Package 'esem'

May 8, 2026

Type Package

Title Exploratory Structural Equation Modeling ESEM

Version 2.0.0

Description A collection of functions developed to support the tutorial on using Exploratory Structural Equiation Modeling (ESEM) (Asparouhov & Muthén, 2009) <https://www.statmodel.com/download/EFACFA810.pdf>) with Longitudinal Study of Australian Children (LSAC) dataset (Mohal et al., 2023) <doi:10.26193/QR4L6Q>.
The package uses 'tidyverse','psych', 'lavaan','semPlot' and provides additional functions to conduct ESEM.
The package provides general functions to complete ESEM, including esem_c(), creation of target matrix (if it is used) make_target(), generation of the Confirmatory Factor Analysis (CFA) model syntax esem_cfa_syntax().
A sample data is provided - the package includes a sample data of the Strengths and Difficulties Questionnaire of the Longitudinal Study of Australian Children (SDQ LSAC) in sdq_lsac().
'ESEM' package vignette presents the tutorial demonstrating the use of ESEM on SDQ LSAC data.

License GPL (>= 3)

Encoding UTF-8

LazyData true

Imports lavaan, magrittr, psych, tidyr, dplyr, rlang, tibble, methods, utils

RoxygenNote 7.2.3

Suggests rmarkdown, knitr

VignetteBuilder knitr

URL https://github.com/maria-pro/esem

BugReports https://github.com/maria-pro/esem/issues

Depends R (>= 2.10), GPArotation

NeedsCompilation no

Author Maria Prokofieva [aut, cre] (ORCID: <https://orcid.org/0000-0003-1974-3827>), Vasileios Stavropoulos [aut], Daniel Zarate [aut]

Maintainer Maria Prokofieva <maria.prokofieva@gmail.com>

Repository CRAN

Date/Publication 2023-07-05 14:03:03 UTC

Contents

`create_referent` *Create a referent list*

Description

Create a referent list

Usage

```
create_referent(esem_efa_results)
```

Arguments

`esem_efa_results`
: is a *psych::fa()* object with the results of exploratory factor analysis (EFA) The object can be created using psych::fa() or a wrapper esem_efa() function The function uses efa object to identify referents A referent indicator is selected for each factor It is the item that has a large (target) loading for the factor it measures and The referents are used to ensure model identification and are used as starting values/ fixed values in the the next step to create a lavaan model syntax.

Value

A list with factors and corresponding referents (i.e. referents in that factor)

esem_c *Exploratory Structural Equiation Modeling ESEM (ESEM)*

Description

Exploratory Structural Equiation Modeling ESEM (ESEM)

Usage

```
esem_c(
  data,
  nfactors,
  fm = "ML",
  rotate = "geominT",
  scores = "regression",
  residuals = TRUE,
  Target = NULL,
  missing = TRUE,
  mimic = c("MPlus"),
  std.lv = TRUE,
  ordered = TRUE
)
```

Arguments

data	is a raw data matrix.
nfactors	is number of factors to extract
fm	is factoring method to be used in factor estimation. The suggested methods are available in *psych::fa()*
rotate	is the rotation method to be used. The suggested methods are available in *psych::fa()*
scores	is the factor scores to be used in EFA estimation. The default scores are estimated using regression as set in "regression".
residuals	is set to FALSE by default. In case the residual matrix is required in the output, this parameter should be set to TRUE
Target	is the target rotation matrix to be used. In case no target matrix is provided, EFA proceeds with alternative approach. The list of target rotations are available from *GPArotation*
missing	is used with scores set to TRUE. The default is missing=TRUE which imputes missing values using either the median or the mean.
mimic	allows to mimic the final output results (i.e. CFA stage) to MPLUS to allow the user to compare the output.
std.lv	is set to TRUE by default to provide standardized latent variables.
ordered	is set to TRUE by default to allow the use of categorical variables.

Value

An object of class *lavaan::lavaan-class*, for which several methods are available, including a summary method.

`esem_cfa` *Confirmatory factor anaysis (CFA) step for ESEM-with-CFA*

Description

is a wrapper for lavaan::cfa() function

Usage

```
esem_cfa(model, data, mimic = c("MPlus"), std.lv = TRUE, ordered = TRUE)
```

Arguments

`model`	is a character vector with a lavaan syntax for the ESEM model.
`data`	is a raw data matrix.
`mimic`	allows to mimic the final output results (i.e. CFA stage) to MPLUS to allow the user to compare the output.
`std.lv`	is set to TRUE by default to provide standardized latent variables.
`ordered`	is set to TRUE by default to allow the use of categorical variables.

Value

An object of class *lavaan::lavaan-class*, for which several methods are available, including a summary method.

`esem_cfa2` *Exploratory Structural Equiation Modeling ESEM (ESEM) with geominT rotation*

Description

Exploratory Structural Equiation Modeling ESEM (ESEM) with geominT rotation

Usage

```
esem_cfa2(
  data,
  nfactors,
  fm = "ML",
  rotate = "geominT",
  scores = "regression",
  residuals = TRUE,
  Target = NULL,
  missing = TRUE,
  mimic = c("MPlus"),
  std.lv = TRUE,
  ordered = TRUE
)
```

Arguments

data	is a raw data matrix.
nfactors	is number of factors to extract
fm	is factoring method to be used in factor estimation. The suggested methods are available in *psych::fa()*
rotate	is the rotation method to be used. The suggested methods are available in *psych::fa()*
scores	is the factor scores to be used in EFA estimation. The default scores are estimated using regression as set in "regression".
residuals	is set to FALSE by default. In case the residual matrix is required in the output, this parameter should be set to TRUE
Target	is the target rotation matrix to be used. In case no target matrix is provided, EFA proceeds with alternative approach. The list of target rotations are available from *GPArotation*
missing	is used with scores set to TRUE. The default is missing=TRUE which imputes missing values using either the median or the mean.
mimic	allows to mimic the final output results (i.e. CFA stage) to MPLUS to allow the user to compare the output.
std.lv	is set to TRUE by default to provide standardized latent variables.
ordered	is set to TRUE by default to allow the use of categorical variables.

Value

An object of class *lavaan::lavaan-class*, for which several methods are available, including a summary method.

esem_cfa_syntax *Title*

Description

Title

Title

Usage

```
esem_cfa_syntax(loadings)

esem_cfa_syntax(loadings)
```

Arguments

loadings	is a matrix with loadings values

Value

A character vector with the syntax of the model tp be used at the CFA stage.

A character vector with the syntax of the model tp be used at the CFA stage.

esem_efa *Exploratory factor analysis (EFA) for ESEM*

Description

Exploratory factor analysis (EFA) for ESEM

Usage

```
esem_efa(
  data,
  nfactors,
  fm = "ML",
  rotate = "geominT",
  scores = "regression",
  residuals = TRUE,
  Target = NULL,
  missing = TRUE
)
```

Arguments

data	is a raw data matrix.
nfactors	is number of factors to extract
fm	is the factoring method.
rotate	is the rotation method to be used. The suggested methods are available in *psych::fa()*
scores	is the factor scores to be used in EFA estimation. The default scores are estimated using regression as set in "regression".
residuals	is set to FALSE by default. In case the residual matrix is required in the output, this parameter should be set to TRUE
Target	is the target rotation matrix to be used. In case no target matrix is provided, EFA proceeds with alternative approach. The list of target rotations are available from *GPArotation*
missing	is used with scores set to TRUE. The default is missing=TRUE which imputes missing values using either the median or the mean.

Value

Eigen values of the common factor solution and reporting results for EFA stage

Examples

```
sdq_lsac<-sdq_lsac
esem_efa(data=sdq_lsac,
nfactors=5,
fm = 'ML',
rotate="geominT",
scores="regression",
residuals=TRUE,
missing=TRUE)
```

---

esem_syntax *Create a model syntax for ESEM-with-CFA*

Description

Create a model syntax for ESEM-with-CFA

Usage

```
esem_syntax(esem_efa_results, referent_list = NULL)
```

Arguments

esem_efa_results	is a *psych::fa()* object with the results of exploratory factor analysis (EFA) The object can be created using psych::fa() or a wrapper esem_efa() function
referent_list	is a list with latent variables (factors) and their corresponding referent items. referent_list can be generated using create_referent() function. If no referent_list is provided, the list is generated automatically

Value

A character vector with a lavaan syntax for the ESEM model.

---

esem_syntax_keys *Title*

Description

Title

Usage

```
esem_syntax_keys(key_matrix, fixed)
```

Arguments

key_matrix	is a matrix to be used to generate loadings
fixed	is the values fixed or should be freely estimated

Value

A character vector with the syntax of the model tp be used at the CFA stage.

---

esem_syntax_mplus *Create a model syntax for ESEM-with-CFA compatible with MPlus*

Description

Create a model syntax for ESEM-with-CFA compatible with MPlus

Usage

```
esem_syntax_mplus(key_matrix = NULL)
```

Arguments

key_matrix	is a key matrix with the primary factor items. It can be made with the make.keys() function. The primary factor items in the matrix are used as referent items.

Value

A character vector with a lavaan syntax for the ESEM model that imitates MPlus.

---

make_target *Title*

Description

Title

Usage

```
make_target(data, keys)
```

Arguments

data	is a dataset to be used in EFA
keys	is a key matrix with the primary factor items. It can be made with the make.keys() function. The primary factor items in the matrix are used as referent items.

Value

a list with target matrix

---

sdq_lsac *Strengths and Difficulties Questionnaire (SDQ) of the Longitudinal Study of Australian Children (LSAC)*

Description

The Longitudinal Study of Australian Children (LSAC) is a major study following the development of 10,000 young people and their families from all parts of Australia. It is conducted in partnership between the Department of Social Services, the Australian Institute of Family Studies and the Australian Bureau of Statistics with advice provided by a consortium of leading researchers.

Usage

```
sdq_lsac
```

Format

A tibble with 3840 rows and 25 variables

Details

The study began in 2003 with a representative sample of children from urban and rural areas of all states and territories in Australia. The study has a multi-disciplinary base, and examines a broad range of topics, including parenting, family, peers, education, child care and health.

Data are collected from two cohorts every two years. The first cohort of 5,000 children was aged 0–1 years in 2003–04, and the second cohort of 5,000 children was aged 4–5 years in 2003–04. The full dataset is available here The SDQ is a 25-item instrument for children aged 4-17 years and includes fives scales: the "Hyperactivity," "Emotional Symptoms," "Conduct Problems," "Peer Problems," and "Prosocial Behaviors".

The dataset was pre-processed and includes only variables relevant to the original latent variables. The cleaning included:

- reverse coding items s7_1, s11_1, s14_1, s21_1, s25_1. The reversed variables are named with R in the end: s7_1R, s11_1R, s14_1R, s21_1R,s25_1R

- the missing data treatment was done is addressed following guidelines of Baraldi & Enders, 2010 and Baraldi & Enders, 2010.

The cases with more than 10 with 5 iterations using multivariate imputations by chained equations approach that is based on Fully Conditional Specification, where each incomplete variable is imputed by a separate model (see

Index