

Psychology 454: Psychological Measurement

An introduction to latent variable modeling

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March 7, 2007

1 Objectives

To understand the fundamental concepts in latent variable modeling in order to make you a better consumer and producer of latent variable models in your research.

To understand how to evaluate the quality of models when applied to data by understanding various sources of variability of goodness of fit tests.

To learn how to apply these concepts to real data sets using a variety of standard statistical packages (e.g., R, Mx, EQS, Lisrel, Prelis, Amos)

2 Text, readings, and requirements

2.1 Text

Loehlin, J. C. Latent Variable Models (4th ed). Lawrence Erlbaum Associates, Mahwah, N.J. 2004

2.2 Readings

Multiple web based readings including, but not limited to:

Syllabus and handouts available at <http://personality-project.org/revelle/syllabi/454/454.syllabus.pdf>

2.3 Requirements

Some basic knowledge of psychometric theory (to be reviewed in week 1). This course is a natural sequel to [Psychology 405: Psychometric Theory](#). Some of the web readings will be taken from the 405 syllabus.

Familiarity with matrix algebra (to be reviewed in week 1)

Willingness to use computer packages that allow for structural equation modeling. These can either be downloaded to your computer (e.g. the open source packages R, and Mx), run on the Social Science Computer Cluster (e.g., Lisrel or Prelis), or ones that you have a license for (e.g., EQS)

Willingness to ask questions and add to the class discussion.

2.4 Evaluation

Homework assignments will be given weekly. These are your benefit and will be graded on a completed, not completed basis.

Students will be expected to write a short paper demonstrating the use of structural equation techniques applied to their particular research interests.

3 Outline (to be added to frequently – keep checking)

| Week | Topic | Reading | Lecture Notes | Homework |
|------|--|--|--|--|
| 1 | Review Correlation/Regression Reliability Matrix Algebra | Loehlin Chapter 1 | Correlation and Regression Matrix Algebra Introduction to R Using the SSCC inverse of a matrix. | Problem set 1 Exercises from Loehlin 1-12 (page 32-34) |
| 2 | Basic Model fitting | Loehlin Chapter 2 | Path models Model fitting Using R | Problem set 2 |
| 3 | Simple models | Loehlin Chapter 3 | OLS/WLS/MLE Simulating structural data. | Problem set 3 |
| 4 | Exploratory FA | Loehlin Chapter 5 Hierarchical factor models | EFA/CFA | Problem set 4 |
| 5 | EFA (continued) | Loehlin Chapter 6 | EFA/CFA continued | Problem set 5 |
| 6 | CFA Multiple Groups | Loehlin Chapter 4 R and LISREL | R and LISREL | Problem set 6 |
| 7 | | Loehlin Chapter Scale and Item quality | Problems with Items Item characteristics | Problem set 8 |
| 8 | Goodness of Fit Evaluating Alternatives | Loehlin Chapter 7 Comparing models | lecture notes. | Problem set 7 |
| 9 | Goodness of Fit Evaluating Alternatives | Loehlin Chapter 7 Comparing models | lecture notes. | Problem set 7 |

4 Detailed Notes

4.1 Week 1

Introduction to latent variables

Review of correlation, regression, and classical reliability theory

Review of matrix algebra ([Appendix 1](#)) See also John Fox's [review of matrices](#).

4.2 Week 2

Application of matrix algebra to pattern and structure Finding the [inverse of a matrix](#).

4.3 Week 3

Structural models and goodness of fit tests. Examples with simulated data.

[How to simulate structural data](#). This has been revised with a correction for two factor simulations and with a more extensive analysis of the effects of sample size on estimating parameters in the two factor model.

4.4 Week 4

[Analysis of hierarchical factor models](#) using hierarchical and bifactor solutions. The lecture notes for week 4 are [here](#).

4.5 Week 5

Exploratory and confirmatory factor analysis, continued. [Lecture notes for week 5](#).

4.6 Week 6

Comparing sem in [R and LISREL](#). Consideration of goodness of fit tests ([Barratt et al., 2007](#)) (Click on Issue 5 in the left had column). [R and LISREL lecture notes](#).

4.7 Week 7

Most personality and affective measures are made up of items rather than scales. Thus, we need to examine the problem of [scale and item quality](#). [Item characteristics lecture notes](#).

4.8 Week 8

What happens if we misspecify a model? What happens if we do not include the right variables or do not include the right paths. [Comparing models](#). [Comparing models lecture notes](#).

4.9 Week 9

What do the various goodness of fit statistics measuring. (The notes and readings are the same as last week, but have been updated) [Comparing models](#). [Comparing models lecture notes](#).

4.10 R advice

The [R tutorial](#) gives a short introduction to the use of R. However, it is not very helpful for the applied problem of how to actually get the [psych](#) package to work! Katherina H. has supplied the following advice:

- (For Macs)
 - From the “Packages and Data” menu, select “Package Installer”
 - Select “other repository” and enter the url <http://personality-project.org/r>
 - Uncheck the binary format box

- A window will report your installed version and what is available at the repository. Select psych.
- “Install selected” (and wait while it does so).
- (For PCs only)
 - Find the psych.zip file at: <http://www.personality-project.org/r/src/contrib> and download it (“psych.zip”) to your PC.
 - Go to the “Packages” menu in RGui, and select, “Install package(s) from local zip files”.
 - Select the psych.zip file.
 - R should now add to the R console:


```
> utils::menuInstallLocal() updating HTML package descriptions
```
- (Macs and PCs) For this, or any other package to work, you must activate it by either using the Package Manager or the “library” command:
 - e.g., library(psych) or library(sem)
 - If loading the psych package works, function such as “describe” and “pairs.panels” should work (or at least give an error message that is NOT “could not find function”).
 - entering ?psych will give a list of the functions available in the psych package as well as an overview of their functionality.
 - objects(“package:psych”) will list the functions available in a package (in this case, psych).

4.11 Using the Social Science Computer Cluster

1. Get [an account](#) and then to log in as a remote user.
2. Log on to the system using SSH (see the [“how to”](#) for doing this)
3. upload the appropriate batch command file using a [sftp connection](#).
4. Issue a batch command (e.g., lisrel8 infile outfile)
5. sftp the outfile back to your desktop
6. repeat (3-5) until satisfied

4.12 Student versions of LISREL

If you don’t want to use the SSCC, you can download a [student version](#) of LISREL from Scientific Software for either a PC or a (non intel) Mac.

4.13 R for SPSS/SAS users

A very thorough document designed to help users of SPSS or SAS understand the joys of R is available from Bob Muenchen at the University of Tennessee [R for SAS and SPSS – pdf version](#) or [R for SAS and SPSS – html version](#)

5 References

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

Barratt, P. (2007) Structural equation modeling: Adjudging model fit. *Personality and Individual Differences*, 815-824. (Available for NU accounts at <http://www.sciencedirect.com/science/journal/01918869>)

Loehlin, J. C. (2004) *Latent Variable Models* (4th ed). Lawrence Erlbaum Associates, Mahwah, N.J.

Rakov, T. & Marcoulides, G.A. (2006), *A first course in structural equation modeling*, 2nd Edition; Mahwah, N.J; Erlbaum