ESRM 64503: Applied Multivariate Analysis

Jihong Zhang

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1 General Information

- Course Code: ESRM 64503
- Course ID: 10434
- Credits: 3 CH
- Course time and location: Mon 17:00-19:45; GRAD 210
- Instructor: Jihong Zhang, Dr.
- Contact Information: jzhang@uark.edu
- Personal Website: http://jihongzhang.org
- Office Location: GRAD 133B
- Office Hours: Tu 1:30-4:30PM
- Office Phone +1 479-575-5235
- Semester: Fall 2024
- Prerequisite: ESRM 64103 and ESRM 64203, both with a grade of C or better.

1.1 Course Objectives, Materials, and Pre-Requisites:

The online syllabus at the address provided above will always have the most up-to-date information. Multivariate statistical procedures as applied to educational research settings. Emphasis on use of existing computer statistical packages

This course has two main objectives:

1. **Modern multivariate analysis using observed variables**
2. **Build a foundation for terminology, concepts, and software from which participants can eventually learn more advanced analysis.**

This course offers an exploration of multivariate statistics within the context of education and psychology. Class time will be devoted primarily to lectures and examples. Lecture materials in-

.html format will be available for download and view at the website above the day prior to class, or else paper copies will be provided in class. Audio/Video recordings of the class lectures in .mp4 format will also be posted online upon requested, but are not intended to take the place of class attendance. Selected book chapters and journal articles will be assigned for each specific topic as needed. The initial list of readings is provided below but will likely be updated throughout the semester. Updates to the reading list will be posted in the online syllabus and announced in class and via email. R language will be the primary statistical tool used throughout the course, with the RStudio front end being the user interface.

1.2 Prerequisite

Participants should be familiar with the general linear model (such as analysis of variance, linear regression) prior to enrolling in this course.

Also, it is assumed that students have has solid statistical training up to and including topics in multivariate statistics (ESRM 64103 Experimental Design in Education, and ESRM 64203 Multiple Regression Techniques for Education). In addition, it is assumed you are also familiar with R language. SPSS may not be sufficient for this course.

1.3 How to Be Successful in This Class

- Come to class ready to learn.
- Complete the out-of-class exercises prior to each class.
- If you become confused or don't fully grasp a concept, ask for help from your instructor
- Know what is going on: keep up with email, course announcements, and the course schedule.
- Try to apply the information to your area of interest — if you have a cool research idea, come talk to me!

1.4 Software

- R and R packages (tidyverse)

2 Homework

- Student evaluation will be made on the basis of **homework grades (84%) and quiz grades (16%)**.
- Homework (HW) assignments will be posted using **online homework portal** on Wednesday. They will be due by Monday end of work hours of the following week.
- Short in-class quiz (1-3 questions) will be administrated in the beginning of each class and aim to refresh the memory. Students have 5-10 minutes to answer those questions. The questions will be very general. I recommend you **bring your laptop device or mobile device** in class so that you can answer those in-class quiz.

After everyone finish the quiz, we will review the in-class quiz together.

To make the most of my office hours, please come prepared.

- In person: This means you should bring printouts and/or your files on a laptop so that we can review them.

- Electronically: If you have questions about your assignment and cannot make my office hours, you can email me specific and detailed questions. (R code and data set attached to the email)

2.1 Online Homework Portal

1. Grading Online Checking
2. Homework 0 (HW0)
3. Homework 1 (HW1)
4. Homework 2 (HW2)
5. Homework 3 (HW3)
6. Homework 4 (HW4)

2.2 Grading

Your grade in this class will be determined based on homework assignment and in class quizzes on the material and required readings. There will be 3 homework assignments. The number of in-class quizzes will be as same as the number of in-person class.

All homework and answers must be your own and not be copied or paraphrased from anyone else's answers. Students will have the opportunity to earn up to **100 total points** in the course. Up to 84 points can be earned from assignments (approximately 28 points for each homework in total). Up to **16 points** may be earned from in-class quizzes on the material and required readings, but students must be present on the day the quiz is administered to earn these points. Please note there will be at least one opportunity to earn up to **10 points of extra credit** (labeled Homework 0 in the online course website).

Percentage of Points	Grade
100-90	A
89-90	B
79-70	C
69-60	D
< 60	F

2.3 Policy on Late Homework Assignments and Incompletes:

In order to be able to provide the entire class with prompt feedback, late homework assignments will incur a **4-point penalty**. However, extensions may be granted as needed for extenuating circumstances (e.g., conferences, family obligations) if requested at least three weeks in advance of the due date. As noted above, missed in-class quizzes cannot be made up.

3 Academic Policies

3.1 AI Statement

Specific permissions will be provided to students regarding the use of generative artificial intelligence tools on certain graded activities in this course. In these instances, I will communicate

explicit permission as well as expectations and any pertinent limitations for use and attribution. Without this permission, the use of generative artificial intelligence tools in any capacity while completing academic work submitted for credit, independently or collaboratively, will be considered academic dishonesty and reported to the Office of Academic Initiatives and Integrity.

3.2 Academic Integrity

As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail.

Each University of Arkansas student is required to be familiar with and abide by the University's **Academic Integrity Policy** at honesty.uark.edu/policy. Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

3.3 Emergency Preparedness

The University of Arkansas is committed to providing a safe and healthy environment for study and work. In that regard, the university has developed a campus safety plan and an emergency preparedness plan to respond to a variety of emergency situations. The emergency preparedness plan can be found at emergency.uark.edu. Additionally, the university uses a campus-wide emergency notification system, UARKAlert, to communicate important emergency information via email and text messaging. To learn more and to sign up: http://safety.uark.edu/emergency-preparedness/emergency-notification-system/

3.4 Inclement Weather

If you have any questions about whether or not class will be canceled due to inclement weather, please contact me. If I cancel class, I will notify you via email and/or Blackboard. In general, students need to know how and when they will be notified in the event that class is cancelled for weather-related reasons. Please see here for more information.

3.5 Access and Accommodations

Your experience in this class is important to me. University of Arkansas Academic Policy Series 1520.10 requires that students with disabilities are provided reasonable accommodations to ensure their equal access to course content. If you have already established accommodations with the Center for Educational Access (CEA), please request your accommodations letter early in the semester and contact me privately, so that we have adequate time to arrange your approved academic accommodations.

If you have **not** yet established services through CEA, but have a documented disability and require accommodations *(conditions include but not limited to: mental health, attention-related, learning, vision, hearing, physical, health or temporary impacts)*, contact CEA directly to set up an Access Plan. CEA facilitates the interactive process that establishes reasonable accommodations. For more information on CEA registration procedures contact 479–575–3104, ada@uark.edu or visit cea.uark.edu.

3.6 Academic Support

A complete list and brief description of academic support programs can be found on the University's Academic Support site, along with links to the specific services, hours, and locations. Faculty are encouraged to be familiar with these programs and to assist students with finding an using the support services that will help them be successful. Please see here for more information.

3.7 Religious Holidays

The university does not observe religious holidays; however Campus Council has passed the following resolution concerning individual observance of religious holidays and class attendance:

> When members of any religion seek to be excused from class for religious reasons, they are expected to provide their instructors with a schedule of religious holidays that they intend to observe, in writing, before the completion of the first week of classes.

4 Schedule

Following materials are only allowed for previewing for students registered in ESRM 64503. DO NOT DISTRIBUTE THEM on the internet. They will be removed after the course ended.

Week	Date	Topic	Reading	HW	Code/Data
1	08/19	Introduction and Overview; Introduction to R and Rstudio	*dplyr* get started R for Data Science Ch.3: Data trasformation (Optional) R manual Ch.2 & 3	• HW0	1. MakeFriendsWithR.qmd 2. heights.csv 3. wide.sav
2	08/26	Descriptive Stats. and General Linear Model	Maxwell & Delaney (2004): 1. Tutorial 3 2. Tutorial 4 (Optional) R manual Ch.11: Statistical models in R	• HW0 (Due)	
3	09/02	Labor Day Holiday (no class)			
4	09/09	Simple, Marginal, and Interaction Effects	Hoffman (2014) Ch. 2	• HW1	
5	09/16	Distributions and Estimation	Kutner et al. (2005), Ch.1 and Appendix A	• HW1(-Due)	
6	09/23	Generalized Linear Models	Enders (2010) Ch.3: An Intro. to MLE (Optional) Buse (1982) (Optional) Enders (2022) Ch.2: MLE		
7	09/30	Maximum Likelihood Estimation (MLE) and the Multivariate Normal Distribution	Johnson & Wichern (2002) 6th ed.: 1. Ch.2.Matrix Algebra And Random Vectors 2. Ch.3.Sample Geometry And Random Sampling 3. Ch.4.The Multivariate Normal Distribution		
8	10/07	Multivariate Linear Models	PennState STAT 415 Sec.1.2		
9	10/14	Fall Break (no class)			
10	10/21	Path Analysis	Kline (2010, 3th Ed.): 1. Ch.5: Specification 2. Ch.6: Identification	• HW2	
11	[illegible]	[illegible] (Last class)	[illegible] Introduction to Bayesian Analysis [illegible] Missing Data Handling	• HW2 (Due)	

Table 2: Weekly breakdown of topics and readings

Academic calendar for Fall 2024: Here

5 Course Materials

5.1 Books

1. Enders, C. K. (2010). *Applied missing data analysis* (1st Ed.). New York, NY: Guilford.
2. Enders, C. K. (2022). *Applied missing data analysis* (2ed Ed.). New York, NY: Guilford.
3. Hoffman, L. (2014). *Longitudinal analysis: Modeling within-person fluctuation and change*. New York, NY:Routledge Academic.
4. Johnson, R. A. & Wichern, D. W. (2002). *Applied multivariate statistical analysis* (5th Ed.). Upper Saddle River, N.J.: Prentice-Hall.
5. Kline, R. B. (2010). *Principles and practice of structural equation modeling* (3th Ed.). New York, NY: Guilford.
6. Kline, R. B. (2023). *Principles and practice of structural equation modeling* (5th Ed.). New York, NY: Guilford.
7. Kutner, M. H., Nachtsheim, C. J., Neter, J., & Li, W. (2005). *Applied linear statistical models* (5th Ed.). New York, NY: McGraw-Hill.
8. Maxwell, S. E., & Delaney, H. D. (2004). *Designing experiments and analyzing data*. Mahwah, NJ: Erlbaum.
9. Venables, W. N., Smith, D. M., & the R Core Team (2013). An introduction to R – Notes on R: A programming environment for data analysis and graphics (3.0.2 ed.). R Core Development team. Retrieved from http://cran.r-project.org/doc/manuals/R-intro.pdf.

5.2 Articles

1. McCutcheon, A. L. (2002). Basic concepts and procedures in single- and multiple-group latent class analysis. In J. A. Hagenaars & A. L. McCutcheon (Eds.), Applied latent class analysis (pp. 56-88). Cambridge, United Kingdom: Cambridge University Press.
2. Vermunt, J. K., & Magidson, J. (2002). Latent class cluster analysis. In J. A. Hagenaars & A. L. McCutcheon (Eds.), Applied latent class analysis (pp. 56-88). Cambridge, United Kingdom: Cambridge University Press.
3. Wright, S. P. (1998). Multivariate analysis using the mixed procedure. Proceedings of the Twenty-Third Annual SAS Users Group International Conference, paper 229. Retrieved from http://www2.sas.com/proceedings/sugi23/Stats/p229.pdf.

5.3 Website

1. muticomp package vignettes
2. Prof. Lesa Hoffman's course: PSQF 6243 - Intermediate Statistical Methods
3. Prof. Jonathan Templin's course: EPSY 905 - Fundamentals of Multivariate Modeling