Intra-individual Networks and Latent Variable Models

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Latent Variable Modeling and Network Modeling

- How does one framework relate to the other?
- Can the frameworks be combined?
- Can you statistically compare between these frameworks?
Model Equivalence

Now well known for both network models for continuous data and network models for binary data: a unidimensional latent variable model is equivalent to a fully connected network.


Fundamental rule of network psychometrics

Clusters in network = latent variables

Consequences of Equivalence

- A single latent common cause leads to a fully connected network with only positive edges (after recoding reverse items)
- No statistical way to compare between these models
  - You can compare statistically between a sparse network and a latent variable model!
- Clusters in a network may be indicative of latent variables, or clusters in a network is what leads to latent variable models fitting!
- Estimating a network with many edges does not provide evidence against the latent variable model
RESEARCH ARTICLE

Estimating psychopathological networks: Be careful what you wish for

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Abstract

Network models, in which psychopathological disorders are conceptualized as a complex interplay of psychological and biological components, have become increasingly popular in the recent psychopathological literature (Borsboom, et. al., 2011). These network models often contain significant numbers of unknown parameters, yet the sample sizes available in psychological research are limited. As such, general assumptions about the true network are introduced to reduce the number of free parameters. Incorporating these assumptions, however, means that the resulting network will lead to reflect the particular structure assumed by the estimation method—a crucial and often ignored aspect of psychopathological networks. For example, observing a sparse structure and simultaneously assuming a sparse structure does not imply that the true model is, in fact, sparse. To illustrate this point, we discuss recent literature and show the effect of the assumption of sparsity in three simulation studies.
Time-series data

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- Arguments against estimating networks from cross-sectional data
  - Relationships may not generalize to within-person level
  - Relationships should unfold over time
**Temporal effects**

- The temporal network shows that one variable predicts another variable in the next measurement occasion.
- *Granger causality*
The contemporaneous network shows that two variables predict one-another after taking temporal information into account.
- Contains effects faster than the time-window of measurement
  - Somatic arousal $\rightarrow$ anticipation of panic attack $\rightarrow$ anxiety
Personalized Networks in Clinical Practice

- Contemporaneous network: conditional concentration given $t - 1$
- Temporal network: regression coefficients between $t - 1$ and $t$
What if data were caused by a dynamical factor model?
Figure by Ellen Hamaker.
Example: all loadings $\sim U(0.5, 1)$, residual variances $\sim U(0.5, 1)$, autocorrelation $= 0.5$ and innovation variance $= 1$. 
Model Equivalence

A dynamical factor model implies fully connected positive (after rescoring variables) contemporaneous and temporal networks!
Estimated using two-step multi-level VAR (mlVAR). Data from:


On the equivalence between lag-1 dynamic factor modeling and graphical vector auto-regression

Sacha Epskamp & Riet van Bork

Work in progress...
Generalized Network Psychometrics

Augment Structural Equation Models (SEM) by modeling either the residuals or latent covariances as a Gaussian Graphical model (GGM):
Residual Network Modeling (RNM)

- Network is formed at the residuals of SEM
- Model a network while not assuming no unobserved common causes
- Model a latent variable structure without the assumption of local independence
Latent Network Modeling (LNM)

- Models conditional independence relations between latent variables as a network
- Model networks between latent variables
- Exploratory search for conditional independence relationships between latents
Generalized Network Psychometrics: Combining Network and Latent Variable Models

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Conclusion

- While network models originated as alternatives to latent variable modeling, the two frameworks are closely related
  - A unidimensional latent variable model is equivalent to a fully connected network
- This is also true for intra-individual VAR networks
  - An edge in the temporal network can easily occur due to a auto-correlated latent common cause
- Network models and latent variable models can also be combined
  - Residual network modeling
  - Latent network modeling
Thank you for your attention!