STAT 431: Generalized Linear Models and Their Applications

Monday, Wednesday & Friday, 1:30-2:20 pm, MC 2066

Professor
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Office Hours: Monday, 2:30-4:00 pm, M3 4112 or by appointment
(The Learn calendar will be kept up to date with any changes)

Teaching Assistants TBA
Office Hours: TBA – see online in early January

COURSE DESCRIPTION

The theory of generalized linear models has had a profound unifying effect on the way the advanced regression methods are taught and has provided great insight into the connections between a variety of statistical procedures. The primary objective of this course is to introduce students to generalized linear models. Attention will be mainly directed towards theory and applications involving binary, categorical, and count data, although the generalized linear model will be presented in its full generality for responses from the exponential family. This course introduces several useful regression techniques for the analysis of data arising in many different settings (ie medicine, industry, psychology etc.). Each new topic will be discussed with one or two applications examined for illustrative purposes. The intended audience consists of students interested in advanced regression modeling. The objectives are to help students develop an understanding of the statistical theory and to equip them with the ability to fit regression models for a wide range of problems.

- **Required Course Notes:** Available for purchase at BookStore or W Store.
- **Prerequisites:** This course relies heavily on material from Stat 330 and Stat 331 (or 371)
- **Course Web Page:** Available through http://learn.uwaterloo.ca for the purpose of distributing lecture slides, assignments, solutions, and announcements. Please review your email and notification settings. I recommend you subscribe to notifications related to Announcements so you don't miss any important information.
- **Recommended Texts:** (on three hour reserve at the DC Library)
    - Dobson, AJ and Barnett, AG. An Introduction to Generalized Linear Models, CRC Press, 2018 (4th edition).
    - McCullagh, P and Nelder, JA. *Generalized Linear Models*, Chapman and Hall, 1989 (2nd edition).

ASSESSMENT PLAN

The course grade will be based on three assignments (3 x 5%), two term tests (2 x 15%), and a final examination (55%).

Assignments

Assignments are **due by 4:00pm** via Crowdmark on **Wednesdays Feb 05, Mar 11, and Apr 08**. You will receive a personal link to submit your assignment via email at least one week before the due date.

Term Tests

There will be two term tests held from 1:30-2:20 pm on **Mondays Feb 10** and **Mar 16**.

Final Examination

The final examination will be scheduled by the Registrar's Office and held during the University Exam Period (April 8 - 25).

Week	Class Date	Lecture Topic (Notes Section)	Course Notes	Assessment
1	Mon-06-Jan	Welcome, Review of Linear Regression		
	Wed-08-Jan	Review of Likelihood methods	Appendix	
	Fri-10-Jan	The Exponential Family	1	
2	Mon-13-Jan	Likelihood for GLMs	1	
	Wed-15-Jan	Iteratively Reweighted Least Squares	1	
	Fri-17-Jan	Binary Data: Estimation of the Odds Ratio	2.1	
3	Mon-20-Jan	Binary Data: Estimation of the Odds Ratio	2.2	
	Wed-22-Jan	Binomial (Logistic) Regression Models	2.3	A1 Released
	Fri-24-Jan	Logistic Regression: Prenatal Care Data	2.4	
4	Mon-27-Jan	Likelihood for Binary (Logistic) Regression	2.5	
	Wed-29-Jan	Logistic Regression: LR tests and Residuals	2.6-2.7	
	Fri-31-Jan	Estimation of Prognosis for Children w Neuroblastoma	2.8	
5	Mon-03-Feb	Logistic Regression: Confidence Intervals	2.9	
	Wed-05-Feb	Bioassay and Does Response Models	2.10	A1 Due 4pm
	Fri-07-Feb	Algorithm for Estimation and Wrap-Up	2.11	
6	Mon-10-Feb	**Term Test 1**		Term Test 1
	Wed-12-Feb	Log Linear Models/Poisson GLM	3.1	
	Fri-14-Feb	Example: Ship Damage Incidents	3.1	
7	Mon-24-Feb	Example: Ship Damage Incidents	3.1	
	Wed-26-Feb	Log Linear Models Continued	3.1	A2 Released
	Fri-28-Feb	Poisson Approximation to the Binomial	3.1	
8	Mon-02-Mar	Analysis of Contingency Tables (Introduction)	3.2	
	Wed-04-Mar	Log Linear Models for Contingency Tables	3.3	
	Fri-06-Mar	Example: A Melanoma Study	3.4	
9	Mon-09-Mar	Log Linear Models for 3-way Contingency Tables	3.5-3.6	
	Wed-11-Mar	Log Linear Model Applications	3.7	A2 Due 4pm
	Fri-13-Mar	Log Linear Model Wrap-Up		
10	Mon-16-Mar	**Term Test 2**		Term Test 2
	Wed-18-Mar	Introduction to Overdispersion	4.1	
	Fri-20-Mar	Poisson Overdispersion	4.2	
11	Mon-23-Mar	Binomial Overdispersion	4.3	
	Wed-25-Mar	Binomial Overdispersion	4.4	A3 Released
	Fri-27-Mar	Introduction to Quasi-likelihood	5.1	
12	Mon-30-Mar	Parameter Estimation	5.2	
	Wed-01-Apr	GEE for Clustered Data	5.3	
	Fri-03-Apr	Final Exam Review		
13	Wed-08-Apr			A3 Due 4pm

COURSE POLICIES

- **Attendance:** Students are responsible for all material covered and announcements made during lectures. In the event that a student is absent from class they are advised to consult with a classmate to determine what material was missed.
- **Rues for Assignment:**
    - **Resubmissions *before* the deadline:** You can resubmit your assignment as many times as you like before the deadline. It is your responsibility to make sure your solutions are visually clear (if your answers cannot be read you will receive a grade of zero) and that each question's answer is uploaded separately into the correct section. ***Be sure to give yourself ample time to upload your solutions before the deadline.***
    - **Resubmissions *after* the deadline:** After the deadline, you cannot resubmit your assignment.
    - **Late or Missed Submissions:** Unless prior arrangements are made, no late assignments will be accepted and a grade of zero will be awarded. Any arrangements for extenuating circumstances are at the discretion of the instructor.
    - **Retrieving Marked Assignments:** A link to your graded assignment will be sent to you via email.
    - **Rules for Collaboration:** Students are encouraged to discuss assignment exercises with each other, the TAs, and the course instructor. Any assistance must be limited to discussion of the problem and sketching general approaches to a solution. Each student must write their own solutions, including code (where relevant). Consulting another student's solution is prohibited, and submitted solutions may not be copied from any source. In particular, submitting solutions copied in whole or in part from an assignment submission or solution key from a previous offering of this course, or from an offering of any other course, is forbidden, even if a student is resubmitting their own work. These and any other forms of collaboration on assignments constitute cheating. Suspected cases of cheating will be immediately forwarded to the Associate Dean. If you have any questions about whether some activity constitutes cheating, please ask the instructor.
- **Term Tests:** Room and seat assignments will be accessible prior to the exam through: https://odyssey.uwaterloo.ca/teaching/schedule
- **Cell phones:** Should be set to silent and out of sight.
- **Laptops:** If you wish to use your laptop during class please be respectful of students around you and do not view videos or images which are unrelated to the course.
- **Calculators:** Only approved calculators with a pink tie sticker will be permitted during tests and exams (see: https://uwaterloo.ca/math/current-undergraduates/regulations-and-procedures/calculator-regulation) (no sticker = no calculator)
- **Requests for re-grading**: You may appeal the grading of an assignment or test by sending an email request to the instructor within two weeks of the date the assessment was returned. You must provide an explanation of why you feel you deserve a different mark. Your grade may go up or down as a result.
- **Accommodation due to Illness**: *Note: Faculty level procedures have recently changed. See:* https://uwaterloo.ca/math/vif.

  When you believe your illness or circumstances will impact your academic studies you must:

  a) Contact the course instructor (e.g. by email) before or within 48 hours of a test, exam or due date, AND

b) Submit the original and completed **Verification of Illness Form (PDF)** in a timely manner when you are well enough to do so (e.g. not coughing or contagious). We ask that you submit the form when you are better to limit the spread of illness. Math students should drop the form off at the Math Undergraduate Office (MC 4022).

c) Students will also be required to complete the **Submission of a VIF (PDF)** when they submit their VIF to the MUO.

d) Students should be aware that when a VIF is registered in the MUO, all of their Math (i.e. course subjects: ACTSC, AMATH, CO, COMM, CS, MATH, MATBUS, MTHEL, PMATH, STAT) and Science (i.e., course subjects: BIOL, CHEM, EARTH, MNS, PHYS, SCI, and SCBUS) instructors will be notified.

In verified cases, typically the weight of the missed assessment will be moved to the final exam. Note if a VIF is used to excuse a missed examination it is expected that the student was unable to write all examinations they had scheduled on that day. For the Final Exam, arrangements for students with official conflicts will be handled on a case by case basis. Student travel plans are not considered acceptable grounds for granting an alternative examination time.

- **Incompletes**: Students who miss the exam for a valid, documented reason will only be awarded a grade of incomplete (INC) if they have earned a passing grade (≥50%) on the term test component of their grade. If a student has missed both term tests for any reason they are not eligible for an INC.
- **Students taking SOA Exams**: Unless the examination was booked prior to the first Stat 431 lecture and cannot be rebooked, SOA exams are not considered acceptable grounds for missing a Stat 431 term test or being given an assignment extension. Please consider the exam and assignment schedules of all your courses prior to booking any SOA exams this term.
- **Intellectual Property and Copyright Notice**: The course notes, lecture slides, assignments, exams, and written lecture notes provided to you are all under the copyright of the current and previous course instructor(s). These materials are made available for the personal use of students registered in the Winter 2020 offering of Stat 431. Students may not distribute or reproduce these materials for commercial or non-commercial means. Failure to abide by these conditions is a breach of copyright and an academic offence (see Policy 71).

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for their actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

AccessAbility Service: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments/schools to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.