Measurement and Latent Trait Models
L32 539

CLASS MEETING	OFFICE HOURS
Friday	Tuesday: 9:00 AM - 11:00 AM
11:00 AM - 1:00 PM	and by appointment
Seigle Hall 205	Seigle Hall 243

Instructor Information

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Course Description

This class is an advanced quantitative methods course in which we will derive, fit, and analyze latent variable models commonly used in social science research. The ultimate goal is to give students the requisite skills and knowledge to apply these models in their own research. The course will focus on building foundational skills needed to engage contemporary measurement models and estimation techniques. In addition, the course will survey prominent and promising models in the political science, statistics, and psychology literatures.

Prerequisites

Students are expected to have previously taken a graduate level course in linear models and maximum likelihood. Students should also be comfortable with the basics elements of matrix algebra. It is desirable (although not required) that students also have some background in the Bayesian approach to statistical inference.

Learning objectives

By the end of this course, you will able to:

- Validate a proposed measure;
- Explain the difference between prominent approaches to estimating latent traits;
- Fit factor models for categorical and continuous latent traits; using continuos, dichotomous, polytomous, and mixed indicators;
- Research and explain more advanced measurement models in the literature; and,
- Estimate and present a measurement model **of theoretical interest**.

Plan of the course

The basic outline of the course is divided into three components. We will begin by exploring basic concepts in theories of measurement validity. In this initial period, we will also review some needed concepts from matrix algebra and statistical inference. The bulk of the course will be spent analyzing and applying latent trait and latent class models using different types of observed indicators including continuous, dichotomous, and categorical data. During this period, students will also present overviews of more advanced methods in the literature. In the final unit, students will present the results of their own empirical analysis to the class.

Textbooks

In addition to assigned readings that will be posted on Blackboard, the following books are required and can be purchased at the bookstore.

David Bartholomew, Martin Knott, and Irini Moustaki. 2011 *Latent Variable Models and Factor Analysis: A Unified Approach, 3rd edition*. John Wiley and Sons, Ltd.
David A. Harvill. 1997. *Matrix Algebra From a Statistician's Perspective*. Springer.
Timothy A Brown. 2006. *Confirmatory Factor Analysis for Applied Research*. Guilford Press.

Academic Honesty

Cheating and plagiarism will not be tolerated. All students are expected to adhere to high standards of academic integrity. In this class especially, that means that all work presented as original must, in fact, be original, and the ideas and contributions of others must always be appropriately acknowledged. Quotations must, of course, be acknowledged, but so must summaries, paraphrases, and the ideas of others. If you have any doubts or questions about documentation requirements, **please ask me**. Don't guess.

Religious observances

Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me before the end of the second week of the term to discuss appropriate accommodations.

Students with disabilities

Students with disabilities enrolled in this course who may need disability-related classroom accommodations are encouraged to make an appointment to see me before the end of the second week of the term.

Late assignments – don't do it

Late assignments will not be accepted and no incompletes will be given for assignments or the course. Exceptions will be granted only under truly extraordinary circumstances at the request of your Director of Graduate Studies. This means that *you need to plan ahead*. When in doubt, turn your assignment in early. Late assignments will not be allowed due to delayed flights, midterms in other classes, etc.

Requirements and Evaluation

Grading in this class will be based on the components described below.

Take home exam – 20%

There will be a take home exam due at the end of the class.

Final paper and presentation – 30%

In consultation with me, students will choose a research project on which to apply an advanced measurement model presented or discussed in class. The data and research question must be selected in consultation with a faculty member in the student's own department. Preliminary research plans including a topic and summary statistics of the dataset will be due after Spring Break. First drafts of the paper are due to me two weeks before the scheduled presentation. Final drafts will be due on the date of the scheduled final.

In-class presentations – 20%

During the semester, students will be asked to research and explain more advanced measurement models. These models will be chosen in consultation with me, and don't show up in my office two days before the presentations are due. Presentations should be approximately 20-30 minutes, and must include at least one application of the method from the political science literature. Outstanding presentations will include fitted results from your own analysis along with practical advice for students seeking to fit the model.

Problem sets – 30%

There will be a problem set due for every class period through 4/5.

Grading scale

The course is graded on the 10 point scale below. There will be no exceptions. Don't ask.

Score	Grade	Score	Grade	Score	Grade	Score	Grade
$\geq$94	A	$\geq$83	B	$\geq$ 73	C	$\geq$63	D
$\geq$90	A-	$\geq$80	B-	$\geq$ 70	C-	$\geq$60	D-
$\geq$87	B+	$\geq$77	C+	$\geq$ 67	D+	$<$60	Fail

Teaching Assistants

There is one graduate teaching assistant who is available to help with problem sets.

Constanza F. Schibber
Email: cfiguero@wustl.edu
Office Hours: Wednesday from 10:00 AM - 12:00 Noon
Office: Seigle 256

Software

The class has no official statistical package, and students may use any statistical software that allows them to complete the homework. I will focus on teaching the R statistical package (`http://www.r-project.org/`), JAGS (`http://mcmc-jags.sourceforge.net/`), and MPlus (`http://www.statmodel.com/`). The latter is quite expensive and I will not require you purchase it. But if you are not confident in your own programming skills in the other programs, MPlus is going to make this class a lot easier.

Flexibility and self-motivation will be required by students. We will try to provide some guidance, but there is no way to figure out how to fit models other than to fit them.

Tentative Schedule

Session #	Date	Topic
1	1/18	Introduction/Basic measurement concepts
2	1/25	Matrix algebra refresh
3	2/1	The general linear factor model
4	2/8	The normal linear factor mode
5	2 /15	Confirmatory factor analysis
6	2/22	Dimensionality, model fit, and model comparison
7	3/1	Dichotomous indicators
8	3/8	Ordered categorical indictors
–	3/11	Spring Break!
9	3/22	MTMM†, multiple groups†, and MIMIC†
10	3/29	Latent class analysis† & Mixture models †
11	4/5	Martin & Quinn/ Computerized Adaptive Testing
–	4/11	Class Cancelled (MPSA)
12	4/19	Mixed indicator models† & PCA & Students' choice †
13	4/26	Student presentations
TBD	Take home exam due	

† Topic will be assigned to a student for presentation

Assigned Readings

1 Handbook of political methodology: Goertz, Jackman, Poole

2 Harville: Chapters 4, 5, 6, 8, 12, 21

3 BKM: Chapters 1-2

4 BKM: Chapter 3; Brown Chapters 1-2

5 Brown: Chapters 3-4; BKM Chapters 3 & 8

6 Brown: Chapter 5; Crespin & Rohde (2010); Roberts, Smith, and Haptonstahl (2009)

7 BKM: Chapter 4; Clinton, Jackman, Rivers (2004); Bafumi, Gelman, Park, and Kaplan (2005)

8 BKM: Chapter 5; Jackman and Treier (2008)

9 Brown: Chapters 6 & 7; Freeze & Montgomery (Unpublished); Perez (2011)

10 BKM: Chapter 6; TBD

11 Martin & Quinn (2002); Montgomery & Cutler (Forthcoming)

12 Quinn (2004); BKM: Chapter 9; TBD

Suggested research topics

More advanced topics that students may research include

- Missing data
- Cluster analysis
- Dynamic factor analysis
- Growth models
- Anchoring & Bridging
- Semi-parametric IRT
- BMA factor analysis
- Topic models
- Hierarchical IRT
- Network positions/community detection