Structural equation modeling

Week 2 (Regular course)

Duration: 12 hours/3 days

Course Description

Structural equation modeling (SEM) is a very general statistical technique, as it has regression analysis, path analysis, and factor analysis as special cases. It is also possible to combine the advantages of these techniques, which makes SEM one of the most general and most flexible techniques available to researchers. As a result, SEM presently is also one the most widely used techniques in the social and behavioral sciences.

This course will introduce you to the fundamentals of SEM by first translating some familiar methods (t tests and ANOVA, regression and correlation) into mean and covariance structure (MACS) analyses. Then you will see how path analysis is more general than the general(ized) linear model and better able to facilitate testing hypotheses about mediation. The second day will introduce tactics for evaluating data–model correspondence, methods for modeling moderation, and measurement models for latent variables. Day 3 will cover path analysis and moderation involving latent variables—the latter of which requires evaluating measurement invariance—and end with how to handle common nonideal data.

Software

All instruction and example syntax will utilize the R software, using add-on packages lavaan and semTools. Students are encouraged to reproduce analyses using the example data provided, as well as using their own data whenever possible.

Prerequisites

Besides familiarity and some experience with R, students are expected to be familiar with the fundamental statistical concepts (e.g., descriptive and inferential statistics, null-hypothesis significance testing) as well as the general(ized) linear model and its special cases: linear and probit regression, t tests, ANOVA, and correlation. Familiarity with basic psychometrics (classical test theory, reliability, and validity) are helpful, especially for the portion of the course involving latent variables.

Schedule

Day 1

• Introduction to lavaan: Mean and Covariance Structures

• Exercises: SEM approach to regression, t tests, AN(C)OVA

• Path analysis, indirect effects (mediation)

• Exercises: Path analysis

Day 2

• Confirmatory factor analysis (CFA)

• Exercises: CFA

• Structural regression with latent variables

• Exercises: Full SEM

Day 3

• Testing hypotheses implied by a SEM: A trilogy of tests

• Exercises: Model comparison

• Global and local indices of approximate data–model fit

• Exercises: Honest evaluation of model fit

References and Recommended Reading

Foundational texts about general(ized) linear modeling and hypothesis testing:

• Judd, C. M., McClelland, G. H., & Ryan, C. S. (2017). Data analysis: A model comparison approach to regression, ANOVA, and beyond (3rd ed.). New York, NY: Routledge. ISBN-13: 9781138819832

• Fox, J. (2016). Applied regression analysis and generalized linear models (3rd ed.) Los Angeles, CA: Sage.

Introductory and advanced SEM texts:

• Beaujean, A. A. (2014). Latent variable modeling using R: A step-by-step guide. Routledge.

• Bollen, K. A. (1989). Structural equations with latent variables. Wiley.

• Loehlin, J. C., & Beaujean, A. A. (2016). Latent variable models: An introduction to factor, path, and structural equation analysis. Taylor & Francis.

• Hoyle, R. H. (Ed.). (2012). Handbook of structural equation modeling. Guilford.

Reporting SEM results:

• Boomsma, A. (2000). Reporting analyses of covariance structures. Structural Equation Modeling, 7(3), 461–483. https://doi.org/10.1207/S15328007SEM0703_6

• McDonald, R. P. & Ho, M. R. (2002). Principles and practice in reporting structural equation analyses. Psychological Methods, 7(1), 64–82. https://psycnet.apa.org/doi/10.1037/1082-989X.7.1.64

Short biography

Terrence D. Jorgensen, PhD, is an assistant professor of methods and statistics within the Department of Child Development and Education at the University of Amsterdam, and he serves as an associate editor of the British Journal of Mathematical and Statistical Psychology. His areas of expertise primarily involve structural equation modeling (SEM), multilevel modeling, nonparametric methods, and modern missing data methods. His methodological research interests include psychometrics (namely, testing measurement equivalence / invariance and detecting differential item functioning [DIF] / measurement bias), resampling methods (permutation, bootstrap, Monte Carlo simulation), Bayesian inference, planned missing data designs, and statistical programming. He frequently intermingles these interests; for example, his dissertation research investigated the use of small-variance priors in Bayesian SEM for detecting DIF, and his postdoctoral work involved developing permutation-randomization methods for detecting DIF. His current research involves integrating the social relations model (SRM) with SEM. Terrence has taught graduate-level SEM for 6 years and maintains the R packages semTools and simsem, and contributes to the lavaan and blavaan packages.