STAT 3690: Multivariate Analysis, Winter 2021 (A01), CRN: 59793

Tentative Course Outline

Course Details

Course Title & Number:	Multivariate Analysis (STAT 3690)
Credit Hours:	3
Class Times:	MWF 9:30 a.m. – 10:20 a.m.
Location for Lectures/Labs:	This is a Remote Learning course
Prerequisites:	May not be held with the former STAT 4690. Prerequisites: [one of STAT 2800, the former STAT 3400, or the former STAT 3500] and [one of STAT 3450, the former STAT 3120, or the former STAT 3470] and [one of MATH 2150, MATH 2151, MATH 2720, MATH 2721, or the former MATH 2750].
Course Description:	Multivariate normal distribution, multivariate regression and applications, visualization of multivariate data and dimension reduction, principal component analysis, canonical correlation.
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:	Mohammad Jafari Jozani
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 Cisco Webex system or Zoom.
E-mail:	m_jafari_jozani@umanitoba.ca (**Note**: I will only respond to e-mail from UMNet ID's)

Textbook

There is no required textbook for this course but I highly recommend to use the following textbooks for further reading and exercises. You can borrow the first two and download the last two from the library for free. 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. I will provide a short note regarding 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. **Applied Multivariate Statistical Analysis (2014).** Pearson New International Edition. Johnson and R., Wichern. 6th Edition. ISBN 1-292-02494-1.

2. **Multivariate Data Analysis (2019)**. Joseph F. Hair J., William C. Black, Barry J. Babin, Rolph E. Anderson. Cengage (Eight Edition). ISBN 978-1-4737-5654-0.

3. **Modern Multivariate Statistical techniques: Regression, Classification and Manifold Learning (2013)**. Alan Julian Izenman. Springer Texts in Statistics. ISBN 978-0-387-78188-4.

4. **An introduction to Applied Multivariate Analysis with R (2011)**. Brian Everitt and Torsten Hothorn. ISBN 978-1-4419-9649-7.

Course Objective Topics

In this course I will cover a number of topics that are very useful these days to study and better understand multivariate data. Although we will be mostly analyzing data but the course is designed such that theoretical and applied aspects of the covered techniques are emphasized equally. At the end of the course, students should be able to make decisions on how and when to use the learned techniques, apply and assess multivariate methods on real data, make sound statistical conclusions based on a multivariate analysis. The course also aims to make students familiar, or competent, with the R statistical software and Rmarkdown document preparation system.

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

- An overview of multivariate methods
- A quick overview of matrix algebra and random vectors
- Visualization of multivariate data and dimension reduction
- Multivariate normal distribution and related topics
- Inference about mean vectors
- Principal Component Analysis (PCA)
- Canonical Correlation Analysis (CCA)
- Multivariate linear Regression Analysis
- Factor Analysis (if time permits).

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 8	Classes Begin	March 31	Last Day for VW
February 15	Louis Riel Day	April 2	Good Friday
February 16–19	Winter Term Break	April 16	**Project Report Deadline**
February 20	**Project Proposal Deadline**	April 16	End of Classes
February 26	**Term Test**	April 19– May 1	Final Exams Period

Midterm and Final Exams: You will be having ONE term test worth 25% of your final grade. The tentative date for your term test is **February 26, 2021** from 9:00 to 10:30. Test content is defined by the lecture notes. **There will be no make-up test.** If you miss the term test with a valid reason and inform me within 24 hours, the weight of the test will be shifted to the final exam. The final exam will also worth 25% of your final grade. The final exam will be held on a date to be selected later by the Department of Statistics and will be 2 hours in duration.

As exams 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 multivariate 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 February 20, 2021** 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 16, 2021**. 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
Mid-Term	25%
Final Exam	25%
Read Data Project	50%
Total	100%

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

Mohammad Jafari Jozani 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 Mohammad Jafari Jozani**. 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