Statistics for Psychosocial Research I: Measurement Models
330.657
First Term

JOHNS HOPKINS BLOOMBERG SCHOOL OF PUBLIC HEALTH

COURSE SYLLABUS

DEPARTMENT OF MENTAL HEALTH

Website: http://courseplus.jhsph.edu/index.cfm?event=showPublicCourseSyllabus&catalogID=7563

Faculty

William Eaton
- Dept. of Mental Health
- 850 Hampton House
  624 North Broadway
  Baltimore, MD 21205
- (410) 955-3908
- weaton@jhsph.edu
- Office hours: by appointment

Elizabeth Garrett-Mayer
- Dept. of Biostatistics
- 11th Floor 550 Bldg.
  550 North Broadway
  Baltimore, MD 21205
- (410) 955-4884
- esg@jhu.edu
- Office hours: by appointment

Jeannie-Marie Leoutsakos
- Dept. of Mental Health
- 792 Hampton House
  624 North Broadway
  Baltimore, MD 21205
- (410) 614-5473
- jsheppar@jhsph.edu
- Office hours: by appointment

Teaching Assistants

Amy Buchanan
- Dept of Mental Health
- 892 Hampton House
- abuchana@jhsph.edu
- Office hrs: Th 11-12

Lilian Ghandour
- Dept of Mental Health
- 892 Hampton House
- lghandou@jhsph.edu
- Office hrs: M 12-1

Shu-chih Su
- Dept. of Biostatistics
- E3040 Bloomberg
- shsu@jhsph.edu
- Office hrs: F 3-4

Keson Theppeang
- Dept. of Biostatistics
- W7508 Bloomberg
- ktheppea@jhsph.edu
- Office hrs: W 1:30-2:30

Course Description

This course presents quantitative approaches to measurement in the psychological and social sciences. It is designed for doctoral students and is conducted jointly by the Departments of Mental Health and Biostatistics. Examples will be drawn from the social sciences, including stress and distress, social class and socioeconomic status, depression, functional impairment and disability. The instructional method will consist of lectures by the instructors as well as hands-on sessions in the computer laboratory and assigned problem sets.

This course is part of a two-quarter series on Statistics for Psychosocial Research, oriented towards structural equation models and related methods, taught jointly by the Departments of Mental Health and Biostatistics. The first quarter concentrates on measurement, and the second quarter on structural models. Credit for this course may be obtained without enrolling in the following course, but this course, or permission of the instructor, is required for enrollment in the second quarter course

Learning Objectives

Upon successful completion of this course, students will be able to read and evaluate scientific articles as regards measurement in public health; to design simple measurement protocols; to design and conduct studies of reliability and validity; and to conduct and present standard quantitative analyses of measurement accuracy. Students will become familiar with the principles of psychometrics, including reliability and validity, and with latent variable-based measurement models, including factor analysis and latent class analysis.

Schedule

All lectures will be at 10:30 in Hampton House 14B (Basement Auditorium). The first lecture is on Friday, September 1st. All other lectures will be on Mondays and Wednesdays.

Problem Sets & Computer Labs

The problem sets will require active manipulation of datasets provided by the instructors, using standard statistical packages such as Stata and MPlus. The three problem sets are all due on Mondays in class; late homework will be accepted until the Wednesday class immediately following but will be penalized half a letter grade. Once the solutions are posted on Wednesday at 5pm, we will no longer be able to accept homework.

Computer lab sessions will be held each Friday (other than September 1st) from 10-12 in Bloomberg W3017. Students will want to bring their lecture notes, a pencil, and a thumb drive (http://en.wikipedia.org/wiki/Thumb_drive) in order to save their computing output. It is recommended that students read through the homework assignment prior to each week's lab session.

CoursePlus Web site

http://courseplus.jhsph.edu/index.cfm?event=showPublicCourseSyllabus&catalogID=7563

The course web site will contain current and previous lectures, problem sets, and data sets for the course. Students must create an e-learning account in order to receive course communications and to access materials. Please do this as soon as possible. If you are not formally registered for the course, please contact us so that we may grant you guest access to the website. The website will also include a bulletin board (BBS) on which students may post questions about the course and its contents. It is requested that students post their questions on the BBS rather than e-mailing them directly to the course staff.

Grading Policy

Grades will be based on three problems sets and a final 90 minute open-notes/book, in-class exam (each contributing 25% toward the final grade).

Prerequisites

Biostatistics 621-624, or Biostatistics 651-654, or equivalent from another institution.

Textbooks

Required:

Netemeyer, Richard G., William O. Bearden, Subhash Sharma. *Scaling Procedures: Issues and Applications*. Thousand Oaks, CA, Sage 2003.

McCutcheon, A.L. *Latent Class Analysis*, Newbury Park, Sage, 1987. (available through e-reserves)

Highly recommended:

DeVellis, Robert F. *Scale Development: Theory and Applications*, Newbury Park, Sage, 1991.

Kim, Jae-on, and Mueller, Charles W., *Factor Analysis: Statistical Methods and Practical Issues*, Beverly Hills, California, Sage, 1978. (available through e-reserves)

Readings

Readings are offered to help students master the material. "Alternative and additional" readings may be ignored, skimmed, or read in full if the student is interested. "Alternative and additional readings" will enrich the student's knowledge of the material, but are not required for

mastery. The texts are available in the bookstore. Alternative and additional readings are available on e-reserve. http://eres.welch.jhmi.edu/eres/coursepage.aspx?cid=190 The password is 330657sph .

Honor Code

The JHU Honor Code http://www.jhsph.edu/schoolpolicies/policy_academic_ethics.html should be followed throughout the course. You will be asked to write and sign the academic ethics statement, "*I have neither given nor received unauthorized aid on this assignment*" on your exam. Any infractions to the honor code will be referred to the Academic Ethics Board.

Students with Disabilities

If you are a student with a documented or suspected disability who requires an academic accommodation, please contact Betty Addison in the Office of Career Services and Disability Support at 410-955-3034, Room E-1002, or via email at dss@jhsph.edu. For information about this office and its services go to: www.jhsph.edu/Student_Life/.

Lecture Schedule

Date	Day	Topic	Instructor	Homework
9/1	F	Introduction to Measurement (at 10:30 in HH Auditorium)	Bill	
No school!	M	---	---	
9/6	W	Association and Dimensionality	Liz	
9/8	F	LAB 0: Intro/Refresher to STATA	TAs	
9/11	M	Reliability I	Bill	
9/13	W	Reliability II	Jeannie	PS#1 handed out
9/15	F	LAB1	TAs	
9/18	M	Validity I	Bill	
9/20	W	Validity II	Jeannie	
9/22	F	LAB 2	TAs	
9/25	M	Scale Development	Bill	PS#1 due & PS#2 handed out
9/27	W	Factor Analysis I	Liz	
9/29	F	LAB 3	TAs	
10/2	M	Factor Analysis II	Liz	
10/4	W	Factor Analysis Examples	Liz	
10/6	F	LAB 4	TAs	
10/9	M	Latent Class Analysis I	Liz	PS#3 handed out
10/11	W	Latent Class Analysis II	Liz	

10/13	F	LAB 5	TAs	
10/16	M	LCA Examples	Jeannie	PS#2 due
10/18	W	Sample Size Issues in FA and LCA	Liz	
10/20	F	LAB 6	TAs	
10/23	M	Review	Jeannie & Liz	PS#3 due
10/25	W	In-Class final	----	

Friday, September 1: ***Introduction*** (Bill)
Introduction & Purpose of Course
Review of syllabus
Classical test theory
Introduction to reliability, examples

After this class students will be able to

- briefly describe the concept of reliability in both intuitive and statistical terms, and
- identify the key assumptions of classical test theory.

Wednesday, September 6: ***Measuring Association and Dimensionality*** (Liz)
Covariance
Pearson & Spearman correlation
Correlations with non-linear data
Polychoric correlation
Covariance, correlation, and odds ratio matrices
Dimensionality

Reading: Netemeyer, pages xiii-xiv and 1-40.

Additional or alternative:

Easier: Pagano and Gauvreau, "Correlation" in *Principles of Biostatistics*, Belmont, CA: Duxbury, 363 - 378, 1993.

Difficult: Digby, P.G.N. "Approximating the Tetrachoric Correlation Coefficient," *Biometrics*, 39:753-757, 1983.

After this class students will be able to

- measure associations between continuous observed variables using covariances and correlations
- measure magnitudes of association between discrete observed variables
- Define multidimensionality regarding latent variables

Monday, September 11: ***Principles of Psychometrics: Reliability I*** (Bill)
Types of reliability (Interrater, Test-retest reliability, Internal consistency)
Different types of reliability coefficients
- Correlation
- Split half measures
- Alpha coefficient
- Kuder Richardson Coefficient
- Kappa

Reading: Netemeyer, pages 41-59.

Additional or Alternative:

Easy: DeVellis, pages 18-42
Anastasi, A. Chapter 5, "Reliability" in her *Psychological Testing,* 6th Edition, Macmillan, 1988.

Moderate: Carmines, E.G., and Zeller, R.A., *Reliability and Validity Assessment*. Beverly Hills, Sage, 1979.

More difficult: Bohrnstedt, G. "Measurement" in Rossi, P.H., Wright, J.D. and Anderson, A.B., editors, *Handbook of Survey Research,* Orlando, Academic Press, 1983.
Shrout, Patrick E., and Joseph L. Fleiss. "Intraclass Correlations: Uses in Assessing Rater Reliability" *Psychological Bulletin* 86:420-428.

After this class students will be able to:
• Describe two definitions of the concept of reliability
• Predict how long a scale should be
• Estimate reliability for continuous and categorical measures

---

Wednesday, September 13: ***Principles of Psychometrics: Reliability II*** (Jeannie)
ANOVA model for reliability
Intra-class Correlation Coefficient
Research Designs

No additional readings for this lecture

After this class students will be able to:
• Describe the relationship of the intraclass correlation coefficient to other measures of reliability
• Correctly identify which intraclass correlation to use for different research designs

---

Monday, September 18: ***Principles of Psychometrics: Validity I*** (Bill)
Types of Validity (face, content, criterion, construct)
Relationship of Reliability to Validity
Correction for attenuation

Reading: Netemeyer, pages 71-94

Additional or alternative:

Easy: DeVellis, pages 43-50.
Anastasi, A. Chapter 6, "Validity: Basic Concepts,"in her *Psychological Testing*, 6th Edition, New York, Macmillan, 1988.

Moderate: Carmines, E.G., and Zeller, R.A., *Reliability and Validity Assessment*. Beverly Hills, Sage, 1979.
McCrae, R.R., and Costa, P.T. "Validation of the Five-factor Model of Personality across Instruments and Observers, *Journal of Personality and Social Psychology,* 52: 81-90, 1987.

More difficult: *Bohrnstedt, G. "Measurement" in Rossi, P.H., Wright, J.D. and Anderson, A.B., editors,* Handbook of Survey Research, *Orlando, Academic Press, 1983.*

After this class students will be able to:
▪ Distinguish four different types of validity
▪ Describe the conceptual and quantitative relationship of reliability to validity
▪ Estimate a true correlation from an observed correlation

Wednesday, September 20: ***Principles of Psychometrics: Validity II*** (Jeannie)
Internal Construct Validity
External Construct Validity
Multi-trait Multimethod Matrix
Sensitivity and Specificity
ROC Curves

No additional readings for this lecture

After this class students will be able to:
•Evaluate the relative utility of different cutoffs for a measure in relation to a gold standard.

Monday, September 25: ***Scale Development*** (Bill)

Readings: Netemeyer, pages 94-107

Streiner, D.L, and Norman, G.R. *Health Measurement Scales: a practical guide to their development and use*, Second edition, New York, Oxford, 1995, Chapter 7 "From items to scales": especially the section "Establishing cut points," pages 96-102; or
Murphy, J.M., et. al. "Performance of screening and diagnostic tests" *Archives of General Psychiatry*, 44, 550-555, 1987.

After this class students will be able to:
•Describe procedures for constructing a scale from scratch

Wednesday, September 27: ***Factor Analysis I*** (Liz)
Introduction to factor analysis
The orthogonal factor model
Loadings

Principal components
Eigenvalues
Introduction to rotation
Communalities/Uniqueness of items

Reading: Netemeyer, pages 115-170.

Additional reading:

Easier: DeVellis, pages 91-109.

Kim, Jae-on, and Mueller, Charles W., *Factor Analysis: Statistical Methods and Practical Issues*, Beverly Hills, California, Sage, 1988.

Everitt, Brian and Dunn, Graham "Factor Analysis" in *Applied Multivariate Data Analysis*, London: Arnold, 2001. Chapter 12.

After this class students will be able to:

- Identify when a factor analysis is appropriate and when it is not
- Run a one-factor and multi-factor analysis
- Interpret the results from a factor analysis

Monday, October 2: ***Factor Analysis II*** (Liz)

Factor extraction
Methods of estimation and rotation: orthogonal and oblique
Choosing the number of factors
Factor scores
Confirmatory factor analysis
Conditional independence
Dichotomous factor analysis

Additional Readings:

Easier: Everitt, Brian and Dunn, Graham "Principal Components Analysis" in *Applied Multivariate Data Analysis*, London: Arnold, 2001. Chapter 3.

More difficult: Fisher, Lloyd D., and Van Belle, Gerald, "Principal Component Analysis and Factor Analysis, pp. 692-762 in their *Biostatistics: A Methodology for the Health Sciences,* New York, Wiley, 1993.

Johnson, Richard A., and Wichern, Dean W. "Chapter 8: Principal Components Analysis," and "chapter 9 : Factor Analysis and Inference for Structured Covariance Matrices," in their *Applied Multivariate Statistical Analysis*, 2nd Edition, Englewood Cliffs, New Jersey, Prentice Hall, 1988.

Long, J.S. *Confirmatory Factor Analysis: A Preface to LISREL.* Beverly Hills, Sage, 1983.

Muthen, B. (1984). A general structural equation model with dichotomous, ordered categorical, and continuous latent variable indicators. Psychometrika, 49, 115-132.

Eaton, W. W., & Bohrnstedt, G. W. (Editors). (1989). *Latent variable models for dichotomous outcomes: Analysis of data from the NIMH Epidemiologic Catchment Area Program.* Newbury Park: Sociological Methods and Research, Special Issue; Sage Publications, Inc

After this class students will be able to:

- Use the statistical procedure of rotation to aid in the interpretation of results from a factor analysis
- Be able to apply both orthogonal and oblique rotations and identify the assumptions underlying each
- Apply the appropriate method of estimation for factor analysis

---

Wednesday, October 4: ***Factor Analysis III: Journal Examples*** (Liz)

Readings: Shapiro, Lasarev, McCauley. (2002) Factor Analysis of Gulf War Illness: What does it add to our understanding of possible health effects of deployment. American Journal of Epidemiology, v. 156, pg. 578-585.

Lakka, Laaksonen, Lakka, Niskanen, Kumpausalo, Tuomilehto, Salonen. (2002). The Metabolic Syndrome and Total and Cardiovascular Disease Mortality in Middle-Aged Men. JAMA, v. 288, pg. 2709-2716.

Hoodin, Kalbfleisch. (2003) Factor analysis and validity of the Transplant Evaluation Rating Scale in a large bone marrow transplant sample. Journal of Psychosomatic Research, v. 54, pg. 465-473.

Costa, P.T., and McCrae, R.R. "Four ways five factors are basic," in *Personality and Individual Differences*, 13, 653-665, 1992.

In this class students will:

- Apply factor analysis to real data
- Critique published use of factor analysis

Monday, October 9: ***Latent Class Analysis I*** (Liz)
The latent class model
The response pattern matrix
Choosing the number of classes
Conditional probabilities
Interpreting the model
Examples: depression; functioning

Reading: McCutcheon, A. *Latent Class Analysis*, Newbury Park, Sage, 1987; chapters 1 & 2.

Additional reading:

Easier: see http://ourworld.compuserve.com/homepages/jsuebersax/faq.htm

After this class students will be able to:

- Differentiate when to use factor analysis and when to use latent class analysis
- Interpret output from a latent class analysis

Wednesday, October 11: ***Latent Class Analysis II*** (Liz)
Statistical model and assumptions
Exploration: response patterns
Issues of model fitting
Identifiability

Checking the model: tests and displays

Reading: McCutcheon, A, *Latent Class Analysis*, Newbury Park, Sage, 1987; Chapter 3.

After this class students will be able to:

- Estimate a latent class analysis
- To interpret different criterion to choose among alternative models

---

Monday, October 16: ***Latent Class: Examples in Journals*** (Jeannie)

Reading: Nestadt, Addington, Samuels, Liang, Bienvenu, Riddle, Grados, Hoehn-Saric, Cullen (2003) The Identification of OCD-Related Subgroups Based on Comorbidity. Biological Psychiatry, v. 53, pg. 914-920.

Eaton WW, Dryman A, Sorenson A, McCutcheon A. (1989) DSM-III Major Depressive Disorder in the Community. A Latent Class Analysis of Data from the NIMH Epidemiologic Catchment Area Programme. *British Journal of Psychiatry (155)48-54.*

Sullivan PF, Kessler RC, Kendler KS (1998) Latent Class Analysis of Lifetime Depressive Symptoms in the National Comorbidity Survey. *Am J Psychiatry (155)1397:1406.*

Reboussin BA, Song E-Y, Shrestha A, Lohman KK, Wolfson M. (2006) A latent class analysis of underage problem drinking : Evidence from a community sample of 16-20 year olds. *Drug and Alcohol Dependence (83):199-209.*

In this class students will:

Apply latent class analysis to real data
Critique published use of latent class analysis

Wednesday, October 18: ***Sample Size in Reliability and Factor Analysis*** (Liz)

Reading: MacCallum, Robert C., Keith F. Widaman, Shaobo Zhang, and Sehee Hong. 1999. "Sample Size in Factor Analysis." Psychological Methods 4:84-99.

After this class students will be able to:

- Estimate the sample size needed to for scales with targeted reliability levels
- Estimate the sample size needed for pilot studies that will use factor analysis.
- Understand issues involved with sample size in latent class analysis.

Monday, October 23: ***Review of Course*** (Jeannie, Liz, & Bill)

Wednesday, October 25: ***In-Class final exam***