Package 'msPCA'

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Type Package

Title Sparse Principal Component Analysis with Multiple Principal Components

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Description Implements an algorithm for computing multiple sparse principal components of a dataset. The method is based on Cory-Wright and Pauphilet ``Sparse PCA with Multiple Principal Components" (2026) <doi:10.48550/arXiv.2209.14790>. The algorithm uses an iterative deflation heuristic with a truncated power method applied at each iteration to compute sparse principal components with controlled sparsity.

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`feasibility_violation_off` *Feasibility violation*

Description

Computes the feasibility violation defined as $\sum_{t>s} u_t^\top u_s$ if orthogonality constraints are enforced (feasibilityConstraintType = 0) and $\sum_{t>s} u_t^\top C u_s$ if zero-correlation constraints are enforced (feasibilityConstraintType = 1).

Usage

```
feasibility_violation_off(C, U, feasibilityConstraintType)
```

Arguments

`C`	A matrix. The correlation or covariance matrix (p x p).
`U`	A matrix. Each column correspond to an p-dimensional PC.
`feasibilityConstraintType`	An integer. Type of feasibility constraints to be enforced. 0: orthogonality constraints; 1: uncorrelatedness constraints.

Value

A float.

Examples

```
library(datasets)
TestMat <- cor(datasets::mtcars)
mspcares <- mspca(TestMat, 2, c(4,4))
feasibility_violation_off(TestMat, mspcares$x_best, 0)
```

fraction_variance_explained

Fraction of variance explained

Description

Computes the fraction of variance explained (variance explained normalized by the trace of the covariance/correlation matrix) by a set of PCs.

Usage

```
fraction_variance_explained(C, U)
```

Arguments

C	A matrix. The correlation or covariance matrix (p x p).
U	A matrix. The matrix containing the r PCs (p x r).

Value

A float.

Examples

```
library(datasets)
TestMat <- cor(datasets::mtcars)
mspcares <- mspca(TestMat, 2, c(4,4))
fraction_variance_explained(TestMat, mspcares$x_best)
```

fraction_variance_explained_perPC

Fraction of variance explained per PC

Description

Computes the fraction of variance explained (variance explained normalized by the trace of the covariance/correlation matrix) by each PC.

Usage

```
fraction_variance_explained_perPC(C, U)
```

Arguments

C	A matrix. The correlation or covariance matrix (p x p).
U	A matrix. The matrix containing the r PCs (p x r).

Value

An array.

`mspca` *Multiple Sparse PCA*

Description

Returns multiple sparse principal component of a matrix using an iterative deflation heuristic.

Usage

```
mspca(
  Sigma,
  r,
  ks,
  feasibilityConstraintType = 0L,
  verbose = TRUE,
  maxIter = 200L,
  feasibilityTolerance = 1e-04,
  stallingTolerance = 1e-08,
  timeLimitTPM = 20L,
  maxRestartTPM = 20L,
  minRestartTPM = 10L
)
```

Arguments

`Sigma`	A matrix. The correlation or covariance matrix, whose sparse PCs will be computed.
`r`	An integer. Number of principal components (PCs) to be computed.
`ks`	A list of integers. Target sparsity of each PC.
`feasibilityConstraintType`	(optional) An integer. Type of feasibility constraints to be enforced. 0: orthogonality constraints; 1: uncorrelatedness constraints. Default 0.
`verbose`	(optional) A Boolean. Controls console output. Default TRUE.
`maxIter`	(optional) An integer. Maximum number of iterations of the algorithm. Default 200.
`feasibilityTolerance`	(optional) A float. Tolerance for the violation of the orthogonality constraints. Default 1e-4
`stallingTolerance`	(optional) A float. Controls the objective improvement below which the algorithm is considered to have stalled. Default 1e-8

timeLimitTPM	(optional) An integer. Maximum time in seconds for the truncated power method (inner iteration). Default 20.
maxRestartTPM	(optional) An integer. Number of random restarts of the truncated power method (inner iteration) for the first outer iteration. Default 20.
minRestartTPM	(optional) An integer. Number of random restarts of the truncated power method (inner iteration) for outer iterations >= 2. Default 10.

Value

An object with 4 fields: ‘x_best‘ (p x r array containing the sparse PCs), ‘objective_value‘, ‘feasibility_violation‘, ‘runtime‘.

Examples

```
library(datasets)
TestMat <- cor(datasets::mtcars)
mspca(TestMat, 2, c(4,4))
```

---

print_mspca *Print mspca output*

Description

Displays the output of the msPCA algorithm.

Usage

```
print_mspca(sol_object, C)
```

Arguments

sol_object	A list. The output of the mspca or tpm function.
C	A matrix. The correlation or covariance matrix (p x p).

Value

None. Prints output to console.

Examples

```
library(datasets)
TestMat <- cor(datasets::mtcars)
mspcares <- mspca(TestMat, 2, c(4,4))
print_mspca(mspcares, TestMat)
```

tpm *Truncated Power Method*

Description

Returns the leading sparse principal component of a matrix using the truncated power method.

Usage

```
tpm(Sigma, k, maxIter = 200L, verbose = TRUE, timeLimit = 10L)
```

Arguments

Sigma	A matrix. The correlation or covariance matrix, whose sparse PCs will be computed.
k	An integer. Target sparsity of the PC.
maxIter	(optional) An integer. Maximum number of iterations of the algorithm. Default 200.
verbose	(optional) A Boolean. Controls console output. Default TRUE.
timeLimit	(optional) An integer. Maximum time in seconds. Default 10.

Value

An object with 3 fields: ‘x_best‘ (p x 1 array containing the sparse PC), ‘objective_value‘, ‘runtime‘.

References

Yuan, X. T., & Zhang, T. (2013). Truncated power method for sparse eigenvalue problems. The Journal of Machine Learning Research, 14(1), 899-925.

Examples

```
library(datasets)
TestMat <- cor(datasets::mtcars)
tpm(TestMat, 4)
```

`variance_explained_perPC` *Variance explained per PC*

Description

Computes the variance explained by each PC.

Usage

```
variance_explained_perPC(C, U)
```

Arguments

`C`	A matrix. The correlation or covariance matrix (p x p).
`U`	A matrix. The matrix containing the r PCs (p x r).

Value

An array.

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