STAT 4900: Selected Topics in Computational Inference, Winter 2022 (T01), CRN: 61791

Tentative Course Outline

Course Details

Course Title & Number:	Selected Topics in Computational Inference (STAT 4900)
Credit Hours:	3
Class Times:	MWF 1:30 p.m. – 2:20 p.m.
Location for Lectures/Labs:	This is a Remote Learning course. Use Zoom with the following ID: 629 8339 9771 and Pass: 692156
Course Description:	Algorithmic and inferential aspects of statistical analysis, Empirical Bayes estimation strategies, Objective Bayes inference, Model selection, Shrinkage estimators , Inference after model selection
Lectures:	Live lectures and office hours will be conducted over Zoom. You do not need a Zoom account; you can simply access my lectures through the link that will be posted on UM Learn webpage. Lectures will not be recorded and students are strongly encouraged to attend the live lectures.

Instructor Contact Information

Instructor:	Nader Nematollahi
Preferred Form of Address:	I'll answer to just about anything.
Office Hours & Availability:	By appointment. Send me an email at least a day before to arrange a meeting using the Zoom.
E-mail:	nader.nematollahi@umanitoba.ca (**Note**: I will only respond to e-mail from UMNet ID's)

Textbook

There is a textbook for this course which is given below. You can borrow it from the library or download it from the book website "https://hastie.su.domains/CASI/index.html" for free. The data that use in this course and also the exercises can be downloaded from this site. I will be having my own notes that will be posted on UMLearn system. I have taken my course materials from several textbooks and resources that are properly cited in my notes. I will make my lecture notes available through the UMLearn system (see below). In this course, I will be heavily using R for data analysis. The following book helps to learn R programming which is left to the students to make themselves familiar with it. In order to prepare for class, I encourage you to read about the topics to be covered before each lecture. I am not expecting you to learn the material on your own, only to familiarize yourself with the main ideas and vocabulary so that the lectures are easier to follow. Do not get bogged down in formulae or details. If you come across something that is confusing or troubling, don't despair. If your questions are not resolved during the lecture, please ask. As you work on the problem sets, it will be helpful to re-read the material on a more detailed level.

1. **Computer Age Statistical Inference: algorithms, evidence, and data science (2010).** Bradley Efron and Trevor Hastie, Cambridge University Press. ISBN 978-1-107-14989-2.
2. **The R software, Fundamentals of Programming and Statistical Analysis (2019)**. Pierre Lafaye de Micheaux, Remy Drouilhet, and Benoit Liquet, Springer, New York. ISBN 978-1-4614-9020-3.

Course Objective Topics

In this course, I will cover a number of theoretical and computational aspects of some selected topics related to the foundation of modern statistical inference with an emphasis on the important issue of inference after model selection. The latter topic is very important as when the model is chosen after viewing the data, classical procedures for inference are no longer valid and one needs to use proper post-selection inferential tools to perform suitable analysis. Throughout the course we provide applications of the methods using real world data. At the end of the course, students should have a good knowledge of the theoretical background of some important topics in modern statistical inference and in particular be able to perform reliable post selection inference via computational methodology.

This is a tentative list of topics to be covered, but not necessarily in the same order as stated below:

- Algorithmic and inferential aspects of statistical Analysis
- Empirical Bayes estimation strategies:
  - Introduction to decision theory and Bayes estimation
  - Objective prior distributions
  - Empirical Bayes estimation
  - Robbins Formula
  - Bayes deconvolution
  - Likelihood, regularization, and accuracy
- Model selection
- Shrinkage estimators
  - The James-Stein estimator and related topics
- Inference After Model Selection
  - Laying down the theoretical foundation of inference after model selection
  - Accuracy after model selection
  - Selection bias

Course Technology

Course web-page: Course materials will be made available through the University of Manitoba's UM Learn system (`umanitoba.ca/d2l`).

Software: We will also be making an occasional use of the software package R in this course. It is freely available for Linux, Macintosh and Windows from *The Comprehensive R Archive Network* at `http://cran.r-project.org/`. Please download and install.

Other Technology: It is the general University of Manitoba policy that all technology resources are to be used in a responsible, efficient, ethical and legal manner. Students should restrict their use of technology to those approved by the instructor and/or University of Manitoba Accessibility Services for educational purposes only.

Important Dates

Some of these dates are tentative and subject to change at the discretion of the instructor and/or based on the learning needs of the students but such changes are subject to Section 2.8 of the ROASS Procedure.

Date	Information	Date	Information
January 24	Classes Begin	April 15	Good Friday
February 21	Louis Riel Day	April 25	Last Day for VW
February 22–25	Winter Term Break	April 25	**Project Report Deadline**
March 4	**Term Test**	April 25	End of Classes
March 25	Project Proposal Deadline	April 26– May 3	Final Exams Period

Course Work, Examinations & Grading

Midterm Exam: You will be having ONE term test worth 20% of your final grade. The tentative date for your term test is **March 4, 2022** from 1:30 to 3:00 p.m. Test content is defined by the lecture notes.
As exam will be online, each student must submit his or her own copy of solutions, including comments, discussions and interpretations. **For any document submitted online you need to confirm in writing that submitted solutions are your own work and you have not cheated and/or consulted with anyone, or used any sources other than your course notes.** Note that actions will be taken against students who are found guilty of acts of academic dishonesty.

Real Data Analysis Projects and Final Presentation: There will be a real data project worth 50% of your final grade. Students should analyze a real data of their own choice from the UCI Machine Learning Repository at `https://archive.ics.uci.edu/ml/datasets.php` using the techniques covered in the course. Students should choose a more recent dataset that is published on the UCI website (i.e., not before 2016). Then **a proposal should be submitted to me by March 25, 2022** outlining the details of the data set, motivation of the study and a tentative plan for the analysis. After your plan is approved by myself (with or without revision) then you can start working on your project and completing the analysis while we are going through the course materials. Final reports should be prepared in Rmarkdown and in the PDF format. **The due date for submitting your final report is April 25, 2022**. More details regarding the data project will be submitted on D2L.

Your report should conform to the following standards:

- Be sure that you explain as clearly as possible the connection of your project and the concepts you learned from class.
- Your report should have a motivation and a quick summary of the problem.
- Real data analysis should be accompanied with the R codes and I should be able to get your answers by running your codes. If your R code does not work you will not get any mark. You are highly encouraged to your Rmarkdown to prepare your homework solutions.
- Revise your report so they are reasonably free of grammatical and typographical errors. Messy or unreadable report will be returned with a mark of zero.
- Make sure each step in your analysis is well justified. I mark what is written on paper and should not have to guess what you mean.
- Each report should have a conclusion section that includes comments on the meaning of the results and open questions.

Grading Scheme: The following are the minimum percentage grades required to receive each of the various letter grades: A+ (90%), A (80%), B+ (75%), B (70%), C+ (65%), C (60%), D (50%).

Item	Percent
Assignments	30%
Mid-Term	20%
Real Data Project	50%
Total	100%

Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. I have ensured that the content I use is appropriately acknowledged and is copied in accordance with copyright laws and University guidelines. Copyrighted works, including those created by me, are made available for private study and research and must not be distributed in any format without permission. Do not upload copyrighted works to a learning management system (such as UM Learn), or any website, unless an exception to the Copyright Act applies or written permission has been confirmed. For more information, see the University Copyright Office website at `http://umanitoba.ca/copyright/` or contact `um_copyright@umanitoba.ca`.

Recording Class Lectures

Nader Nematollahi and the University of Manitoba hold copyright over the course materials, presentations and lectures which form part of this course. **No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without permission of Nader Nematollahi**. Course materials (both paper and digital) are for the participant private study and research. If class recordings are provided by the instructor those are meant to be for your own personal use only. **It is not permitted to copy or distribute the recordings.**

Class Communication

The University requires all students to activate an official University email account. Please note that all communication between your instructor and you as a student must comply with the Electronic Communication with Students Policy. Please see

http://umanitoba.ca/admin/governance/governing_documents/community/electronic_ communication_with_students_policy.html

You are required to obtain and use your U of M email account for all communication between yourself and the university.

Academic Integrity

It is important that you understand what constitutes academic dishonesty and that you are familiar with the very serious consequences. Please familiarize yourself with the information contained in *Academic Calendar > General Academic Regulations> SECTION 8: Academic Integrity*. (see `http://umanitoba.ca/calendar`) The Faculty of Science home page at www.umanitoba.ca/science also contains links regarding academic and disciplinary matters.

ROASS Schedule A

Schedule "A" of the *Responsibilities of Academic Staff with regards to Students (ROASS)* policies of the University of Manitoba lists resources and policies for students. It is important that you familiarize yourself with these resources and policies. This document will be posted to the Department of Statistics web page and to the UM Learn system.

Accommodations for Students with Disabilities

If you have a disability and have an accommodations letter from the Student Accessibility Services (SAS) office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the SAS office, I encourage you to contact them. SAS can provide you academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g. mental, learning, medical, hearing, injury-related and or visual illness) are invited to contact SAS to arrange a confidential consultation. https://umanitoba.ca/student/accessibility/about-us.html

Students - UM COVID-19 - Syllabus Insert January 19, 2022.

The University of Manitoba (the UM) is committed to maintaining a safe learning environment for all students, faculty, and staff. Should campus operations change because of health concerns related to the COVID-19 pandemic or other campus-wide emergency, it is possible that this course will move to a fully remote delivery format. Should the instructor be required to stay at home for an extended period and an alternate instructor not be available, the course may move temporarily to a remote delivery format. In that instance, you may be provided with an asynchronous option to minimize the impact the change may have on your schedule.

PPE and Mask Wearing

In a face-to-face environment, our commitment to safety requires students to observe all physical distancing (2m) and personal protective equipment (PPE) guidelines set by the University (https://umanitoba.ca/coronavirus)

While on campus and in class, you must wear PPE (Personal Protective Equipment) as stipulated in current University policies, procedures, and guidelines. Students who fail to comply are subject to disciplinary action in accordance with the Student Discipline Bylaw and the Non-Academic Misconduct and Concerning Behaviour Procedure.

Medical-grade 3-ply masks are available at many locations on campus, including specific classroom locations, designated by your unit, the Elizabeth Dafoe Library (Fort Garry Campus) and the Brodie Centre main doors (Bannatyne Campus). Additional PPE, if necessary for a specific learning environment, will be provided to you by the teaching unit.

If you do not follow masking and other requirements you will be asked to leave the learning space and may only return to the class already in progress when you have complied with these requirements. Repeated issues will result in disciplinary action as previously noted.

Students should not eat or drink during class time.

Illness

Remember: **STAY HOME IF YOU HAVE SYMPTOMS OR ARE ILL.** If you become sick or are required to self-isolate you should notify your instructor by email so you can develop a plan to complete the course learning outcomes while you are absent.

If you have symptoms, do not come to campus or any UM facilities. Complete the self-assessment on the Manitoba Public Health site and follow the guidelines, which may include booking a COVID-19 test.

What to do if you become ill while at UM:

1. Leave the classroom, lab or workspace immediately. Continue to wear your mask while leaving the premises and/or while waiting for transportation.

2. Perform hand hygiene (soap and water or hand sanitizer) and avoid contact with others, and minimize contact with the physical environment.

3. Once at home, complete the MB self-assessment and follow the directions that are provided.

4. Inform your supervisor(s), instructor(s) or, if in residence, the appropriate individual.

5. You must remain off campus and all UM facilities until cleared to return in accordance with self-assessment, testing results, or MB Health requirements.

Recommended transportation options (in order):

1. Drive yourself home.

2. Pick-up by family or friend remember to keep your mask on and to distance as much as possible, and where possible, open a window to improve ventilation.

3. Pickup by taxi/Uber:

- Remain masked and perform hand hygiene before entering the vehicle.
  - Avoid touching the inside of the vehicle
  - Keep your mask on for the duration of the ride
  - Where possible, open a window to improve ventilation.

4. Winnipeg Transit buses - Winnipeg Transit has indicated that individuals that are ill **must not use Transit.**