# Package ‘vsp’

December 5, 2022

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<th>Package</th>
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<tr>
<td>Title</td>
<td>Vintage Sparse PCA for Semi-Parametric Factor Analysis</td>
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<tr>
<td>Version</td>
<td>0.1.1</td>
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<tr>
<td>Description</td>
<td>Provides fast spectral estimation of latent factors in random dot product graphs using the vsp estimator. Under mild assumptions, the vsp estimator is consistent for (degree-corrected) stochastic blockmodels, (degree-corrected) mixed-membership stochastic blockmodels, and degree-corrected overlapping stochastic blockmodels.</td>
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<tr>
<td>License</td>
<td>MIT + file LICENSE</td>
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<tr>
<td>URL</td>
<td><a href="https://github.com/RoheLab/vsp">https://github.com/RoheLab/vsp</a></td>
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<td>BugReports</td>
<td><a href="https://github.com/RoheLab/vsp/issues">https://github.com/RoheLab/vsp/issues</a></td>
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<td>Depends</td>
<td>R (&gt;= 3.1)</td>
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<tr>
<td>Imports</td>
<td>ggplot2, glue, invertiforms, LRMF3, magrittr, Matrix, rlang, RSpectra, stats, tibble, withr</td>
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<tr>
<td>Suggests</td>
<td>covr, dplyr, GGally, igraph, igraphdata, knitr, purrr, rmarkdown, scales, testthat (&gt;= 3.0.0), tidygraph, tidyR</td>
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<td>VignetteBuilder</td>
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<td>Config/testthat/edition</td>
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<td>no</td>
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| bff | Find features most associated with cluster membership |

Description

Find features most associated with cluster membership

Usage

bff(loadings, features, num_best)

Arguments

- loadings An n by k matrix of weights that indicates how important that ith user is to the jth cluster, i.e., the Z or Y matrix calculated by vsp().
- features An n by d matrix of features measured for each node in the network.
- num_best An integer indicating how many of the top features for differentiating between loadings you want.

Details

See vignette("bff").

Value

An n by k matrix whose [i, j] entry is the ith "most important" feature for cluster j.
**bind_varimax_z**

Add Z factor loadings to node table of tidygraph

### Description

Add Z factor loadings to node table of tidygraph

### Usage

```r
bind_varimax_z(graph, fa, ...)
bind_varimax_y(graph, fa, ...)
bind_svd_u(graph, fa, ...)
bind_svd_v(graph, fa, ...)
```

### Arguments

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<tr>
<td><code>graph</code></td>
<td>A <code>tidygraph::tbl_graph</code> object.</td>
</tr>
<tr>
<td><code>fa</code></td>
<td>Optionally, a <code>vsp</code> object to extract varimax loadings from. If you do not passed a <code>vsp</code> object, one will be created.</td>
</tr>
<tr>
<td>...</td>
<td>Arguments passed on to <code>vsp</code></td>
</tr>
<tr>
<td><code>x</code></td>
<td>Either a graph adjacency matrix, <code>igraph::igraph</code> or <code>tidygraph::tbl_graph</code>. If <code>x</code> is a <code>matrix</code> or <code>Matrix::Matrix</code> then <code>x[i, j]</code> should correspond to the edge going from node <code>i</code> to node <code>j</code>.</td>
</tr>
<tr>
<td><code>rank</code></td>
<td>The number of factors to calculate.</td>
</tr>
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### Value

The same graph object with columns `factor1`, ..., `factor{rank}` in the table of node information.

### Functions

- `bind_varimax_y`: Add Y factor loadings to node table of tidygraph
- `bind_svd_u`: Add left singular vectors to node table of tidygraph
- `bind_svd_v`: Add right singular vectors to node table of tidygraph
get_svd_u

Get left singular vectors in a tibble

Description

Get left singular vectors in a tibble

Usage

get_svd_u(fa, factors = 1:fa$rank)
get_svd_v(fa, factors = 1:fa$rank)
get_varimax_z(fa, factors = 1:fa$rank)
get_varimax_y(fa, factors = 1:fa$rank)

Arguments

fa A vsp_fa() object.
factors The specific columns to index into. The most reliable option here is to index with an integer vector of column indices, but you could also use a character vector if columns have been named. By default returns all factors/singular vectors.

Value

A tibble::tibble() with one row for each node, and one column containing each of the requested factor or singular vector, plus an additional id column.

Functions

• get_svd_v: Get right singular vectors in a tibble
• get_varimax_z: Get varimax Y factors in a tibble
• get_varimax_y: Get varimax Z factors in a tibble

get_z_hubs

Get most important hubs for each Z factor

Description

Get most important hubs for each Z factor
plot_ipr_pairs

Usage

get_z_hubs(fa, hubs_per_factor = 10, factors = 1:fa$rank)

get_y_hubs(fa, hubs_per_factor = 10, factors = 1:fa$rank)

Arguments

fa
A vsp_fa() object.

hubs_per_factor
The number of important nodes to get per latent factor. Defaults to 10.

factors
The specific columns to index into. The most reliable option here is to index with an integer vector of column indices, but you could also use a character vector if columns have been named. By default returns all factors/singular vectors.

Value

A tibble::tibble() where each row corresponds to a single hub, and three columns:

- id: Node id of hub node
- factor: Which factor that node is a hub for. Nodes can be hubs of multiple factors.
- loading: The actual value of the hubs factor loading for that factor.

Functions

• get_y_hubs: Get most important hubs for each Y factor

plot_ipr_pairs

Plot pairs of inverse participation ratios for singular vectors

Description

When IPR for a given singular vector is \( O(1) \) rather than \( O(1 / \sqrt{n}) \), this can indicate that the singular vector is localizing on a small subset of nodes. Oftentimes this localization indicates overfitting. If you see IPR values that are not close to zero (where "close to zero" is something you sort of have to pick up over time), then you need to some further investigation to see if you have localization and that localization corresponds to overfitting. Note, however, that not all localization is overfitting.

Usage

plot_ipr_pairs(fa)

Arguments

fa
A vsp_fa() object.
plot_varimax_z_pairs

Value
A `tibble::tibble()` with one row for each node, and one column containing each of the requested factor or singular vector, plus an additional `id` column.

plot_mixing_matrix  
*Plot the mixing matrix B*

Description
Plot the mixing matrix B

Usage
plot_mixing_matrix(fa)

Arguments
fa  
A `vsp_fa()` object.

Value
A `tibble::tibble()` with one row for each node, and one column containing each of the requested factor or singular vector, plus an additional `id` column.

plot_varimax_z_pairs  
*Create a pairs plot of select Y factors*

Description
To avoid overplotting, plots data for a maximum of 1000 nodes. If there are more than 1000 nodes, samples 1000 nodes randomly proportional to row norms (i.e. nodes with embeddings larger in magnitude are more likely to be sampled).

Usage
plot_varimax_z_pairs(fa, factors = 1:min(5, fa$rank), ...)
plot_varimax_y_pairs(fa, factors = 1:min(5, fa$rank), ...)
plot_svd_u(fa, factors = 1:min(5, fa$rank))
plot_svd_v(fa, factors = 1:min(5, fa$rank))
Arguments

fa A `vsp_fa()` object.

factors The specific columns to index into. The most reliable option here is to index with an integer vector of column indices, but you could also use a character vector if columns have been named. By default returns all factors/singular vectors.

Arguments passed on to `GGally::ggpairs`

data data set using. Can have both numerical and categorical data.
ribbon aesthetic mapping (besides x and y). See `aes()`. If mapping is numeric, columns will be set to the mapping value and mapping will be set to NULL.

columns which columns are used to make plots. Defaults to all columns.
title title, x label, and y label for the graph
xlab title, x label, and y label for the graph
ylab title, x label, and y label for the graph
upper see Details
lower see Details
diag see Details

params deprecated. Please see `wrap_fn_with_param_arg`
axisLabels either "show" to display axisLabels, "internal" for labels in the diagonal plots, or "none" for no axis labels

columnLabels label names to be displayed. Defaults to names of columns being used.
labeller labeller for facets. See `labellers`. Common values are "label_value" (default) and "label_parsed".

switch switch parameter for facet_grid. See `ggplot2::facet_grid`. By default, the labels are displayed on the top and right of the plot. If "x", the top labels will be displayed to the bottom. If "y", the right-hand side labels will be displayed to the left. Can also be set to "both"

showStrips boolean to determine if each plot’s strips should be displayed.
NULL will default to the top and right side plots only. TRUE or FALSE will turn all strips on or off respectively.

legend May be the two objects described below or the default NULL value.
The legend position can be moved by using ggplot2’s theme element `pm + theme(legend.position = "bottom")`

a numeric vector of length 2 provides the location of the plot to use the legend for the plot matrix’s legend. Such as `legend = c(3,5)` which will use the legend from the plot in the third row and fifth column

a single numeric value provides the location of a plot according to the display order. Such as `legend = 3` in a plot matrix with 2 rows and 5 columns displayed by column will return the plot in position `c(1,2)`

a object from `grab_legend()` a predetermined plot legend that will be displayed directly

cardinality_threshold maximum number of levels allowed in a character / factor column. Set this value to NULL to not check factor columns. Defaults to 15
progress NULL (default) for a progress bar in interactive sessions with more than 15 plots, TRUE for a progress bar, FALSE for no progress bar, or a function that accepts at least a plot matrix and returns a new progress::progress_bar. See ggmatrix_progress.

proportions Value to change how much area is given for each plot. Either NULL (default), numeric value matching respective length, grid::unit object with matching respective length or "auto" for automatic relative proportions based on the number of levels for categorical variables.

Value

A ggplot2::ggplot() plot or GGally::ggpairs() plot.

Functions

- plot_varimax_y_pairs: Create a pairs plot of select Z factors
- plot_svd_u: Create a pairs plot of select left singular vectors
- plot_svd_v: Create a pairs plot of select right singular vectors

---

screeplot.vsp_fa  
Create a screeplot from a factor analysis object

Description

Create a screeplot from a factor analysis object

Usage

## S3 method for class 'vsp_fa'
screeplot(x, ...)

Arguments

x A vsp_fa() object.

... Ignored, included only for consistency with S3 generic.

Value

A tibble::tibble() with one row for each node, and one column containing each of the requested factor or singular vector, plus an additional id column.
**set_z_factor_names**  
Give the dimensions of Z factors informative names

### Description
Give the dimensions of Z factors informative names

### Usage
```
set_z_factor_names(fa, names)
set_y_factor_names(fa, names)
```

### Arguments
- `fa`: A `vsp_fa()` object.
- `names`: Describe new names for Z/Y factors.

### Value
A new `vsp_fa()` object, but the columns names of Z and the row names of B have been set to names (for `set_z_factor_names`), and the column names of B and the column names of Y have been set to names (for `set_y_factor_names`).

### Functions
- `set_y_factor_names`: Give the dimensions of Y factors informative names

---

**vsp**  
Semi-Parametric Factor Analysis via Vintage Sparse PCA

### Description
This code implements TODO.

### Usage
```
vsp(x, rank, ...)
```

## Default S3 method:
```
vsp(x, rank, ...)
```

## S3 method for class 'matrix'
```
vsp(x, rank, ...)
```

## S3 method for class 'matrix'
```
vsp(x, rank, ...)
```

## Default S3 method:
```
vsp(x, rank, ...)
```

## S3 method for class 'matrix'
```
vsp(x, rank, ...)
```
rank,
..., 
center = FALSE,
recenter = FALSE,
degree_normalize = TRUE,
renormalize = FALSE,
tau_row = NULL,
tau_col = NULL,
kaiser_normalize_u = FALSE,
kaiser_normalize_v = FALSE,
rownames = NULL,
colnames = NULL
)

## S3 method for class 'Matrix'
vsp(
  x,
  rank,
  ..., 
center = FALSE,
recenter = FALSE,
degree_normalize = TRUE,
renormalize = FALSE,
tau_row = NULL,
tau_col = NULL,
kaiser_normalize_u = FALSE,
kaiser_normalize_v = FALSE,
rownames = NULL,
colnames = NULL
)

## S3 method for class 'dgCMatrix'
vsp(
  x,
  rank,
  ..., 
center = FALSE,
recenter = FALSE,
degree_normalize = TRUE,
renormalize = FALSE,
tau_row = NULL,
tau_col = NULL,
kaiser_normalize_u = FALSE,
kaiser_normalize_v = FALSE,
rownames = NULL,
colnames = NULL
)
### S3 method for class 'igraph'

```r
vsp(x, rank, ..., edge_weights = NULL)
```

**Arguments**

- `x` Either a graph adjacency matrix, `igraph::igraph` or `tidygraph::tbl_graph`. If `x` is a `matrix` or `Matrix::Matrix` then `x[i, j]` should correspond to the edge going from node `i` to node `j`.
- `rank` The number of factors to calculate.
- `...` These dots are for future extensions and must be empty.
- `center` Should the adjacency matrix be row and column centered? Defaults to FALSE.
- `recenter` Should the varimax factors be re-centered around the original factor means? Only used when `center = TRUE`, defaults to FALSE.
- `degree_normalize` Should the regularized graph laplacian be used instead of the raw adjacency matrix? Defaults to TRUE. If `center = TRUE`, `A` will first be centered and then normalized.
- `renormalize` Should the regularized graph laplacian be used instead of the raw adjacency matrix? Defaults to TRUE. If `center = TRUE`, `A` will first be centered and then normalized.
- `tau_row` Row regularization term. Default is NULL, in which case we use the row degree. Ignored when `degree_normalize = FALSE`.
- `tau_col` Column regularization term. Default is NULL, in which case we use the column degree. Ignored when `degree_normalize = FALSE`.
- `kaiser_normalize_u` Whether or not to use Kaiser normalization when rotating the left singular vectors `U`. Defaults to FALSE.
- `kaiser_normalize_v` Whether or not to use Kaiser normalization when rotating the right singular vectors `V`. Defaults to FALSE.
- `rownames` Character vector of row names of `x`. These row names are propagated into the row names of the `U` and `Z`. Defaults to NULL.
- `colnames` Character vector of column names of `x`. These column names are propagated into the row names of the `V` and `Y`. Defaults to NULL.
- `edge_weights` When `x` is an `igraph::igraph`, an edge attribute to use to form a weighted adjacency matrix.

**Details**

Sparse SVDs use RSpectra for performance.

**Value**

An object of class `vsp`. TODO: Details
Examples

library(LRMF3)
vsp(ml100k, rank = 2)

**vsp.svd_like**

Perform varimax rotation on a low rank matrix factorization

**Description**

Perform varimax rotation on a low rank matrix factorization

**Usage**

```r
## S3 method for class 'svd_like'
vsp(
  x,
  rank,
  ..., 
  centerer = NULL,
  scaler = NULL,
  recenter = FALSE,
  renormalize = FALSE,
  kaiser_normalize_u = FALSE,
  kaiser_normalize_v = FALSE,
  rownames = NULL,
  colnames = NULL
)
```

**Arguments**

- **x**: Either a graph adjacency matrix, igraph::igraph or tidygraph::tbl_graph. If `x` is a matrix or Matrix::Matrix then `x[i, j]` should correspond to the edge going from node `i` to node `j`.
- **rank**: The number of factors to calculate.
- **...**: These dots are for future extensions and must be empty.
- **centerer**: TODO
- **scaler**: TODO
- **recenter**: Should the varimax factors be re-centered around the original factor means? Only used when `center` = TRUE, defaults to FALSE.
- **renormalize**: Should the regularized graph laplacian be used instead of the raw adjacency matrix? Defaults to TRUE. If `center` = TRUE, `A` will first be centered and then normalized.
kaiser_normalize_u
  Whether or not to use Kaiser normalization when rotating the left singular vectors U. Defaults to FALSE.

kaiser_normalize_v
  Whether or not to use Kaiser normalization when rotating the right singular vectors V. Defaults to FALSE.

rownames
  Character vector of row names of x. These row names are propagated into the row names of the U and Z. Defaults to NULL.

colnames
  Character vector of column names of x. These column names are propagated into the row names of the V and Y. Defaults to NULL.

Examples

library(LRMF3)
library(RSpectra)

s <- svds(ml100k, k = 2)
mf <- as_svd_like(s)
fa <- vsp(mf, rank = 2)

vsp_fa

Create a vintage sparse factor analysis object

Description

vsp_fa objects are a subclass of LRMF3::fa_like(), with additional fields u, d, v, transformers, R_U, and R_V

Usage

vsp_fa(
  u,
  d,
  v,
  Z,
  B,
  Y,
  transformers,
  R_U,
  R_V,
  rownames = NULL,
  colnames = NULL
)
Arguments

- u: A `matrix()` of "left singular-ish" vectors.
- d: A `numeric()` vector of "singular-ish" values.
- v: A `matrix()` of "right singular-ish" vectors.
- Z: A `matrix` of embeddings for each observation.
- B: A mixing `matrix` describing how observation embeddings and topics interact. Does not have to be diagonal!
- Y: A `matrix` describing the compositions of various topics or factors.
- transformers: A list of transformations from the `invertiforms` package.
- R_U: Varimax rotation matrix use to transform u into Z.
- R_V: Varimax rotation matrix use to transform v into Y.
- rownames: Identifying names for each row of the original data. Defaults to `NULL`, in which cases each row is given a row number left-padded with zeros as a name.
- colnames: Identifying names for each column of the original data. Defaults to `NULL`, in which cases each column is given a row column left-padded with zeros as a name.

Value

A `svd_fa` object.
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