Package 'OmegaG'

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Title Omega-Generic: Composite Reliability of Multidimensional Measures

Description It is a computer tool to estimate the item-sum score's reliability (composite reliability, CR) in multidimensional scales with overlapping items. An item that measures more than one domain construct is called an overlapping item.
The estimation is based on factor models allowing unlimited cross-factor loadings such as exploratory structural equation modeling (ESEM) and Bayesian structural equation modeling (BSEM). The factor models include correlated-factor models and bi-factor models. Specifically for bi-factor models, a type of hierarchical factor model, the package estimates the CR hierarchical subscale/hierarchy and CR subscale/scale total. The CR estimator 'Omega-generic' was proposed by Mai, Srivastava, and Krull (2021) <https://whova.com/embedded/subsession/enars_202103/1450751/1452993/>. The current version can only handle continuous data.
Yujiao Mai contributes to the algorithms, R programming, and application example. Deo Kumar Srivastava contributes to the algorithms and the application example. Kevin R. Krull contributes to the application example. The package 'OmegaG' was sponsored by American Lebanese Syrian Associated Charities (ALSAC). However, the contents of 'OmegaG' do not necessarily represent the policy of the ALSAC.

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Depends R (>= 2.50)

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Contents

`OmegaG` *Composite Reliability Coefficient Omega-Generic*

Description

This function is used to estimate the composite reliability coefficient Omega-generic (*Mai, Srivastava, & Krull, 2021*), given factor loadings, factor covariance matrix, and covariance matrix of item residuals.

Usage

```
OmegaG(
  Lambda = NULL,
  Phi = NULL,
  Psi = NULL,
  items.index = NULL,
  factor.index = NULL,
  scale.structure = NULL,
  modeltype = c("correlated-factor", "bi-factor")
)
```

Arguments

`Lambda`	The input factor lading matrix. Each row contains the loadings of one item on factors. Each column includes the loadings of one factor. In the case of bi-factor structure, the first column of loadings is on the global factor.
`Phi`	The input factor covariance matrix.
`Psi`	The input covariance matrix of item residuals. Typically, `Psi` is a diagonal matrix.
`items.index`	The vector indexing the items of which the composite reliability is being estimated. It is an optional argument. If it is specified, the argument `scale.structure` is not effective. If it is not specified, the the argument `scale.structure` is expected to be specified and effective.
`factor.index`	The vector indexing the factor(s)/construct(s) regarding which the composite reliability is being estimated. It is an optional argument. If it is not specified, the function will estimate the composite reliability regarding each factor/construct.
`scale.structure`	The scale structure in a list or a Boolean matrix form. In a list form, each element is a vector of items (names) of a subscale. If in a boolean form, the element on the i-th row and the j-th column indicates whether the i-th item is

within the j-th subscale. If both the argument `scale.structure` and `Lambda` include colnames and rownames, the names must be match with each other. This argument `scale.structure` is optional. Only when `item-index` is not specified, this argument is effective.

`modeltype` The type of factor structure (`"corr-factor"` or `"bi-factor"`). The current version supports correlated-factor structure and bi-factor structure. A bi-factor model typically assumes factors are uncorrelated. The default is correlated-factor structure.

Value

The estimated composite reliability coefficient OmegaG.

Author(s)

Yujiao Mai, Deo Kumar Srivastava, and Kevin R Krull

References

Mai, Y., Srivastava, D.K., & Krull, K.R. (2021). Estimating Composite reliability of Multidimensional Measurement with Overlapping Items. Present at the 2021 Eastern North American Region (ENAR) Spring Virtual Meeting.

Examples

```
#### Example 1:
OmegaG(Lambda = PedsQLMFS$ESEM$Lambda,
                       Phi = PedsQLMFS$ESEM$Phi,
                        Psi = PedsQLMFS$ESEM$Psi,
                        modeltype = "correlated-factor",
                        scale.structure = PedsQLMFS$ScaleStructure
                        )

#  Model type = correlated-factor
#
#  CR of each subscale:
#       GeneralFatigue :    0.770
#         SleepFatigue :    0.690
#     CognitiveFatigue :    0.777


#### Example 2:
 OmegaG(Lambda = PedsQLMFS$biESEM$Lambda,
                Phi = PedsQLMFS$biESEM$Phi,
                Psi = PedsQLMFS$biESEM$Psi,
                modeltype = "bi-factor",
                scale.structure = PedsQLMFS$ScaleStructure
 )

# Model type = bi-factor
```

```
#
# Hierarchy and Hierarchical-subscale CR:
#                           GlobalFatigue :    0.806
#                          GeneralFatigue :    0.174
#                            SleepFatigue :    0.361
#                        CognitiveFatigue :    0.190
#
# Scale Total and Subscale CR:
#   GlobalFatigue + all sepcific factors :    0.926
#         GlobalFatigue + GeneralFatigue :    0.859
#           GlobalFatigue + SleepFatigue :    0.758
#       GlobalFatigue + CognitiveFatigue :    0.839


# Example 3:
 OmegaG::OmegaG(Lambda = PedsQLMFS$biESEM$Lambda,
       Phi = PedsQLMFS$biESEM$Phi,
       Psi = PedsQLMFS$biESEM$Psi,
       modeltype = "bi-factor",
       items.index = 1:6,factor.index = 2
 )

# Model type = bi-factor
#
# CR of Items 1 2 3 4 5 6 regarding factor 2:
#                       GeneralFatigue :    0.174


# Example 4:
  OmegaG::OmegaG(Lambda = PedsQLMFS$ESEM$Lambda,
                 Phi = PedsQLMFS$ESEM$Phi,
                  Psi = PedsQLMFS$ESEM$Psi,
                 modeltype = "correlated-factor",
                  items.index = 7:12,factor.index = 2
   )

# Model type = correlated-factor
#
# CR of Items 7 8 9 10 11 12 regarding factor 2:
#   SleepFatigue :    0.690
```

PedsQLMFS *PedsQL Multidimensional Fatigue Scale Factor Structure*

Description

The data provide the information needed for estimating the CR coefficient Omega-generic of the PedsQL Multidimensional Fatigue Scale *(Varni et al., 2002)*. The estimated parameter matrices

(Lambda, Phi, and Psi) were obtained by fitting factor models with participants' respontses to the PedsQL Multidimensional Fatigue Scale. Two different factor structures, a three-correlated-factor model and a bi-factor model, were included in the example. Exploratory structural equation modeling *(ESEM; Asparouhov, & Muthen, 2009; Morin, Arens, & Marsh, 2016)* was employed to estimate the model. The sample included 87 young-adult cancer survivors. Sample data were collected by St. Jude LIFE Study *(SJCRH., 2007-2021)*. Please refer to the publication *(Mai, Srivastava, & Krull, 2021)* for more information.

Usage

```
PedsQLMFS
```

Format

PedsQLMFS: A list including three sub-lists: ScaleStructure, ESEM, and biESEM.

1. PedsQLMFS$ScaleStructure: ScaleStructure is a list used to describe the subscale names and items within each subscale. It contains three vectors: GeneralFatigue, SleepFatigue and CognitiveFatigue.

GeneralFatigue A vector of item varibale names that are in the subscale "General Fatigue"

SleepFatigue A vector of item varibale names that are in the subscale "Sleep/rest Fatigue"

CognitiveFatigue A vector of item varibale names that are in the subscale "Cognitive Fatigue"

2. PedsQLMFS$ESEM: ESEM is a list of parameter matrices of a three-correlated-factor model. It contains three matrices: Lambda, Phi, and Psi.

Lambda: The factor-loading matrix; A matrix with 18 rows and 3 columns, each row represent one scale item, each column represent one factor.

GeneralFatigue Factor loadings on the sub-domain construct "Gneral Fatigue"

SleepFatigue Factor loadings on the sub-domain construct "Sleep/rest Fatigue"

CognitiveFatigue Factor loadings on the sub-domain construct "Cognitive Fatigue"

Phi: The factor variance-covariance matrix; A matrix with 3 rows and 3 columns. Each row represent one factor. So does each column.

GlobalFatigue Factor loadings on the global (general factor) construct "Global Fatigue"

GeneralFatigue Factor loadings on the specific (group factor) construct "General Fatigue"

SleepFatigue Factor loadings on the specific (group factor) construct "Sleep/rest Fatigue"

CognitiveFatigue Factor loadings on the specific (group factor) construct "Cognitive Fatigue"

Psi: The item-error variane-covariance matrix; A matrix with 18 rows and 18 columns. Each row represent one item. So does each column.

Y1 item GeneralFatigue1 measurement-error variance and covariance with other items

Y2 item GeneralFatigue2 measurement-error variance and covariance with other items

Y3 item GeneralFatigue3 measurement-error variance and covariance with other items

Y4 item GeneralFatigue4 measurement-error variance and covariance with other items

Y5 item GeneralFatigue5 measurement-error variance and covariance with other items

Y6 item GeneralFatigue6 measurement-error variance and covariance with other items

Y7 item SleepFatigue1 measurement-error variance and covariance with other items

Y8 item SleepFatigue2 measurement-error variance and covariance with other items

Y9 item SleepFatigue3 measurement-error variance and covariance with other items

Y10 item SleepFatigue4 measurement-error variance and covariance with other items

Y11 item SleepFatigue5 measurement-error variance and covariance with other items

Y12 item SleepFatigue6 measurement-error variance and covariance with other items

Y13 item CognitiveFatigue1 measurement-error variance and covariance with other items

Y14 item CognitiveFatigue2 measurement-error variance and covariance with other items

Y15 item CognitiveFatigue3 measurement-error variance and covariance with other items

Y16 item CognitiveFatigue4 measurement-error variance and covariance with other items

Y17 item CognitiveFatigue5 measurement-error variance and covariance with other items

Y18 item CognitiveFatigue6 measurement-error variance and covariance with other items

3. PedsQLMFS$biESEM: biESEM is a list of parameter matrices of a bi-factor model. It contains three matrices: Lambda, Phi, and Psi.

Lambda: The factor-loading matrix; A matrix with 18 rows and 4 columns, each row represent one scale item, each column represent one factor. The first factor is the global factor (also called general factor) of a bi-factor structure .

GlobalFatigue Factor loadings on the global (general factor) construct "Global Fatigue"

GeneralFatigue Factor loadings on the specific (group factor) construct "Gneral Fatigue"

SleepFatigue Factor loadings on the specific (group factor) construct "Sleep/rest Fatigue"

CognitiveFatigue Factor loadings on the specific (group factor) construct "Cognitive Fatigue"

Phi: The factor variance-covariance matrix; A matrix with 4 rows and 4 columns, each row represent one factor, each column represent one factor. The first factor is the global factor (also called general factor) of a bi-factor structure .

GlobalFatigue Factor loadings on the global (general factor) construct "Global Fatigue"

GeneralFatigue Factor loadings on the specific (group factor) construct "General Fatigue"

SleepFatigue Factor loadings on the specific (group factor) construct "Sleep/rest Fatigue"

CognitiveFatigue Factor loadings on the specific (group factor) construct "Cognitive Fatigue"

Psi: The item-error variane-covariance matrix; A matrix with 18 rows and 18 columns. Each row represent one item. So does each column.

Y1 item GeneralFatigue1 measurement-error variance and covariance with other items

Y2 item GeneralFatigue2 measurement-error variance and covariance with other items

Y3 item GeneralFatigue3 measurement-error variance and covariance with other items

Y4 item GeneralFatigue4 measurement-error variance and covariance with other items

Y5 item GeneralFatigue5 measurement-error variance and covariance with other items

`Y6` item GeneralFatigue6 measurement-error variance and covariance with other items

`Y7` item SleepFatigue1 measurement-error variance and covariance with other items

`Y8` item SleepFatigue2 measurement-error variance and covariance with other items

`Y9` item SleepFatigue3 measurement-error variance and covariance with other items

`Y10` item SleepFatigue4 measurement-error variance and covariance with other items

`Y11` item SleepFatigue5 measurement-error variance and covariance with other items

`Y12` item SleepFatigue6 measurement-error variance and covariance with other items

`Y13` item CognitiveFatigue1 measurement-error variance and covariance with other items

`Y14` item CognitiveFatigue2 measurement-error variance and covariance with other items

`Y15` item CognitiveFatigue3 measurement-error variance and covariance with other items

`Y16` item CognitiveFatigue4 measurement-error variance and covariance with other items

`Y17` item CognitiveFatigue5 measurement-error variance and covariance with other items

`Y18` item CognitiveFatigue6 measurement-error variance and covariance with other items

Author(s)

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References

Asparouhov, T., & Muthen, B. (2009). Exploratory structural equation modeling. Structural equation modeling: a multidisciplinary journal, 16(3), 397–438.

Mai, Y., Srivastava, D.K., & Krull, K.R. (2021). Estimating Composite reliability of Multidimensional Measurement with Overlapping Items. Present at the 2021 Eastern North American Region (ENAR) Spring Virtual Meeting.

Morin, A. J. S., Arens, A. K., & Marsh, H. W. (2016). A Bifactor Exploratory Structural Equation Modeling Framework for the Identification of Distinct Sources of Construct-Relevant Psychometric Multidimensionality. Structural equation modeling, 23(1), 116–139. doi: 10.1080/10705511.2014.961800

Varni, J. W., Burwinkle, T. M., Katz, E. R., Meeske, K., & Dickinson, P. (2002). The PedsQL in pediatric cancer: Reliability and validity of the Pediatric Quality of Life Inventory Generic Core Scales, Multidimensional Fatigue Scale, and Cancer Module. Cancer, 94(7), 2090.

St. Jude Children's Research Hospital. SJCRH. (2007-2021). St. Jude LIFE Study.

Examples

```
 OmegaG::PedsQLMFS$ScaleStructure
#  $GeneralFatigue
#  [1] "Y1" "Y2" "Y3" "Y4" "Y5" "Y6"
#
#  $SleepFatigue
#  [1] "Y7"  "Y8"  "Y9"  "Y10" "Y11" "Y12"
#
#  $CognitiveFatigue
#  [1] "Y13" "Y14" "Y15" "Y16" "Y17" "Y18"
```

```
 OmegaG::PedsQLMFS$ESEM$Lambda
#           GeneralFatigue  SleepFatigue  CognitiveFatigue
#  Y1            0.582        0.134           -0.093
#  Y2            0.640        0.161            0.109
#  Y3            0.779        0.180            0.110
#  Y4            0.728        0.039            0.097
#  Y5            0.283        0.109            0.431
#  Y6            0.412       -0.011            0.365
#  Y7            0.010        0.597           -0.150
#  Y8            0.516        0.009            0.195
#  Y9            0.578        0.092            0.057
#  Y10           0.010        0.820           -0.108
#  Y11          -0.043        0.696            0.119
#  Y12           0.024        0.652            0.222
#  Y13           0.376        0.123            0.350
#  Y14           0.073        0.194            0.639
#  Y15           0.052        0.183            0.693
#  Y16          -0.026        0.161            0.445
#  Y17           0.042        0.025            0.696
#  Y18          -0.019        0.175            0.607
```

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