Course Outline STAT*405/406/6802: WINTER 2018

General Information

Course Title: Topics in Statistics I and II/ Generalized Linear Models and Extensions

Course Description: 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.

Credit Weight: 0.5

Academic Department (or campus): Math and Stats

Campus: Guelph

Semester Offering: Winter 2018

Class Schedule and Location: Tuesday and Thursday 4:00 to 5:20, MCKN 227

Instructor Information

Instructor Name: Tony Desmond
Instructor Email: tdesmond@uoguelph.ca
Office location and office hours: MCN 523 Friday 4- 5 pm.

Course Content

This course will deal with generalized linear models, a central paradigm for modern parametric statistical modeling, and their implementation in R. This extends the core ideas from Linear Models in a variety of directions. Non-normality of the response is introduced via exponential family regression models. Thus core areas of statistics such as binomial regression for proportions and log-linear models for counts such as Poisson and multinomial regression are encompassed. Further extensions to include random effects extend the Linear Mixed Model framework resulting in GLMMs, which have many applications to hierarchical, clustered or longitudinal data. Relaxation of the exponential family assumption for the response to simpler second order assumptions leads to quasi-likelihood and related methods such as Generalized Estimating Equations. Time permitting, extensions to high-dimensional covariate spaces via penalized likelihood methods as well as Bayesian approaches will be treated. In the project component of the course the student is encouraged to work in areas (both applied and theoretical), of his or her own interest, with the instructor's permission. Much of the material in the required and recommended texts relates to research published in the last two decades or so. Areas of application include medicine, finance, agriculture, economics, pharmacokinetics,

bioassay, engineering reliability, to name only a few. Familiarity with R will be assumed. The best way to acquire familiarity is via the manuals (available on line). Also simply working through the required texts is of great value.

Learning Outcomes:

1. Understand basic components of generalized linear models such as: exponential family response models, linear predictors, link functions, deviance, maximum likelihood fitting via iterated reweighted least squares.
2. Explore and understand special cases such as logistic regression for binary and proportion data and log-linear models for count data.
3. Explore and understand quasi-likelihood models allowing relaxation of the exponential family assumption.
4. Explore and extend extensions to GLMs to allow random effects and apply them to clustered and longitudinal data.
5. Implement the approaches in 2, 3, and 4 using the software package R on real data from various subject matter areas.

Lecture Content:

1. Review of the Linear Model. Introduction to exponential families and their role in GLMs. Link functions, linear predictors and variance functions. Fitting GLMs via maximum likelihood The iterated weighted least squares algorithm. GLM diagnostics. Deviance.

2. Regression models for binary and binomial data; logistic regression; overdispersed binomial models.

3. Modelling count data; Poisson regression; models for overdispersed count data.

4. Categorical data; multinomial regression; ordinal data models.

5. Gamma and inverse Gaussian GLMs; joint modeling of mean and dispersion.

6. Quasi-likelihood and GLMs. Generalized estimating equations.

7. Penalized likelihood methods for GLMs with high-dimensional data.

8. Review of Linear Mixed Models; Generalized Linear Mixed models; Bayesian approaches.

Course Assignments and Tests:

4 assignments, total worth 30%; handed out in class approximately every 2 weeks.

Midterm: Thursday March 1, 4-6pm (In Class), worth 30%.
Final Term Project, worth 40%; Due Date: Monday April 16, 5pm.

Course Resources

Required Texts:

Extending the Linear Model with R, by Julian Faraway, 2nd Ed. Chapman and Hall 2016.

Generalized Linear Models with Random Effects: Unified Analysis via H-likelihood, by Youngjo Lee, John A. Nelder, Yudi Pawitan, 2nd Ed. Chapman and Hall 2017

Additional Recommended Reading:

An Introduction to Statistical Learning with Applications in R, by James, G et al., Springer 2014.

Statistical Learning with Sparsity: The LASSO and its Generalizations, by Hastie et al, Chapman and Hall 2016

Modern Applied Statistics with S, 4th Edition, by W.N. Venables and B.D. Ripley. Springer 2004.

NB: Copies of each of these texts have been placed on reserve in the library.

Course Policies

Late Assignments will not be accepted, except under very exceptional circumstances.

Course Policy on Group Work:

Assignment solutions should be your own work, be clear, legible and well organized. You may discuss assignments with other classmates, but the work handed in should be your own.
Course Policy regarding use of electronic devices and recording of lectures

Electronic recording of classes is expressly forbidden without consent of the instructor. When recordings are permitted they are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.

University Policies

Academic Consideration

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor in writing, with your name, id#, and e-mail contact. See the academic calendar for information on regulations and procedures for

Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

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 detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or

a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

Course Evaluation Information

Please see http://www.mathstat.uoguelph.ca/files/TeachevaluationformF10.pdf

Drop date

The last date to drop one-semester courses, without academic penalty, is ***Friday*, March 9 2018**. For regulations and procedures for Dropping Courses, see the Academic Calendar: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Additional Course Information

Additional Course Information will be provided in class.