UNIVERSITY of GUELPH

STAT*4350 Applied Multivariate Statistical Methods
STAT*6821 Multivariate Analysis Fall 2021

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0 Course Preamble

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via Courselink and/or class email. This includes on-campus scheduling during the semester, midterms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website and circulated by email.

Mental Health. One out of every five students in Canada experiences some sort of mental health issue at some point in their academic career. If you find yourself facing a mental health crisis, or just need to talk to someone, please consider taking advantage of one of the following resources available to University of Guelph students:

Counseling Services: (x53244) is located at Health Services (J.T. Powell Building) and offers individual and group counselling sessions by appointment or walk-in.

Student Support Network is located in Raithby House (across from the cannon) and offers confidential, peer-based, drop-in support.

Good2Talk: (1-866-925-5454) is a free, 24/7 student hotline that provides professional counselling and referrals for mental health, addictions and well-being.

Here 24/7: (1-844-437-3247) specializes in assessment, referral and appointment booking and is available 24/7 for crisis support.

You are not alone and you will not be judged for asking for help.

For information on current safety protocols, follow these links:

[https://news.uoguelph.ca/return-to-campuses/how-u-of-g-is-preparing-for-your-safe-return/]
[https://news.uoguelph.ca/return-to-campuses/spaces/\#ClassroomSpaces]

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives. Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g. final exam or major assignment).

1 INSTRUCTOR

Instructor: Ayesha Ali
Office: MACN 509
Phone extension: 53896
E-mail: aali@uoguelph.ca (best way to reach me)

2 AIMS & OBJECTIVES

2.1 Calendar Description

This course introduces the multivariate normal, Wishart and Hotelling's T-square distributions. Topics covered include: statistical inference on the mean vector, canonical correlation, multivariate analysis of variance and covariance, multivariate regression, principal components analysis, and factor analysis. Topics will be illustrated using examples from various disciplines. For graduate students, topics that are more current to the field will also be discussed such as: multivariate adaptive regression splines; projection pursuit regression; and wavelets.

2.2 Course Description

We will begin with a brief review of matrix algebra and random vectors. We will then move on to the multivariate normal distribution and making inferences about one or more means. Relevant distributions also include the Hotelling's T-squared distribution and the Wishart distribution. Statistical methods of analysis include multivariate analysis of variance and covariance (MANOVA, MANCOVA), multivariate regression, and dimension reduction methods including principal components analysis, factor analysis and canonical correlation analysis. Other important multivariate techniques are discrimination, classification and clustering methods. Time permitting, or through projects/presentations, we will look at advanced topics such as multivariate adaptive regression splines, projection pursuit regression, graphical Markov models, and methods for discrete multivariate data.

Pre-requisites: (1 of MATH*1160, MATH*2150 or MATH*2160), STAT*3110, STAT*3240

Credit Weight: 0.5 **Academic Department**: Mathematics & Statistics

2.3 Learning Outcomes

The objective of this course is to acquaint students with the concepts, applicability, and methods of multivariate data analysis. Students who have successfully completed this course will be expected to:

1. Have a general knowledge and understanding of many of the key concepts, theoretical approaches and assumptions needed for dealing with multivariate problems;
2. Derive some fundamental classical results of multivariate analysis;
3. Recognize types of problems (e.g., classification versus clustering) and the appropriate method(s) of analysis;
4. Analyze multivariate data using statistical software (e.g. using R and related R packages);
5. Develop independent and critical thinking skills regarding multivariate data and data reduction;
6. Describe statistical methods and analysis results for multivariate data to a non-statistician in a written report with appropriate tables and figures.

2.4 Instructor's Role and Responsibility to Students

The role of the instructor is to teach new concepts, facilitate discussion, provide feedback to students, and supervise students throughout the design and implementation of the final project.

3 TEACHING AND LEARNING ACTIVITIES

3.1 Timetable

Lectures: WF 10:00 - 11:20am

Office Hours : TBD and provided on Courselink once set. Office hours may change.

Due to the Fall Study Break, lecture for Monday, October 11 is rescheduled for Friday, December 3.

3.2 Course Topics and Schedule

Week	Topic
Week 1	Overview of multivariate analysis tasks; Review of matrix algebra
Week 2-3	Random vectors and matrices
Weeks 3-4	Multivariate normal distribution
Weeks 5-6	Inference for means; simultaneous confidence intervals
Week 7	MANOVA/MANCOVA

Weeks 8-9	Principal Component Analysis, Factor Analysis
Week 10-11	Discrimination, Classification and Clustering
Week 12	Class Presentations

4 LEARNING RESOURCES

4.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the course site on Courselink. You are responsible for checking the site regularly.

4.2 Readings and Resources

Required Text: *Applied Multivariate Statistics with R*, D. Zelterman, Springer, 2015. (online in library)

Recommended Texts:

1. *Applied Multivariate Statistical Analysis*, 5th Ed., Johnson and Wichern, Preston Hall, 2002.
2. *Methods of Multivariate Analysis*, 3rd Ed., Renchner and Christensen, Wiley, 2012. (online in library)

5 ASSESSMENT

5.1 Dates and Distribution

		Weighting	
Assignment	**Due Date**	**ST4350**	**ST6821**
Participation		5%	5%
Assignment 1	Thurs. Sept. 30	7%	7%
Assignment 2	Thurs. Oct. 14	7%	7%
Assignment 3	Thurs. Oct. 28	7%	7%
Midterm Exam	Wed. Nov. 3	25%	15%
Presentation Article Selection	Tues. Nov. 6	--	--
Assignment 4	Thurs. Nov. 11	7%	7%
Project – Proposal	Tues. Nov. 16	5%	5%
Assignment 5	Thurs. Nov. 25	7%	7%
Final Presentation			15%
Project – Final project submission	Fri. Dec. 3 (ST4350)	30%	--
	Mon. Dec. 5 (ST6821)	--	25%

5.2 Assessment Descriptions

Participation: Students are expected to participate in class discussion. Every week, some class time will be dedicated to a data set or problem and we will discuss aspects of analyzing such data or addressing the problem. Some data sets/problems may be related to assignment questions.

Assignments: Assignments will be posted on Courselink and due at 11:59pm on the due date as outlined above. Students are encouraged to discuss assignment questions with each other, but you are expected to complete the assignments yourself and to submit your own work. See below for the University of Guelph policies on Academic Misconduct.

Presentation: (Graduate students only). The presentation will involve finding a recent article or book chapter that covers an advanced topic in multivariate analysis. You will have to read the article/chapter, understand it, and present it to the class in a twenty to twenty-five minute talk. You are strongly encouraged to select a method that will be used in your final project. In other words, you present the article (NOT your project) for your presentation, and then apply that method to a data set for your final project. The dates and order of presentations will be determined later in the semester. BEFORE you start working on the presentation, inform the instructor of your choice article by Nov. 6. The instructor may deem the article not suitable for this presentation and/or suggest an alternate article. However, you are encouraged to select the paper yourself. Final slides used will need to be submitted by the last day of classes.

Final Project: The project will consist of a written statistical report of a particular application of a multivariate technique to analyse a data set. You are responsible for proposing your own project topic and finding suitable data. You will have to submit a project proposal to the instructor approximately two weeks before the project due date. Graduate students are expected to use advanced multivariate methods that have not been covered in class, preferably one that can be presented to the class for the Presentation component of the course grade.

Usually, a project will require data exploration and a clear understanding of the materials presented in class or any reading assignments. The project is an extremely important tool, not only to help you understand the course subject matter, but also to help you develop a critical view of data analysis and refine your written communication skills. Your report must document the procedures used in your project and relevant findings. **Raw computer output is not acceptable**. Further details for the project will be given out later in the semester.

5.3 Course Grading Policies

Passing grade: In order to pass the course, STAT*4350 students must obtain a 50% or higher while STAT*6821 students must obtain a grade of 65% or higher on the total mark of all assessments.

Course Policy on Group Work: Students are encouraged to work together but must each write up individually the material they turn in. Work on the final project may be done in consultation

with other students or with faculty but the final project must be completely written and executed by the student.

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the graduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: [https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2228.shtml]

6 UNIVERSITY STATEMENTS

6.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly; e-mail is the official route of communication between the University and its students.

6.2 When You Cannot Meet a Course Requirement

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 calendars for information on regulations and procedures for Academic Consideration:
Undergraduate Calendar - Academic Consideration and Appeals
[https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml]
Graduate Calendar - Grounds for Academic Consideration
[https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2182.shtml]

6.3 Drop Date

Courses that are one semester long must be dropped by the end of the last class day; two-semester courses must be dropped by the last day of class in the second semester. The regulations and procedures for changing graduate course registration are available in the Undergraduate and Graduate Calendars.

Undergraduate Calendar – Dropping Courses
[https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml]

Graduate Calendar – Registration Changes
[https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml]

6.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments; you may be asked to resubmit work at any time.

6.5 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 Student Accessibility Services (SAS) as soon as possible. Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway. It should be noted that common illnesses such as a cold or the flu do not constitute a disability. For more information, see SAS the website: [http://www.uoguelph.ca/sas]

6.6 Academic Integrity

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.

Undergraduate Calendar – Academic Misconduct

[https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml]

Graduate Calendar – Academic Misconduct
[https://www.uoguelph.ca/registrar/calendars/graduate/2018-2019/genreg/sec_d0e2632.shtml]

Inappropriate online behaviour will not be tolerated. Examples of inappropriate online behaviour include:

- Posting inflammatory messages about your instructor or fellow students
- Using obscene or offensive language online
- Copying or presenting someone else's work as your own
- Adapting information from the Internet without using proper citations or references
- Buying or selling term papers or assignments
- Posting or selling course materials to course notes websites
- Having someone else complete your quiz or completing a quiz for/with another student
- Making false claims about lost quiz answers or other assignment submissions

- Threatening or harassing a student or instructor online
- Discriminating against fellow students, instructors or TAs
- Using the course website to promote profit-driven products or services
- Attempting to compromise the security or functionality of the learning management system
- Sharing your username and password
- Recording lectures without the permission of the instructor

6.7 Recording of Materials

Presentations that are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

6.8 Other University Resources

The Academic Calendars [https://www.uoguelph.ca/academics/calendars] are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.