

Applied Factor Analysis & Structural Equation Modeling (SEM)
Family Relations and Applied Nutrition
FRAN 6440
Winter 2018

Instructor: Scott B. Maitland, Ph.D.
MINS 225
824-4120 ext. 56156
smaitlan@uoguelph.ca

Office Hours: Wed. 1:30 - 3:00
by appt.

Class: Tues. 8:30 - 11:20 in MACS 243

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

Course 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

Byrne, B. M. (2016). *Structural equation modeling with AMOS* (3rd ed.). New York, NY: Routledge.

Data to accompany Byrne: http://s3-euw1-ap-pe-ws4-cws-documents.ri-prod.s3.amazonaws.com/9781138797031/data_sets.zip

Additional readings (e.g., published articles or chapters) discussing topics covered, and SPSS guides (i.e., chapters from SPSS manuals) will be distributed or made available for duplication.

Required Software

SPSS will be used for the first part of this course. Additionally, AMOS software is required for confirmatory factor analyses/SEM. SPSS is available in the MACS 243 computer lab. For those wishing to obtain a copy of SPSS the **free concurrent version** is available from:

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

Limited copies of AMOS will be available in the computer lab (MACS 243). It is strongly recommended that students purchase a copy of AMOS. One option is Studica:

<http://www.studica.com/software.html>

You may also find it even cheaper at:

<https://estore.onthehub.com/WebStore/OfferingDetails.aspx?o=2ac379dc-4a84-e711-80f3-000d3af41938>

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 AMOS 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.

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 or AMOS output available in electronic format if requested for review. 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.

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.

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 an in-course requirement because of illness or compassionate reasons, please advise the instructor in writing, with your name, id#, and e-mail contact.

See the graduate calendar for information on regulations and procedures for Academic Consideration:

http://www.uoguelph.ca/registrar/calendars/graduate/2013-2014/genreg/sec_d0e1415.shtml

Drop Date

The last date to drop one-semester courses, without academic penalty, is **Friday, March 9th**. Refer to the Graduate Calendar for the schedule of dates:

<https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/sched/sched-dates-w11.shtml>

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. The Academic Misconduct Policy is detailed in the Graduate Calendar: http://www.uoguelph.ca/registrar/calendars/graduate/2013-2014/genreg/sec_d0e1702.shtml

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

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

Class Schedule and Reading Assignments

Date	Topic	Readings and Comments
January 9	Introduction to course Exploratory Factor Analysis & Principal Components Analysis	<p>Stats: Hertzog & Nesselroade (2003)</p> <p>EFA: Bandalos & Boehm-Kaufman (2009); Beres et al (2004); Costello & Osborne (2005); Cudeck (2000); Dwyer et al. (2012) ; Fabrigar et al (1999) ; Field (2017) ; Gould (1981) ; Horn & McArdle, (2007); Jones (2007); Milhausen et al. (2010) ; Pituch & Stevens (2016)</p> <p>SEM overview: Dillala (2000) & Byrne (2010, Ch 1-2)</p> <p>SPSS: Chapter 17 – Factor Analysis (Norusis, 2004)</p> <p>Also start working with AMOS Tutorial in AMOS book</p>
January 16	Exploratory Factor Analysis (EFA) & Principal Components Analysis (PCA) con't	<p>Stats: see above</p> <p>SPSS: see above</p> <p>Hand out Assignment 1</p>
January 23	Introduction to AMOS & Structural Equation Modeling (SEM)	<p>Stats: SEM: Barrett, (2007); Dilalla (2000)</p> <p>AMOS: Getting running with AMOS graphics</p> <p>Byrne: Ch 1-2</p>
January 30	Measurement Models and Confirmatory Factor Analysis (CFA)	<p>Stats: CFA: Byrne (2005); Hoyle (2000); Gottlieb et al. (2013); Whittaker (2016)</p> <p>AMOS Examples: Ex. 8</p>

		<i>Byrne</i> : Ch 3-4 Assignment 1 due Tues, Jan 30th
February 6	Factorial Validity & CFA	<i>Byrne</i> : Ch 4-5; Landis, Edwards, & Cortina (2009); Milhausen et al (2010); Noar (2003); Vandenberg & Grelle (2009) Maitland et al. (2001) Maitland et al. (2009a & b)
February 13	Second Order CFA, Validity & Causal Structures	Maitland et al (2009a & b) AMOS examples: Byrne: Ch 6
February 20	NO CLASSES THIS WEEK	
February 27	Introduction to Multiple Group Models	Byrne: Ch 7-8 AMOS examples: Ex. 11, 12 Assignment 2 Handed Out
March 6	Measurement Equivalence/Invariance (ME/I)	Byrne: Ch 7-8; Byrne (2004) Bontempo & Hofer (2007) Dwyer et al (2012); Gottlieb et al. (2012); Maitland et al. (2001); Maitland et al. (2004); Milhausen et al. (2010); Vandenberg & Lance (2000)
March 13	More on ME/I: Examples and applications including analysis of Latent Means	Byrne: Ch 9 ; Ployhart & Oswald (2004) ; Williams et al. (2003) AMOS examples: Ex. 15 Gottlieb et al. (2012) ; Maitland et al. (2004) Assignment 2 due Tuesday, Mar 13th

March 20	Invariant patterns in the full latent variable model	Byrne: Ch 10 Gottlieb et al., (2012)
March 27	Advanced Topics in SEM – Latent Growth Curve Models and longitudinal designs.	Byrne: Ch 11, 12, 13 (as time permits) Readings: Byrne & Crombie (2003); Willett & Sayer (1994); Willett & Keiley (2000) Maitland et al. (2012); Maitland et al (2013)
April 3	Pulling it all together, Course evaluation Final Project	

References

- Bandalos, D. L., & Boehm-Kaufman, M. R. (2009). Four common misconceptions in exploratory factor analysis. In C. E. Lance & R. J. Vandenberg (Eds). *Statistical and methodological myths and urban legends* (pp. 61-88). New York: Routledge.
- Barrett, P. M. (2007). Structural equation modeling: Adjudging model fit. *Personality and Individual Differences, 42*, 815–824.
- Beres, M., Herold, E., & Maitland, S. B. (2004). Sexual consent behaviours in same sex relationships. *Archives of Sex Research, 33*, 475-486.
- Bontempo, D. E. & Hofer, S. M. (2007). Assessing factorial invariance in cross-sectional and longitudinal studies. (pp. 153 – 175).
- Bryant, F. (2000). Assessing the validity of measurement. In L. G. Grimm & P. R. Yarnold (Eds). *Reading and understanding more multivariate statistics* (pp. 99-146). Washington, DC: American Psychological Association.
- Byrne, B. M. (2004). Testing for multigroup invariance using AMOS graphics : A road less traveled. *Structural Equation Modeling, 11*, 272-300.
- Byrne, B. M. (2005). Factor Analytic Models: Viewing the structure of an assessment instrument from three perspectives. *Journal of Personality Assessment, 85*, 17 – 32.
- Byrne, B. M. & Crombie, G. (2003). Modeling and testing change : An introduction to latent growth curve modeling. *Understanding Statistics, 2*, 177-203.
- Byrne, B. M. & Watkins, D. (2003). The issue of measurement invariance revisited. *Journal of Cross-Cultural Psychology, 34*, 155-175
- Costello, A. B. & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment Research & Evaluation, 10*(7). Available online: <http://pareonline.net/getvn.asp?v=10&n=7>
- Cudeck, R. (2000). Exploratory factor analysis. In H. E. A. Tinsley & S. D. Brown (Eds.), *Handbook of applied multivariate statistics and mathematical modeling* (pp. 265 – 295). San Diego, CA: Academic Press.
- Dilalla, L. F. (2000). Structural equation modeling: Uses and issues. In H. E. A. Tinsley & S. D. Brown (Eds.), *Handbook of applied multivariate statistics and mathematical modeling* (pp. 440 - 462). San Diego, CA: Academic Press.

- Dwyer, J. J. M., Chulak, T., Maitland, S. B., Allison, K. R., Lysy, D. C., Faulkner, G. E. J., Sheeshka, J. (2012). Adolescents' Self-efficacy to overcome barriers to physical activity scale (SOBPAS). *Research Quarterly for Exercise and Sport*, 83, 513-521
- Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Bulletin*, 4, 272-299.
- Field, A. (2017). *Discovering statistics using SPSS (5th ed.)*. London: Sage.
- Gottlieb, B. H., Maitland, S. B., & Shera, W. (2013). Take this job and love it: A model of support, job satisfaction, and affective commitment among managers of volunteers. *Journal of Community Psychology*, 41, 65-83.
- Gould, S. J. (1981). The real error of Cyril Burt: Factor analysis and the reification of intelligence. In S. J. Gould, *The mismeasure of man* (pp. 234-320). New York: W. W. Norton.
- Hertzog, C. & Nesselroade, J. R. (2003). Assessing psychological change in adulthood: An overview of methodological issues. *Psychology and Aging*, 18, 639-657.
- Horn, J. L. & McArdle, J. J. (2007). Understanding human intelligence since Spearman. In R. Cudeck & R. C. MacCallum (Eds). *Factor analysis at 100: Historical developments and future directions* (pp. 205- 248). New Jersey: Lea.
- Hoyle, R. H. (2000). Confirmatory factor analysis. In H. E. A. Tinsley & S. D. Brown (Eds.), *Handbook of applied multivariate statistics and mathematical modeling* (pp. 466 – 492). San Diego, CA: Academic Press.
- Jones, L. V. (2007). Remembering L. L. Thurstone. In R. Cudeck & R. C. MacCallum (Eds). *Factor analysis at 100: Historical developments and future directions* (pp. 23-34). New Jersey: Lea.
- 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: American Psychological Association.
- Landis, R. S., Edwards, B. D., & Cortina, J. M. (2009). On the practice of allowing correlated residuals among indicators in structural equation models. In C. E. Lance & R. J. Vandenberg (Eds). *Statistical and methodological myths and urban legends* (pp. 193-215). New York: Routledge.

- Maitland, S. B., Davey, A., Wiebe, J., Hodgins, D., & Gottlieb, B. H. (2012). *Chasing the money, playing the odds: Gambling trajectories and covariates*. Paper presented at the Annual Scientific Meetings of The Gerontological Society of America, San Diego, CA
- Maitland, S. B., Dixon, R. A., Hultsch, D. F., & Hertzog, C. (2001). Well-Being as a moving target: Measurement equivalence of the Bradburn Affect Balance scale. *Journal of Gerontology: Psychological Sciences*, *56*, P69-P77.
- Maitland, S. B., Herlitz, A., Nyberg, L., Backman, L., & Nilsson, L-G., (2004). Selective sex differences in declarative memory. *Memory and Cognition*, *32*, 1160-1169.
- Maitland, S. B., Nyberg, L., Bäckman, L., Nilsson, L-G, & Adolfsson, R. (2009a). The search for structure: The temperamental character of the Temperament and Character Inventory. In H. B. Bosworth & C. Hertzog (Eds), *Cognition in Aging: Methodologies and Applications* (pp. 77 – 99). Washington, DC: American Psychological Association.
- Maitland, S. B., Nyberg, L., Backman, L., Nilsson, L-G., & Adolfsson, R. (2009b). On the structure of personality: Are there separate temperament and character factors? *Personality and Individual Differences*, *47*, 180-184.
- Maitland, S. B., Taylor, R. N., Dawczyk, A, Davey, A., Wiebe, J., Hodgins, D., & Gottlieb, B. H. (2013). *Gambling related cognitions in adulthood: What shapes their thinking?* Paper presented at the Annual Scientific Meetings of The Gerontological Society of America, New Orleans, LA.
- Milhausen, R. R., Graham, C. Y., Sanders, S. A., Yarber, W. L., & Maitland, S. B. (2010). Validation of the Sexual Excitation/Sexual Inhibition Inventory for Women and Men (SESII-W/M). *Archives of Sexual Behavior*, *39*, 1091-1004.
- Noar, S. M. (2003). The role of Structural Equation Modeling in scale development. *Structural Equation Modeling*, *10*, 622-647.
- Norusis, M. J. (2006). *SPSS 14.0 Statistical procedures companion*. Upper Saddle River, NJ: Prentice Hall.
- Pituch, K. A. & Stevens, J. P. (2016). Exploratory factor analysis. In K. A. Pituch & J. P. Stevens. *Applied Multivariate Statistics for the Social Sciences* (6th ed.; pp. 339 - 390). New York, NY: Routledge.

- Ployhart, R. E. & Oswald, F. L. (2004). Applications of mean and covariance structure analysis: Integrating correlational and experimental approaches. *Organizational Research Methods*, 7, 27-65.
- 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, DC: American Psychological Association.
- Vandenberg, R. J. & Grelle, D. M. (2009). Alternative model specifications in structural equation modeling: Facts, fictions, and truth. In C. E. Lance & R. J. Vandenberg (Eds.). *Statistical and Methodological Myths and Urban Legends* (pp. 165-191). New York: Routledge.
- Vandenberg, R. J., & Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational Research Methods*, 2, 4-69.
- Whittaker, T. A. (2016). Structural equation modeling. In K. A. Pituch & J. P. Stevens. *Applied Multivariate Statistics for the Social Sciences* (6th Ed.; pp. 639 - 733). New York, NY: Routledge.
- Willett, J. B. & Keiley, M. K. (2000). Using covariance structure analysis to model change over time. In H. E. A. Tinsley & S. D. Brown (Eds.), *Handbook of applied multivariate statistics and mathematical modeling* (pp. 666 – 692). San Diego, CA: Academic Press.
- Willett, J. B. & Sayer, A. G. (1994). Using covariance structure analysis to detect correlates and predictors of individual change over time. *Psychological Bulletin*, 116, 363-381.
- Williams, L. J., Edwards, J. R., & Vandenberg, R. J. (2003). Recent advances in causal modeling methods for organizational and management research. *Journal of Management*, 29, 903-936.