Package 'LFM'

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Type Package

Title Laplace Factor Model Analysis and Evaluation

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Description
Enables the generation of Laplace factor models across diverse Laplace distributions and facilitates the application of Sparse Online Principal Component (SOPC), Incremental Principal Component (IPC), Parallel Principal Component (PPC), Sparse Approximate Principal Component (SAPC), Standard Principal Component (SPC), and Farm Test methods to these models. Evaluates the efficacy of these methods within the context of Laplace factor models by scrutinizing parameter estimation accuracy, mean square error, and the degree of sparsity.

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Contents

Ftest_LFM *Apply the Farmtest method to the Laplace factor model*

Description

This function simulates data from a Lapalce factor model and applies the FarmTest for multiple hypothesis testing. It calculates the false discovery rate (FDR) and power of the test.

Usage

```
Ftest_LFM(data, p1)
```

Arguments

data A matrix or data frame of simulated or observed data from a Laplace factor model.

p1 The proportion of non-zero hypotheses.

Value

A list containing the following elements:

FDR The false discovery rate, which is the proportion of false positives among all discoveries (rejected hypotheses).

Power The statistical power of the test, which is the probability of correctly rejecting a false null hypothesis.

PValues A vector of p-values associated with each hypothesis test.

RejectedHypotheses
The total number of hypotheses that were rejected by the FarmTest.

Examples

```
library(LaplacesDemon)
library(MASS)
n=1000
p=10
m=5
mu=t(matrix(rep(runif(p,0,1000),n),p,n))
mu0=as.matrix(runif(m,0))
sigma0=diag(runif(m,1))
F=matrix(mvrnorm(n,mu0,sigma0),nrow=n)
A=matrix(runif(p*m,-1,1),nrow=p)
lanor <- rlaplace(n*p,0,1)
epsilon=matrix(lanor,nrow=n)
D=diag(t(epsilon)%*%epsilon)
data=mu+F%*%t(A)+epsilon
p1=40
results <- Ftest_LFM(data, p1)
print(results$FDR)
print(results$Power)
```

IPC_LFM *Apply the IPC method to the Laplace factor model*

Description

This function performs Incremental Principal Component Analysis (IPC) on the provided data. It updates the estimated factor loadings and uniquenesses as new data points are processed, calculating mean squared errors and loss metrics for comparison with true values.

Usage

```
IPC_LFM(data, m, A, D, p)
```

Arguments

data	The data used in the IPC analysis.
m	The number of common factors.
A	The true factor loadings matrix.
D	The true uniquenesses matrix.
p	The number of variables.

Value

A list of metrics including:

Ai	Estimated factor loadings updated during the IPC analysis, a matrix of estimated factor loadings.

Di — Estimated uniquenesses updated during the IPC analysis, a vector of estimated uniquenesses corresponding to each variable.

MSESigmaA — Mean squared error of the estimated factor loadings (Ai) compared to the true loadings (A).

MSESigmaD — Mean squared error of the estimated uniquenesses (Di) compared to the true uniquenesses (D).

LSigmaA — Loss metric for the estimated factor loadings (Ai), indicating the relative error compared to the true loadings (A).

LSigmaD — Loss metric for the estimated uniquenesses (Di), indicating the relative error compared to the true uniquenesses (D).

Examples

```
library(SOPC)
library(LaplacesDemon)
library(MASS)
n=1000
p=10
m=5
mu=t(matrix(rep(runif(p,0,1000),n),p,n))
mu0=as.matrix(runif(m,0))
sigma0=diag(runif(m,1))
F=matrix(mvrnorm(n,mu0,sigma0),nrow=n)
A=matrix(runif(p*m,-1,1),nrow=p)
lanor <- rlaplace(n*p,0,1)
epsilon=matrix(lanor,nrow=n)
D=diag(t(epsilon)%*%epsilon)
data=mu+F%*%t(A)+epsilon
results <- IPC_LFM(data, m, A, D, p)
print(results)
```

LFM *Generate Laplace factor models*

Description

The function is to generate Laplace factor model data. The function supports various distribution types for generating the data, including: - ‘truncated_laplace‘: Truncated Laplace distribution - ‘log_laplace‘: Univariate Symmetric Log-Laplace distribution - ‘Asymmetric Log_Laplace‘: Log-Laplace distribution - ‘Skew-Laplace‘: Skew-Laplace distribution

Usage

```
LFM(n, p, m, distribution_type)
```

Arguments

n An integer specifying the sample size.

p An integer specifying the sample dimensionality or the number of variables.

m An integer specifying the number of factors in the model.

distribution_type
A character string indicating the type of distribution to use for generating the data.

Value

A list containing the following elements:

data A numeric matrix of the generated data.

A A numeric matrix representing the factor loadings.

D A numeric matrix representing the uniquenesses, which is a diagonal matrix.

Examples

```
library(MASS)
library(matrixcalc)
library(relliptical)
n <- 1000
p <- 10
m <- 5
sigma1 <- 1
sigma2 <- matrix(c(1,0.7,0.7,1), 2, 2)
distribution_type <- "truncated_laplace"
results <- LFM(n, p, m, distribution_type)
print(results)
```

PPC_LFM *Apply the PPC method to the Laplace factor model*

Description

This function computes Projected Principal Component Analysis (PPC) for the provided input data, estimating factor loadings and uniquenesses. It calculates mean squared errors and loss metrics for the estimated values compared to true values.

Usage

```
PPC_LFM(data, m, A, D, p)
```

Arguments

data	A matrix of input data.
m	The number of principal components.
A	The true factor loadings matrix.
D	The true uniquenesses matrix.
p	The number of variables.

Value

A list containing:

Ap	Estimated factor loadings.
Dp	Estimated uniquenesses.
MSESigmaA	Mean squared error for factor loadings.
MSESigmaD	Mean squared error for uniquenesses.
LSigmaA	Loss metric for factor loadings.
LSigmaD	Loss metric for uniquenesses.

Examples

```
library(SOPC)
library(LaplacesDemon)
library(MASS)
n=1000
p=10
m=5
mu=t(matrix(rep(runif(p,0,1000),n),p,n))
mu0=as.matrix(runif(m,0))
sigma0=diag(runif(m,1))
F=matrix(mvrnorm(n,mu0,sigma0),nrow=n)
A=matrix(runif(p*m,-1,1),nrow=p)
lanor <- rlaplace(n*p,0,1)
epsilon=matrix(lanor,nrow=n)
D=diag(t(epsilon)%*%epsilon)
data=mu+F%*%t(A)+epsilon
results <- PPC_LFM(data, m, A, D, p)
print(results)
```

SAPC_LFM *Apply the SAPC method to the Laplace factor model*

Description

This function calculates several metrics for the SAPC method, including the estimated factor loadings and uniquenesses, and various error metrics comparing the estimated matrices with the true matrices.

Usage

```
SAPC_LFM(data, m, A, D, p)
```

Arguments

`data`	The data used in the SAPC analysis.
`m`	The number of common factors.
`A`	The true factor loadings matrix.
`D`	The true uniquenesses matrix.
`p`	The number of variables.

Value

A list of metrics including:

`Asa`	Estimated factor loadings matrix obtained from the SAPC analysis.
`Dsa`	Estimated uniquenesses vector obtained from the SAPC analysis.
`MSESigmaA`	Mean squared error of the estimated factor loadings (Asa) compared to the true loadings (A).
`MSESigmaD`	Mean squared error of the estimated uniquenesses (Dsa) compared to the true uniquenesses (D).
`LSigmaA`	Loss metric for the estimated factor loadings (Asa), indicating the relative error compared to the true loadings (A).
`LSigmaD`	Loss metric for the estimated uniquenesses (Dsa), indicating the relative error compared to the true uniquenesses (D).

Examples

```
library(SOPC)
library(LaplacesDemon)
library(MASS)
n=1000
p=10
m=5
mu=t(matrix(rep(runif(p,0,1000),n),p,n))
mu0=as.matrix(runif(m,0))
sigma0=diag(runif(m,1))
F=matrix(mvrnorm(n,mu0,sigma0),nrow=n)
A=matrix(runif(p*m,-1,1),nrow=p)
lanor <- rlaplace(n*p,0,1)
epsilon=matrix(lanor,nrow=n)
D=diag(t(epsilon)%*%epsilon)
data=mu+F%*%t(A)+epsilon
results <- SAPC_LFM(data, m, A, D, p)
print(results)
```

SOPC_LFM *Apply the SOPC method to the Laplace factor model*

Description

This function calculates various metrics for the SOPC analysis on the Laplace factor model. It estimates the factor loadings and uniquenesses, and computes metrics such as mean squared error, loss metrics, and sparsity.

Usage

```
SOPC_LFM(data, m, p, A, D)
```

Arguments

`data`	A numeric matrix containing the data used in the SOPC analysis.
`m`	An integer specifying the number of subsets or common factors.
`p`	An integer specifying the number of variables in the data.
`A`	A numeric matrix representing the true factor loadings.
`D`	A numeric matrix representing the true uniquenesses.

Value

A list containing the following metrics:

`Aso`	Estimated factor loadings matrix.
`Dso`	Estimated uniquenesses matrix.
`MSEA`	Mean squared error of the estimated factor loadings (Aso) compared to the true loadings (A).
`MSED`	Mean squared error of the estimated uniquenesses (Dso) compared to the true uniquenesses (D).
`LSA`	Loss metric for the estimated factor loadings (Aso), indicating the relative error compared to the true loadings (A).
`LSD`	Loss metric for the estimated uniquenesses (Dso), indicating the relative error compared to the true uniquenesses (D).
`tauA`	Proportion of zero factor loadings in the estimated loadings matrix (Aso), representing the sparsity.

Examples

```
library(MASS)
library(SOPC)
library(matrixcalc)
library(LaplacesDemon)
n=1000
```

```
p=10
m=5
mu=t(matrix(rep(runif(p,0,1000),n),p,n))
mu0=as.matrix(runif(m,0))
sigma0=diag(runif(m,1))
F=matrix(mvrnorm(n,mu0,sigma0),nrow=n)
A=matrix(runif(p*m,-1,1),nrow=p)
lanor <- rlaplace(n*p,0,1)
epsilon=matrix(lanor,nrow=n)
D=diag(t(epsilon)%*%epsilon)
data=mu+F%*%t(A)+epsilon
results <- SOPC_LFM(data, m, p, A, D)
print(results)
```

SPC_LFM *Apply the SPC method to the Laplace factor model*

Description

This function performs Sparse Principal Component Analysis (SPC) on the input data. It estimates factor loadings and uniquenesses while calculating mean squared errors and loss metrics for comparison with true values.

Usage

```
SPC_LFM(data, A, D, m, p)
```

Arguments

data	The data used in the SPC analysis.
A	The true factor loadings matrix.
D	The true uniquenesses matrix.
m	The number of common factors.
p	The number of variables.

Value

A list containing:

As	Estimated factor loadings, a matrix of estimated factor loadings from the SPC analysis.
Ds	Estimated uniquenesses, a vector of estimated uniquenesses corresponding to each variable.
MSESigmaA	Mean squared error of the estimated factor loadings (As) compared to the true loadings (A).
MSESigmaD	Mean squared error of the estimated uniquenesses (Ds) compared to the true uniquenesses (D).

LSigmaA Loss metric for the estimated factor loadings (As), indicating the relative error compared to the true loadings (A).

LSigmaD Loss metric for the estimated uniquenesses (Ds), indicating the relative error compared to the true uniquenesses (D).

tau Proportion of zero factor loadings in the estimated loadings matrix (As).

Examples

```
library(SOPC)
library(LaplacesDemon)
library(MASS)
n=1000
p=10
m=5
mu=t(matrix(rep(runif(p,0,1000),n),p,n))
mu0=as.matrix(runif(m,0))
sigma0=diag(runif(m,1))
F=matrix(mvrnorm(n,mu0,sigma0),nrow=n)
A=matrix(runif(p*m,-1,1),nrow=p)
lanor <- rlaplace(n*p,0,1)
epsilon=matrix(lanor,nrow=n)
D=diag(t(epsilon)%*%epsilon)
data=mu+F%*%t(A)+epsilon
results <- SPC_LFM(data, A, D, m, p)
print(results)
```

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