

Psychology 756
Multivariate Techniques in Psychology
George Mason University
Spring 2021 Semester

Tuesdays & Thursday 12:00 – 13:15
Synchronous Online Course

PROFESSOR: Philseok Lee, Ph.D.
ZOOM OFFICE HOURS: By appointment
OFFICE: 3056 David King Hall
EMAIL: plee27@gmu.edu

LECTURES: T, TR: 12:00-13:15 pm online

TEXTBOOK: There is NO required textbook for this course. The course materials are made from various textbooks as well as recent research literature. Reading materials will be provided.

COURSE OVERVIEW AND OBJECTIVES

Psychologists increasingly are using multivariate statistical techniques to address their research questions. Largely underlying this proliferation is 1) the increasing complexity of proposed models and 2) the computer capabilities available to test these models. In reality, the second factor probably drives the first more so than the converse. Given this trend, an understanding of multivariate techniques is essential today for conducting and interpreting psychological research. The purpose of this course is to provide you with a strong foundation in various applied multivariate statistics.

The course will cover introduction to matrix algebra, maximum likelihood estimation approach, missing data analysis, various dimension reduction techniques (e.g., principal component analysis, exploratory factor analysis, canonical correlation, multidimensional scaling), various classification analyses (e.g., discriminant analysis, logistic regression), various clustering analysis (cluster analysis, latent profile analysis, latent class analysis), and multilevel data analysis.

I think of this course as providing you with a “toolbox” from which you later can draw. We will cover several different techniques (i.e., tools) in here. Some of these techniques you will use frequently going forward while others you may rarely use. However, I can ensure you that you will encounter most if not all of these techniques in the future. My goal is that, by the end of this semester, you all will be able to:

- Read, interpret, and evaluate multivariate research findings
- Determine which type of (multivariate) analysis to utilize
- Conduct multivariate analyses and correctly interpret the results

STATISTICAL SOFTWARE

The course will use the R statistical package with R Studio and a set of packages. Sample R codes will be provided for most of the examples, so that you can try R programming on your own and gain hands-on experience. You can download R (<https://www.r-project.org/>) and R studio (<https://www.rstudio.com/products/rstudio/download/>).

Here are some useful materials for R:

- An Introduction to R by Venables et al. (2013) <https://cran.r-project.org/doc/manuals/R-intro.pdf>
- Quick-R <https://www.statmethods.net/>
- Cookbook for R <http://www.cookbook-r.com/>

COURSE STRUCTURE, GRADING, AND REQUIREMENTS

Attendance and Participation:

It will count **5%** toward your final grade.

- Given this is a virtual class, I will check your attendance. You will lose 0.17% for each day you miss the class.
- My expectation is that you will attend every class meeting and engage during class sessions.

Homework Assignments:

The homework assignments will count **60%** toward your final grade. There will be 5 homework assignments.

- Please submit your assignments through Blackboard by noon on the date listed below. Assignments received after 12 pm will be late.
- You will lose 10% for each day the assignment is late (with the first day beginning after 12 pm the day it was due).
- Homework submitted more than a week late will not be accepted and a grade of zero will be given.
- You are free to discuss the assignments with other students in the class. However, you **MUST** complete the work **INDEPENDENTLY**.

Take-Home Exams:

Final take-home exams will count **20%** toward your final grade. You **SHOULD NOT** discuss the take-home exam with other students in the class. This **SHOULD** be done **INDEPENDENTLY**.

Quiz:

Quizzes will count **15%** toward your final grade.

- You can take quizzes through blackboard
- There will be 10 quizzes and each quiz will count 1.5% of your final grade.
- Quiz will be about concepts or applications of multivariate statistics.
- Quiz will be short answer or multiple-choice questions.
- This should be an **INDEPENDENT** work. You **SHOULD NOT** discuss with other students.

Grading:

Letter grades will be determined according to the following scheme:

A+ 98-100%	A 93-97.9%	A- 90-92.9%	B+ 87-89.9%
B 83-86.9%	B- 80-82.9%	C+ 77-79.9%	C 73-76.9%
C- 70-72.9%	D+ 67-69.9%	D 63-66.9%	D- 60-62.9%
F Below 60%			

Failure to complete course requirements:

Students who miss a small portion of the course due to an excused absence may be given a grade of Incomplete (I). However, failure to complete the required work by the end of the following semester will result in a grade of F.

Missing class due to religious observances:

Students who anticipate the necessity of being absent from class due to the observation of a major religious observance must provide notice of the date(s) to the instructor, in writing.

ACADEMIC INTEGRITY

Homework: You can discuss and work on assignments with other students, but each student must turn in his/ her own results and interpretation. For example, when analyzing data, students might discuss how to approach a problem, run their own analyses, and independently write up the results. Simply copying someone else's answers verbatim is unacceptable and will be subject to loss of points or a zero credit.

Quiz: Students must work alone on each quiz. If you have questions about problems or potential solutions, consult with your instructor only.

Take-Home Exam: Students must work alone on final take-home exam. If you have questions about problems or potential solutions, consult with your instructor only.

Failure to follow these guidelines may be viewed as evidence of academic dishonesty, which can result in a grade of FF for the course and other penalties through the University System.

DISABILITY SERVICES

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit <http://ds.gmu.edu/> for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu | Phone: (703) 993-2474

IMPORTANT DATES

Please check Fall 2021 – Drop / Withdrawal Deadline Changes from this link
<https://registrar.gmu.edu/calendars/spring-2021/>

Last day to add a class: February 1

Last day to drop (with 100% tuition refund): February 16

Selective withdrawal period: March 2 – April 1

Last day of classes: April 30

Reading day(s): May 1

Final exam period: May 3 – May 10

COURSE SCHEDULE, READINGS, AND ASSIGNMENTS

*Note: While we certainly will try to adhere to this schedule, we may need to rearrange things a bit during the semester.

Week	Date	Topic	Assignment	Quiz
1	26-Jan	Orientation: Psy 756 Multivariate Statistics		
	28-Jan	Review of Statistics		
2	2-Feb	Introduction to Matrix Algebra		
	4-Feb	Introduction to Matrix Algebra		
3	9-Feb	Introduction to Maximum Likelihood Estimation		Quiz1 (1.5%)
	11-Feb	Missing data analysis	Assignment 1 (10%) OUT	
4	16-Feb	Missing data analysis		
	18-Feb	Dimensionality Reduction: Principal Component Analysis	Assignment 1 (10%) DUE	
5	23-Feb	Dimensionality Reduction: Principal Component Analysis		Quiz2 (1.5%)
	25-Feb	Dimensionality Reduction: Exploratory Factor Analysis	Assignment 2 (10%) OUT	
6	2-Mar	Dimensionality Reduction: Exploratory Factor Analysis		
	4-Mar	Canonical Correlation	Assignment 2 DUE	Quiz3 (1.5%)
7	9-Mar	Canonical Correlation		
	11-Mar	Multidimensional Scaling		Quiz4 (1.5%)
8	16-Mar	Multidimensional Scaling		
	18-Mar	Discriminant Analysis	Assignment 3 (10%) OUT	Quiz5 (1.5%)
9	23-Mar	Discriminant Analysis		
	25-Mar	Logistic Regression	Assignment 3 DUE	Quiz6 (1.5%)
10	30-Mar	Logistic Regression		
	1-Apr	Logistic Regression	Assignment 4 (10%) OUT	
11	6-Apr	Cluster Analysis		Quiz7 (1.5%)

	8-Apr	Cluster Analysis		
12	13-Apr	Cluster Analysis	Assignment 4 DUE	
	15-Apr	Latent Class/Latent Profile Analysis		Quiz 8 (1.5%)
13	20-Apr	Latent Class/Latent Profile Analysis		
	22-Apr	Latent Class/Latent Profile Analysis	Assignment 5 (10%) OUT	Quiz 9 (1.5%)
14	27-Apr	Multilevel Analysis		
	29-Apr	Multilevel Analysis	Assignment 5 DUE FINAL TAKE-HOME EXAM OUT	
15	4-May	Multilevel Analysis		Quiz 10 (1.5%)
	6-May	Reading Day	FINAL TAKE-HOME EXAM DUE	

Recommended Reading List:

* indicates book chapter (Book chapters will be provided)

Week1-2: Review of Statistics and Introduction to Matrix Algebra

- *Everitt, B., & Hothorn, T. (2011). Multivariate Data and Multivariate Analysis. In *An Introduction to Applied Multivariate Analysis with R* (pp. 105-134). Springer, New York, NY.

Week3: Missing Data and Data Preprocessing Topic

- Newman, D. A. (2014). Missing data: Five practical guidelines. *Organizational Research Methods, 17*, 372-411.
- Roth, P. L. (1994). Missing data: A conceptual review for applied psychologists. *Personnel psychology, 47*(3), 537-560.
- Aguinis, H., & Vandenberg, R. J. (2014). An ounce of prevention is worth a pound of cure: Improving research quality before data collection. *Annual Review of Organizational Psychology and Organizational Behavior, 1*, 569–595
- Aguinis, H. (2013). Best-practice recommendations for defining, identifying, and handling outliers. *Organizational Research Methods, 16*, 270 - 301.

Week4-5: Principal Component and Exploratory Factor Analysis

- Henson, R.K. & Roberts, J.K. (2006). Use of exploratory factor analysis in published research: Common errors and some comment on improved practice. *Educational and Psychological Measurement, 66*, 393-416.
- Floyd, F.J. & Widaman, K.F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment, 7*, 286-299.
- *Everitt, B., & Hothorn, T. (2011). Principal Component Analysis. In *An Introduction to Applied Multivariate Analysis with R* (pp. 105-134). Springer, New York, NY.
- *Everitt, B., & Hothorn, T. (2011). Exploratory Factor Analysis. In *An Introduction to Applied Multivariate Analysis with R* (pp. 105-134). Springer, New York, NY.

Week6: Canonical Correlation (Applied research papers using canonical correlations)

- Tutuncu, O., & Kucukusta, D. (2010). Canonical correlation between job satisfaction and EFQM business excellence model. *Quality & Quantity, 44*(6), 1227-1238.
- Bouranta, N., Chitiris, L., & Paravantis, J. (2009). The relationship between internal and external service quality. *International Journal of Contemporary Hospitality Management.*
- Macinati, M. S. (2008). The relationship between quality management systems and organizational performance in the Italian National Health Service. *Health policy, 85*(2), 228-241.
- Safari, H., Abdollahi, B., & Ghasemi, R. (2012). Canonical correlation analysis between people criterion and people results criterion in EFQM model. *Total Quality Management & Business Excellence, 23*(5-6), 541-555.

Week7: Multidimensional Scaling

- *Everitt, B., & Hothorn, T. (2011). Multidimensional scaling. In *An Introduction to Applied Multivariate Analysis with R* (pp. 105-134). Springer, New York, NY.
- *Ding, C. S. (2013). Multidimensional scaling. *The Oxford handbook of quantitative methods in psychology, 2*, 235-256.

- *Davison, M. L., & Sireci, S. G. (2000). Multidimensional scaling. In *Handbook of applied multivariate statistics and mathematical modeling* (pp. 323-352). Academic Press.
- Davison, M. L. (1983). Introduction to multidimensional scaling and its applications. *Applied Psychological Measurement*, 7, 373– 379.
- Weinberg, S. L. (1991). An introduction to multidimensional scaling. *Measurement and Evaluation in Counseling and Development*, 24(1), 12–36.
- Cooper, L. G. (1983). A review of multidimensional scaling in marketing research. *Applied Psychological Measurement*, 7(4), 427-450.

Week8: Discriminant Analysis

- Huberty, C. J., & Barton, R. M. (1989). An introduction to discriminant analysis. *Measurement and Evaluation in Counseling and Development*, 22(3), 158-168.
- Goodstein, R. E. (1987). An introduction to discriminant analysis.
- *Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). Discriminant Analysis. In *Using multivariate statistics* (Vol. 5, pp. 481-498). Boston, MA: Pearson.

Week9-10: Logistic Regression

- Peng, C. Y. J., Lee, K. L., & Ingersoll, G. M. (2002). An introduction to logistic regression analysis and reporting. *The journal of educational research*, 96(1), 3-14.
- *Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (Vol. 398). John Wiley & Sons.
- *Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). Logistic Regression. In *Using multivariate statistics* (Vol. 5, pp. 481-498). Boston, MA: Pearson.

Week11: Cluster Analysis

- *Everitt, B., & Hothorn, T. (2011). Cluster Analysis. In *An Introduction to Applied Multivariate Analysis with R* (pp. 105-134). Springer, New York, NY.
- Blashfield, R. K., & Aldenderfer, M. S. (1988). The methods and problems of cluster analysis. In *Handbook of multivariate experimental psychology* (pp. 447-473). Springer, Boston, MA.
- *Teo, T. (Ed.). (2014). Cluster Analysis. In *Handbook of quantitative methods for educational research*. Springer Science & Business Media.
- *Rupp, A. A. (2013). Clustering and Classification. *The Oxford handbook of quantitative methods in psychology*, 2, 517-550.

Week12-13: Latent Class Analysis and Latent Profile Analysis

- *Masyn, K. E. (2013). Latent class analysis and finite mixture modeling. *The Oxford handbook of quantitative methods*, 2, 551-611.
- Howard, M. C., & Hoffman, M. E. (2018). Variable-centered, person-centered, and person-specific approaches: where theory meets the method. *Organizational Research Methods*, 21(4), 846-876.
- Williams, G. A., & Kibowski, F. (2016). Latent class analysis and latent profile analysis. *Handbook of methodological approaches to community-based research: Qualitative, quantitative, and mixed methods*, 143-151.
- Wang, M., & Hanges, P. J. (2011). Latent class procedures: Applications to organizational research. *Organizational Research Methods*, 14(1), 24-31.

- Woo, S. E., Jebb, A. T., Tay, L., & Parrigon, S. (2018). Putting the “person” in the center: Review and synthesis of person-centered approaches and methods in organizational science. *Organizational Research Methods*, 21(4), 814-845.
- Morin, A. J., Morizot, J., Boudrias, J. S., & Madore, I. (2011). A multifoci person-centered perspective on workplace affective commitment: A latent profile/factor mixture analysis. *Organizational Research Methods*, 14(1), 58-90.
- Gabriel, A. S., Daniels, M. A., Diefendorff, J. M., & Greguras, G. J. (2015). Emotional labor actors: A latent profile analysis of emotional labor strategies. *Journal of Applied Psychology*, 100, 863.

Week14-15: Multilevel Analysis

- Schonfeld, I. S., & Rindskopf, D. (2007). Hierarchical linear modeling in organizational research: Longitudinal data outside the context of growth modeling. *Organizational Research Methods*, 10(3), 417-429.
- *Hox, J. J., Moerbeek, M., & Van de Schoot, R. (2017). Chapter 1 and Chapter 2. In *Multilevel analysis: Techniques and applications*. Routledge.
- Hofmann, D.A. (1997). An overview of the logic and rationale of hierarchical linear models. *Journal of Management*, 23, 723-744.
- Hox, J. J., & Kreft, I. G. (1994). Multilevel analysis methods. *Sociological Methods & Research*, 22(3), 283-299.
- Enders, C.K. & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*, 12, 121–138.