Psychology 9540. Research Design and Statistical Modeling (2018-2019)

COURSE OUTLINE

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Lectures: Wednesdays, 9:00 am to 12:00 noon, Room SSC 7405/7409. Start date: Wednesday, September 12, 2018 (Full course; two terms).

I. COURSE DESCRIPTION

This course covers the main univariate and multivariate statistical and modeling procedures with the objective of developing a solid conceptual understanding and ability to use the methods proficiently in independent research. The lab assignments provide hands-on training at the conceptual/hypothesis, design, measurement, data visualization and statistical analysis levels by using data examples that simulate realistic and often challenging research situations (e.g., missing data, non-normal distributions, unbalanced designs, and confounding variables). Software used for demonstration include R (and jamovi), SPSS, and Mplus (for multilevel and structural equation modeling). Students will have the flexibility to work with their preferred software.

The course topics are organized into four general units: I. Fundamental Statistics (estimation, sampling distributions, data visualization and management, missing data techniques, inferential statistics, confidence intervals, effect size, replication and power analysis, and introduction to meta-analysis), II. General linear model and experimental designs with ANOVA, ANCOVA and MANOVA, III. Multiple Regression and Extensions (including mediation, moderation, multilevel modeling, and models for categorical outcomes such as logistic regression), and IV. Factor Analysis and Structural Equation Modeling with applications to measurement, test construction and construct validation.

Course Objectives and My Teaching Philosophy

Content. The content includes four broad domains: (1) essential foundational material, (2) the simple and advanced models in analysis of variance, (3) multiple regression techniques including an introduction to multilevel modelling, (4) and the factor analytic and structural

equation modelling approaches[1]. By the end of this course you should be able to use any of these methods effectively in your own research. Although you may not plan to use all of these methods, I think you will profit from learning about 'the big picture' or interconnectedness of the different statistical procedures.

Three pillars. I see empirical research methodology as involving three important and interrelated components: measurement, research design, and statistical analysis. I am convinced and have seen that if any of these three components is not addressed properly in any research project, the quality of the research suffers. In terms of measurement, I will address foundational concepts such as aggregation and techniques like exploratory and confirmatory factor analysis as useful tools for developing and evaluating measures. In terms of research design, my aim is to help students think about the feasibility of their hypotheses and designs through exercises including power analyses and simulations. In terms of statistical analyses, I like to foster a step by step model building approach rather than throwing everything into a black box and expecting a meaningful result to emerge from a spin cycle.

Balance between theory and application. In each lecture, my objective is to strike the right balance between theory and application. For example, by the end of the lecture and assignment on moderation in multiple regression, students should have acquired a clear understanding of moderation conceptually, visually, and mathematically (i.e., the basic equation). They will know how to do a moderation analysis using multiple regression; they will have a clear sense of when to use this technique; and they will understand how it relates to interactions in analysis of variance.

Accepting complexity. Students often expect straight yes or no answer in statistics (e.g., "Is my sample of 100 participants large enough?"). By now you know that I do not subscribe to a cookbook approach. I will include material that addresses the nuances of issues that do not have a simple solution. Most real data sets have missing observations and they may not completely satisfy all the statistical test assumptions. We will see that there are a number of different ways to test a specific hypothesis.

[1] You may be aware of the debates in the literature about the value of null hypothesis significance testing (NHST) vs. using only effect sizes and confidence intervals. I take the approach that both perspectives are important and therefore cover both. Also, some methodologists argue that analysis of variance designs can all be taught from a multiple regression perspective, I have found that it helps tremendously to develop a solid understand of ANOVA especially for the more complex designs. In this course we cover both approaches.

II. COURSE READINGS

Textbook (available at the Bookstore):

Warner, R. M. (2013). *Applied Statistics. From Bivariate Through Multivariate Techniques*. *Second Edition*. Los Angeles: Sage.

Journal articles for specific lectures (available on OWL course website):

Meta-analysis

Cheung, M. W. L., & Vijayakumar, R. (2016). A guide to conducting a meta-analysis. *Neuropsychology Review*, *26*, 121-128. doi: 10.1007/s11065-016-9319-z

Field, A. P., & Gillett, R. (2010). How to do a meta-analysis. *British Journal of Mathematical and Statistical Psychology*, *63*, 665-694. doi: 10.1348/000711010X502733

Multilevel modeling

Nezlek, J. B. (2008). An introduction to multilevel modeling for social and personality psychology. *Social and Personality Psychology Compass, 2(2)*, 842-860. doi: 10.1111/j.1751-9004.2007.00059.x

Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology*, *48*, 85-112. doi: 10.1016/j.jsp.2009.09.002

Confirmatory factor analysis and structural equation modeling

Schreiber, J. B., Stage, F. K., King, J., Nora, A., Barlow, E. A. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, *99(6)*, 323-337. doi: http://dx.doi.org/10.3200/JOER.99.6.323-338

Weston, R. & Gore Jr, P. A. (2006). A brief guide to structural equation modeling. *The Counseling Psychologist*, *34*, 719-751. doi: 10.1177/0011000006286345

III. METHOD OF EVALUATION

Assignments: 90%

- 12 equally-weighted assignments. The schedule (previous page) indicates when the assignments will be distributed. You will have two weeks to complete an assignment (due at the beginning of class).
- Assignments will include data analysis reporting, interpretation, and discussion of results, and other questions.
- Assignment reports will typically consist of a two double-spaced page write-up including a description, interpretation and discussion of your results, answers to specific questions, and an appendix with your analysis output.
- Late assignments will receive a 5% deduction per 24 hours. Assignments that are more than one week late will not be accepted for partial marks.
- *Rules about working in groups*. I am supportive of students working in groups to conduct the analyses and discuss the assignments. However, you are required to write your own report with no duplication from your colleagues' work. The assignments will often require you to choose a subset of variables, to make decisions about plausible strategies, or to describe research ideas from your own area of interest. Also, some questions will ask you to design your own hypothetical research designs. As a result, it is unlikely that two students will work with the exact same material.

Participation: 10%

For each class, you are expected to attend the lecture (on time and being engaged by active listening and prepared to discuss readings), participate in group discussions, and prepare a follow-up question or comment after each lecture on the material covered. I will allow two missed lectures (including showing up late) over the academic year without a deduction regardless of the reason. Missing more than two lectures will result in a deduction of 1% out of 10% for each additional missed lecture (i.e., missing 12 lectures in total would result in 0 on class participation). If you have a serious problem preventing you from attending more than two lectures, please inform me or the Associate Chair (Graduate Affairs).

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

	Date	Topic	Readings	Assign
1	Sep 12	Overview	Ch. 1	
2	Sep 19	Basic Statistics and Distributions - Visualization	Ch. 2	A 1
3	Sep 26	Inferential Statistics – Simulation and Power analysis	Ch. 3	
4	Oct 3	Data Inspection and Missing Data Analysis	Ch. 4	A 2
5	Oct 10	T-tests	Ch. 5	
6	Oct 17	One-way ANOVA	Ch. 6	A 3
7	Oct 24	Factorial ANOVA	Ch. 13	
8	Oct 31	Repeated Measures and Trends	Ch. 22	A 4
9	Nov 7	Split Plot ANOVA	TBA	
10	Nov 14	Measures of Association	Ch. 7, 8	A 5
11	Nov 21	Bivariate Regression	Ch. 9	
12	Nov 28	Introduction to Meta Analysis	See list	A 6
13	Dec 5	Multiple Correlation – Understanding “Statistical Control”	Ch. 10	
14	Jan 9	Multiple Regression	Ch. 11	A7
15	Jan 16	Categorical Predictors in Multiple Regression	Ch. 12	
16	Jan 23	ANCOVA – Mix of Categorical and Continuous Predictors	Ch. 17	A8
17	Jan 30	Moderation in Multiple Regression	Ch. 15	
18	Feb 6	Mediation in Multiple Regression	Ch. 16	A9
19	Feb 13	Logistic Regression	Ch. 23	
20	Feb 27	Multilevel Modeling-I – Subjects Within Groups	See list	A10
21	Mar 6	Multilevel Modeling-II – Observations within Individuals	See list	
22	Mar 13	Factor Analysis	Ch. 20	A11
23	Mar 20	Confirmatory Factor Analysis and Structural Equation Mod	See list	
24	Mar 27	Measurement Theory (Classical and Item Response)	Ch. 21	A12
25	Apr 3	Construct Validation Design	Ch. 21	

Supplementary Resources (available in OWL course website)

Basic Statistics

Cumming G., & Finch, S. (2005). Inference by eye. Confidence intervals and how to read pictures of data. *American Psychologist*, *60*, 170-180. doi: 10.1037/0003-066X.60.2.170

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *frontiers in Psychology*. doi: 10.3389/fpsyg.2013.00863

Inferential Statistics

Boos, D. D. (2003). Introduction to the bootstrap world. *Statistical Science*, *18*, 168-174.

Kruschke, J. K., & Liddell, T. M. (2017). Bayesian data analysis for newcomers. *Psychonomic Bulletin & Review* (published online). doi: 10.3758/s13423-017-1272-1

Data Inspection

Baraldi, A. N., & Enders, C. K. (2010). An introduction to modern missing data analyses. *Journal of School Psychology*, *48*, 5–37. doi: 10.1016/j.jsp.2009.10.001

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*, 549–576. doi: 10.1146/annurev.psych.58.110405.085530

ANOVA

Cardinal R. N. *Graduate-level statistics for psychology and neuroscience ANOVA in practice, and complex ANOVA designs*. Version of 2 May 2004. Retrieved from https://egret.psychol.cam.ac.uk/psychology/graduate/Guide_to_ANOVA.pdf

Categorical Predictors

Wendorf, C. A. (2004). Primer on multiple regression coding: Common forms and the additional case of repeated contrasts. *Understanding Statistics*, *3*, 47–57. doi:10.1207/s15328031us0301_3

Mediation and Moderation

Hayes, A. F., & Rockwood, N. J., (2016). Regression based statistical mediation and moderation analysis in clinical research: Observations, recommendations and implementation. *Behaviour Research and Therapy*, 1-19. http://dx.doi.org/10.1016/j.brat.2016.11.001

Logistic Regression

Peng, C.-Y.J., & So T.-S. H. (2002). Logistic regression analysis and reporting: A primer. *Understanding Statistics*, *1*, 31-70. doi: 10.1207/S15328031US0101_04

Multilevel Modeling

Kahn, J. H. (2011). Multilevel modeling: Overview and applications to research in counseling psychology. *Journal of Counseling Psychology*, *58(2)*, 257-271. doi: 10.1037/a0022680

Factor Analysis

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*, 272-299. doi: 10.1037//1082-989X.4.3.272

Measurement Theory

DeVellis, R. F. (2006). Classical test theory. *Medical Care*, *44*, S50 S59. http://www.jstor.org/stable/41219505

Test Construction and Validation

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, *7*, 309-319. doi: 10.1037/1040-3590.7.3.309

Smith, G. T. (2005). On construct validity: Issues of method and measurement. *Psychological Assessment*, *17*, 396-408. doi: 10.1037/1040-3590.17.4.396

Item Response Theory (IRT)

Toland, M. D. (2014). Practical guide to conducting an item response theory analysis. *Journal of Early Adolescence*, *34*, 120-151. doi: 10.1177/0272431613511332