STAT*6841: Computational Statistical Inference

Winter 2019

General information

Course description: Likelihood and Bayesian methods, large sample theory, nuisance parameters, EM algorithms and other optimization methods, estimating functions, Monte Carlo methods for exploring posterior distributions and likelihoods, data augmentation, importance sampling and MCMC methods.

Instructor: Prof. Zeny Feng
Email: zfeng@uoguelph.ca

Office hour: Monday and Wednesday 9:30-10:30am, Tuesday 10 -11am at MACN 540

Lecture Time and Location: Lecture: Tue and Thur: 8:30-9:50am at MCKN 034

Prerequisites: Stat*4340 Statistical Inference.

Course Resources:

Course Website: Go to `https://courselink.uoguelph.ca`. Use your central login ID and password to login. Lecture notes, assignments, solutions, other course material, and course announcements will be posted on the course website. It is your responsibility to check that posted marks are accurate.

Recommended Readings:

1. Caseller and Berger's *Statistical Inference*, 2nd ed., by Duxbury.
2. Garthwaite, Jollieffe, and Jones' *Statistical Inference*, 2nd edition by Oxford Science Publications.

3. Carlin and Louis' *Bayesian Methods for Data Analysis*, 3rd edition by Chapman and Hall, CRC Press.

4. Gelman, Carlin, Stern, and Rubin's *Bayesian Data Analysis*, 2nd edition by Chapman and Hall, CRC Press.

The Lecture notes are not to be re-distributed in any form.

Computer Software: The The primary statistical software package that will be used in this course is R, which is freely available for download at `http://www.r-project.org/` Students are strongly encouraged to install R on their personal computers.

Course Content

Specific Learning Outcomes:

By the end of this course, students should be able to

- understand the fundamental concepts in probability and large sample theory including sampling distribution and asymptotic properties of key statistics such as sample mean and moments;

- carry out inference procedure based on likelihood methods, such as point estimates, interval estimates, and hypothesis test;

- understand and utilize various likelihood based methods to handle more complex situations. For example, implement the EM algorithm for fitting models involving missing data and fitting mixture models; use R package function to carry out regularized regression analysis;

- understand the basic principles and concepts of Bayesian methods: prior distribution, and posterior distribution for the parameter(s) of interest;

- work out the Bayesian estimates of parameters under special situations such as conjugate family of distributions;

- implement the Markov Chain Monte Carlo methods: Gibbs sampler, metropolis-Hasting algorithm, importance sampling, and adaptive sampling, to obtain the Bayesian estimate of parameters;

- know the connections and differences between likelihood based methods and Bayesian methods, and algorithms or procedures related to these two different approaches.

Lecture Content:

- Review of probability and distribution theory, random sample and sampling distribution
- Large sample theory, stochastic convergence
- Maximum likelihood estimation, properties of MLEs, profile likelihood, conditional likelihood, penalized likelihood
- Expectation and Maximization algorithm
- Hypothesis testing, UMPT, unbiased test, Generalized likelihood test (GLRT)
- Bayes methods, prior distributions, posterior distribution
- Bayesian inference: point estimation, interval estimation, and hypothesis testing
- Markov chain Monte Carlo methods: Rejection sampling, importance sampling, Gibbs sampler and Metropolis-Hastings algorithm

Evaluation:

- Assignments 30%, tentative due dates: January 24, February 7, March 7, March 21 (all on Thursday)
- Midterm 25%, tentatively scheduled on Thursday, February 28, in class
- Final exam 45%, Thursday, April 22, 7 - 9pm

Course policies

Grading Policies: Assignments are due 4pm on the due date in class. No late assignments will be accepted, and late or missed assignments will receive a grade of 0 automatically. If you are unable to submit an assignment with a valid reason (appropriate documentation is needed, e.g, doctor note for

the illness), then, your mark will be based on the remaining assignments. While you are encouraged to discuss the assignment problems with fellow students, each student must hand in an individual solution which is the result of his/her own effort.

Midterm test will be held in class and therefore no student should have a conflict with the date or time. If a conflict does exist, it is your responsibility to resolve it immediately. Students who missed the midterm for a valid, documented reason (such as medical illness, attending conference) must contact me within 3 business days of the midterm, and provide the appropriate document for approval. In this situation, the weight of the missed midterm test will be added to the final exam.

Any work that is submitted for regrading, I reserve the right to regrade the entire written component of the assignments and test, not just the question under consideration.

The final exam (date, time and location) is scheduled by the Registrar's Office. If you miss the final exam for any reason, you must contact your program counsellor for advice. University regulations require specific procedures to be followed regrading the conduct of final examinations, including resource, if any, for missed final examinations. These procedures are out of my control.

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 Accommodation of Religious Obligations

If you are unable to complete a course requirement due to religious obligations, please let the instructor know within the first two weeks of class. See the academic calendar for more information:
`https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml`

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, student ID#, and email contact. See the academic calendar for information on regulations and procedures:
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. Contact CSD at: 519-824-4120 ext 56208, or email: csd@uoguelph.ca.

Drop Date: The last date to drop this course, without academic penalty, is Friday, March 8, the 40th class day. For regulations and procedures for Dropping Courses, see the Academic Calendar:
`http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml`