

Package ‘esem’

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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 Equation 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](https://doi.org/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.

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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

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create_referent	Create a referent list
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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 Equation Modeling ESEM (ESEM)***Description**

Exploratory Structural Equation 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 <i>psych::fa()</i>
rotate	is the rotation method to be used. The suggested methods are available in <i>psych::fa()</i>
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 <i>GPArotation</i>
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	<i>Confirmatory factor analysis (CFA) step for ESEM-with-CFA</i>
----------	--

Description

is a wrapper for `lavaan::cfa()` function

Usage

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

Arguments

- | | |
|----------------------|---|
| <code>model</code> | is a character vector with a lavaan syntax for the ESEM model. |
| <code>data</code> | is a raw data matrix. |
| <code>mimic</code> | allows to mimic the final output results (i.e. CFA stage) to MPLUS to allow the user to compare the output. |
| <code>std.lv</code> | is set to TRUE by default to provide standardized latent variables. |
| <code>ordered</code> | 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	<i>Exploratory Structural Equation Modeling ESEM (ESEM) with geominT rotation</i>
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Description

Exploratory Structural Equation 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

<code>data</code>	is a raw data matrix.
<code>nfactors</code>	is number of factors to extract
<code>fm</code>	is factoring method to be used in factor estimation. The suggested methods are available in <i>psych::fa()</i>
<code>rotate</code>	is the rotation method to be used. The suggested methods are available in <i>psych::fa()</i>
<code>scores</code>	is the factor scores to be used in EFA estimation. The default scores are estimated using regression as set in "regression".
<code>residuals</code>	is set to FALSE by default. In case the residual matrix is required in the output, this parameter should be set to TRUE
<code>Target</code>	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 <i>GPArotation</i>
<code>missing</code>	is used with scores set to TRUE. The default is missing=TRUE which imputes missing values using either the median or the mean.
<code>mimic</code>	allows to mimic the final output results (i.e. CFA stage) to MPLUS to allow the user to compare the output.
<code>std.lv</code>	is set to TRUE by default to provide standardized latent variables.
<code>ordered</code>	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	<i>Title</i>
-----------------	--------------

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	<i>Exploratory factor analysis (EFA) for ESEM</i>
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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 <i>psych::fa()</i>
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 <i>GPArotation</i>
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	<i>Title</i>
------------------	--------------

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	<i>Create a model syntax for ESEM-with-CFA compatible with MPlus</i>
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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	<i>Title</i>
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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	<i>Strengths and Difficulties Questionnaire (SDQ) of the Longitudinal Study of Australian Children (LSAC)</i>
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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 five 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 as 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

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