Course Outline
Generalized Linear Models and Extensions
STAT * 4050/6802
University of Guelph, W 2023

I. General Information

Calendar description: (0.5 credits)
Topics include: generalized linear models; generalized linear mixed models; joint modelling of mean and dispersion; generalized estimating equations; modelling longitudinal categorical data; modelling clustered data. This course will focus both on theory and implementation using relevant statistical software. Extra work is required for graduate students.

Prerequisite(s): STAT*3110, STAT*3240
Restriction(s): Credit may be obtained for only one of STAT*4050 or STAT*4060 or STAT*6802
Department(s): Department of Mathematics and Statistics

Instructor: Julie Horrocks
Office: McN518
E-mail: jhorrock@uoguelph.ca
Office hours: by appointment (email me!)
Lecture Days and Times: T, Th 4:00 - 5:20pm, MACN 201

II. Learning outcomes
After successful completion of the course, students will be able to:
1. Understand general theory and inference (frequentist and Bayesian) for GLM's
2. Fit and interpret common Generalized Linear Models (GLMs) including Gaussian, binary, binomial, ordinal, multinomial, and Poisson regression models. Perform inference, model diagnostics, GOF tests, variable selection.
3. Understand general theory and inference for Generalized Linear Mixed Models (GLMMs).
4. Fit/interpret various GLMMs and their applications to longitudinal or clustered data.
5. Understand, fit and interpret Generalized Estimating Equations (GEEs).
6. Select and implement appropriate methods for computer analysis of a given data set.
7. Effectively visualize multivariate data.
8. Show proficiency in using, writing, debugging, testing, and commenting computer code.
9. Show proficiency in performing a data analysis, presenting results and writing a report
10. Show ability to cite and reference sources appropriately.
11. Show ability to do independent work.

III. Course content

Content will be presented through a combination of online materials, instructor presentation, computer demo/work and student presentations. Assignments and materials will be posted on the Courselink site.

TENTATIVE Schedule of topics:

Week	Topic	Assessments
Week 1 Week of Jan 10	GLMs: Intro and History Review: Likelihood, Numerical optimization Bayesian methods	
Week 2 Week of Jan 17	Systematic Component, Linear Predictor Random Component, Exponential Family	A1 due Jan19
Week 3 Week of Jan 24	Poisson. Predicted values, residuals. Overdispersion, offset	A2 due Jan 26
Week 4 Week of Jan 31	Binomial, links. Overdispersion, separation	A3 due Feb 2
Week 5 Week of Feb 7	Multinomial, Ordinal Models, Log-linear models Clustered, Longitudinal, Spatial Data	A4 due Feb 9
Week 6 Week of Feb 14	Review/Catch up MIDTERM	Midterm Thursday Feb 16
Week of Feb 21	WINTER BREAK	
Week 7 Week of Feb 28	Linear Mixed Models (LMM)	PROJECT Proposal due Mar 2 A5 due Mar 2
Week 8 Week of Mar 7	Generalized Linear Mixed Models (GLMM) Generalized Estimating Equations (GEE)	A6 due Mar 9
Week 9 Week of Mar 14	Spatial models.	PROJECT Draft due Mar 16 A7 due Mar 16
Week 10 Week of Mar 21	PROJECT Meetings	A8 due Mar 23
Week 11 Week of Mar 28	PROJECT presentations	Presentations Mar 28, 30
Week of Apr 4	PROJECT presentations. Last day of classes is Thursday April 6	Presentations Apr 4,6 Written Project due Apr 6

IV. Course Resources

Recommended Textbook – Course Reserves UoG library
- Faraway, Julian. *Extending the Linear Model with R*, Second Edition, Chapman & Hall/CRC (2016). **ebook**

Other GLM Resources – Course Reserves UoG library (3 day reserve)
- McCullagh & Nelder, John. *Generalized Linear Models,* 2nd edition, Chapman & Hall (1999)
- Dobson, A. *An Introduction to Generalized Linear Models,* 2nd edition, Chapman & Hall (2002)
- Galecki, Andrzej & Burzykowski, Tomasz. *Linear Mixed-Effects Models Using R: A Step-by-Step Approach.* **ebook**
- Gelman, Carlin, et al. Bayesian Data Analysis, 3rd edition, (2013). Also available as a pdf from http://www.stat.columbia.edu/~gelman/book/BDA3.pdf

R Resources– Course Reserves UoG library
- Zuur, A.F., Ieno E.N., & Meesters, E.H.W.G., *A Beginner's Guide to R*, Springer (2009) **ebook**
- Venables, W.N. & Ripley, B.D. *Modern Applied Statistics with S-PLUS.* Springr (2013) **ebook**

Free R Resources
- Wickham, Hadley, Chief Scientist at RStudio. http://hadley.nz/

Statistical software:
- R. Free! For installation on your own computer, go here: http://cran.r-project.org.
- RStudio. Interface for R. Also free! Get it here: https://www.rstudio.com/

V. Methods of Assessment

- **NO LATE ASSESSMENTS WILL BE ACCEPTED.**
- All assessments will be submitted **as a single pdf file** to **Dropbox** on Courselink. TurnItIn and Google will be used to check for originality. Use Word, LaTex, or some other text editor to produce your assessments. Formulas can be hand-written and captured with your phone or scanned. Graphics should be shrunk to ¼ page at most. Convert all components to a single pdf document, with components in the correct order, then upload to Dropbox on Courselink.
- **All facts should be properly cited and referenced**.
- Grad students will generally have extra or harder questions on each. Undergrads can do these as well, but they will not count for marks.
- Discussion often leads to better understanding, so I encourage you to discuss course concepts and assessment problems with other students or instructional personnel. However, for individual assessments, each individual is responsible for their own work. Each individual must hand in a separate complete assessment, that is entirely their own work.

Assignments: Assignments will be due on **Thursdays at 11:59pm** on the stated dates (see table). Only 7 out of 8 assignments count toward your final grade; the assignment with the lowest mark will be dropped. Assignments will generally require you to
- answer some theoretical questions involving equations.
- write code (in R)
- write short reports summarizing data analysis results.
- reflect on material that you learned in the past week.

Late/Missed Assignments. If an assignment is late or you do not hand in an Assignment, for whatever reason, you get a mark of 0. If this happens once, it counts as your dropped Assignment. Please do **not** get a note from your doctor.

Midterm: In class on Feb 16.
Midterm covers material from Week 1 – Week 4 inclusive and Assignments 1- 4 inclusive.

Project: The project has several components: Proposal, Draft, 10 min Presentation and Written Report of a data analysis. Proposal & Draft are due on the stated dates at **11:59pm** (see table). Grad students are strongly encouraged to analyze longitudinal or spatial data.

NO LATE Work will be accepted.

	Due Dates	Percent of Final Grade	
Assignments	Jan 19, 26 Feb 2, 9 Mar 2, 9, 16, 23		45%
Midterm	Feb 16		25%
Project			
Proposal	Mar 2	2.5%	
Draft (Title, Outline, Intro)	Mar 16	2.5%	
Instructor Meeting	week of Mar 21	2.5%	
Presentation	Mar 28, 30, Apr 4,6	7.5%	
Final Written Project	Apr 6	15.0%	
Total Project			30%

VI. University Statements
https://mathstat.uoguelph.ca/node/534

Academic Misconduct
The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is outlined in the Undergraduate Calendar.