UNIVERSITY OF VICTORIA
DEPARTMENT OF PSYCHOLOGY

PSYC 533 (A01)
General Linear Model -- Multivariate

Spring 2022

Time:	Mondays / Thursdays 11:30-12:50 p.m.
Room:	Zoom: https://uvic.zoom.us/j/86078206377?pwd=S0NIeURuS0w5bFpVam9xWE1aNVlRQT09
	In-person: CLE A030 (dates TBD)

Instructor:	Jonathan Rush, PhD	**Office:**	Cornett B318
Office Hours:	Flexible; by appointment	**Phone:**	(250) 472-4861
		E-mail:	jrush@uvic.ca

TERRITORY ACKNOWLEDGEMENT

We acknowledge with respect the Lekwungen peoples on whose traditional territory the university stands and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

COURSE DESCRIPTION

This graduate course is designed to introduce you to the concepts and practical application of contemporary approaches to multivariate analysis. Select techniques that are special cases of the general linear model (GLM) including both multivariable and multivariate will be presented.

In brief, *multivariable* procedures involve a single outcome measure with two or more predictors (e.g., multiple regression), whereas true *multivariate* procedures incorporate two or more dependent measures with a set of predictors (e.g., multivariate multiple regression, factor analysis). The variety of multivariate techniques introduced in this class will cover a number of key themes including *data reduction and structure* (principal components analysis, exploratory factor analysis, structural equation modeling), *time-based analyses* (repeated measures ANOVA, multilevel modeling), *prediction of group membership* (logistic regression, multi-state survival analysis). Classical techniques will also be considered, such as the testing of *group differences* (MANOVA) and *degree of association* (multivariate multiple regression), but will be done so within the context of contemporary modeling approaches.

To facilitate learning, the course emphasizes conceptual understanding and practical application (assignments). Our discussions will teach you how to ask intelligent questions of your data, and in particular how you decide upon the most appropriate analytic technique for addressing your question(s), and subsequently how to build and adopt the optimal statistical model among alternative competing models. In many respects, this course represents an extension of the material covered in PSYC 532 to the situation in which there are multiple dependent and independent variables, with varying distributions (both continuous and categorical variables). Another central objective will be to hone your practical skills through various assignments by computing analyses, navigating the output, and interpreting your results.

COURSE PREREQUISITES	

The official prerequisite for this course is PSYC 532 (GLM: Univariate). If you have not completed this introductory course (or a comparable course such as PSYC 400A), please contact me to discuss your background. I would be happy to provide suggestions for supplementary reading material.

COURSE FORMAT AND LEARNING GOALS	

This graduate course on select multivariate applications of the GLM (factor analysis, structural equation modeling, repeated measures and multilevel modeling) is specifically designed to promote learning through lecture, practical application, and discussion. Our regular meetings will integrate conceptual learning with practical application.

In my capacity as a guide to your learning, I am committed to you achieving the following learning outcomes upon completion of the course:

1. Augment your basic understanding of the GLM with coverage of various multivariable and multivariate modeling approaches, with specific emphasis on approaches that explore data structure (factor analysis, structural equation modeling), prediction of group membership (logistic regression), the analysis of time (repeated measures ANOVA, multilevel modeling), group differences (MANOVA), and degree of association (multivariate multiple regression).

2. Develop practical skills in data management and analysis for topics in Objective 1.

3. Learn which statistical approach(es) to adopt in a given context, and how to adapt the analytic techniques learned to your own data (e.g., master's thesis, manuscript).

4. Appreciate that your research questions are of foremost importance, and that the choice of analytic technique will naturally follow.
   'Models designed to fit behavior' vs 'Behavior fit to designed models'

ACADEMIC EXPECTATIONS	

To achieve the learning outcomes, it is necessary for you to attend class, be engaged in discussions, and to complete each laboratory assignment. Should circumstances prevent your attendance, please inform me (in advance if possible). If you are unable to submit the final written exam on the specified date due to illness or family affliction, you should apply at Records Services for a "Request for Academic Concession", normally within 10 working days of the exam date.

You are expected to abide by the University's policy on plagiarism and cheating (*see last 3 pages of syllabus*).

COURSE REGISTRATION	

You are personally responsible for checking your registration status before the end of the course-add period (<u>Wednesday, January 26, 2022</u>). Please verify and confirm your registration status with me as, according to University policy, I am unable to facilitate a course addition after this date even if you have been attending class. Also note that <u>Monday, February 28, 2022</u> is the last day for officially withdrawing from PSYC 533 without academic penalty. University policy states that failing to attend lectures does not constitute official withdrawal.

EVALUATION	

Evaluation of your progress toward the course objectives will be based upon several graded requirements including: (a) in-class and take-home *practical assignments;* and (b) two written *take-home examinations*.

(a) Practical Assignments

Each assignment will be *completed in groups of 3* to foster collaboration and collective learning. The number of assignments and their associated due dates will be determined according to weekly progress in covering the conceptual material. Approximately **4-5 assignments** will be distributed across the entire term. Each brief assignment will be due **ONE WEEK** after it has been distributed in class.

The purpose of each assignment is to have you gain experience in computing analyses and interpreting results for a given multivariate technique. Assignment questions are constructed to emulate the thought processes you will often face in your own research pursuits. Performance will be evaluated on (a) fitting of appropriate statistical models (e.g., submit copy of model syntax), and (b) identification and succinct explanation of key findings in response to the questions. For example, in select assignments, you may be asked to draft a statistical procedures subsection that summarizes the statistical procedure (as you would draft in the method section of a manuscript), as well as a corresponding summary of the results. The practical exercises will be advantageous for your retention of the concepts covered during lectures.

(b) Exams

There will be **2 take-home exams** that are to be *completed individually*.
The first take-home exam will cover techniques related to the theme of data structure. The second take-home exam will focus largely on new material covered following the first take-home exam. The two exams will be very intuitive, and are intended to assess your conceptual understanding of the GLM techniques covered, as well as your ability to interpret the analytic output. The exams will be completed during a limited 48-hour time window, and accordingly will <u>evaluate</u> conceptual understanding and ability to <u>interpret</u> output.

Take-home exam #1 is due on FRIDAY, MARCH 11, 2022*
Take-home exam #2 is due on WEDNESDAY, APRIL 13, 2022*

*These dates are <u>TENTATIVE</u>; exams will be made available electronically 48 hours prior to the scheduled due date/time.

Grading

I have purposely employed several forms of evaluation in recognition that each of you has an individual learning style. Your grade for the course will be based upon the practical assignments as well as the two take-home exams, providing you the best opportunity to demonstrate your many competencies. Further, to minimize anxiety associated with individual projects/exams that count toward a large percentage of your grade, I have specifically chosen to parse evaluation into smaller components. Your workload should not increase, but rather be more evenly dispersed across the term.

1. Practical Assignments = 50%
2. Take-home exam #1 = 25%
3. Take-home exam #2 = 25%

Graded course requirements will be weighted and aggregated to yield a percentage score. The final letter grade in the course will be based on total percent score rounded up at values of .5 or greater (e.g., 89.5 will be rounded up to 90, but 89.4 will not). Final grades will be assigned according to the following scale: 90-100% = A+; 85-89 = A; 80-84 = A-; 77-79 = B+; 73-76 = B; 70-72 = B-; 65-69 =C+; 60-64 = C; 50-59 = D; 0-49 = F.

WEEKLY TOPICS AT A GLANCE

Please note that the following weekly schedule *is tentative*, and will likely change pending student responses to the *questionnaire that you complete* prior to the first class. My objective will be for you to learn the basics of each multivariate technique, with any remaining time devoted to coverage of other special multivariate topics (e.g., survival analysis).

Week	Date	Topic(s)	Associated Reading & Assignment
1	Mon., Jan. 10 & Thur. Jan 13	**Introductions** • Course overview and objectives • GLM Review • A modeling approach to statistics	***Required:*** Rodgers (2010). The epistemology of mathematical and statistical modeling: A quiet methodological revolution. *American Psychologist* Judd & McClelland (2008)
2	Mon., Jan. 17 & Thur, Jan 20	**Principal Components Analysis (PCA)**	*Suggested:* Bryant & Yarnold (1994)
3	Mon., Jan. 24 & Thu., Jan. 27	**Exploratory Factor Analysis** • Basics of factor analysis • EFA vs PCA • Data analysis: examples	*Suggested:* Tabachnick & Fidell (2001). Principal Components and Factor Analysis (pp. 582-652) Tabachnick & Fidell (2001). A Skimpy Introduction to Matrix Algebra (pp. 908-917) **Assignment 1 (EFA/PCA) tentatively due <u>Feb 4</u>**
4	Mon., Jan. 31 & Thu., Feb. 3	**Structural Equation Modeling (SEM)** • Gentle intro to SEM • Confirmatory Factor Analysis (CFA) • PCA/EFA vs CFA	• Blunch,(2008), pp. 127-156 • Byrne (2001)

5	Mon., Feb. 7	• CFA Data analysis examples	**Assignment 2 (CFA) tentatively due <u>Feb 14</u>**
	Thu., Feb. 10	**SEM: Path Modeling** • Model specification and identification • Evaluation and model fit • Model comparisons	• Klem (1994)
6	Mon., Feb. 14	**SEM: Path Modeling** • Model comparison • Data examples	
	Thu., Feb. 17	**SEM: Structural Models** • Basic steps in fitting SEMs • SEM vs Multivariate Multiple Regression	• Blunch,(2008); Byrne (2001); Kline (2005)
7	Mon., Feb. 21 Thu., Feb. 24	**Reading Break**	
8	Mon., Feb. 28	**SEM: Structural Models** • Data examples	**Assignment 3 (Path Modeling) tentatively due <u>March 4</u>**
	Thu., Mar. 3	**Repeated Measures ANOVA** • Classical approach to measuring change • Assumptions / Limitations	• Weinfurt (2000)
9	Mon., Mar. 7 & Thu., Mar. 10	**Multilevel Models (MLM)** • Gentle introduction • MLM vs repeated measures ANOVA	*Required:* • Singer & Willett (2003) **TAKE HOME TEST #1 tentatively due <u>Mar 11</u>**
10	Mon., Mar. 14 & Thu., Mar. 17	**Multilevel Models (MLM)** • Data examples	
11	Mon., Mar. 21	**Generalized Linear Model** • Categorical outcomes • Logistic Regression review	• Wright (1997); Tabachnick & Fidell (2001) **Assignment 4 (MLM) tentatively due <u>Mar 25</u>**
	Thu., Mar. 24	**Multi-state survival analysis** • Guest Lecture	• TBA
12	Mon., Mar. 28	**Generalized Linear Models** • Data examples	
	Thu., Mar. 31	**Classical approaches / Special Topics** • Multivariate Multiple Regression • Multivariate Analysis of Variance (MANOVA)	• Cohen (1982) • Weinfurt (1997)
13	Mon., Apr. 4 & Thu., Apr. 7	**Special Topics and/or Review** • Multilevel SEM • Course recap	**TAKE HOME TEST #2 tentatively due <u>Apr 12</u>**

The above schedule, readings, and assignments are subject to change

DETAILED READINGS LIST	

There is no required textbook for this class. In part, this decision reflects the diversity of analytic topics that we will cover and the fact that <u>no single</u> multivariate text provides sufficient coverage of these techniques. In lieu, I have carefully identified select chapters and articles that overview a given week's theme and that provide the foundation for group discussions, practical demonstrations, assignments, and take-home exams. Each article identified below represents a core reading for a given week's theme that I may supplement with additional suggested readings. Please note that this is a ***tentative reading list*** that will most likely evolve.

JANUARY 10 & 13
Introduction and GLM Overview

Required Reading:
Rodgers, J. L. (2010). The epistemology of mathematical and statistical modeling: A quiet methodological revolution. *American Psychologist*.

Secondary Readings:
Judd, C. M., McClelland, G. H., & Ryan, C. S. (2008). Data analysis: A model comparison approach (pp. 1-8).

JANUARY 17
Principal Components Analysis (PCA)

Suggested Readings:
Bryant, F.B., & Yarnold, P.R. (1994). Principal-components analysis and exploratory and confirmatory factor analysis. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading and Understanding Multivariate Statistics* (pp. 99-136). Washington D.C.: APA.

JANUARY 24
Exploratory Factor Analysis (EFA)

Suggested Readings:
Bryant, F.B., & Yarnold, P.R. (1994). Principal-components analysis and exploratory and confirmatory factor analysis. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading and Understanding Multivariate Statistics* (pp. 99-136). Washington D.C.: APA.

Secondary Readings:
Tabachnick, B.G., & Fidell, L.S. (2001). Principal Components and Factor Analysis. In B.G. Tabachnick & L.S. Fidell (Eds.), *Using Multivariate Statistics* (4th ed.) (pp. 582-652). Needham Heights, MA: Allyn and Bacon.

Tabachnick, B.G., & Fidell, L.S. (2001). A Skimpy Introduction to Matrix Algebra. In B.G. Tabachnick & L.S. Fidell (Eds.), *Using Multivariate Statistics* (4th ed.) (pp. 908-917). Needham Heights, MA: Allyn and Bacon.

JANUARY 31
Structural Equation Modeling: Confirmatory Factor Analysis

Suggested Readings:
Blunch, N. (2008). The Measurement Model in SEM: Confirmatory Factor Analysis. In Introduction to Structural Equation Modelling Using SPSS and AMOS (pp. 127-156). Thousand Oaks, CA: Sage Publications.

Byrne, B.M. (2001). Application 1: Testing for the Factorial Validity of a Theoretical Construct (First-Order CFA Model). In *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming* (pp. 57-97). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Byrne, B.M. (2001). Application 2: Testing for the Factorial Validity of Scores From a Measuring Instrument (First-Order CFA Model). In *Structural Equation Modeling with AMOS: Basic Concepts,Applications, and Programming* (pp. 98-119). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Klem, L. (2000). Structural equation modeling. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading and Understanding More Multivariate Statistics* (pp. 227-260). Washington DC

Raykov, T., & Marcoulides, G.A. (2000). Fundamentals of structural equation modeling. In, *A First Course in Structural Equation Modeling* (pp. 1-45). New Jersey: Erlbaum.

Ullman, J.B. (2001). Structural Equation Modeling. In B. Tabachnick, & L. Fidell (Eds.), *Using Multivariate Statistics* (4th ed.) (pp. 653-771). Needham Heights, MA: Allyn & Bacon.University of Texas AMOS Tutorial

FEBRUARY 10 – Structural Equation Modeling: Path Analysis

Suggested Readings:
Klem, L. (1994). Path analysis. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading and UnderstandingMultivariate Statistics* (pp. 65-97). Washington D.C.: APA.

FEBRUARY 24 – Structural Equation Modeling: Structural Models

Suggested Readings:
Blunch, N. (2008). The General Causal Model. In *Introduction to Structural Equation Modelling Using SPSS and AMOS* (pp. 157-185). Thousand Oaks, CA: Sage Publications Inc.

Byrne, B.M. (2001). Application 4: Testing for the validity of a causal structure. In *Structural EquationModeling with AMOS: Basic Concepts, Applications, and Programming* (pp. 142-170). New Jersey: Lawrence Erlbaum Associates.

Kline, R.B. (2005). How to fool yourself with SEM. In, *Principles and Practice of Structural EquationModeling* (2nd ed.) (pp. 313-324). New York: The Guilford Press.

Thompson, B. (2000). Ten Commandments of structural equation modeling. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading and Understanding More Multivariate Statistics* (pp. 261-283). Washington D.C.: APA.

MARCH 3 – Repeated Measures Analysis of Variance (ANOVA)

Suggested Readings:
Weinfurt, K.P. (2000). Repeated measures analyses: ANOVA, MANOVA, and HLM. In L.G. Grimm,& P.R. Yarnold (Eds.), *Reading and understanding more multivariate statistics* (pp. 317-362). Washington D.C.: APA.

MARCH 7 – Multilevel Modeling (MLM)

Required Readings:
Singer, J.D., & Willett, J.B. (2003). Introducing the multilevel model for change. In *Applied longitudinal data analysis: Modeling change and event occurrence* (pp., 45-74). New York: Oxford University Press.

Bryk, A.S., & Raudenbush, S.W. (1987). Application of hierarchical linear models to assessing change. *Psychological Bulletin, 101*, 147-158.

MARCH 21 – Generalized Linear Model

Suggested Readings:
Wright, R.E. (1997). Logistic Regression. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading andUnderstanding Multivariate Statistics* (pp. 217-244). Washington D.C.: APA.

Tabachnick, B.G., & Fidell, L.S. (2001). Logistic Regression. In B.G. Tabachnick & L.S. Fidell (Eds.), *Using Multivariate Statistics* (4th ed.) (pp. 517-581). Needham Heights, MA: Allyn and Bacon.

MARCH 24 – Multi-State Survival Analysis

Required Readings:

 TBA

MARCH 31 – Classical Approaches

Suggested Readings:
Cohen, J (1982). Set Correlation As A General Multivariate Data-Analytic Method. *Multivariate Behavioral Research, 17*, 301-341.

Weinfurt, K.P. (1997). Multivariate Analysis of Variance. In L.G. Grimm, & P.R. Yarnold (Eds.), *Reading and Understanding Multivariate Statistics* (pp. 245-276). Washington D.C.: APA.

Tabachnick, B.G., & Fidell, L.S. (2001). Multivariate Analysis of Variance and Covariance. In B.G.Tabachnick & L.S. Fidell (Eds.), *Using Multivariate Statistics* (4th ed.) (pp. 322-390). Needham Heights, MA: Allyn and Bacon.

PLAGIARISM AND CHEATING	

UNIVERSITY OF VICTORIA
Department of Psychology

<u>Important Course Policy Information</u>
Spring 2022

Commitment to Inclusivity and Diversity

The University of Victoria is committed to promoting, providing and protecting a positive and supportive and safelearning and working environment for all its members.

Policy on Academic Integrity including Plagiarism and Cheating

The Department of Psychology fully endorses and intends to enforce rigorously the Senate Policy on Academicintegrity
https://www.uvic.ca/calendar/future/undergrad/#/policy/Sk_0xsM_V?bc=true&bcCurrent=08%20-%20Policy%20on%20Academic%20Integrity&bcGroup=Undergraduate%20Academic%20Regulations&bcItemType
=policies. It is of utmost importance that students who do their work honestly be protected from those who donot. Because this policy is in place to ensure that students carry out and benefit from the learning activities assigned in each course, it is expected that students will cooperate in its implementation.

The offences defined by the policy can be summarized briefly as follows:

1. **Plagiarism**. You must make sure that the work you submit is your work and not someone else's. Thereare proper procedures for citing the works of others. The student is responsible for being aware of and using these procedures.

2. **Unauthorized Use of an Editor**. The use of an editor is prohibited unless the instructor grants explicitwritten authorization.

3. **Multiple Submission**. Only under exceptional circumstances may a work submitted to fulfill an academicrequirement be used to satisfy another similar requirement. The student is responsible for clarifying this with the instructor(s) involved.

4. **Falsifying Materials Subject to Academic Evaluation**. This includes falsification of data, use of commercially prepared essays, using information from the Internet without proper citation, citing sourcesfrom which material is not actually obtained, etc.

5. **Cheating on Assignments, Tests, and Examinations**. You may not copy the work of others in or outof class; you may not give your work to others for the purpose of copying; you may not use unauthorized material or equipment during examinations or tests; and you may not impersonate or allow yourself to be impersonated by another at an examination. The Department of Psychology has a policy of not making oldexaminations available for study purposes. Therefore, use of old exams without the express written permission of the instructor constitutes cheating by the user, and abetting of cheating by the person who provided the exam.

6. **Aiding Others to Cheat**. It is a violation to help others or attempt to help others to engage in any of theconduct described above.

Instructors are expected to make every effort to prevent cheating and plagiarism. This may include the assignment of seating for examinations, asking students to move during examinations, requests to see student identification cards, and other measures as appropriate. Instructors also have available to them a variety of tools and procedures to check for Internet and electronic media-based cheating. In instances of suspected or actual plagiarism or cheating, instructors, following prescribed procedures, are authorized to take steps consistent with the degree of the offence. These measures will range from a zero on the test or assignment or a failing grade forthe course, probation within a program to temporary or even permanent suspension from the University.

Rights of Appeal are described in the Policy on Academic Integrity in the University calendar January 2021.

The definitive source for information on Academic Integrity is the University Calendar

Other useful resources on Plagiarism and Cheating include:
1. The Ombudsperson's office: https://uvicombudsperson.ca/tips/plagiarism/
   The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations. Phone: 250-721-8357;Email: ombuddy@uvic.ca;Web: uvicombudsperson.ca.
2. UVic Library Resources: http://www.uvic.ca/library/research/citation/plagiarism/
3. https://www.uvic.ca/library/research/citation/documents/avoiding%20plagiarism%20guideUpdate_Sept_20_13.pdf

BE WELL

A note to remind you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone.

Discovering Victoria, UVic and your Community:
Grad school can involve a lot of time studying and researching on your own – but it does not have to be an isolating experience. There are a lot of other grad students out there like you who are looking to connect outside of academics.
www.uvic.ca/mentalhealth/graduate/connect/index.php

Counselling Services:
Counselling Services can help you make the most of your university experience. They offer free professional, confidential, inclusive support to currently registered UVic students. www.uvic.ca/services/counselling/

Health Services:
University Health Services (UHS) provides a full service primary health clinic for students, and coordinates healthy student and campus initiatives.
www.uvic.ca/services/health/

Centre for Accessible Learning*:*
The CAL staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations www.uvic.ca/services/cal/. The sooner you let us know your needs, the quicker we can assist you in achieving your learning goals in this course.

Elders' Voices:
The Office of Indigenous Academic and Community Engagement (IACE) has the privilege of assembling a group of Elders from local communities to guide students, staff, faculty and administration in Indigenous ways of knowing and being.
www.uvic.ca/services/indigenous/students/programming/elders/

Mental Health Supports and Services:
Mental health supports and services are available to students from all areas of the UVic community: www.uvic.ca/mentalhealth/graduate/