

Course Outline
Generalized Linear Models and Extensions
STAT * 4060/6802
University of Guelph, W 2022

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. Offered in conjunction with STAT*4050/4060. Extra work is required for graduate students.

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: **While Online: Thursdays 4-5 pm (during first hour of class time)**

While Face-to-Face: 3:00 or by appointment (email me!)

Lecture Days and Times:

While Online: asynchronous

Face-to-Face: T, Th 4:00 - 5:20pm, ROZH108,

II. Learning outcomes

After successful completion of the course, students will be able to:

1. Understand general theory and inference for GLM's
2. Fit and interpret common Generalized Linear Models (GLMs) including Gaussian, binary, binomial, and Poisson regression models. Perform inference, model diagnostics, GOF tests, variable selection.
3. Understand and apply quasi-likelihood
4. Understand general theory and inference for Generalized Linear Mixed Models (GLMMs).
5. Fit/interpret various GLMMs and their applications to longitudinal or clustered data.
6. Understand, fit and interpret Generalized Estimating Equations (GEEs).
7. Select and implement appropriate methods for computer analysis of a given data set.
8. Effectively visualize multivariate data.
9. Show proficiency in using, writing, debugging, testing, and commenting computer code.
10. Show ability to do Independent Work
 - a. Undergrads: Show proficiency in performing a data analysis, presenting results and writing report
 - b. Grads: Research, present, and write report on a topic related to the course material.

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	
Week 2 Week of Jan 17	Review: Inference, Delta Method Systematic Component, Linear Predictor	A1 due Jan20
Week 3 Week of Jan 24	Random Component, Exponential Family Model Fitting: LS, WLS, IWLS	A2 due Jan 27
Week 4 Week of Jan 31	Deviance, Hypothesis Tests (GOF, Model Selection) Normal, Binomial GLMs; probit, logit, cloglog links	A3 due Feb 3
Week 5 Week of Feb 7	Overdispersion, Separation – Firth’s method Poisson GLMs, Offset, Overdispersion	A4 due Feb 10
Week 6 Week of Feb 14	Review/Catch up MIDTERM	Midterm Feb 17
Week of Feb 21	WINTER BREAK	
Week 7 Week of Feb 28	Multinomial, Ordinal Models, Log-linear models Gamma and Inverse Gaussian, QuasiLikelihood	A5 due Mar 3
Week 8 Week of Mar 7	Random Effects, Linear Mixed Models (LMM) More on LMM	A6 due Mar 10
Week 9 Week of Mar 14	GLMM, PQL and GH Quadrature, GEE More on GLMM	Project Draft due Mar 15 A7 due Mar 17
Week 10 Week of Mar 21	Meetings with Instructor re: Projects	A8 due Mar 24
Week 11 Week of Mar 28	PROJECT presentations	Presentations Mar 29, 31,
Week of Apr 5	PROJECT presentations	Presentations Apr 5, 7 Written Project due Apr 8

IV. Course Resources

Recommended Textbook – Course Reserves UoG library

- Faraway, Julian. *Extending the Linear Model with R*, Second Edition, Chapman & Hall/CRC (2016). **Online**

Other GLM Resources – Course Reserves UoG library

- McCullagh, Peter & Nelder, John. *Generalized Linear Models*, 2nd edition, Chapman & Hall (1999) (on 3day reserve)
- Dobson, Annette. *An Introduction to Generalized Linear Models*, 2nd edition, Chapman & Hall (2002) (3day reserve)
- Galecki, Andrzej & Burzykowski, Tomasz. *Linear Mixed-Effects Models Using R: A Step-by-Step Approach*. **Online**

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) **Online**
- Venables, W.N. & Ripley, B.D. *Modern Applied Statistics with S-PLUS*. Springer (2013) **Online**

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. Academic dishonesty, such as plagiarism (including copying all or part of an assignment) and impersonation is grounds for loss of course credit and dismissal. More information on the subject of academic misconduct can be found at the following website: http://www.uoguelph.ca/undergrad_calendar/c08/c08-amisconduct.shtml

	Due Dates	Percent of Final Grade	
Assignments	Jan 20, 27 Feb 3, 10 Mar 3, 10, 17, 24		45%
Midterm	Feb 17		25%
Project			
Draft (Title, Outline, Intro)	Mar 15	2.5%	
Instructor Meeting	week of Mar 21	2.5%	
Presentation	Mar 29, 31, Apr 5, 7	10%	
Final Written Project	Apr 8	15%	
Total Project			30%

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. See above under Methods of Assessments for more information. 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. What surprised you, what new thing did you learn, how does it connect with previous work, what more do you want to learn?

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 17.

Project: This will consist of:

- Undergraduate Students: 10 min presentation and written report of a data analysis.
- Grad Students: 20 min presentation and written report on a topic chosen from a list.

Components are due on the stated dates at **11:59pm**. (see table). See above under Methods of Assessments for more information.

NO LATE Work will be accepted.

7 University Statements 7.1 Email Communication As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

7.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml> Associate

Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

7.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml> Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

7.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

7.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student. When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway. Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability. Use of the SAS Exam Centre requires students to book their exams at least 14 days in advance and not later than the 40th Class Day. For Guelph students, information can be found on the SAS website <https://www.uoguelph.ca/sas> For Ridgetown students, information can be found on the Ridgetown SAS website <https://www.ridgetownc.com/services/accessibilityservices.cfm>

7.6 Academic Integrity

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 encourages academic integrity. 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. Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml> Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

7.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

7.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs. Academic Calendars <https://www.uoguelph.ca/academics/calendars>

7.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email. This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

7.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g., final exam or major assignment).

7.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

<https://news.uoguelph.ca/return-to-campus-es/how-u-of-g-is-preparing-for-your-safe-return/>

<https://news.uoguelph.ca/return-to-campus-es/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.
