Package ‘EFA.MRFA’

October 12, 2022

Type Package
Title Dimensionality Assessment Using Minimum Rank Factor Analysis
Version 1.1.2
Date 2021-06-15
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Description Performs parallel analysis (Timmerman & Lorenzo-Seva, 2011 <doi:10.1037/a0023353>) and hull method (Lorenzo-Seva, Timmerman, & Kiers, 2011 <doi:10.1080/00273171.2011.564527>) for assessing the dimensionality of a set of variables using minimum rank factor analysis (see ten Berge & Kiers, 1991 <doi:10.1007/BF02294464> for more information). The package also includes the option to compute minimum rank factor analysis by itself, as well as the greater lower bound calculation.
Depends R (>= 2.10)
Imports stats, psych, scales, PCovR, ggplot2, reshape2
License GPL-3
Encoding UTF-8
NeedsCompilation no
LazyData true
RoxygenNote 6.0.1
Repository CRAN
Date/Publication 2021-06-16 08:00:02 UTC

R topics documented:

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## Description

Package for performing Parallel Analysis using Minimum Rank Factor Analysis (MRFA). It also include a function to perform the MRFA only and another function to compute the Greater Lower Bound step for estimating the variables communalities.

## Details

For more information about the methods used in each function, please go to each main page.

## Value

- **parallelMRFA**: Performs Parallel Analysis using Minimum Rank Factor Analysis (MRFA).
- **hullEFA**: Performs Hull analysis for assessing the number of factors to retain.
- **mrfa**: Performs Minimum Rank Factor Analysis (MRFA) procedure.
- **GreaterLowerBound**: Estimates the communalities of the variables from a factor model.

## Author(s)

David Navarro-Gonzalez

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## References


Examples

## Example 1:

## perform a Parallel Analysis using an example Database with only 5 random data sets and
## using the 90th percentile of distribution of the random data
parallelMRFA(IDAQ, Ndatsets=5, percent=90)

## For speeding purposes, the number of datasets have been largely reduced. For a proper
## use of parallelMRFA, we recommend to use the default Ndatsets value (Ndatsets=500)

##Example 2:

## Perform the Hull method defining the maximum number of dimensions to be tested by the
## Parallel Analysis + 1 rule, with Maximum Likelihood factor extraction method and CAF
## as Hull index.
hullEFA(IDAQ, extr = "ML")

---

**GreaterLowerBound**  
**Greater Lower Bound step (glb)**

**Description**

Estimates the communalities of the variables from a factor model where the number of factors is the number with positive eigenvalues.

**Usage**

GreaterLowerBound(C, conv = 0.000001, T, pwarnings = FALSE)

**Arguments**

- **C**  
  Covariance/correlation matrix to be used in the analysis.

- **conv**  
  Convergence criterion for glb step. The default convergence criterion will be conv=0.000001. If the user determine a specific value, this will prevail.

- **T**  
  Random matrix for start (can be omitted). If provided, it has to be the same size than the matrix provided in the C argument.

- **pwarnings**  
  Determines if the possible warnings occurred during the computation will be printed in the console.

**Details**


**Value**

- **gam**  
  Optimal communalities for each variable
Author(s)
David Navarro-Gonzalez
Urbano Lorenzo-Seva

References

Examples
## perform glb using the correlation matrix of the IDAQ dataset, and using severe convergence criterion.
GreaterLowerBound(cor(IDAQ), conv=0.000001)

hullEFA

Hull method for selecting the number of common factors

Description
Performs the Hull method (Lorenzo-Seva, Timmerman, & Kiers, 2011), which aims to find a model with an optimal balance between model fit and number of parameters.

Usage
hullEFA(X, maxQ, extr = "ULS", index_hull = "CAF", display = TRUE, graph = TRUE, details = TRUE)

Arguments
x Raw sample scores.
maxQ Maximum of dimensions to be tested. By default it will be determined by the Parallel Analysis advised dimensions, but the user can define it manually.
extr Extraction method, the two options available being: "ULS" (Unweigthed Least Squares, by default) and "ML" (Maximum Likelihood).
index_hull The index that will be used for determining the number of dimensions. The available options are the following: "CAF", "CFI" "RMSEA", being "CAF" by default.
display Determines if the output will be displayed in the console, TRUE by default. If it is TRUE, the output is returned silently and if it is FALSE, the output is returned in the console.
graph Request a plot representing the Hull curve.
details If detailed table will be displayed, containing the factors outside the convex Hull.
hullEFA is based on the procedure proposed by Lorenzo-Seva, Timmerman, & Kiers (2011) which is designed for assessing the dimensionality of a variable set. The hull heuristic was originally proposed by Ceulemans & Kiers (2006) in the context of model selection in multiway data analysis.

The hull analysis is performed in four main steps:
1. The range of factors to be considered is determined.
2. The goodness-of-fit of a series of factor solutions is assessed.
3. The degrees of freedom of the series of factor solutions is computed.
4. The elbow is located in the higher boundary of the convex hull of the hull plot.

The number of factors extracted in the solution associated with the elbow is considered the optimal number of common factors.

In the Lorenzo-Seva, Timmerman, & Kiers (2011) simulation study, the Hull method outperformed the other selected methods in recovering the correct number of major factors.

Value

- **Matrix**: Matrix containing the results of the Hull method using for the selected index.
- **n_factors**: Number of advised dimensions by the selected index.

Author(s)

- David Navarro-Gonzalez
- Urbano Lorenzo-Seva

References


Examples

```r
## Perform the Hull method defining the maximum number of dimensions to be tested by the Parallel Analysis + 1 rule, with Maximum Likelihood factor extraction method and CAF as Hull index.
hullEFA(IDAQ, extr = "ML")
```
Description

A database to be used as example in the functions included on DA.MRFA package. It contains the answers of 100 participants to IDAQ questionnaire (Ruiz-Pamies, Lorenzo-Seva, Morales-Vives, Cosi, Vigil-Colet, 2014), which was developed for assessing Physical, Verbal and Indirect aggression. The original questionnaire contains 27 Likert-items, ranging from 1 to 5.

Usage

data("IDAQ")

Format

A data frame with 100 observations and 23 variables measuring 3 different types of aggression (Physical, Verbal and Indirect).

Details

The original sample contains 27 items, because includes 4 Social Desirability markers, but for the purpose of the DA.MRFA functions, they had been removed. Also, the original sample contains 750 participants, and the following database only contains 100 for speeding purposes.

Source

More information about the questionnaire can be found at:


References


Examples

data(IDAQ)
**Description**


**Usage**

```r
mrfa(SIGMA, dimensionality = 1, random = 10, conv1, conv2, display = TRUE,
     pwarnings = FALSE)
```

**Arguments**

- **SIGMA**: Covariance/correlation matrix to be used in the analysis.
- **dimensionality**: Common factors used to find communality estimates. The value has to be between 0 and the number of items minus 1, being the default option: 1 dimension to be retained. If 0 is selected, a more strict convergence criterion will be used.
- **random**: Number of random starts.
- **conv1**: Convergence criterion for MRFA. The default convergence criterion will be conv1=0.0001. If the user determine a specific value, this will prevail.
- **conv2**: Convergence criterion for glb step. The default convergence criterion will be conv2=0.001. If the user determine a specific value, this will prevail.
- **display**: Determines if the output will be displayed in the console, TRUE by default. If it is TRUE, the output is returned silently and if it is FALSE, the output is returned in the console.
- **pwarnings**: Determines if the possible warnings occurred during the computation will be printed in the console.

**Value**

- **A**: Factor loading matrix
- **Matrix**: Covariance/Correlation matrix with optimal communalities in the diagonal
- **gam**: Optimal communalities for each variable

**Author(s)**

David Navarro-Gonzalez
Urbano Lorenzo-Seva

**References**

Examples

```r
## perform MRFA using the correlation matrix of the IDAQ dataset, and using the default
## convergence criterion for MRFA and glb step.
mrfa(cor(IDAQ), dimensionality=3)
```

---

**parallelMRFA**  
*Parallel Analysis using Minimum Rank Factor Analysis (MRFA)*

**Description**

Performs Parallel Analysis using Minimum Rank Factor Analysis (MRFA).

**Usage**

```r
parallelMRFA(X, Ndatasets = 500, percent = 95, corr= "Pearson", display = TRUE, 
graph = TRUE)
```

**Arguments**

- `X`  
  Raw sample scores.

- `Ndatasets`  
  Number of random datasets used to compute the random distribution of eigenvalues.

- `percent`  
  Desired percentile of distribution of random eigenvalues (for example 95 for the 95th percentile) to be used as threshold.

- `corr`  
  Determine if Pearson or Polychoric matrix will be used "Pearson": Computes Pearson correlation matrix "Polychoric": Computes Polychoric/Tetrachoric correlation matrix (heavy time consuming).

- `display`  
  Determines if the output will be displayed in the console, TRUE by default. If it is TRUE, the output is returned silently and if it is FALSE, the output is returned in the console.

- `graph`  
  Request a plot representing the percentage of explained variance by the real data, by the mean of the random data and using the percentile of distribution of random eigenvalues, defined in the percent argument.

**Details**

`parallelMRFA` is based on the procedure proposed by Timmerman and Lorenzo-Seva (2011) which is designed for assessing the dimensionality of a variable set. The principal advantage of using MRFA (Ten Berge & Kiers, 1991) instead the usual PCA extraction process is that the eigenvalues obtained from MRFA can be used to estimate the explained common variance per factor.

The eigenvalue sampling distribution is obtaining using a nonparametric approach: a permutation of the raw data (Buja & Eyuboglu, 1992). This approach is recommended for PA especially in cases where the observed data distribution clearly deviates from normality.

If the matrix to analyze is not positive-defined, a smoothing procedure will be applied (Devlin, Gnanadesikan & Kettenring, 1981).
Value

Real_Data       A vector containing the percentage of explained variance by the real data for each factor
Mean_random    A vector containing the percentage of explained variance by the mean of random data for each factor
Percentile_random  A vector containing the percentage of explained variance by the percentile of distribution of random data for each factor
Number_factors_mean  The number of factors to be retained suggested comparing the real data with the mean of the random data
Number_factors_percentiles The number of factors to be retained suggested comparing the real data with the percentile of distribution of the random data

Author(s)

David Navarro-Gonzalez
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References


Examples

```r
## perform a Parallel Analysis using an example Database with only 10 random data sets and using the 90th percentile of distribution of the random data
parallelMRFA(IDAQ, Ndatsets=10, percent=90)
```

```r
## For speeding purposes, the number of datasets have been largely reduced. For a proper use of parallelMRFA, we recommend to use the default Ndatsets value (Ndatsets=500)
```
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