Multivariate Statistical Techniques

PSY613

CRN 35871

Spring 2010

Tues, Thurs 10:00-11:20 a.m. 360 Condon

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Teaching Assistants

Karyn Lewis Office Hours: Mon 2:30-3:30, Fri 1:30-2:30, 408 Straub Hall

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Overview. This course focuses on the basic multivariate techniques currently used in psychology and related sciences: principal components and factor analysis, multivariate analysis of variance, and discriminant function analysis. We will also cover some other important techniques that were not covered in Psy 612: log-linear analysis, logistic regression, and meta-analysis.

The learning goal for you is to have a conceptual and statistical understanding of each technique, be able to apply the correct technique to any given data set, properly interpret the output of statistical computer packages (primarily SPSS), and understand and critique scientific papers that use these techniques.

Even though much work will go into learning to conduct the various analyses, a primary goal is to gain a conceptual understanding of each technique, which refers to its function and capacity to answer *scientific questions* (not achieve *p* values). Each technique is a tool that can immensely assist you in understanding your data and testing your hypotheses; but to apply each tool correctly you need to understand both your data and the nature of the proper analysis tools.

The level of understanding you will reach in this course lies one step deeper than the level at which you will operate when using the techniques in years to come. During this term you will learn to think about some mathematical underpinnings of the techniques, and this step will give you a deeper understanding of the workings of each technique. Even if you later forget the details of these underpinnings, you will not forget the conceptual implications they have. All mathematics introduced in this course is meant to serve your conceptual understanding.

Grading. Your grade will be based on 9 homeworks (100 pts each) and two take-home exams (300 points each), for a total of 1500 points. The homeworks consist of data retrieval, analysis, interpretation and write-up of results, all done electronically. The exams (posted on Blackboard **Apr 29** and **June 1**) consist of conceptual questions on the functional character of techniques and your understanding of central concepts.

Readings: Because there is no all-around good, complete, and affordable textbook of multivariate statistics, I have selected readings from various textbooks and other sources for this class (all available on Blackboard). You should at least speed-read the relevant chapters/papers before class to familiarize yourself with the terminology.
For those of you who would like to own a source book, I recommend Tabachnick and Fidell (T & F), *Multivariate Statistics* (2006, 5th ed.).

Blackboard: All lecture slides, readings, and weekly homework files will be posted on Blackboard.

Homework: Each Thursday by 10am, a homework assignment will be posted on Blackboard that is due the following Thursday. Your homework is complete if you run all required analyses, edit the output files down to the essential information, and annotate the output to demonstrate your understanding of what SPSS was doing. Finally, you write up a one-page summary of the results as you would for an empirical journal article. The annotated outputs and the written results must be sent to your TA via email by Thursday at noon. Be sure to write clearly, concisely, and meaningfully.

Friday Lab Session: I assume that you are comfortable with the structure of the lab sessions by now (having taken 611 and 612). Julia and/or Karyn will discuss the lab in more detail on Friday.

Topics and Readings

The readings in this class are selected chapters from various statistics textbooks, and a few journal articles. In addition, I have listed the relevant Tabachnick & Fidell chapters where available. In some cases, a Tabachnick & Fidell chapter is required reading. Required readings are printed in blue font below. All reading materials are available as pdf files on Blackboard.

Textbook authors cited below:

Cliff, N. (1987). *Analyzing multivariate data.* Harcourt Brace Jovanovich: San Diego.

Dillon, W. R., & Goldstein, M. (1984). *Multivariate Analysis: Methods and Applications.* Wiley: New York.

Stevens, J. (1996). Applied multivariate statistics for the social sciences. Mahwah, NJ: Erlbaum.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). New York: HarperCollins.

L 1: Tues March 30 The multivariate approach: Introduction and overview

Dillon & Goldstein (1984). Overview of multivariate techniques (pp. 19-22)

Tabachnick & Fidell (2001). ch. 1 + ch. 2.

L 2: Thurs Apr 1 Data screening and exploratory data analysis

Tabachnick & Fidell (2001). ch. 4

Cohen, J. (1990). Things I have learned (so far). *American Psychologist, 45,* 1304-1312.

Optional

SPSS EXAMINE complete chapter

Fri April 2 *Lab:1 Exploratory data analysis*

L 3: Tues April 6 From χ^2 to log-linear analysis

Stevens (1996). Categorical data analysis: The log linear model (Ch. 14, pp. 518-521, 524-547).

L 4: Tues April 8 Log-linear and logit analysis

SPSS Advanced Statistics User's Guide. ch. 5 (Procedure HILOGLINEAR) and ch. 6 (Procedure LOGLINEAR)

Fri April 9 *Lab:2 Log-Linear analysis*

L 5: Tues April 13 Logistic Regression

Tabachnick & Fidell (2001). ch. 12

SPSS Advanced Statistics User's Guide. ch. 2 (LOGISTIC REGRESSION)

L 6: Thurs April 15 Logistic Regression continued

Fri April 16 *Lab:3 Logistic regression*

L 7: Tues April 20 Matrix algebra (Introduction)

Cliff, N. (1987). Elements of matrix algebra for statistical applications (ch. 1), Vectors (ch. 3). [Basic, slow pace]

Optional

Dillon & Goldstein (1984). Vector and matrix operations and selected statistical concepts (pp. 521-539). [Faster pace]

L 8: Thurs April 22 Matrix algebra for statistics

Cliff, N. (1987). Statistical formulas in matrix form (ch. 2), Variances and covariances of linear combinations (ch. 4), The inverse (ch. 5). [Slower pace]

Optional

Dillon & Goldstein (1984). Statistical concepts and vector and matrix operations (pp. 6-18). [Faster pace]

Fri April 23 *Lab:4 Matrix concepts*

L 9: Tues April 27 Test Theory and Item Analysis

http://en.wikipedia.org/wiki/Classical_test_theory

SPSS Base System User's Guide. ch. 26 (Procedure RELIABILITY)

Optional

Nunnally, J. C. (1967). Theory of measurement error. In J. C. Nunnally, *Psychometric theory* (ch. 6, pp. 172-205). New York: McGraw-Hill.

L 10: Thurs April 29 Principal components analysis (PCA)

Dillon & Goldstein (1984). Principal components analysis (ch. 2, pp. 23-39, 47-52)

Optional

Tabachnick & Fidell (2006). ch. 13

Fri April 30 *Lab:5 PCA*

Midterm take-home exam posted Thursday, April 29

Due Thursday May 6 at 4pm.

L 11: Tues May 4 Factor analysis (FA)

Dillon & Goldstein (1984). Factor Analysis (ch. 3)

SPSS Base System User's Guide. ch. 21 (Procedure FACTOR)

Optional

Cliff (1987). The common factor model (ch. 15)

Gorsuch, R. L. (1997). Exploratory factor analysis: Its role in item analysis. *Journal of personality assessment, 68*, 532-560.

L 12: Thurs May 6 More FA: Extraction, rotation, confirmation

Russell, D. W. (2002). In search of underlying dimensions: The use (and abuse) of factor analysis in Personality and Social Psychology Bulletin. *Personality and Social Psychology Bulletin, 28*, 1629-1646.

Fri May 5 *Lab:6 Factor Analysis*

L 13: Tues May 11 (M)ANOVA preludes: Interactions, orthogonality

Rosnow, R. L., & Rosenthal, R. (1989). Statistical procedures and the justification of knowledge in psychological science. *American Psychologist, 44,* 1276-1284.

Rosnow, R. L., & Rosenthal, R. (1989). Definition and interpretation of interaction effects. *Psychological Bulletin, 105,* 143-146.

L 14: Thurs May 13 Statistical significance; meta-analysis

Schmidt, F. (1996). Statistical significance testing and cumulative knowledge in psychology: Implications for training of researchers. *Psychological Methods*, 1, 115-129.

DeCoster, J. (2004). Meta-analysis. In Kempf-Leonard, K. (Ed.), *The Encyclopedia of SocialMeasurement*. San Diego, CA: Academic Press.

Optional

TBA

Fri May 14 *Lab:7 Meta-analysis*

L 15: Tues May 18 Multivariate Analysis of Variance (MANOVA)

Tabachnick & Fidell (2001). ch. 9

SPSS Manual: Appendix B–Categorical variable coding schemes.

Huberty, C. J., and Morris, J. D. (1989). Multivariate analysis versus multiple univariate analyses. *Psychological Bulletin, 105*, 302-308.

L 16: Thurs May 20 Discriminant function analysis (DFA)

Dillon & Goldstein (1984). Multiple discriminant analysis and related topics (Ch. 11, pp. 394-416).

Optional

Tabachnick & Fidell (2001). ch. 11

Fri May 21 *Lab:8 General MANOVA and DFA*

L 17: Tues May 25 TBA
L 18: Thurs May 27 TBA

Fri May 28 *Lab:9 TBA*

L 19: Tues June 1 Further expansions: doubly multivariate designs, multi-level modeling

L 20: Thurs June 3 The multivariate tool box/Luxury techniques

No lab

Final take-home exam posted Tuesday, June 1

Final take-home exam due Tuesday, June 8, noon
