>Session 2 Break</td>
</tr>
<tr>
<td>9</td>
<td>Logistic regression contd; Zero-inflated models; Generalized additive models</td>
</tr>
<tr>
<td>10</td>
<td>Regression models for ordinal and categorical responses</td>
</tr>
<tr>
<td>11</td>
<td>Correlated data: Models for longitudinal data, and other data structures in which there is clustering or correlation between observations</td>
</tr>
<tr>
<td>12</td>
<td>Correlated data</td>
</tr>
<tr>
<td>13</td>
<td>Revision</td>
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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
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.

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.students.mq.edu.au/support/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 Enquiry Service

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

Equity 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.

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 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 generalized additive model.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Take home exam
- 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 generalized additive model.

Assessment tasks

• Assignment 1
• Assignment 2
• Assignment 3
• Take home exam
• 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 generalized additive model.

Assessment tasks

• Assignment 1
• Assignment 2
• Assignment 3
• Take home exam
• 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
- Take home exam
- 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**

- Take home exam

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
- Take home exam