semTools: Useful tools for SEM with R

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What is semTools?

- Useful tools for SEM modeling in R
- An open source, community supported package
  - Have an idea for a function? Or a way to improve an existing function? Let us know!
  - Currently the package includes over 15 different contributors
  - An easy way to make new methods available to a large audience

What is semTools?

- A large variety of useful functions
  - Functions that extend the capability of lavaan
  - Functions that extend the capability of OpenMx
  - General purpose functions not tied to a specific package

- `auxiliary` – allows for easy addition of auxiliary variables with FIML in lavaan
- `runMI` – takes data with missing observations imputes the data, fits a model to imputed data with lavaan and pools the results.
  - Imputation can be performed with Amelia or mice. Or users can supply a list of imputed data sets
  - Multiple methods of pooling the χ^2 statistic are available
- `bsBootMiss` – Implement the Bollen-Stine bootstrap with missing data (Savalei & Yuan, 2009)
  - Savalei, V., & Yuan, K.-H. (2009). On the model-based bootstrap with missing data: obtaining a p-value for a test of exact fit. *Multivariate Behavioral Research*, *44*, 741-763.

```
HS.model <- ' visual  =~ x1 + x2 + x3
               textual =~ x4 + x5 + x6
               speed   =~ x7 + x8 + x9 '
#Fit model with runMI
#HSMIss is data set with 10% missing MCAR
out <- runMI(HS.model, data=HSMiss, m = 20,
             chi="all", fun = "cfa")
summary(out)
inspect(out, "fit")
#Provides fraction of missing information
#and fit for each chi square statistic
inspect(out, "impute")
```

Model evaluation functions

- `moreFitIndices` – calculates additional model fit indices not built into lavaan. Fit indices include Gamma Hat, RMSEA of the null model, Stochastic Information Criterion, and many more
- `miPowerFit` – model evaluation using modification indices and their power (Saris, Satorra, & van der Veld, 2009)
  - Saris, W. E., Satorra, A., & van der Veld, W. M. (2009). Testing structural equation models or detection of misspecifications? *Structural Equation Modeling*, *16*, 561-582.

Measurement invariance

- `measurementInvariance` – Fits a series of models to test for multiple group measurement invariance
  - Fits and compares 4 models: configural invariance, weak invariance, strong invariance, and latent mean invariance
- `longInvariance` – Fits a series of models to test for longitudinal measurement invariance
  - Currently only works for a single factor measured across time

Example measurementInvariance Code

```
HW.model <- ' visual =~ x1 + x2 + x3
              textual =~ x4 + x5 + x6
              speed =~ x7 + x8 + x9 '
measurementInvariance(HW.model, data=HolzingerSwinefor
                                group="school")
```

Example measurementInvariance Output

```
Model 1: configural invariance:
chisq         df    pvalue        cfi      rmsea        bic
115.851   48.000     0.000      0.923      0.097  7706.822
Model 2: weak invariance (equal loadings):
chisq         df    pvalue        cfi      rmsea        bic
124.044   54.000     0.000      0.921      0.093  7680.771
[Model 1 versus model 2]
delta.chisq       delta.df delta.p.value     delta.cfi
8.192          6.000          0.224          0.002
```

Many more...

- Many, many more helpful functions available:
  - `efaUnrotate` – fits an unrotated EFA model with lavaan (functions `orthRotate` and `oblqRotate` can be used to rotate the results)
  - `indProd` – creates product terms for latent interaction variables using three different centering techniques
  - `lisrel2lavaan` – translates LISREL syntax and fits a lavaan model
  - `reliability` – computes reliability of factors using coeffcient alpha and multiple versions of coefficent omega (`reliabilityL2` computes reliability for higher order factors)
  - ...

A call to action

- We want your functions!
  - If you wrote a function that is related to SEM and might be useful to others please contact us.
    - We will help with documentation, debugging, and maintaining the function
  - If you have an idea for a function, please contact us.
    - We will work with you to develop the function and include it in semTools.

- You can contact us via email or through github
  - https://github.com/simsem/semTools

Thank you!

- Questions?
- Thanks to
  - Todd Little
  - Yves Rosseel
  - All the contributors to the semTools package
- semTools wiki: https://github.com/simsem/semTools/wiki
- email: schoemanna@ecu.edu