Applied Factor Analysis & Structural Equation Modeling (SEM)
Family Relations and Applied Nutrition
FRAN 6440
Winter 2020

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Office Hours: TBA
                by appt.

Class: Tues. 8:30 - 11:20 in MACS 331

Web Site: There is a Courselink site for the course.

Calendar Description

This course introduces students to exploratory analysis (including exploratory factor analysis and principal components analysis), confirmatory factor analysis, and structural equation modeling approaches appropriate in applied social/health science research. The course covers conceptual and practical applications of statistical analyses with emphasis on selection of appropriate methods and models to address complex, multi-factorial data. This course is data-driven and students will learn primarily through hands-on analytic experiences accompanied by in-class lectures and readings.

Required Readings

1. Beaujean, A. A. (2014). *Latent variable modeling using R*. New York, NY: Routledge.

   Data to accompany Beaujean (2014): https://blogs.baylor.edu/rlatentvariable/

2. For the SEM components of this course, we will be using an R package called 'lavaan'. The *lavaan* tutorial by Yves Rosseel is required reading:
   http://lavaan.ugent.be/tutorial/index.html

Additional readings (e.g., published articles or chapters) discussing topics covered will be distributed or made available for duplication.

Required Software
SPSS will be used for data management and for the Exploratory Factor Analysis (EFA) components of the course. A **free concurrent version of SPSS** is available from:

   http://www.uoguelph.ca/ccs/software/software-distribution

R:

The parts of the course focused on latent variable modeling (i.e., SEM) will use R.
http://cran.stat.sfu.ca/

It is free and works on both Windows and Mac computers. Click the appropriate "Download and Install R" link, depending on your operating system, and install the software.

R Studio:
R is the primary software for the course, however, it is not a particularly user friendly or attractive program at baseline. R Studio is a free (and also Windows and Mac compatible) supplemental program that makes R more user friendly and functional.

https://www.rstudio.com/products/rstudio/download2/

You must first install R, then install R studio. From then on, you can simply launch R Studio.

<u>Install R and R Studio prior to the first day of class and ensure that it opens.</u>

Recommended (not required) reading and resources:

Recommended additional resources for R
R is likely new for many of you. Although I spend time introducing students to R in this course, I strongly recommend that students take DataCamp's Introduction to R course:
https://www.datacamp.com/courses/free-introduction-to-r

Recommended additional readings
Little (2013). *Longitudinal structural equation modeling*. Guilford Press.
        Todd Little has a way with words. This book does a splendid job of telling the reader about both the basics of SEM and the more advanced longitudinal components of it in simple (and often funny!) language without ignoring the complexities. A must read for anyone wishing to push their SEM knowledge further.

Brown (2015). *Confirmatory factor analysis for applied research*. Guilford Press.
        In my opinion, an amazing compendium of CFA knowledge. A bit more on the technical side. Recommended for more advanced usage.

Kline (2015). *Principles and practices of structural equation modeling*. Guilford Press.
        Covers the basic 'Principles and Practices' underlying SEM. Like Brown (2015), it is a bit more advanced – however – like Little (2013) it is a must read for anyone who wishes to push their knowledge.
Course Objectives
Recent advances in computers, software, and statistics have made multivariate statistics more easily accessible. This course will explore many extensions and variations of factor analysis (both exploratory and confirmatory approaches) and structural equation modeling. The unique combination of backgrounds and the various foci of research among class participants make a course like this very interesting. However, the basic tools remain the same and share a common language across disciplines, and the new methods you will gain will be applicable to your

specific interests.

In this course you will have the opportunity to:
- Examine testable hypotheses/relationships in complex environments
- Expand your abilities to work with SPSS to include multivariate analytic procedures, and learn how to use R to help test advanced models

And, not surprisingly, we will still emphasize:
- Interpretation of computer output, focusing on critical components necessary for properly reporting results, and understand what story the data tell
- Practice writing skills necessary for technical reports, methods and results sections
- Preparation for thesis work, publication efforts, and future professional activities by adding advanced methods to the methodological "tool box" we started in the earlier course

Course Structure
Class time will be divided between: (1) introduction of new material in lecture; and, (2) demonstrations and interpretations of statistical techniques using empirical examples.

Course Requirements
Employing multivariate analysis allows us to examine more realistic, complex problems. The use of SEM software will show you how complex systems of variables are examined simultaneously. Materials are presented in an applied, conceptual manner aided by hands-on examples demonstrating concepts discussed in lecture.

It is not the purpose of this course to overload you with symbols and equations, although this is more difficult to achieve in the current versus previous course.

Please keep in mind that you are expected to be present, thoroughly prepared, and ready to be an active participant in this course.

Class Schedule and Reading Assignments

Date	Topic	Readings and Comments
January 7	Introduction to course Exploratory Factor Analysis & Principal Components Analysis	*SPSS:* Chapter 17 – Factor Analysis (Norusis, 2004) Brown (2010), p. 10-33 Costello & Osborne (2005) **Examples**: Dwyer et al. (2012); Milhausen et al. (2010); Quinn-Nilas et al. (2016)
January 14	Exploratory Factor Analysis (EFA) & Principal Components Analysis (PCA) con't	Optional: Beaujean (2013), EFA in R **Hand out Assignment 1**
January 21	Introduction to R lavaan & Structural Equation Modeling (SEM)	**Absolutely Mandatory:** Hooper, Coughlan, & Mullen (2008): Guidelines for Determining Model Fit Introduction to SEM: Beaujean (2014, Ch 1-3) *R lavaan*: The lavaan tutorial: Ch 1-3
January 28	Measurement Models and Confirmatory Factor Analysis (CFA)	Beaujean (2014, Ch 3) *R lavaan*: The lavaan tutorial: Ch 4 **Examples**: Quinn-Nilas et al. (2019)
February 4	Factorial Validity & CFA	Beaujean (2014, Ch 3) Flake, Pek, & Hehman (2017) Hussey & Hughes (2018) **Examples:** Landis, Edwards, & Cortina (2009); Milhausen et al (2010); Noar (2003); Vandenberg & Lance (2000); Maitland et al. (2001); Maitland et al. (2009a & b)

February 11	Second Order CFA, Validity & Causal Structures	Beaujean (2014, Ch 9) **Examples:** Maitland et al (2009a & b) **Assignment 1 due** **Assignment 2 Handed Out**
February 18	**NO CLASSES THIS WEEK**	
February 25	Introduction to Multiple Group Models	Beaujean (2014, Ch 4) *R lavaan*: The lavaan tutorial: Ch 8
March 3	Measurement Equivalence/Invariance (ME/I)	Beaujean (2014, Ch 4, pp.) Flake & Fried (2019) **Examples:** Dwyer et al (2012); Maitland et al. (2001); Maitland et al. (2004); Milhausen et al. (2010); Quinn-Nilas et al. (2019)
March 10	More on ME/I: Examples and applications including analysis of Latent Means	Ployhart & Oswald (2004); Williams et al. (2003) **Assignment 2 due**
March 17	Indirect effects/Mediation in SEM	*R lavaan*: The lavaan tutorial: Ch 13 Quinn-Nilas et al. (2019)
March 24	Advanced Topics in SEM – Latent Growth Curve Models and longitudinal designs.	Beaujean (2014, Ch 4) "12 Frequently Asked Questions about Growth Curve Modeling", Curran, Obeidat, & Losardo (2010) Maitland et al. (2012); Maitland et al (2013); Quinn-Nilas (2019)

March 31	Replicability, misc. topics including power, missing data (FIML), choosing different estimators Final Project	Missing data: Beaujean (2014, Ch 7) Power: Beaujean (2014, Ch 8) Estimators and missing data: The lavaan tutorial: Ch 12

Note: This is a tentative schedule; however, due to various unknown factors there may be changes. Any changes will be announced during class and an announcement will be posted on the CourseLink site. Additional readings may be assigned – I will notify you if this is the case.

Evaluation

Data Application
There will be **two** graded assignments contributing a total of **60**% to your grade. You are expected to submit write-ups that includes a modified version of an APA methods, results, and brief discussion section, demonstrating your understanding. You should also have your SPSS available in electronic format if requested for review. You **must submit your R syntax alongside your assignments** (when applicable)**.** The best method for learning a statistical software package, a new analysis, or to understand output is actually doing it yourself. Whereas I encourage you to ask your colleagues questions, you are strongly urged to do your own work rather than relying on someone else for answers.

Final Project
There will be **one** take-home final project contributing **40**% to your final grade.

Assignments are due by 11:59 p.m. on due dates. Late papers will be accepted with a penalty of 5% deduction per day.

Keep the following issue in mind:
More ≠ better! The take-home format does not mean you have to write hundreds of pages. You are expected to answer the questions and discuss and interpret the results. Concise scientific writing is more difficult to accomplish than lengthy diatribes. Strive to be concise!

The due date for the final project will be announced in class. I will try to maximize the amount of time to complete the project while ensuring that I have time to complete assessment and submit grades on time!

Class Participation
I consider active participation in the learning process vital to meeting the goals and objectives of this course. You will be expected to participate as an equal team member in this class. In practice, this means focusing on furthering class discussions.

1. UNIVERSITY STATEMENTS

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

When you cannot meet a course requirement:
When you find yourself unable to meet in-course requirements due to illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing with name, ID#, and email contact. [See the undergraduate calendar for information on regulations and procedures for Academic Consideration.](#)

Drop date:
Students have until the last day of classes to drop courses without academic penalty. The regulations and procedures for [Dropping Courses](#) are available in the Undergraduate Calendar.

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.

Accessibility:
The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

Academic misconduct:
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.

[The Academic Misconduct Policy is detailed in the Undergraduate Calendar.](#)

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

Resources:
The [Academic Calendars](#) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

References

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