



Structural Equation Modeling
6–11 July 2015

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Seminar Web Site and Computer Tools

There is a web page for this seminar at

<http://psychology.concordia.ca/fac/kline/sem/istql.html>

Participants can freely download this course outline, slides for all lectures, computer output for selected examples, and the articles for the seminar listed below.

Two computer practice sessions use the student version of LISREL 9.1 for Windows platform computers. It can be freely downloaded from

<http://www.ssicentral.com/lisrel/student.html>

The Onyx graphical SEM computer program will be demonstrated. It runs under the Java Runtime Environment (version 1.6 or later) on Windows, Macintosh, or Linux platform computers and can be freely downloaded from

<http://onyx.brandmaier.de/>

It is recommended that you download course materials and computer programs before you arrive at the seminar.



Content and Objectives

This six-day seminar deals with the principles, assumptions, strengths, limitations, and applications of structural equation modeling (SEM). Basic SEM techniques, including path analysis, confirmatory factor analysis (CFA), and full “LISREL,” or structural regression (SR), models are covered. Some familiarity with basic statistical techniques, such as multiple regression and exploratory factor analysis, is assumed, but higher levels of quantitative knowledge are not required. The presentation of topics will be conceptually rather than mathematically oriented, and examples of the application of SEM to different kinds of actual research problems are considered. Participants can freely download this course outline, lecture slides, computer output for selected examples, and the articles listed next.



Main Source

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). New York: Guilford Press. (Book resource site for 3rd edition at <http://www.guilford.com/kline>)

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Other Readings (Seminar Web Site)

- Hoyt, W. T., Leierer, S., & Millington, M. J. (2006). Analysis and interpretation of findings using multiple regression techniques. *Rehabilitation Counseling Bulletin, 49*, 223–233.
- Lei, P.-W., & Wu, Q. (2007). Introduction to structural equation modeling: Issues and practical considerations. *Educational Measurement: Issues and Practice, 26*(3), 33–43.
- MacCallum, R. C., & Austin, J. T. (2000). Applications of structural equation modeling in psychological research. *Annual Review of Psychology, 51*, 201–226.
- McCoach, D. B., Black, A. C., & O'Connell, A. A. (2007). Errors of inference in structural equation modeling. *Psychology in the Schools, 44*, 461–470.
- Narayanan, A. (2012). A review of eight software packages for structural equation modeling. *American Statistician, 66*, 129–138.
- Sava, F. A. (2002). Causes and effects of teacher conflict-inducing attitudes towards pupils: A path analysis model. *Teaching and Teacher Education, 18*, 1007–1021.
- Shah, R., & Goldstein, S. M. (2006). Use of structural equation modeling in operations management research: Looking back and forward. *Journal of Operations Management, 24*, 148–169.



Daily Schedule

Morning

9:30–11:00am	Session 1
11:00–11:15am	Break
11:15am–12:30pm	Session 2
12:30–2:30pm	Lunch

Afternoon

2:30–4:00pm	Session 3
4:00–4:15pm	Break
4:15–5:30pm	Session 4



Topics and Schedule

- Jul 6 (M) Seminar overview, smart modeling, background statistical concepts, data and models
Hoyt et al. (2006)
- Jul 7 (T) Introduction to path analysis and path models, estimation basics
Lei & Wu (2007)
- Jul 8 (W) Assessing model fit, hypothesis testing in SEM
McCoach et al. (2007)
Computer exercise 1 (2:30pm)
- Jul 9 (Th) Comparing alternative models, equivalent models
MacCallum & Austin (2000), Shah & Goldstein (2006)
Computer exercise 2 (2:30pm)
- Jul 10 (F) Introduction to CFA, analyzing nonnormal indicators
Narayanan (2012), Sava (2002)
Computer exercise 3 (2:30pm)
- Jul 11 (S) Introduction to SR models, reflective versus formative measurement
Narayanan (2012), Sava (2002)



Computer Exercises

The computer practice component of the seminar has three exercises. These exercises will be easier if your computer shows file names with extensions. In Windows, go to Folder Options, select the View tab, and then uncheck the box "Hide extensions for known file types," if already checked.

Exercise 1. LISREL Syntax Analysis

Variable names in LISREL are case sensitive and limited to 8 characters in length. Syntax is executed by clicking on the Run LISREL icon, or . If the analysis is successful, displayed in the Path Diagram window is

Chi-Square=11.11, df=5, P-value=0.04929, RMSEA=0.057

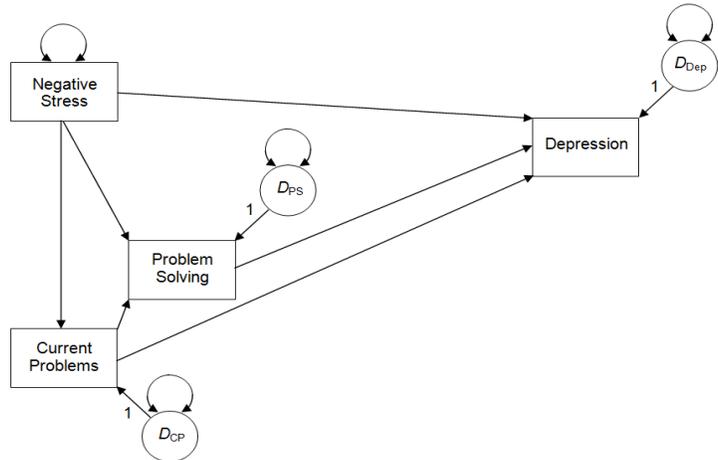
1. Create a new SIMPLIS syntax file: select File | New | Syntax Only, and then save the file as roth.spl

2. Study the syntax listed next for the example path model:

```

four-variable example
observed variables
neg_str cur_prob prob_sol depress
covariance matrix
76.913
55.668 249.324
33.757 115.685 478.297
21.775 53.614 60.695 37.700
sample size is 205
relationships
cur_prob = neg_str
prob_sol = neg_str cur_prob
depress = neg_str cur_prob prob_sol
LISREL output: ND = 3 SC RS MI
path diagram
end of problem

```

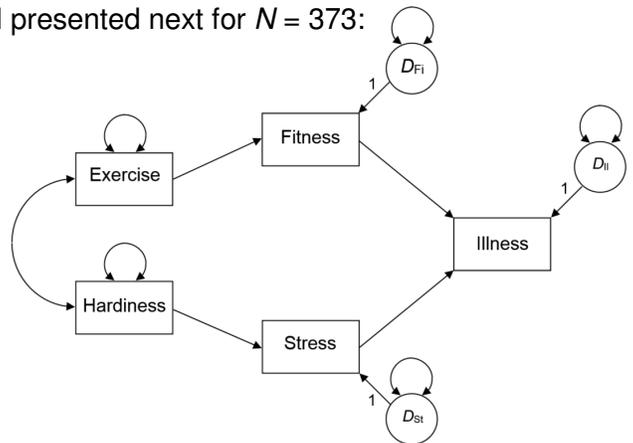


3. Adapt the syntax just shown for the data and model presented next for $N = 373$:

```

exercise, hardy, fitness, stress, illness
4422.250
-75.810 1444.000
477.204 48.944 338.560
-111.388 -292.790 -80.132 1122.250
-332.394 -379.878 -333.393 711.647 3903.750

```



Exercise 2. LISREL Path Diagram Editor

1. Save just the covariances from exercise 1 in the text file `roth.cov`
2. Create a new path diagram: select File | New | Path Diagram, and then save the diagram as `roth.pth`
3. These steps will be demonstrated in class, but you can try them on your own: Use the Setup menu to specify the data file, variable names, and sample size before drawing the model onscreen. Check the boxes for the endogenous variables (Observed Y) before dragging and dropping the observed variables from the list to the drawing palette. Select View | Toolbars | Drawing Bar to display the shape tools, if not already visible.
4. When the diagram is finished, select Setup | Build SIMPLIS syntax, and then run it.

Exercise 3. Onyx Demonstration

1. Type the covariance matrix exactly as listed next. *Separate the variable names using the Tab key.* Save the matrix in the text file `roth-onyx.cov`

```
COVARIANCE
4422.250
  -75.810 1444.000
  477.204  48.944  338.560
-111.388 -292.790  -80.132 1122.250
-332.394 -379.878 -333.393  711.647 3903.750
SAMPLE SIZE
373
OBSERVED VARIABLES
exercise    hardy fitness    stress    illness
```

2. The analysis of the Roth path model and data in Onyx will be demonstrated in class.