Psychology 9548B. Advanced Latent Variable Models (Winter 2020)

COURSE OUTLINE

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Lectures: Tuesdays 1:30 – 4:30 (starting January 7) Rm SSC 7405/7409

I. COURSE DESCRIPTION

This course is a continuation of the PSY9555 Structural Equation Modeling course with a more in-depth investigation of latent variables from several perspectives. The first topic is the analysis of dichotomous and ordinal item responses focusing mainly on **Item Response Theory** (IRT) of ability/performance/achievement and the common self-report measures using rating scales. IRT provides a number of benefits over the classical test theory approach to measurement and test construction. For example, in IRT, measurement error and reliability can be quantified and assessed at different levels of the scale. IRT provides a flexible way to identify and select items that will discriminate well at various levels of the dimension. IRT also provides techniques to investigate differential item functioning to assess item bias across groups, and it goes hand in hand with computer adaptive testing.

The second topic, **Mixture Modeling**, deals with categorical latent variables that explain population heterogeneity. Mixtures are essentially subpopulations (e.g., different typologies of people) that can be uncovered from patterns of responses to a set of variables. We will investigate (1) latent profile/class analysis, growth mixture modeling, and factor mixture models.

Additional topics include **Network Analysis** (an alternative way of modeling "causal" relations between variables), an investigation of the meaning and partitioning of the variance in **Bi-Factor Models**, and an introduction to **Generalizability Theory** (another approach to help us understand how to isolate different sources of variance in item responses).

By the end of this course, students will (1) have developed a solid conceptual understanding of the latent variable in all its structures (2) be able to design a study that uses any of the modeling methods in the course (3) be able to use software for these modeling methods, and (4) have developed in-depth expertise with one of these methods by having conducted a demonstration study.

Students need to have completed the Structural Equation Modeling (PSY9555) course prior to enrolling in this course.

II. COURSE READINGS

Key articles are listed in the lecture schedule (section V) below. These will be available in the course OWL site.

III. METHOD OF EVALUATION

Manuscript for publication. (70%) Students will have the opportunity to take the lead on a simulation/demonstration study and manuscript in a style not unlike the APA journal *Psychological Methods*. As described in that journal, the articles include "*original theoretical, quantitative, empirical, and methodological articles, reviews of important methodological issues, tutorials, articles illustrating innovative applications of new procedures to psychological problems and articles on the teaching of quantitative methods*." Ultimately by the end of the course, your manuscript will be ready or nearing completion for submission in a journal.

Your manuscript should include a demonstration component, either in the form of simulated data or using existing data but for the purpose of a demonstration or tutorial on a specific modeling method.

A list of topics related to the course will be presented in the first lecture, along with sample articles that we could use as a blueprint. Alternative topics are welcome as long as they are related to the topics in the course, follow the objectives for the manuscript listed above, and are approved by me.

You will be required to submit **a weekly cumulative draft** of your manuscript with a brief statement of your progress beginning in the second week and continuing for ten consecutive weeks. I will provide a rubric and suggested week-by-week plan and milestones to make the process more feasible. I will grade your progress on a weekly basis and provide guidance and assistance at all stages. Half of your grade of the paper will come from your weekly progress (35 points), and the other half (35 points) from the final product. It is expected that by the end of the course, you will have a solid draft ready to submit or that would require minimal work before submission to a journal.

The final manuscript should be **8,000 to 12,000 words**, not counting references or tables. In Times Roman 12, this is about 28 to 42 double-spaced pages, typical of the length of this type of article.

Authorship. The expectation is for you to be the first author and do most of the work on this manuscript and me to act as a second author by providing extensive feedback, helping structure the paper and assist you with developing the simulations, examples, and tutorial as needed. Students are welcome to solicit the help of colleagues or other researchers for secondary roles and authorship as needed.

Participation. (30%) Starting in the second lecture, students will be required to prepare a brief one-page thought paper that includes a paragraph or two illustrating how the method discussed that week could be applied in the student's research area and one discussion question for the group. This question could focus on something that is unclear from the articles or a discussion of applications.

Submit your thought paper each week. Although there will be 11 lectures with this format, you are required to submit 10 thought papers.

IV. STATEMENT OF ACADEMIC OFFENCES

Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

V. LECTURE SCHEDULE, TOPICS, AND READINGS

Jan 7. OVERVIEW

Overview of Discussion of projects and course structure

Jan 14. LATENT VARIABLES

The latent variable in its different forms.

Bollen, K. A. (2002). Latent variables in psychology and the social sciences. *Annual Review of Psychology*, *53*, 605-634.

Borsboom, D. (2008). Latent variable theory. *Measurement*, *6*, 25-53.

Marcus, K. A., & Borsboom, D. (2013). Reflective measurement models, behavior domains, and common causes. *New Ideas in Psychology*, *31*, 54-64.

Tay, L., Jebb, A. T. (2018). Establishing construct continua in construct validation: The process of continuum specification. *Advances in Methods and Practices in Psychological Science*, *1(3),* 375–388. doi.org/10.1177/2515245918775707

Jan 21. MEASUREMENT MODELS

The reflective vs. formative (causal) indicator ‘dichotomy’ and its implications.

Bollen, K. A., & Bauldry, S. (2011). Three Cs in measurement models: Causal indicators, composite indicators, and covariates. *Psychological Methods*, *16*, 265-284. DOI: 10.1037/a0024448

Bollen, K. A., & Diamantopoulos, A. (2017). In defense of causal-formative indicators: A minority report. *Psychological Methods*, *22*, 581-596.

Hardin, A. (2017). A call for theory to support the use of causal-formative indicators: A commentary on Bollen and Diamantopoulos. *Psychological Methods*, *22*, 597-604.

Bollen, K. A., & Diamantopoulos, A. (2017). Notes on measurement theory for causal-informative indicators: A reply to Hardin. *Psychological Methods*, *22*, 605-608.

Jan 28. FACTOR ANALYSIS OF ITEMS – ORDINAL APPROACH

Treating item response scales as dichotomous or ordinal rather than as continuous and interval requires a different kind of factor analysis that is very similar to IRT models

Dumenci, L., & Achenbach, T. M. (2008). Effects of estimation methods on making trait-level inferences from ordered categorical items for assessing psychopathology. *Psychological Assessment*, *20*(1), 55–62. https://doi.org/10.1037/1040-3590.20.1.55

Flora, D. B., & Curran, P. J. (2004). An empirical evaluation of alternative methods of estimation for confirmatory factor analysis with ordinal data. *Psychological Methods*, *9*, 466-491. doi: 10.1037/1082-989X.9.4.466

Rhemtulla, M., Brosseau-Liard, P. E., & Savalei, V. (2012). When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychological Methods*, *17*, 354-373.

Wirth, R. J., & Edwards, M. C. (2007). Item factor analysis: Current approaches and future directions. *Psychological Methods, 12(1)*, 58-79. doi: 10.1037/1082-989X.12.1.58

Feb 4. IRT I

An overview of IRT focusing on its features and various models

Edwards, M. C. (2009). An introduction to item response theory using the need for cognition scale. *Social and Personality Psychology Compass*, 3/4/, 507-529.

Paek, I., Cui, M., Nese, O. G., & Yang Y. (2018). Estimation of an IRT model by Mplus for dichotomously scored responses under different estimation methods. *Educational and Psychological Measurement*, *78*, 569-588.

Rizopoulos, D. (2006). Ltm: An R package for latent variable modeling and item response theory analyses. *Journal of Statistical Software*, *17 (5)*. http://www.jstatsoft.org/

Toland, M. D. (2014). Practical Guide to Conducting an Item Response Theory Analysis. In *Journal of Early Adolescence* (Vol. 34). https://doi.org/10.1177/0272431613511332

Wesolowski, B. C. (2019). Item Response Theory in music testing. In T. Brophy (Ed.), *The Oxford handbook of assessment policy and practice in music education* (pp. 479-503). New York: Oxford University Press.

Feb 11. IRT II

Recent examples of IRT studies with a focus on particular issues.

Cole, K. L., Turner, R. C., & Gitchel, W. D. (2019). A study of polytomous IRT methods and item wording directionality effects on perceived stress items. *Personality and Individual Differences*, *147*, 63-72.

Eichenbaum, A. E., Marcus, D. K., & French, B. F. (2019). Item response theory analysis of the Psychopathic Personality Inventory—Revised. *Assessment*, *26*, 1046-1058.

Iwata, N., Tsutsumi, A., Wakita, T., Kumagai, R., Noguchi, H., & Watanabe, N. (2019). The effect of alternative scoring procedures on the measurement properties of a self-administered depression scale. An IRT investigation on the CES-D scale. *European Journal of Psychological Assessment*, *35*, 55-62.

Hill, C. D., et al. (2007). Practical issues in the application of item response theory. A demonstration using items from the Pediatric Quality of Life Inventory (PedsQL) 4.0 Generic Core Scales. *Medical Care*, *45 (5), Suppl 1*, S39-S47.

Pelham III, W. E., et al. (2019). Item response theory analysis of the Five Facet Mindfulness Questionnaire and its short forms. *Mindfulness*, *10*, 1615-1628.

Feb 25. IRT III APPLICATIONS

We will focus of two main applications: (1) evaluation of invariance across groups and item bias and (2) computer adaptive testing.

Davey, T., & Pitoniak, M. J. (2006). Designing computerized adaptive tests. In *Handbook of Test Development*. https://doi.org/10.4324/9780203874776.ch24

Demars, C. E. (2011). *An Analytic comparison of effect sizes for differential item functioning*. *Applied Measurement in Education, 24, 189-209*. https://doi.org/10.1080/08957347.2011.580255

Gibbons, R. D., et al. (2014). Development of the CAT-ANX: A computerized adaptive test for anxiety. *American Journal of Psychiatry*, *171*, 187-194.

Kolen, M. J., & Hendrickson, A. B. (2011). Scaling, norming, equating. In C. Secolsky & D. B. Denison (Eds.) *Handbook of Measurement, Assessment and Evaluation in Higher Education* (Ch 12).

Lopez, G. E. (2012). *Detection and Classification of DIF Types Using Parametric and Nonparametric Methods: A comparison of the IRT-Likelihood Ratio Test, Crossing-SIBTES, and Logistic Regression Procedures*. (January).

Magis, D., & Barrada, J. R. (2017). Computerized adaptive testing with R: Recent updates of the package catR. *Journal of Statistical Software*, *76*, doi: 10.18637/jss.v076.c01

Mar 3. MIXTURE MODELING I. LATENT PROFILE AND LATENT CLASS ANALYSIS

Continuing from the SEM 9555 course, a more in-depth look at the issues in latent class and latent profile analysis with some examples.

El-Gabalawy, R., Tsai, J., Harpaz-Rotem, I., Hoff, R., Sareen, J., & Pietrzak, R. H. (2013). Predominant typologies of psychopathology in the United States: A latent class analysis. *Journal of Psychiatric Research*, *47*, 1649-1657.

Meyer, J. P., & Morin, A. J. S. (2016). A person-centered approach to commitment research: Theory, research, and methodology. *Journal of Organizational Behavior*, *37*, 584-612.

Morin, A. J. S., & Marsh, H. W. (2015). Disentangling shape from level effects in person-centered analyses: An illustration based on university teachers' multidimensional profiles of effectiveness. *Structural Equation Modeling: A Multidisciplinary Journal*, *22*, 39-59.

Mar 10. MIXTURE MODELING II. LATENT GROWTH MIXTURE MODELING and FACTOR MIXTURE MODELING

Here we merge latent growth modeling with latent class/profile analysis to investigate prototypical trajectories across time. This is an idea follow-up procedure to use once you have found substantial variability in the mean trajectory of a sample. We will also look at factor mixture models.

Jackson, K. M., Sher, K. J. (2006). Comparison of longitudinal phenotypes based on number and timing of assessments: A systematic comparison of trajectory approaches II. *Psychology of Addictive Behaviors*, *20*, 373-384.

Lubke, G. H., & Muthén, B. (2005). Investigating population heterogeneity with factor mixture models. *Psychological Methods*, *10*, 21-39.

Wright, A. G. C., & Hallquist, M. N. (2013). Mixture modeling methods for the assessment of normal and abnormal personality, part II: Longitudinal models. *Journal of Personality Assessment*, *96,* 269-282, DOI: 10.1080/00223891.2013.830262

Mar 17. NETWORK ANALYSIS

What if we conceptualized indicator variables in a different way? Rather than influenced by a common factor, what if they influenced each other?

Costantini, G., et al. (2014). State of the aRt personality research: A tutorial on network analysis of personality data in R. *Journal of Research in Personality*. http://dx.doi.org/10.1016/j.jrp.2014.07.003

Cramer, A. O. J., Waldorp, L. J., van der Maas, H. L. J., & Borsboom, D. (2010). Comorbidity: A Network perspective. *Behavioral and Brain Sciences*, *33*, 137-193.

Schmittmann, V. D., Cramer, A. O. J., Waldorp, L. J., Epskamp, S., Kievit, R. A., & Borsboom, D. (2013). Deconstructing the construct: A network perspective on psychological phenomena. *New Ideas in Psychology*, *31*, 45-53.

Van Bork, R., Rhemtulla, M., Waldorp, L. J., Kruis, J., Rezvanifar, S., & Borsboom, D. (2019). Latent variable models and networks: Statistical equivalence and testability. *Multivariate Behavioral Research*, DOI: 10.1080/00273171.2019.1672515

Mar 24. BI-FACTOR MODELS

The bi-factor model is very interesting when we explore not only how the variance in an indicator variable is partitioned into two different factors but also the meaning of those factors.

Hammer, J. H., & Toland, M. D. (2016, November). Bifactor analysis in Mplus. [Video file]. Retrieved from http://sites.education.uky.edu/apslab/upcoming-events/

http://drjosephhammer.com/research/bifactor-analysis-resources/

Koch, T., & Holtmann, J., Bohn, J., & Eid, M., (2017). Explaining general and specific factors in longitudinal, multimethod, and bifactor models: Some caveats and recommendations. *Psychological Methods*, Online First Publication, July 24, 2017. http://dx.doi.org/10.1037/met0000146

Morin, A. J. S., Arens, A. K., & Marsh, H. W. (2016). A bifactor exploratory structural equation modeling framework for the identification of distinct sources of construct-relevant psychometric multidimensionality. *Structural Equation Modeling*, *23*, 116-139. doi: 10.1080/10705511.2014.961800

Rodriguez, A., Reise, S. P., & Haviland, M. G. (2016). Evaluating bifactor models: Calculating and interpreting statistical indices. *Psychological Methods*, *21*, 137-150. http://dx.doi.org/10.1037/met0000045

Mar 31. GENERALIZABILITY THEORY

And with generalizability theory, we continue to partition the variance in response scores into various sources (such as observers/judges or occasions) that we may even introduce in the design of a study.

Shavelson, R. J., & Webb, N. M. (2006). Generalizability theory. In Green, J. L., Camilli, G. & Elmore, P. B. (Eds.), *Complementary Methods for Research in Education,* (pp. 309-322). (3rd ed.) Washington, DC: AERA.

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Applications of generalizability theory and their relations to classical test theory and structural equation modeling. *Psychological Methods*, 23, 1-26.
