Multivariate Analysis (STAT 388 or 488)

Spring 2024

LOYOLA UNIVERSITY CHICAGO

Preparing people to lead extraordinary lives

Course Description

When: Tuesday Thursday 1:00 - 2:15 pm

Location: Cuneo Hall Rm 002

Office Hours: Loyola Hall (Office 108)
TBA Message on campuswire for appointment

Make individual appointment/meeting requests through Campuswire (discussed below) by selecting *Post to instructors*.

Much of the data collected by researchers is multivariate, meaning that multiple measurements are taken on a single individual or unit. Sometimes we may be interested in a single measurement in isolation, but often times we want to study them simultaneously. The goal of this course is to help students develop the statistical skills to approach and analyse multivariate data correctly in an applied, as opposed to theoretical, context. The course will cover describing and exploring multivariate data, as well as techniques for making inference. The course will build on student's basic knowledge of mathematics and statistical concepts to introduce topics such as linear algebra, principle components, factor analysis, canonical correspondence analysis, cluster analysis, discriminant analysis, multivariate normal/MANOVA, and other dimensionality reduction techniques. The course will aim to teach these tools through their application. R will be the used to solve these problems. **STAT-488 students will be required to solve some more-challenging homework exercises**.

Prerequisite: STAT 203 or 335 with a C- or better

Instructor

Mena CR Whalen, PhD
Assistant Professor
✉ mwhalen3@luc.edu
☎ 773.508.3580
Loyola Hall (Office 108)

Course Structure

- Class Time: Class will be composed of lecturing, discussions, collaborative activities, and R practice. Please come to class having done the reading, a charged computer, and ready to discuss and learn in a collaborative manner.
- Assessments: Students will complete homeworks, write 1 critical analysis papers, and 2 projects.
- Participation, Discussion, and Group Work: One important aspect of a Jesuit education is learning to respect the rights and opinions of others. Please respect others by (1) allowing all classmates the right to voice their opinions without fear of ridicule, and (2) not making objectionable (gendered,

racial or ethnic) comments, especially comments directed at a classmate. Group work and discussion are vital to this class since no one student will understand everything, please lean on each other for help and learn to hear concepts and ideas from another perspective.

Textbook

REQUIRED

- An Introduction to Applied Multivariate Analysis with R by Everitt & Hothorn 2011 ISBN 978-1-4419-9650-3

Recommended

- Applied Multivariate Statistical Analysis, 6th Edition by Johnson & Wichern 2008 ISBN-13: 9780131877153

Software

R and RStudio(Posits)

WE WILL BE USING/INTRODUCING the free statistical software R. While R is the engine, we will use the free and open source IDE (Integrated Development Environment) RStudio/Posits to run it. R and RStudio are set up and available on all library computers.

R: Version 4.3.2, "Eye Holes", https://cran.rstudio.com/

RStudio Version 2023.12.0 "Ocean Storm", https://posit.co/

Zoom

We could be used for office hours or for appointments. Students **must** use their Loyola Zoom[1] accounts for office hours. Beyond using Zoom for office hours we hope students make use of Zoom to study and work with other students.

University computers have R installed on them and R support is offered through ITRS found here.

If assistance is needed to obtain consistent use of a laptop please see Equipment Loan Program.

[1] Loyola Zoom https://luc.zoom.us/ - Download the most recent version of Zoom!

Asking Questions & Course Communication

This term we will be using Campuswire as our preferred platform for questions about homework, reading checks, R questions and general course questions. The system is highly catered to getting you help quickly and efficiently from classmates and the instructor. Rather than emailing questions to the instructor, you should post your questions on Campuswire. You can ask and answer questions anonymously on the site.

Enrollment Code: 0964

Questions concerning individual grades or appointments should be addressed through email.

I will check Campuswire periodically and answer questions[2], but I strongly encourage students to answer each other's questions (especially 488 students).

[2] Please do not expect answers during weekends and evenings.

Tips for Success

- DEDICATE YOURSELF to being an active and engaged learner.
- WORK IN GROUPS TO learn and complete activities[3].
- ASK QUESTIONS! Ask them during class, office hours, or on Campuswire[4].
- SEARCH THE INTERNET for help, especially for software issues.
- CONTRIBUTE TO a welcoming and inclusive learning environment.
- DON'T BE AFRAID to make mistakes, you learn from mistakes.

[3] Don't just copy, help each other.

[4] Be active on Campuswire!

Evaluation

STUDENTS WILL BE EVALUATED through (1) Homework (2) Paper; (3) Projects {2}.

Participation and Dicussions

Students are expected to attend and actively participate in class. Experience has shown that two or more absences (over a week) will severely negatively affect student's grade in this class so absences should be avoided.

Homework

Homeworks will be submitted on their assigned due dates. Problems will be posted on Campuswire and Sakia but will be submitted on Sakia. Please write legibly and in a matter that clearly indicated the answer. Some questions will be using R software and using RStudio Markdown files would be beneficial to use.

I do not accept any homework, paper, project, etc. that is submitted to me via e-mail.

Paper

Students are to outline, discuss and *critique* the statistical methods used in a chosen research article. Students are to select, read and critique 1 peer-reviewed published research article that uses multivariate analysis methods (such as multivariate normal distribution, MANOVA, PCA, factor analysis, clustering, multidimensional scaling, CCA, etc). The article will need to be approved by Professor Whalen. *Each student will work alone for their paper.*

Projects

Students will perform multivariate analysis methods ((such as multivariate normal distribution, MANOVA, PCA, factor analysis, clustering, multidimensional scaling, CCA, etc) to a practical dataset in a field that is of interest to the individual student. It also permits students to teach themselves about – and to demonstrate – some of the modelling techniques learned in class. *388 students may work in a group of max 2 for project 1, 488 students should work alone for project 1. Project 2 388 and 488 students may work in a group of max 2.*

- Project 1 will require students to find a data set, submit an analysis plan for approval for the data set, and then perform and describe output of said analysis. This is strongly recommended to be done through Markdown. Professor Whalen must approve of the data set and analysis plan.
- Project 2 can be related to their paper. Students can replicate analysis performed in their paper from the data provided. Students will compare their result to the paper and describe their results in a presentation and a paper. Project 2 will be approved alongside the paper. Or students can find another dataset but demonstrate more complex statistical techiniques than the first project with a presentation of results and paper write up of their analysis.

More specific details on each paper and project will be given at a later date.

Grading

Grading Scale	
93 - 100%	A
90 - 92.9%	A-
87 - 89.9%	B+
83 - 86.9%	B
80 - 82.9%	B-
77 - 79.9%	C+
73 - 76.9%	C
70 - 72.9%	C-
67 - 69.9%	D+
60 - 66.9%	D
Below 60%	F

Category	Weight
Homework	25%
Project 1	15%
Paper	25%
Project 2	35%

Final grades will be rounded to nearest tenth of a percent. I reserve the right to alter the course grading scale. However, any alterations will be limited to those that would be beneficial to students (i.e. an upward grade curve).

Student Academic Services

Tutoring

The www.luc.edu/tutoring embodies the mission of Loyola University Chicago by providing academic services and resources which foster development

of skills and attitudes necessary to increase the knowledge and academic independence of all students. Through multiple learning services, the Tutoring Center helps to contribute towards student success and growth efforts that are made by Loyola University Chicago.

Accommodations

Loyola University provides reasonable accommodations for students with disabilities. Any student requesting accommodations related to a disability or other condition is required to register with \href{Student Accessibility Center (SAC), located in Sullivan Center, Suite 117. Students will provide professors with an accommodation notification from SAC, preferably within the first two weeks of class. Students are encouraged to meet with their professor individually in order to discuss their accommodations. All information will remain confidential. For more information or further assistance, please call 773.508.3700 or email ✉ sac@luc.edu.

Academic Integrity

Academic Integrity

Academic dishonesty can take several forms, including, but not limited to cheating, plagiarism, copying another student's work, and submitting false documents. Academic cheating is a serious act that violates academic integrity. Cheating includes, but is not limited to, such acts as

- Obtaining, distributing, or communicating examination materials prior to the scheduled examination without the consent of the teacher
- Providing information to another student during an examination
- Obtaining information from another student or any other person during an examination
- Using any material or equipment during an examination without consent of the instructor, or in a manner which is not authorized by the instructor
- Attempting to change answers after the examination has been submitted
- Unauthorized collaboration, or the use in whole or part of another student's work, on homework, lab reports, - programming assignments, and any other course work which is completed outside of the classroom Falsifying medical or other documents to petition for excused absences or extensions of deadlines
- Any other action that, by omission or commission, compromises the integrity of the academic evaluation process
- For more details on Loyola's Academic Integrity Statement please see here.

Intellectual Property

All lectures, notes, PowerPoints, and other instructional materials in this course are the intellectual property of the professor. As a result, they may not be distributed or shared in any manner, either on paper or virtually without my written permission. Lectures may not be recorded without my written consent; when consent is given, those recordings may be used for review only and may not be distributed. Recognizing that your work, too, is your intellectual property, I will not share or distribute your work in any form without your written permission.

Privacy Statement

Assuring privacy among faculty and students engaged in online and face-to-face instructional activities helps promote open and robust conversations and mitigates concerns that comments made within the context of the class will be shared beyond the classroom. As such, recordings of instructional activities occurring in online or face-to-face classes may be used solely for internal class purposes by the faculty member and students registered for the course, and only during the period in which the course is offered. Students will be informed of such recordings by a statement in the syllabus for the course in which they will be recorded. Instructors who wish to make subsequent use of recordings that include student activity may do so only with informed written consent of the students involved or if all student activity is removed from the recording. Recordings including student activity that have been initiated by the instructor may be retained by the instructor only for individual use.

Diversity Equity and Inclusion

The diversity that students bring to this class, in all its forms, is viewed as a resource, a strength, and a benefit. It is my intent to invest in each student's success and attend to each student's learning needs, both in and out of class. It is my intent to present materials and activities that are respectful of diversity, equity and inclusion, and that students from all diverse backgrounds and perspectives be well-served by this course. Students in this course are encouraged to participate freely and share personal opinions, perspectives, and stories. There may be diverse, and perhaps contradictory ideas shared, in class. This variety is a strength of the academic community. Students are asked to show respect and treat peers in a way that validates various experiences and opinions based on a range of identities, including ability, economic class, ethnicity, faith tradition or no faith, gender identity and expression, nationality, religion, sexual orientation, veteran status, and their intersections.

Acts of bias, harassment, abuse, discrimination, relationship violence, sexual violence (i.e. sexual assault, sexual harassment, etc.), gender harassment,

and stalking are not tolerated at Loyola. If you or someone you care about has experienced any one of these crimes and/or violations of LUC Community Standards, please know that you have rights, reporting options, and other support services available to you. Please visit here for more information.

Land Acknowledgement

As we come together as a learning community, we need to acknowledge the land we live and work on by naming the Muscogee Creek, Cherokee, and Chickasaw Peoples upon whose unceded and stolen territory the university stands. Also, we should acknowledge the enslaved peoples, primarily of African descent, whose labour built much of the university. Visit LUC's Faculty Center for Ignatian Pedagogy land acknowledgement page for more information.

Campus Support Services

- ITS HelpDesk ✉ `helpdesk@luc.edu` ☎ 773-508-4487
- Library
  - Subject Librarian Greer Martin
- Student Accessibility Center
- Writing Center
- Ethics Hotline ☎ 855-603-6988
- Center for Tutoring and Academic Excellence
- Bookstore
- Financial Aid
- Wellness Center
  - Mental Health Appointment First Steps
  - For urgent, non-life threatening mental health needs ☎ 773-508-2530 **option 3**

Tentative Course Schedule

Week	Date	Content	HW/Papers/Projects
Week 01	Jan 16 (Tues)	Syllabus Day	
	Jan 18 (Thurs)	Intro JW CH1	
Week 02	Jan 23 (Tues)	Linear Algebra JW CH 2	
	Jan 25 (Thurs)	Linear Algebra JW CH 2	
Week 03	Jan 30 (Tues)	Linear Algebra JW CH 2	
	Feb 1 (Thurs)	Random Vectors JW CH 2	HW 1 (LA)
Week 04	Feb 6 (Tues)	MVN JW CH 4	
	Feb 8 (Thurs)	MVN JW CH 4	
Week 05	Feb 13 (Tues)	MVN JW CH 4	
	Feb 15 (Thurs)	MANOVA JW CH 6	HW 2 (MVN)
Week 06	Feb 20 (Tues)	MANOVA JW CH 6	
	Feb 22 (Thurs)	PCA JW CH 8 EH CH 3	Project 1 Approval
Week 07	Feb 27 (Tues)	PCA JW CH 8 EH CH 3	HW 3 (MANOVA)
	Feb 29 (Thurs)	PCA JW CH 8 EH CH 3	
Week 08	Mar 5 (Tues)	Spring Break	**No Class**
	Mar 7 (Thurs)	Spring Break	**No Class**
Week 09	Mar 12 (Tues)	Factor JW CH 9 EH CH 5	Project 1 Due
	Mar 14 (Thurs)	Factor JW CH 9 EH CH 5	HW 4 (PCA)
Week 10	Mar 19 (Tues)	Factor JW CH 9 EH CH 5	
	Mar 21 (Thurs)	Clustering JW CH 12 EH CH 6	Paper/Project2 Approval
Week 11	Mar 26 (Tues)	Clustering JW CH 12 EH CH 6	HW 5 (Factor)
	Mar 28 (Thurs)	Clustering JW CH 12 EH CH 6	
Week 12	Apr 2 (Tues)	CCA JW CH 10 EH 3.13	
	Apr 4 (Thurs)	CCA JW CH 10 EH 3.13	Paper Due
Week 13	Apr 9 (Tues)	Multivariate Scaling EH CH 4	HW 6 (Cluster)
	Apr 11 (Thurs)	Multivariate Scaling EH CH 4	
Week 14	Apr 16 (Tues)	Bonus Topics	
	Apr 18 (Thurs)	Present Project	HW 7 (CCA/Scaling+)
Week 15	Apr 23 (Tues)	Present Project	
	Apr 25 (Thurs)	Present Project	
Finals	May 1 (Tues)		Project 2 Due