Package 'l1rotation'

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Title Identify Loading Vectors under Sparsity in Factor Models

Version 1.0.1

Description Simplify the loading matrix in factor models using the l1 criterion as proposed in Freyaldenhoven (2025) <doi:10.21799/frbp.wp.2020.25>. Given a data matrix, find the rotation of the loading matrix with the smallest l1-norm and/or test for the presence of local factors with main function local_factors().

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Depends R (>= 3.5)

Imports cli, doParallel, dplyr, foreach, ggplot2, magrittr, matrixStats, pracma, scales, stats

Suggests knitr, quarto, rmarkdown, testthat (>= 3.0.0)

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Encoding UTF-8

LazyData true

RoxygenNote 7.3.2

URL https://kobleary.github.io/l1rotation/, https://github.com/SimonFreyaldenhoven/l1rotation

BugReports https://github.com/SimonFreyaldenhoven/l1rotation/issues

VignetteBuilder knitr

Config/Needs/website quarto, rmarkdown

NeedsCompilation no

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Repository CRAN

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Contents

`example_data` *Example data with two factors from the replication files of Freyaldenhoven (2025).*

Description

Example data with two factors from the replication files of Freyaldenhoven (2025).

Usage

```
example_data
```

Format

`example_data`**:**
A matrix with 224 rows and 207 columns.

Source

Dataset available as a .mat file can be found under local_factors.zip at https://simonfreyaldenhoven.github.io/software/

`find_local_factors` *Find the rotation of the loading matrix with the smallest l1-norm, as in* `local_factors()`*, with additional flexibility.*

Description

Find the most sparse rotation of an orthonormal basis of the loading space of a t by n matrix X. Additional flexibility with the `initial_loadings` argument allows the user to specify any orthonormal basis rather than defaulting to PCA.

Usage

```
find_local_factors(X, r, initial_loadings, parallel = FALSE, n_cores = NULL)
```

Arguments

X	A (usually standardized) t by n matrix of observations.
r	An integer denoting the number of factors in X.
initial_loadings	Matrix that represents an orthonormal basis of the loading space. If not supplied, PCA is used by default in this function and also in local_factors.
parallel	A logical denoting whether the algorithm should be run in parallel.
n_cores	An integer denoting how many cores should be used, if parallel == TRUE.

Value

Returns a list with the following components:

- initial_loadings Principal Component estimate of the loading matrix (if not supplied).
- rotated_loadings Matrix that is the rotation of the loading matrix that produces the smallest l1-norm.
- rotation_diagnostics A list containing 3 components:
  - R Rotation matrix that when used to rotate initial_loadings produces the smallest l1-norm.
  - l1_norm Vector of length r containing the value of the l1 norm each solution generates.
  - sol_frequency Vector of length r containing the frequency in the initial grid of each solution.

Examples

```
# Minimal example with 2 factors, where X is a 224 by 207 matrix
r <- 2
M <- nrow(example_data)
n <- ncol(example_data)

# Compute PCA estimates
basis <- svd(example_data / sqrt(M), nu = M, nv = n)
initial_loadings <- sqrt(n) * basis$v[, 1:r]

# Find minimum rotation using orthonormal basis initial_loadings
rotation_result <- find_local_factors(X = example_data, r = r, initial_loadings = initial_loadings)
```

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local_factors *Check whether local factors are present and find the rotation of the loading matrix with the smallest l1-norm.*

Description

local_factors tests whether local factors are present and returns both the Principal Component estimate of the loadings and the rotation of the loadings with the smallest l1-norm. It also produces graphical illustrations of the results.

Usage

```
local_factors(X, r, parallel = FALSE, n_cores = NULL)
```

Arguments

X	A (usually standardized) t by n matrix of observations.
r	An integer denoting the number of factors in X.
parallel	A logical denoting whether the algorithm should be run in parallel.
n_cores	An integer denoting how many cores should be used, if parallel == TRUE.

Value

Returns a list with the following components:

- has_local_factors A logical equal to TRUE if local factors are present.
- initial_loadings Principal component estimate of the loading matrix.
- rotated_loadings Matrix that is the rotation of the loading matrix that produces the smallest l1-norm.
- rotation_diagnostics A list containing 3 components:
  - R Rotation matrix that when used to rotate initial_loadings produces the smallest l1-norm.
  - l1_norm Vector of length r containing the value of the l1 norm each solution generates.
  - sol_frequency Vector of length r containing the frequency in the initial grid of each solution.
- pc_plot Tile plot of the Principal Component estimate of the loading matrix.
- rotated_plot Tile plot of the l1-rotation of the loading matrix estimate.
- small_loadings_plot Plot of the number of small loadings for each column of the l1-rotation of the loading matrix estimate.

Examples

```
# Minimal example with 2 factors, where X is a 224 by 207 matrix
lf <- local_factors(X = example_data, r = 2)

# Visualize Principal Component estimate of the loadings
lf$pc_plot

# Visualize l1-rotation loadings
lf$pc_rotated_plot
```

`test_local_factors` *Test for the presence of local factors, as in* `local_factors()`*, with additional flexibility.*

Description

Test for the presence of local factors, as in `local_factors()`, with additional flexibility.

Usage

```
test_local_factors(X, r, loadings = NULL)
```

Arguments

`X`	A (usually standardized) t by n matrix of observations.
`r`	An integer denoting the number of factors in X.
`loadings`	(optional) Matrix that represents a sparse basis of the loading space.

Value

Returns a list with the following components:

- `has_local_factors` Logical equal to `TRUE` if local factors are present.
- `n_small` Integer denoting the number of small loadings in sparse rotation.
- `gamma_n` Integer denoting the critical value to compare `n_small` to.
- `h_n` Number denoting the cutoff used to determine which loadings are small.
- `loadings` Matrix that is the rotation of the loadings that produces the smallest l1-norm (if not supplied).

Examples

```
# Minimal example with 2 factors, where X is a 224 by 207 matrix
r <- 2
M <- nrow(example_data)
n <- ncol(example_data)

# Find minimum rotation
rotation_result <- find_local_factors(X = example_data, r)

# Test if sparse basis has local factors
test_result <- test_local_factors(
   X = example_data,
   r = r,
   loadings = rotation_result$rotated_loadings
)

test_result$has_local_factors
```

Index