Meeting of the SEM Working Group
15 and 16 March 2018
Amsterdam

Venue

CREA Muziekzaal
Nieuwe Achtergracht 170
1018 WV Amsterdam
www.crea.uva.nl

Directions

CREA is situated in a car-free area and there is very limited parking space close to CREA. There are many spaces to park your bike, however, and there is good connection with public transport. The closest subway station is Weesperplein; the subway is most convenient for traveling from north to south(east). The closest tram stop is 's Gravesandestraat; the tram is most convenient for traveling from east to west.

From Schiphol:

Take the train to Central station. See directions subway.

By subway:

Take the subway to Weesperplein (third stop from Central Station). Follow the signs to exit 'Roetersstraat' to ground level and turn right, into the Valckeniersstraat. When you arrive at the Roetersstraat, cross the street and walk on the right side of the canal towards to UvA building. Walk past the entrance of the UvA building and in about 50 meters you will see the CREA entrance on the right.

By tram:

Take tram 7 or tram 10 to the 's Gravesandestraat. Walk to the Sarphatistraat, direction west. Near the Albert Heijn (Sarphatistraat 141K) is a small car-free street (Pancrasstraat). Walk into this street and you will see the back of the CREA building. Walk towards the canal, go left when you reach the canal and you will see the CREA entrance on the left.

Contact information local organizer

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Co-organizers

Suzanne Jak
Terrence Jorgensen
Laura Kolbe
Kees Jan Kan
Frans Oort

Social Program

Conference dinner:

- Thursday March 15, 7pm
- Venue: Café de Brakke Grond, Nes 43 1012 KD Amsterdam (www.brakkegrond.nl)
- Fixed price: 50 euro (includes 3-course menu, including beer, wine, water, coffee/tea)
- If you wish to join: please send an email to m.g.e.verdam@uva.nl (before March 10); you will be asked to pay (in cash) when you arrive at the conference.

List of Hotels

Hotel Casa 400
https://hotelcasa.nl/

Fletcher Hotel
https://www.fletcherhotelamsterdam.nl/en/

Hampshire Hotel
https://www.hampshire-hotels.com/hampshire-hotel-lancaster-amsterdam

Hotel Plantage
http://plantage.hoteleamsterdam.net/

NH Hotel
https://www.nh-hotels.com/hotels/amsterdam

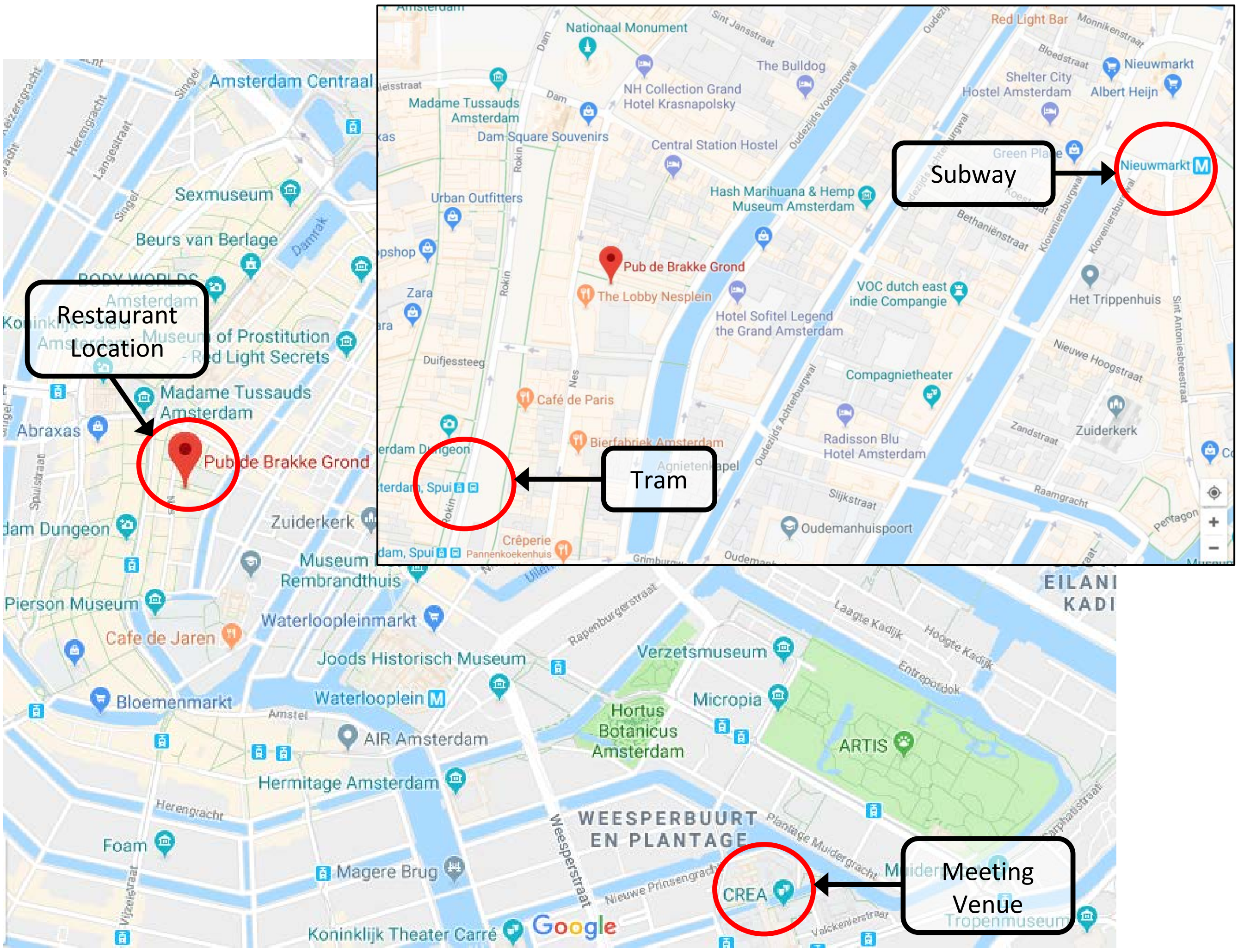
Hotel Résidence Le Coin
https://www.nh-hotels.com/hotels/amsterdam

Volks Hotel
http://www.volkshotel.nl/en/hotel/

Student Hotel
https://www.thestudenthotel.com/amsterdam-city/

City Plan


Subway
Tram
CREA
University cultural
center, with theater
Amsterdam Center for
Entrepreneurship (ACE)
Mercurius
UvA Talen BV
Muiderpoort
Tropenmuseum
Weesperplein
Hotel Arena
Generator Hostels
Plantage Middenlaan
Plantage Muidergracht
Nieuwe Prinsengracht
Nieuwe Kerkstraat
Nieuwe Keizersgracht
Valckenierstraat
Sarphatistraat
Spinozastraat
Spinozahof
Alexanderkade
Kazernestraat


Restaurant
Location
Subway
Tram
Meeting
Venue
Pub de Brakke Grond
Nieuwmarkt
CREA
Amsterdam Centraal
Sexmuseum
Beurs van Berlage
Madame Tussauds
Amsterdam
Abraxas
Zuiderkerk
Museum
Rembrandthuis
Pierson Museum
Cafe de Jaren
Waterloopleinmarkt
Joods Historisch Museum
Waterlooplein
Bloemenmarkt
AIR Amsterdam
Hermitage Amsterdam
Foam
Magere Brug
Koninklijk Theater Carré
Verzetsmuseum
Micropia
Hortus
Botanicus
Amsterdam
ARTIS
WEESPERBUURT
EN PLANTAGE
Nationaal Monument
NH Collection Grand
Hotel Krasnapolsky
The Bulldog
Dam Square Souvenirs
Central Station Hostel
Urban Outfitters
Hash Marihuana & Hemp
Museum Amsterdam
The Lobby Nesplein
VOC dutch east
indie Compagnie
Hotel Sofitel Legend
the Grand Amsterdam
Het Trippenhuis
Compagnietheater
Café de Paris
Radisson Blu
Hotel Amsterdam
Oudemanhuispoort
Crêperie
Shelter City
Hostel Amsterdam
Albert Heijn

Timetable Meeting SEM Working Group Thursday March 15

Time	Title & Presenter
12.30-13.00	Registration
13.00-13.10	*Mathilde Verdam, University of Amsterdam*
	Welcome
13.10-13.35	*Todd Little, Texas Tech University*
	On the Merits of Parceling
13.35-14.00	*Fan Yang Wallentin, Uppsala University*
	Nonlinear Structural Equation Modelling Using H-likelihood
14.00-14.25	*Suzanne Jak, University of Amsterdam*
	The Influence of Cross-level Invariance Constraints When Testing Multilevel Mediation Using SEM
14.25-14.50	*Dylan Molenaar, University of Amsterdam*
	On the Problem of Spurious Non-Linear Effects in Aggregated Scores: Investigating Differentiation of Cognitive Abilities using Item Level Data
30 MIN BREAK	
15.20-15.45	*Heiner Meulemann, University of Cologne*
	Makes Religion Happy – Or Makes Happiness Religious? An Analysis of a Three-wave Panel Using and Comparing Discrete and Continuous Time Techniques.
15.45-16.10	*Erik-Jan van Kesteren, Utrecht University*
	Exploratory Mediation Analysis with Many Potential Mediators
16.10-16.35	*Yves Rosseel, Ghent University*
	Why We May Not Need SEM After All
20 MIN BREAK	
16.55-17.20	*Charles Driver, Max Planck Institute for Human Development*
	Understanding the Time Course of Interventions
17.20-17.45	*Rens van de Schoot, Utrecht University*
	Temptation Island: Do You Need Questionable Research Practices to Survive Academia?
17.45-18.15	Meeting of the Working Group
19.00	Conference dinner

Timetable Meeting SEM Working Group Friday March 16

Time	Title & Author
09.30-09.55	*Florian Schuberth, University of Twente* Confirmatory Composite Analysis
09.55-10.20	*Ed Merkle, University of Missouri* Bayesian SEM in Blavaan: Estimation and Model Comparison Results
10.20-10.45	*Sara van Erp, Tilburg University* Prior Sensitivity Analysis in Default Bayesian Structural Equation Modeling
10.45-11.10	*Piotr Tarka, Poznan University of Economics and Business* Discussion over the Effects of Big Data Trend on Structural Equation Modeling
30 MIN BREAK	
11.40-12.05	*Niels Smits, University of Amsterdam* On the Use of the Factor Model for the Construction of Tests Aimed at Prediction
12.05-12.30	*Artur Pokropek, Polish Academy of Science and EC Joint Research Centre* Challenging Partial, Approximate and Partial Approximate Measurement Invariance. A Monte Carlo Simulation Study
12.30-12.55	*Maksim Rudnev, University Institute of Lisbon* Measurement Invariance Explorer – Shiny Application
LUNCH	
13.55-14.20	*Kees Jan Kan, University of Amsterdam* Three Applications of Structural Equation Modeling as a Handy Tool: A Network Comparison Test, Testing Moderated Mediation, and a Means to Correct for the Effects of Censoring
14.20-14.45	*Mariska Barendse, Ghent University* Multilevel SEM for Ordinal Data in the 'Wide' Format Approach
14.45-15.10	*Rebecca Büchner, Goethe-University Frankfurt* Global Model Fit Test for Nonlinear SEM
20 MIN BREAK	

15.30-15.55	*Harry Garst, University of Amsterdam* Algebraic Expression for Standard Errors in Structural Equation Modeling
15.55-16.20	*Alexandru Agache, Ruhr-University Bochum* Exploring Multicausal Patterns in Sparse Longitudinal Data With Dynamic Fixed Effects SEM Models and Network Analysis
16.20-16.45	*Rosario Scandura, Autonomous University of Barcelona* How Different Education and Training Systems Configure Literacy Skills: A Comparative Analysis of Five OECD Countries Using Structural Equation Modelling
CLOSING	

Abstracts

On the Merits of Parceling

Todd D. Little – Texas Tech University

Parceling is a data pre-processing strategy by which two or more items are averaged to create a new aggregate indicator to use in both exploratory and confirmatory factor models (aka. Latent variable modeling, structural equation modeling). First introduced by Cattell over half a century ago, the practice of parceling has been a hotly debated practice and even earned the moniker "the items versus parcels controversy." In this lecture, I will outline the arguments both pro and con regarding the items versus parcels controversy. I will conclude with why the items versus parcels needn't be one and provide compelling reasons for why parcels are highly preferred.

Nonlinear Structural Equation Modelling Using H-Likelihood

Fan Yang Wallentin – Upssala University

Nonlinear relationship including interaction and quadratic terms between two latent constructs is common in social and behavioral sciences. To model such relations, nonlinear structural equation modelling has attracted many empirical researchers.

Due to the nature of non-normally distributed indicators, various distribution analytic approaches have been proposed. In the current study, we adopt h-likelihood which known for the linear mixed models framework to nonlinear SEM model with interaction and quadratic effects. We preformed simulations to evaluate the behavior of proposed approaches.

The Influence of Cross-Level Invariance Constraints When Testing Multilevel Mediation Using SEM

Suzanne Jak – University of Amsterdam

Preacher, Zyphur & Zhang (2010) presented an integrative two-level SEM framework for testing mediational hypotheses involving observed and latent variables in two-level data. When modeling latent variables at multiple levels, it is important to consider the meaning of the latent variables at the different levels. If a higher-level common factor represents the aggregated version of a lower-level factor, the associated factor loadings will be equal across levels. Preacher et al. did not consider cross-level invariance constraints in their framework. In this study I will evaluate how applying cross-level invariance constraints on factor loadings affects the mediation results. I expect that wrongly applying the constraints leads to biased mediational effects, while wrongly *not* applying the constraints leads to convergence issues.

On the Problem of Spurious Non-Linear Effects in Aggregated Scores: Investigating Differentiation of Cognitive Abilities using Item Level Data

Dylan Molenaar – University of Amsterdam

Differentiation of cognitive abilities occurs if the structure of intelligence changes across a given individual differences variable. Past studies have focused on establishing differentiation with respect to general intelligence, or 'ability differentiation', and differentiation with respect to age, or 'age differentiation' (Spearman, 1927). Typically, these studies focused on differences in the covariance structure of aggregated intelligence subtest scores (i.e., sum scores or factor scores) across groups that differ in age or ability. Results are however rather mixed, showing different effects between studies or even within studies. An important aspect about these mixed results is that the differentiation effect is in essence a non-linear effect (Tucker-Drob, 2009) which makes it challenging to study. That is, as non-linear effects are scale dependent (e.g., Loftus, 1978), the non-linear differentiation effects may show up differently in different subtests due to arbitrary properties of the data (e.g., difficulty of the items, number of the items, scale of the items).

In the present talk, first, the problem of spurious non-linear effects in aggregated scores is illustrated in a small simulation study. Next, a non-linear extension of the discrete factor model (Takane & De Leeuw, 1987) is presented that can be used to test for differentiation but which does not suffer from spurious non-linear effects. Finally, the model is applied to the item level data of the Hungarian standardization data of the WAIS-IV to illustrate the use of the model in practice.

Loftus, G. R. (1978). On interpretation of interactions. *Memory & Cognition*, *6*(3), 312-319.
Spearman, C. E. (1927). The abilities of man: Their nature and measurement. New York:Macmillan.

Takane, Y., & De Leeuw, J. (1987). On the relationship between item response theory and factor analysis of discretized variables. *Psychometrika*, *52*(3), 393-408.

Tucker-Drob, E. M. (2009). Differentiation of cognitive abilities across the life span. *Developmental Psychology, 45*, 1097–1118.

Makes Religion Happy – Or Makes Happiness Religious? An Analysis of a Three-Wave Panel Using and Comparing Discrete and Continuous Time Techniques

Heiner Meulemann – University of Cologne
Johan H.L. Oud – Radboud University

The paper addresses the question of the advantages of continuous time analysis over discrete time analysis in a panel of three waves, which at least are required to apply continuous time analysis. The reciprocal effects of religiosity and life satisfaction are examined in a three wave panel study of German former high school students at age 30, 43, and 56. Religiosity is measured as church attendance and Christian belief such that three measures are followed up over three time points. Analyses by discrete and continuous structural equation modelling are compared. According to both methods, church attendance has the strongest autoregression/auto-effect, followed by Christian worldview, and by life satisfaction; furthermore, all cross-regressions/ cross-effects are slightly negative. The answer to both questions in the title is therefore negative. In contrast to the cross-regressions in the discrete time analysis, the continuous time analysis reveals significance of all negative cross-effects and reverses the order of the strength of the cross-effects between the two dimensions of religiosity. Continuous time analysis also enables to compute and display the complete autoregression and cross-regressions functions as well as the development of means and variances of the three variables across continuous time.

Exploratory Mediation Analysis with Many Potential Mediators

Erik-Jan van Kesteren – Utrecht University
Daniel Oberski – Utrecht University

Mediation analysis is an established procedure for investigating the direct and indirect components of an effect with a single or a few theoretically relevant potential mediators. Recently, technology such as gene sequencing has enabled novel data collection methods yielding theory-sparse, high-dimensional data. Such data provide a large number of potential mediators, which calls for *exploratory* mediation analysis. However, high-dimensional data leads to modelling problems for mediation analysis: (a) classical SEM modelling is unavailable as the full model is unidentified, (b) considering each potential mediator individually is possible but strictly assumes uncorrelated mediators, and (c) a recently introduced regularised SEM method only works when the mediation path is relatively strong.

We introduce a new algorithmic method, the generalised coordinate descent filter (GCDF). This method cyclically applies univariate decisions to the potential mediators, but *conditional* on the set of selected mediators. Although several issues remain to be solved, this method does not fail in boundary cases where the other methods do. This makes it a promising technique for general exploratory mediation analysis.

Why We May Not Need SEM After All

Yves Rosseel – Ghent University
Ines Devlieger – Ghent University

In this presentation, I will argue that in the standard setting, full-fledged structural equation modeling (SEM) using a full information estimator like maximum likelihood (ML), is not needed. In the standard setting I have in mind, the focus of the analysis is on the structural part of the model, and the measurement part of the model is just there to handle measurement error. An alternative approach is to replace the (measured) latent variables by factor scores, and then use regression (or path analysis) using these factor scores as if they were observed. When used in a naive way, this will lead to bias. But using a small correction (known as Croon's correction), we can get unbiased estimates. I will show a few examples of this `factor score regression' approach, and highlight some advantages and disadvantages.

Understanding the Time Course of Interventions

Charles Driver – Max Planck Institute for Human Development

How long does a treatment take to reach maximum effect? Is the effect maintained, does it dissipate, or perhaps even reverse? Do certain sorts of people respond faster or stronger than others? Is the treatment more effective in the long run for those that respond quickly? I describe a SEM based continuous time dynamic modelling approach for considering the potentially complex shape of intervention effects over time, as well as mediation and individual differences in such a context, with examples using the R software ctsem.

Temptation Island: Do You Need Questionable Research Practices to Survive Academia?

Rens van de Schoot – Utrecht University

Science has always been a dynamic process with continuously changing rules and attitudes. While innovation and new knowledge production are essential in academia, making sure the best practices in research are widely known is vital. However, rules and traditions on responsible research practices differ greatly between research disciplines and often different rules apply in different fields. Most of these rules are subjective and in fact 'unwritten' that makes them difficult to identify, differentiate and grasp. The current debate about appropriate scientific practices is fierce and lively and has moved from academia to the public domain, resulting in many public opinions, not solely driven by objective information, but instead loaded by emotions.

The Young Academy of the KNAW (www.dejongeakademie.nl/livingroom/) has started a project titled 'The living room of science: promoting responsible research practices through an interactive discussion'. The ultimate goal of this project is to create an accessible online open platform for early career scientists (ranging from Phd students to young assistant professors) to acquire information about appropriate research practices. We hope that arguments like "this is how we always do it", or "get used to it, this is what it takes to publish your paper" will no longer be used.

The session at the SEM meeting can be seen as a part of this larger project. I will present the results of a vignette study among PhD-students in The Netherlands and Belgium about responsible research practices (carried out in collaboration with PNN). Topics are data fabrication, deleting outliers to get significant effects, salami slicing, gift authorship and excluding information from your paper. During the session we will discuss if within the field of SEM we also struggle with these issues, or maybe not…

Confirmatory Composite Analysis

Florian Schuberth – University of Twente
Jörg Henseler – University of Twente
Theo K. Dijkstra – University of Groningen

We introduce confirmatory composite analysis (CCA) as a structural equation modeling technique that aims at testing composite models. CCA entails the same steps as confirmatory factor analysis: model specification, model identification, model estimation, and model testing. Composite models are specified such that they consist of a set of interrelated theoretical constructs, all of which emerge as linear combinations of observed variables. Researchers must ensure theoretical identification of their specified model. For the estimation of the model, several estimators are available; in particular Kettenring's extensions of canonical correlation analysis provide consistent estimates. Model testing relies on the Bollen-Stine bootstrap to assess the discrepancy between the empirical and the model-implied correlation matrix. A Monte Carlo simulation examines the efficacy of CCA, and demonstrates that CCA is able to detect various forms of model misspecification.

Bayesian SEM in Blavaan: Estimation and Model Comparison Results

Ed Merkle – University of Missouri

In this talk, I will discuss research stemming from the development of R package blavaan. I will first compare JAGS and Stan in the context of SEM, discussing some tricks and timings for each piece of software. Tricks include use of phantom latent variables and matrix manipulations for improving sampling efficiency. Next, I will discuss some issues related to Bayesian SEM information criteria (such as BIC or WAIC), specifically focusing on use of conditional vs marginal likelihoods. All issues and metrics presented in the talk are implemented in blavaan and can potentially be used by other researchers.

Prior Sensitivity Analysis in Default Bayesian Structural Equation Modeling

Sara van Erp – Tilburg University
Joris Mulder – Tilburg University
Daniel L. Oberski – Utrecht University

Bayesian structural equation modeling (BSEM) has recently gained popularity because it enables researchers to fit complex models while solving some of the issues often encountered in classical maximum likelihood (ML) estimation, such as nonconvergence and inadmissible solutions. An important component of any Bayesian analysis is the prior distribution of the unknown model parameters. Often, researchers rely on default priors, which are constructed in an automatic fashion without requiring substantive prior information. However, the prior can have a serious influence on the estimation of the model parameters, which affects the mean squared error (MSE), bias, coverage rates, and quantiles of the estimates.

In this presentation, the performance of three different default priors will be discussed: noninformative improper priors, vague proper priors, and empirical Bayes priors, with the latter

being novel in the BSEM literature. Based on a simulation study, we find that these three default BSEM methods may perform very differently, especially with small samples. A careful prior sensitivity analysis is therefore needed when performing a default BSEM analysis. For this purpose, we provide a practical step-by-step guide for practitioners to conducting a prior sensitivity analysis in default BSEM, which is illustrated using a well-known case study from the structural equation modeling literature.

Discussion over the Effects of Big Data Trend on Structural Equation Modeling (SEM)

Piotr Tarka – Poznan University of Economics and Business

Big Data as socio-economic global trend provides new opportunities, but simultaneously creates many threats for social researchers in many areas, also during the process of Structural Equation Modeling (SEM). In the presentation, author discusses selected influences and consequences of this trend assuming the perspective of two effects which stimulate quality of SEM models. First effect will be discussed in context of the influence of excessively large portion of indicators falling per latent variable(s), while second effect will correspond to large number of observations in datasets. As expected, both effects lead to biased level of the SEM model fit, including misleading values (parameter estimates and standard errors). As a consequence, large scale and complexity in SEM, due to big data (i.e., number of observations and variables) generates unreliable and invalid results. There appears a twofold option for researchers. When regard it, we notice that large data from one hand deploy researchers more closely to reality of the investigated research problems, but on the other hand make the whole process of SEM modeling more cumbersome. These contrasts which arise between rich informational resources and problems associated with optimal modeling of the SEM models are hard to combine. Therefore, the main point of presentation will be a theoretically-based discussion focused on the negative and positive influences of big data trend in reference to SEM modeling, but also discussion over the selected methods allowing to solve methodological problems caused by excessive number of indicators and observations.

On the Use of the Factor Model for the Construction of Tests Aimed at Prediction

Niels Smits – University of Amsterdam
Kees-Jan Kan – University of Amsterdam

Background Two important goals when using questionnaires are (i) measurement: the questionnaire is constructed to assign numerical values that accurately represent the test taker's attribute, and (ii) pre- diction: the questionnaire is constructed to give an accurate forecast of an external criterion. Construction methods aimed at measurement prescribe that items should be reliable. When using factor analysis this leads to items that have high factor loadings, and therefore high inter-item correlations. By contrast, construction methods aimed at prediction typically prescribe that items have a high correlation with the criterion and low inter-item correlations. The latter approach has often been said to produce a paradox concerning the relation between reliability and validity [1; 2; 3], because it is often assumed that good measurement is a prerequisite of good prediction.

Objective To answer four questions: (1) Why are methods based on the factor model suboptimal for questionnaires that are used for prediction? (2) How should one construct aquestionnaire that is used for prediction? (3) Do questionnaire-construction methods that optimize the fit of the factor model and prediction methods lead to the selection of differentitems in the questionnaire? (4) Is it possible to construct a questionnaire that can be used for both measurement and prediction?

Illustrative example An empirical data set consisting of scores of Belgian 1500 adolescents on the Motivation scale of the School Attitude Questionnaire Internet (SAQI) is used to select items by means of two methods: A method that optimizes the predictive value of the scale (i.e., forecast grade point average), and a method that optimizes the reliability of the scale under the one factor model. We show that for the two scales different sets of items are selected, and that a scale constructed to meet the one goal does not show optimal performance with reference to the other goal.

Discussion The answers are: (1) Because Factor analysis-based methods tend to maximize inter-item correlations by which predictive validity reduces. (2) Through selecting items that correlate highly with the criterion and lowly with the remaining items. (3) Yes, these methods may lead to different item selections. (4) For a single questionnaire: Yes, but it is problematic because reliability cannot be estimated accurately; For a test battery: Yes, but it is very costly. Implications for the construction of questionnaires are discussed.

1. H. Gulliksen. *Theory of Mental Tests*. Wiley, New York, 1950.
2. F. M. Lord and M. R. Novick. *Statistical Theories of Mental Test Scores.* Addison-Wesley, Reading, MA, 1968.
3. R. P. McDonald. *Test Theory: A Unified Treatment.* Lawrence Erlbaum, Mahwah, NJ, 1999

Challenging Partial, Approximate and Partial Approximate Measurement Invariance. A Monte Carlo Simulation Study

Artur Pokropek – Polish Academy of Science and EC Joint Research Centre
Peter Schmidt – University of Giessen
Eldad Davidov – University of Cologne and University of Zurich

In comparative analysis measurement invariance (MI, also referred to as measurement equivalence) is a necessary condition to allow meaningful comparisons between groups. However, researchers often experience difficulties in reaching sufficient levels of MI especially scalar invariance as a prerequisite of comparing latent means and composite scores. Several authors have suggested that the requirements of MI testing may be too severe. They proposed less strict ways to test for MI.

One of these proposals suggested testing for partial rather than full MI. According to this method, it is argued that valid comparisons of means or associations across groups can also be made if only a subset of the indicators functions equivalently (Byrne et al. 1989). Another approach and a significant contribution to this discussion proposed by Muthén and Asparouhov (2013) and van der Schoot et al. (2013) suggest testing for approximate rather than exact MI. According to this approach, parameters need not be exactly equal across groups. It is sufficient that item parameters are approximately equal. A third possibility is to combine these two more liberal approaches, that is, test for partial approximate MI, thus allowing for the parameters of some items to be completely non-invariant and requiring others to be only approximately invariant across groups (Muthén and Asparouhov, 2013).

The main aim of this paper is to understand under what conditions partial approximate MI may be sufficient for conducting meaningful comparisons. More specifically, we perform a series of simulation studies to test this proposition. We tested how different models perform under different conditions and levels of MI, how robust they are to the model misspecifications, and to what extent they are able to detect partial and approximate MI.

First results suggest that partial measurement invariance might be well addressed by the traditional exact partial invariance multi-group CFA model, particularly when the scales use a relatively large number of items and when the detection of non-invariant items is effective. Approximate measurement invariance is much more demanding in terms of the mean recovery. Even small deviations of approximate MI introduce significant noise to the data and make it difficult to estimate reliable mean rankings. Finally, partial approximate MI was hardly sufficient to recover the means. On the other hand, estimates of regression coefficients can be well recovered in partial approximate MI models.

Measurement Invariance Explorer – Shiny Application

Maksim Rudnev - National Research University Higher School of Economics, and ISCTE – University Instiute of Lisbon

Measurement invariance of the constructs is required for meaningful comparison of the scores across groups. If a construct of interest is a latent variable and measured with a number of observed indicators, measurement invariance can be tested by the means of multiple groups confirmatory factor analysis (MGCFA). A standard practice is to apply MGCFA with a group as a known source of heterogeneity (e.g. country, gender), and test whether a structure is reproduced in every group. When all indicators are continuous, the sequence of procedures involves testing at least three models with different sets of constraints: a general similarity of factor loadings pattern (configural), equality of loadings (metric), and equality of loadings and intercepts (scalar invariance) across groups. In practice though, invariance is often not supported for all groups and indicators, and a researcher is involved in repeated refitting models with excluded groups/relaxed constraints led by modification indices, theoretical considerations and personal intuition. It might become a very tedious especially when one works with many groups or many indicators. Measurement Invariance Explorer (MIE) is a new interactive tool that aimed at facilitating this tedious process.

The central idea of MIE is to apply measurement model to each pair of groups, extract some measure of invariance, and use it as a proximity measure for plotting all the groups. By this, one can identify clusters of groups based on the applied measurement model and more easily find a set of groups that possibly share the same model, i.e. provide measurement invariance at a given level. The measures of proximity are of the three types: with no model implied (covariance matrix, correlation matrix), all-groups-included MGCFA parameter estimates (factor loadings in configural model, indicator intercepts in scalar model). The third kind of measure comes from the following procedure. First, MIE fits configural and metric MGCFA, or metric and scalar

MGCFA to each pair of groups; second, it computes an increment in model fit indices: CFI, RMSEA, and SRMR (here, Chen's criterion can be applied); and third, it uses these model fit increments as a proximity matrix to plot the groups in a two-dimensional space.

MIE interface is graphical, intuitive, and simple. It is expected that a user would be able to find a subset of groups with a needed level of invariance in a few clicks and few minutes. Users are expected to follow several steps: upload their data, state a factor model structure to be tested, and choose the proximity measure. After that they can see the revealed clustering of the groups on the two-dimensional plot and all the computed measures depending on their selection. They can click on the deviating groups to exclude from analysis, and see if the invariance criteria were satisfied.

MIE is R Shiny application built on the top of *lavaan* package, computation of proximities is processed with multidimensional scaling. In order to reduce computation time, fitting of models to each pair of groups is done only once, and after exclusion of some groups, the same information about proximity between groups is recycled.

The limitations of the alpha version of MIE are few. It currently works only with linear indicators, it does not allow application of partial invariance models, and it does not make use of modification indices; the use of survey weights through *lavaan.survey*, application of Bayesian approximate invariance tests through *blavaan* package, and through calling external software Mplus is not available yet. However, these features are planned to be implemented in the release versions of MIE.

Currently, MIE is published online
https://rudnev.shinyapps.io/measurement_invariance_explorer/

Three Applications of Structural Equation Modeling as a Handy Tool: A Network Comparison Test, Testing Moderated Mediation, and a Means to Correct for the Effects of Censoring

Kees-Jan Kan – University of Amsterdam
Niels Smits – University of Amsterdam

When researchers think of Structural Equation Modeling (SEM), the first applications that come into mind are probably those covered in introduction courses, such as path analysis, confirmatory factor modeling, combinations of the two (e.g. structural relation modeling on the latent variable level), and latent growth modeling. Next, one may think of advanced applications of the previous, e.g. testing for measurement invariance, or of extended modeling techniques such as multilevel SEM, nonlinear SEM, or even dynamical SEM. Clearly, SEM is a very flexible 'tool' that researchers use to test hypotheses or to investigate predictive value. The flexibility of SEM is in large part due to the possibility to introduce equality (and inequality) constraints, which allows for the comparison of nested models, for example. In principle, one could also use SEM to implement models that underlie t-tests, simple and multivariate regression models, and many (M)ANO(C)VA models. A good reason not to do so lies in the fact that statistical programs incorporate functions that are ready to use. We here demonstrate three useful applications of SEM of which researcher are apparently unaware or have not realized the benefits over ready-to-use functions. Specifically, we show (1) SEM provides the means to test if two (or more) psychometric networks can be considered equivalent, globally or locally, (2) that testing for moderated mediation is more straightforward and useful in SEM than in the popular SPSS PROCESS macro, and (3) that SEM can be used to correct for the effects of censoring. Future (extensions of these) applications are discussed.

Multilevel SEM for Ordinal Data in the 'Wide' Format Approach

Mariska T. Barendse – Ghent University
Yves Rosseel – Ghent University

For continuous data, Bauer (2003) and Mehta & Neale (2005) among others showed how to model multilevel data, where units at Level 1 are nested in clusters at Level 2,which in turn may be nested in even larger clusters at Level 3, and so on, in a 'wide' or 'multivariate' format approach. Hence, complex balanced and unbalanced multilevel structural equation (SEM) models can be modeled intuitively and easily fitted in single-level SEM programs. In this presentation, we will show how to apply this 'wide' format approach to SEM with ordinal data. Random intercept models can then be fitted in any software program that can handle ordinal data while random slope models can only be modeled by fixing model parameters to individual specific data values. We will discuss the implications for model identification and model estimation. A real data example from educational research will be used to illustrate the approach.

Bauer, D. J. (2003). Estimating multilevel linear models as structural equation models. *Journal of Educational and Behavioral Statistics, 28* (2), 135-167.

Mehta, P. D. & Neale, M. C. (2005). People are variables too: Multilevel structural equations modeling. *Psychological methods, 10* (3), 259-283.

Global Model Fit Test for Nonlinear SEM

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Andreas Klein – Goethe-University Frankfurt
Julien Irmer – Goethe-University Frankfurt

Nonlinear structural equation modeling (SEM) has received much attention in recent years, enabling a more detailed specification of the structural part of a model. Goodness of fit of conventional SEM is usually evaluated by a likelihood ratio test (the χ^2 test), which compares the target model to a saturated model. Until now, there did not exist a comparable global model test for nonlinear SEM. Based on the quasi-maximum likelihood method (QML, Klein & Muthén, 2006), we propose a quasi-likelihood ratio test (Q-LRT) equivalent to the likelihood ratio test of linear SEM. This test is based on quasi-ML instead of normal ML and includes a proper saturated model especially tailored for nonlinear SEM. Results from a Monte Carlo study show that the Q-LRT performs well with regard to Type I error rates and power rates, when sample size is sufficiently large. However, in a robustness study, nonnormally distributed predictors resulted in inflated Type I error rates.

Algebraic Expression for Standard Errors in Structural Equation Modeling

Harry Garst – University of Amsterdam

Standard errors in Structural Equation modeling can be calculated using either Expected or Observed Information matrices. What is less known is that analytical expression have been formulated for both expected and observed information matrices (Yung & Bentler, 1996). In this presentation it will be shown that for a few small models we can get algebraic expression for standard errors (using Maple).

Yung, Y. -F., & Bentler, P.M. (1996). On the hessian and information for ML factor analysis with mean and covariance structures. In F. Faulbaum & W. Bandilla (Eds.). Softstat'95: Advances in statistical software 5 (pp. 211-218). Stuttgart: Lucius & Lucius.

Exploring Multicausal Patterns in Sparse Longitudinal Data with Dynamic Fixed Effects SEM Models and Network Analysis

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Our ongoing work was inspired by recent developments in network analysis that allow to explore multivariate structures, especially for observations that don't fit well in the traditional conceptualization of latent variables (e.g., networks of interacting symptoms; Borsboom, 2017). Another interesting network analysis output is the identification of variables that are more important within one network (i.e., based on so called centrality indices). Current approaches in longitudinal network analysis require intensive time series data (Epskamp et al., 2017). Fixed and random effects models (Bollen & Brand, 2010) are a flexible framework that make it possible to control for unobserved confounders and allow for lagged relationships starting with 3 or 4 time points. I present how the existing network and SEM analysis techniques can be integrated to explore patterns of reciprocal causation. I describe the advantages of this approach using two empirical examples. The first example is an analysis of teacher-child interactions within 177 preschool classrooms across four repeated observation cycles. The second example is an analysis of life satisfaction in adolescents and their parents across six annual data waves of the German Socio-Economic Panel Study (SOEP). Plans for the future include simulation work and the development of an add on for existing R packages (e.g., lavaan).

How Different Education and Training Systems Configure Literacy Skills: A Comparative Analysis of Five OECD Countries Using Structural Equation Modelling

Rosario Scandurra – Atonomous University of Barcelona
Jorge Calero – Atonomous University of Barcelona

This article examines the relationship between family background, education, skills use and direct measures of literacy skills in five countries: United States, Japan, Germany, Denmark and Spain. The main aim is to contribute to the research on skills acquisition by providing a comprehensive analysis of literacy skills. We employ a structural equation modelling and use PIAAC data. Results show that skills are configured in a highly complex manner and that significant differences emerge across the five countries, reflecting their historical and institutional characteristics. Intergenerational transmission of educational inequality is a crucial factor in shaping skills outcomes, although this factor varies considerably between countries. The effects of family background, educational attainment, and skills use in daily life on literacy respond to country specific equilibria.