

Package ‘dimensio’

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Title Multivariate Data Analysis

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Description Simple Principal Components Analysis (PCA) and Correspondence Analysis (CA) based on the Singular Value Decomposition (SVD). This package provides S4 classes and methods to compute, extract, summarize and visualize results of multivariate data analysis. It also includes methods for partial bootstrap validation described in Greenacre (1984) <isbn:978-0-12-299050-2> and Lebart et al. (2006) <isbn:978-2-10-049616-7>.

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URL <https://packages.tesselle.org/dimensio/>,
<https://github.com/tesselle/dimensio>

BugReports <https://github.com/tesselle/dimensio/issues>

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'dimensio-package.R' 'ggplot2.R' 'helpers.R' 'mutators.R'
'pca.R' 'plot.R' 'show.R' 'subset.R' 'summary.R' 'svd.R'
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R topics documented:

benthos	3
biplot	3
bootstrap	6
ca	7
CA-class	9
colours	10
countries	10
envelopes	11
get_contributions	13
get_coordinates	14
get_data	16
get_distances	16
get_eigenvalues	17
MultivariateAnalysis	18
MultivariateBootstrap	19
MultivariateResults	19
MultivariateSummary	20
mutators	21
pca	22
PCA-class	24
plot_contributions	25
plot_coordinates	27
plot_eigenvalues	30
predict	31
subset	32
summary	34
tidy	35
Index	37

benthos	<i>Benthos</i>
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Description

Abundances of Marine Species in Sea-Bed Samples

Usage

```
benthos
```

Format

A `data.frame` with 13 columns (sites) and 92 rows (species).

Source

<http://www.carme-n.org/?sec=data7>

See Also

Other datasets: [colours](#), [countries](#)

biplot	<i>Biplot</i>
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Description

Biplot

Usage

```
## S4 method for signature 'CA'
biplot(
  x,
  axes = c(1, 2),
  type = c("rows", "columns", "contributions"),
  active = TRUE,
  sup = TRUE,
  label = c("rows", "columns")
)

## S4 method for signature 'PCA'
biplot(
  x,
  axes = c(1, 2),
```

```

type = c("form", "covariance"),
active = TRUE,
sup = TRUE,
label = c("individuals", "variables")
)

```

Arguments

x	A CA or PCA object.
axes	A length-two numeric vector giving the dimensions to be plotted.
type	A character string specifying the biplot to be plotted (see below). It must be one of "rows", "columns", "contribution" (CA), "form" or "covariance" (PCA). Any unambiguous substring can be given.
active	A logical scalar: should the active observations be plotted?
sup	A logical scalar: should the supplementary observations be plotted?
label	A character vector specifying whether "rows"/"individuals" and/or "columns"/"variables" names must be mapped (e.g. for use with ggrepel::geom_label_repel()). Any unambiguous substring can be given.

Details

A biplot is the simultaneous representation of rows and columns of a rectangular dataset. It is the generalization of a scatterplot to the case of multivariate data: it allows to visualize as much information as possible in a single graph (Greenacre 2010).

Biplots have the drawbacks of their advantages: they can quickly become difficult to read as they display a lot of information at once. It may then be preferable to visualize the results for individuals and variables separately.

Value

A [ggplot2::ggplot](#) object.

PCA Biplots

form Form biplot (row-metric-preserving). The form biplot favors the representation of the individuals: the distance between the individuals approximates the Euclidean distance between rows. In the form biplot the length of a vector approximates the quality of the representation of the variable.

covariance Covariance biplot (column-metric-preserving). The covariance biplot favors the representation of the variables: the length of a vector approximates the standard deviation of the variable and the cosine of the angle formed by two vectors approximates the correlation between the two variables. In the covariance biplot the distance between the individuals approximates the Mahalanobis distance between rows.

CA Biplots

rows Row principal biplot.
columns Column principal biplot.
contribution Contribution biplot.

Author(s)

N. Frerebeau

References

Aitchison, J. and Greenacre, M. (2002). Biplots of Compositional Data. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 51(4): 375-92. doi:10.1111/14679876.00275.
Greenacre, M. J. *Biplots in Practice*. Bilbao: Fundación BBVA, 2010.

See Also

Other plot methods: [envelopes](#), [plot_contributions\(\)](#), [plot_coordinates](#), [plot_eigenvalues](#)

Examples

```
## Replicate examples from Greenacre 2007, p. 59-68
data("countries")

## Compute principal components analysis
## All rows and all columns obtain the same weight
row_w <- rep(1 / nrow(countries), nrow(countries)) # 1/13
col_w <- rep(1 / ncol(countries), ncol(countries)) # 1/6
Y <- pca(countries, scale = FALSE, weight_row = row_w, weight_col = col_w)

## Row-metric-preserving biplot (form biplot)
biplot(Y, type = "form") +
  ggrepel::geom_label_repel()

## Column-metric-preserving biplot (covariance biplot)
biplot(Y, type = "covariance") +
  ggrepel::geom_label_repel()

## Replicate examples from Greenacre 2007, p. 79-88
data("benthos")

## Compute correspondence analysis
X <- ca(benthos)

## Row principal CA biplot
biplot(X, type = "row") +
  ggrepel::geom_label_repel()

## Column principal CA biplot
biplot(X, type = "column") +
```

```
ggrepel::geom_label_repel()

## Contribution CA biplot
biplot(X, type = "contrib") +
  ggrepel::geom_label_repel()
```

bootstrap

Partial Bootstrap Analysis

Description

Checks analysis with partial bootstrap resampling.

Usage

```
bootstrap(object, ...)

## S4 method for signature 'CA'
bootstrap(object, n = 30)

## S4 method for signature 'PCA'
bootstrap(object, n = 30)
```

Arguments

object	A CA or PCA object.
...	Currently not used.
n	A non-negative integer giving the number of bootstrap replications.

Value

#' Returns a [BootstrapCA](#) or a [BootstrapPCA](#) object.

Author(s)

N. Frerebeau

References

Greenacre, Michael J. *Theory and Applications of Correspondence Analysis*. London: Academic Press, 1984.

Lebart, L., Piron, M. and Morineau, A. *Statistique exploratoire multidimensionnelle: visualisation et inférence en fouille de données*. Paris: Dunod, 2006.

Examples

```
## Bootstrap on CA
## Data from Lebart et al. 2006, p. 170-172
data("colours")

## Compute correspondence analysis
X <- ca(colours)

## Bootstrap (30 replicates)
Y <- bootstrap(X, n = 30)

## Not run:
## Get replicated coordinates
get_replications(Y, margin = 1)
get_replications(Y, margin = 2)

## End(Not run)

## Plot with ellipses
plot_rows(Y, colour = "group") +
  ggplot2::stat_ellipse()

## Plot with convex hulls
plot_columns(Y, colour = "group", fill = "group") +
  stat_hull(geom = "polygon", alpha = 0.5)

## Bootstrap on PCA
## Compute principal components analysis
data("iris")
X <- pca(iris)

## Bootstrap (30 replicates)
Y <- bootstrap(X, n = 30)

## Plot with ellipses
plot_columns(Y, colour = "group") +
  ggplot2::stat_ellipse()
```

ca

Correspondence Analysis

Description

Computes a simple correspondence analysis based on the singular value decomposition.

Usage

ca(object, ...)

```
## S4 method for signature 'data.frame'  
ca(object, rank = NULL, sup_row = NULL, sup_col = NULL)
```

```
## S4 method for signature 'matrix'  
ca(object, rank = NULL, sup_row = NULL, sup_col = NULL)
```

Arguments

object	A $m \times p$ numeric matrix or a data.frame .
...	Currently not used.
rank	An integer value specifying the maximal number of components to be kept in the results. If NULL (the default), $\min(m, p) - 1$ components will be returned.
sup_row	A numeric or logical vector specifying the indices of the supplementary rows.
sup_col	A numeric or logical vector specifying the indices of the supplementary columns.

Value

A [CA](#) object.

Author(s)

N. Frerebeau

References

Greenacre, M. J. *Theory and Applications of Correspondence Analysis*. London: Academic Press, 1984.

Greenacre, M. J. *Correspondence Analysis in Practice*. Seconde edition. Interdisciplinary Statistics Series. Boca Raton: Chapman & Hall/CRC, 2007.

Lebart, L., Piron, M. and Morineau, A. *Statistique exploratoire multidimensionnelle: visualisation et inférence en fouille de données*. Paris: Dunod, 2006.

See Also

[svd\(\)](#)

Other multivariate analysis: [pca\(\)](#), [predict\(\)](#)

Examples

```
## Data from Lebart et al. 2006, p. 170-172  
data("colours")  
  
## The chi square of independence between the two variables  
stats::chisq.test(colours)  
  
## Compute correspondence analysis  
X <- ca(colours)
```



```
## Get row coordinates
head(get_coordinates(X, margin = 1))

## Get column coordinates
head(get_coordinates(X, margin = 2))

## Get row distances to centroid
head(get_distances(X, margin = 1))

## Get row inertias
head(get_inertia(X, margin = 1))

## Get row contributions
head(get_contributions(X, margin = 1))

## Get eigenvalues
get_eigenvalues(X)
```

CA-class

CA Results

Description

An S4 class to store the results of a simple correspondence analysis.

Author(s)

N. Frerebeau

See Also

Other class: [MultivariateAnalysis](#), [MultivariateBootstrap](#), [MultivariateResults](#), [MultivariateSummary](#), [PCA-class](#)

Examples

```
## Data from Lebart et al. 2006, p. 170-172
data("colours")

## The chi square of independence between the two variables
stats::chisq.test(colours)

## Compute correspondence analysis
X <- ca(colours)

## Get row coordinates
head(get_coordinates(X, margin = 1))

## Get column coordinates
head(get_coordinates(X, margin = 2))
```

```
## Get row distances to centroid
head(get_distances(X, margin = 1))

## Get row inertias
head(get_inertia(X, margin = 1))

## Get row contributions
head(get_contributions(X, margin = 1))

## Get eigenvalues
get_eigenvalues(X)
```

colours

Colours

Description

Contingency table of eye and hair colours of different individuals.

Usage

colours

Format

A [data.frame](#) with 4 columns (hair colours) and 4 rows (eye colours).

Source

Lebart, L., Piron, M. and Morineau, A. *Statistique exploratoire multidimensionnelle: visualisation et inférence en fouille de données*. Paris: Dunod, 2006, p. 170-172

See Also

Other datasets: [benthos](#), [countries](#)

countries

Countries

Description

Student ratings of 13 countries on six attributes.

Usage

countries

Format

A `data.frame` with 6 columns (attributes) and 13 rows (countries).

Source

Greenacre, M. J. *Biplots in Practice*. Bilbao: Fundación BBVA, 2010.

See Also

Other datasets: [benthos](#), [colours](#)

 envelopes

Wrap Observations

Description

- `wrap_hull()` computes convex hull of a set of observations.

Usage

```
wrap_hull(x, ...)

stat_hull(
  mapping = NULL,
  data = NULL,
  geom = "polygon",
  position = "identity",
  na.rm = FALSE,
  show.legend = NA,
  inherit.aes = TRUE,
  ...
)

## S4 method for signature 'MultivariateAnalysis'
wrap_hull(x, margin = 1, axes = c(1, 2), group = NULL)

## S4 method for signature 'BootstrapPCA'
wrap_hull(x, axes = c(1, 2))
```

Arguments

<code>x</code>	An object from which to wrap observations (a CA or PCA object).
<code>...</code>	Currently not used.
<code>mapping</code>	Set of aesthetic mappings created by aes() or aes_() . If specified and <code>inherit.aes = TRUE</code> (the default), it is combined with the default mapping at the top level of the plot. You must supply mapping if there is no plot mapping.

<code>data</code>	<p>The data to be displayed in this layer. There are three options:</p> <p>If <code>NULL</code>, the default, the data is inherited from the plot data as specified in the call to <code>ggplot()</code>.</p> <p>A <code>data.frame</code>, or other object, will override the plot data. All objects will be fortified to produce a data frame. See <code>fortify()</code> for which variables will be created.</p> <p>A function will be called with a single argument, the plot data. The return value must be a <code>data.frame</code>, and will be used as the layer data. A function can be created from a formula (e.g. <code>~ head(.x, 10)</code>).</p>
<code>geom</code>	The geometric object to use display the data
<code>position</code>	Position adjustment, either as a string, or the result of a call to a position adjustment function.
<code>na.rm</code>	A <code>logical</code> scalar: should missing values be silently removed? If <code>FALSE</code> (the default), missing values are removed with a warning.
<code>show.legend</code>	<code>logical</code> . Should this layer be included in the legends? <code>NA</code> , the default, includes if any aesthetics are mapped. <code>FALSE</code> never includes, and <code>TRUE</code> always includes. It can also be a named <code>logical</code> vector to finely select the aesthetics to display.
<code>inherit.aes</code>	If <code>FALSE</code> , overrides the default aesthetics, rather than combining with them. This is most useful for helper functions that define both data and aesthetics and shouldn't inherit behaviour from the default plot specification, e.g. <code>borders()</code> .
<code>margin</code>	A length-one <code>numeric</code> vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
<code>axes</code>	A length-two <code>numeric</code> vector giving the dimensions to be for which to compute results.
<code>group</code>	A vector specifying the group an observation belongs to.

Value

- `stat_hull()` return a `ggplot2::layer()`.
- `wrap_hull()` return a `data.frame` of envelope principal coordinates. An extra column named `group` is added specifying the group an observation belongs to.

Author(s)

N. Frerebeau

References

<https://ggplot2.tidyverse.org/articles/extending-ggplot2.html>

See Also

Other plot methods: `biplot()`, `plot_contributions()`, `plot_coordinates`, `plot_eigenvalues`

Examples

```
## Load data
data("iris")

## Compute principal components analysis
X <- pca(iris, scale = TRUE)

## Plot results
plot_rows(X, colour = "group", group = iris$Species) +
  khroma::scale_colour_highcontrast()

## Convex hull coordinates
hulls <- wrap_hull(X, group = iris$Species)
head(hulls)

## Plot with convex hulls
plot_rows(X, colour = "group", group = iris$Species) +
  stat_hull(geom = "path") +
  khroma::scale_colour_highcontrast()
```

get_contributions *Get Contributions*

Description

Get Contributions

Usage

```
get_contributions(x, ...)

get_correlations(x, ...)

get_cos2(x, ...)

## S4 method for signature 'MultivariateAnalysis'
get_contributions(x, margin = 1)

## S4 method for signature 'PCA'
get_correlations(x, sup_name = ".sup")

## S4 method for signature 'MultivariateAnalysis'
get_cos2(x, margin = 1, sup_name = ".sup")
```

Arguments

x An object from which to get element(s) (a [CA](#) or [PCA](#) object).

... Currently not used.

margin	A length-one numeric vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
sup_name	A character string specifying the name of the column to create for supplementary points attribution (see below).

Value

- `get_contributions()` returns a **data.frame** of contributions to the definition of the principal dimensions.
- `get_correlations()` returns a **data.frame** of correlations between variables and dimensions (PCA). An extra column (named after `sup_name`) is added specifying whether an observation is a supplementary point or not.
- `get_cos2()` returns a **data.frame** of \cos^2 values (i.e. quality of the representation of the points on the factor map). An extra column (named after `sup_name`) is added specifying whether an observation is a supplementary point or not.

Author(s)

N. Frerebeau

See Also

Other mutators: `get_coordinates()`, `get_data()`, `get_distances()`, `get_eigenvalues()`, `mutators`, `subset()`

get_coordinates	<i>Get Coordinates</i>
-----------------	------------------------

Description

Get Coordinates

Usage

```
get_coordinates(x, ...)

get_replications(x, ...)

## S4 method for signature 'MultivariateAnalysis'
get_coordinates(x, margin = 1, principal = TRUE, sup_name = ".sup")

## S4 method for signature 'MultivariateBootstrap'
get_replications(x, margin = 1)

## S4 method for signature 'BootstrapPCA'
get_replications(x)
```

Arguments

x	An object from which to get element(s) (a CA or PCA object).
...	Currently not used.
margin	A length-one numeric vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
principal	A logical scalar: should principal coordinates be returned? If FALSE, standard coordinates are returned.
sup_name	A character string specifying the name of the column to create for supplementary points attribution (see below).

Value

- `get_coordinates()` returns a [data.frame](#) of coordinates. An extra column (named after `sup_name`) is added specifying whether an observation is a supplementary point or not.
- `get_replications()` returns an [array](#) of coordinates.

Author(s)

N. Frerebeau

See Also

Other mutators: [get_contributions\(\)](#), [get_data\(\)](#), [get_distances\(\)](#), [get_eigenvalues\(\)](#), [mutators](#), [subset\(\)](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
X <- pca(iris, scale = TRUE, sup_row = 5:10)

## Get row principal coordinates
head(get_coordinates(X, margin = 1, principal = TRUE))

## Get row standard coordinates
head(get_coordinates(X, margin = 1, principal = FALSE))

## Tidy principal coordinates
head(tidy(X, margin = 1))
head(tidy(X, margin = 2))

head(augment(X, margin = 1, axes = c(1, 2)))
head(augment(X, margin = 2, axes = c(1, 2)))
```

get_data	<i>Get Original Data</i>
----------	--------------------------

Description

Get Original Data

Usage

```
get_data(x, ...)
```

```
## S4 method for signature 'MultivariateAnalysis'  
get_data(x)
```

Arguments

x	An object from which to get element(s) (a CA or PCA object).
...	Currently not used.

Value

Returns a [data.frame](#) of original data.

Author(s)

N. Frerebeau

See Also

Other mutators: [get_contributions\(\)](#), [get_coordinates\(\)](#), [get_distances\(\)](#), [get_eigenvalues\(\)](#), [mutators](#), [subset\(\)](#)

get_distances	<i>Get Distances</i>
---------------	----------------------

Description

Get Distances

Usage

```
get_distances(x, ...)
```

```
## S4 method for signature 'MultivariateAnalysis'  
get_distances(x, margin = 1)
```


Arguments

x	An object from which to get element(s) (a CA or PCA object).
...	Currently not used.
margin	A length-one numeric vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.

Value

- `get_distances()` returns a [numeric](#) vector of squared distance to the centroid.

Author(s)

N. Frerebeau

See Also

Other mutators: [get_contributions\(\)](#), [get_coordinates\(\)](#), [get_data\(\)](#), [get_eigenvalues\(\)](#), [mutators](#), [subset\(\)](#)

get_eigenvalues	<i>Get Eigenvalues</i>
-----------------	------------------------

Description

Get Eigenvalues

Usage

```
get_eigenvalues(x)
```

```
get_inertia(x, ...)
```

```
get_variance(x, ...)
```

```
## S4 method for signature 'MultivariateAnalysis'  
get_eigenvalues(x)
```

```
## S4 method for signature 'MultivariateAnalysis'  
get_inertia(x, margin = 1)
```

```
## S4 method for signature 'MultivariateAnalysis'  
get_variance(x, digits = 2)
```

Arguments

<code>x</code>	An object from which to get element(s) (a CA or PCA object).
<code>...</code>	Currently not used.
<code>margin</code>	A length-one numeric vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
<code>digits</code>	An integer indicating the number of decimal places to be used.

Value

- `get_eigenvalues()` returns a [data.frame](#) with the following columns: eigenvalues, variance (percentage of variance) and cumulative (cumulative percentage of variance).
- `get_variance()` returns a [numeric](#) vector giving the percentage of explained variance of each dimension.
- `get_inertia()` returns a [numeric](#) vector.

Author(s)

N. Frerebeau

See Also

Other mutators: [get_contributions\(\)](#), [get_coordinates\(\)](#), [get_data\(\)](#), [get_distances\(\)](#), [mutators](#), [subset\(\)](#)

MultivariateAnalysis *Output of Multivariate Data Analysis*

Description

A virtual S4 class to store the output of a multivariate data analysis.

Slots

`data` A [numeric matrix](#).
`dimension` An [integer](#) giving the dimension of the solution.
`singular_values` A [numeric](#) vector giving the singular values.
`rows` A [MultivariateResults](#) object.
`columns` A [MultivariateResults](#) object.

Subset

In the code snippets below, `x` is a [MultivariateAnalysis](#) object.

`x[[i]]` Extracts information from a slot selected by subscript `i`. `i` is a length-one [character](#) vector.

Author(s)

N. Frerebeau

See Also

Other class: [CA-class](#), [MultivariateBootstrap](#), [MultivariateResults](#), [MultivariateSummary](#), [PCA-class](#)

MultivariateBootstrap *Output of Bootstrap Replications*

Description

A virtual S4 class to store the output of a bootstrap analysis.

Slots

replications An [integer](#) giving the number of bootstrap replications.

Author(s)

N. Frerebeau

See Also

Other class: [CA-class](#), [MultivariateAnalysis](#), [MultivariateResults](#), [MultivariateSummary](#), [PCA-class](#)

MultivariateResults *Multivariate Data Analysis Results*

Description

An S4 class to store the results of a multivariate data analysis.

Slots

names A [character](#) vector specifying the row names.

principal A [numeric matrix](#) giving the principal coordinates.

standard A [numeric matrix](#) giving the standard coordinates.

contributions A [numeric matrix](#) giving the contributions to the definition of the dimensions.

cosine A [numeric matrix](#) giving the \cos^2 values.

distances A [numeric](#) vector giving the distances to centroid.

weights A [numeric](#) vector giving the masses/weights.

supplement A [logical](#) vector specifying the supplementary points.

order An [integer](#) vector giving the original indices of the data (computation moves all supplementary points at the end of the results).

groups A [character](#) vector specifying the class for each observation.

Author(s)

N. Frerebeau

See Also

Other class: [CA-class](#), [MultivariateAnalysis](#), [MultivariateBootstrap](#), [MultivariateSummary](#), [PCA-class](#)

MultivariateSummary *Summary of Multivariate Data Analysis*

Description

A virtual S4 class to store the summary of a multivariate data analysis.

Slots

data A [numeric matrix](#).

eigenvalues A [numeric matrix](#).

results A [numeric matrix](#).

supplement A [logical](#) vector specifying the supplementary points.

margin An [integer](#).

Author(s)

N. Frerebeau

See Also

Other class: [CA-class](#), [MultivariateAnalysis](#), [MultivariateBootstrap](#), [MultivariateResults](#), [PCA-class](#)

mutators

Get Results

Description

Getters to retrieve parts of an object.

Usage

```
## S4 method for signature 'MultivariateAnalysis'  
dim(x)  
  
## S4 method for signature 'MultivariateAnalysis'  
rownames(x)  
  
## S4 method for signature 'MultivariateAnalysis'  
colnames(x)  
  
## S4 method for signature 'MultivariateAnalysis'  
dimnames(x)  
  
## S4 method for signature 'PCA'  
loadings(x)
```

Arguments

x An object from which to get element(s) (a [CA](#) or [PCA](#) object).

Value

loadings() returns variable loadings (i.e. the coefficients of the linear combination of the original variables). loadings() is only implemented for consistency with `[stats][stats::loadings]`.

Author(s)

N. Frerebeau

See Also

Other mutators: [get_contributions\(\)](#), [get_coordinates\(\)](#), [get_data\(\)](#), [get_distances\(\)](#), [get_eigenvalues\(\)](#), [subset\(\)](#)

Description

Computes a principal components analysis based on the singular value decomposition.

Usage

```
pca(object, ...)  
  
## S4 method for signature 'data.frame'  
pca(  
  object,  
  center = TRUE,  
  scale = TRUE,  
  rank = NULL,  
  sup_row = NULL,  
  sup_col = NULL,  
  weight_row = NULL,  
  weight_col = NULL  
)  
  
## S4 method for signature 'matrix'  
pca(  
  object,  
  center = TRUE,  
  scale = TRUE,  
  rank = NULL,  
  sup_row = NULL,  
  sup_col = NULL,  
  weight_row = NULL,  
  weight_col = NULL  
)
```

Arguments

object	A $m \times p$ numeric matrix or a data.frame .
...	Currently not used.
center	A logical scalar: should the variables be shifted to be zero centered?
scale	A logical scalar: should the variables be scaled to unit variance?
rank	An integer value specifying the maximal number of components to be kept in the results. If NULL (the default), $p - 1$ components will be returned.
sup_row	A numeric or logical vector specifying the indices of the supplementary rows (individuals).

sup_col	A numeric or logical vector specifying the indices of the supplementary columns (variables).
weight_row	A numeric vector specifying the active row (individual) weights. If NULL (the default), uniform weights are used. Row weights are internally normalized to sum 1
weight_col	A numeric vector specifying the active column (variable) weights. If NULL (the default), uniform weights (1) are used.

Value

A **PCA** object.

Author(s)

N. Frerebeau

References

Lebart, L., Piron, M. and Morineau, A. *Statistique exploratoire multidimensionnelle: visualisation et inférence en fouille de données*. Paris: Dunod, 2006.

See Also

[svd\(\)](#)

Other multivariate analysis: [ca\(\)](#), [predict\(\)](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
X <- pca(iris, scale = TRUE, sup_row = sample(150, 10), sup_col = 2)

## Get row coordinates
head(get_coordinates(X, margin = 1))

## Get column coordinates
head(get_coordinates(X, margin = 2))

## Get row contributions
head(get_contributions(X, margin = 1))

## Get correlations between variables and dimensions
head(get_correlations(X))

## Get eigenvalues
get_eigenvalues(X)
```

PCA-class

PCA Results

Description

An S4 class to store the results of a principal components analysis.

Slots

center A **numeric** vector giving the column mean of the initial dataset (active individuals only).

scale A **numeric** vector giving the column standard deviations of the initial dataset (active individuals only).

Author(s)

N. Frerebeau

See Also

Other class: [CA-class](#), [MultivariateAnalysis](#), [MultivariateBootstrap](#), [MultivariateResults](#), [MultivariateSummary](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
X <- pca(iris, scale = TRUE, sup_row = sample(150, 10), sup_col = 2)

## Get row coordinates
head(get_coordinates(X, margin = 1))

## Get column coordinates
head(get_coordinates(X, margin = 2))

## Get row contributions
head(get_contributions(X, margin = 1))

## Get correlations between variables and dimensions
head(get_correlations(X))

## Get eigenvalues
get_eigenvalues(X)
```

plot_contributions *Visualize Contributions and cos²*

Description

Plots contributions histogram and \cos^2 scatterplot.

Usage

```
plot_contributions(object, ...)  
  
plot_cos2(object, ...)  
  
## S4 method for signature 'MultivariateAnalysis'  
plot_contributions(  
  object,  
  margin = 2,  
  axes = 1,  
  sort = TRUE,  
  decreasing = TRUE,  
  limit = 10,  
  fill = "grey30",  
  border = "grey10"  
)  
  
## S4 method for signature 'MultivariateAnalysis'  
plot_cos2(  
  object,  
  margin = 2,  
  axes = c(1, 2),  
  active = TRUE,  
  sup = TRUE,  
  sort = TRUE,  
  decreasing = TRUE,  
  limit = 10,  
  fill = "grey30",  
  border = "grey10"  
)
```

Arguments

object	A CA or PCA object.
...	Currently not used.
margin	A length-one numeric vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
axes	A length-one numeric vector giving the dimensions to be plotted.

sort	A logical scalar: should the data be sorted?
decreasing	A logical scalar: should the sort order be decreasing? Only used if sort is TRUE.
limit	An integer specifying the number of top elements to be displayed.
fill, border	A character string specifying the bars infilling and border colors.
active	A logical scalar: should the active observations be plotted?
sup	A logical scalar: should the supplementary observations be plotted?

Value

A [ggplot2::ggplot](#) object.

Author(s)

N. Frerebeau

See Also

Other plot methods: [biplot\(\)](#), [envelopes](#), [plot_coordinates](#), [plot_eigenvalues](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
Y <- pca(iris, scale = TRUE)

## Plot results
plot_individuals(Y, colour = "group", shape = "group", group = iris$Species) +
  khroma::scale_colour_highcontrast()

plot_individuals(Y, colour = "group", size = "cos2", group = iris$Sepal.Width) +
  khroma::scale_color_YlOrBr()

plot_individuals(Y, colour = "contribution", size = "contribution") +
  khroma::scale_color_iridescent(range = c(0.5, 1))

plot_variables(Y, colour = "contribution") +
  ggrepel::geom_label_repel() +
  khroma::scale_color_YlOrBr(range = c(0.5, 1))
```

plot_coordinates	<i>Visualize Factor Map</i>
------------------	-----------------------------

Description

Plots principal coordinates.

Usage

```
plot_rows(object, ...)
```

```
plot_columns(object, ...)
```

```
plot_individuals(object, ...)
```

```
plot_variables(object, ...)
```

```
## S4 method for signature 'MultivariateAnalysis'
```

```
plot_rows(  
  object,  
  axes = c(1, 2),  
  active = TRUE,  
  sup = TRUE,  
  alpha = NULL,  
  colour = NULL,  
  fill = NULL,  
  shape = NULL,  
  size = NULL,  
  group = NULL  
)
```

```
## S4 method for signature 'MultivariateAnalysis'
```

```
plot_columns(  
  object,  
  axes = c(1, 2),  
  active = TRUE,  
  sup = TRUE,  
  alpha = NULL,  
  colour = NULL,  
  fill = NULL,  
  shape = NULL,  
  size = NULL,  
  group = NULL  
)
```

```
## S4 method for signature 'BootstrapPCA'
```

```
plot_columns(  
  object,  
  axes = c(1, 2),  
  active = TRUE,  
  sup = TRUE,  
  alpha = NULL,  
  colour = NULL,  
  fill = NULL,  
  shape = NULL,  
  size = NULL,  
  group = NULL  
)
```

```

    object,
    axes = c(1, 2),
    active = TRUE,
    sup = TRUE,
    alpha = NULL,
    colour = NULL,
    fill = NULL,
    shape = NULL,
    size = NULL,
    group = NULL
)

## S4 method for signature 'PCA'
plot_individuals(
  object,
  axes = c(1, 2),
  active = TRUE,
  sup = TRUE,
  alpha = NULL,
  colour = NULL,
  fill = NULL,
  shape = NULL,
  size = NULL,
  group = NULL
)

## S4 method for signature 'PCA'
plot_variables(
  object,
  axes = c(1, 2),
  active = TRUE,
  sup = TRUE,
  alpha = NULL,
  colour = NULL,
  linetype = NULL,
  size = NULL,
  group = NULL
)

```

Arguments

object	A CA or PCA object.
...	Currently not used.
axes	A length-two numeric vector giving the dimensions to be plotted.
active	A logical scalar: should the active observations be plotted?
sup	A logical scalar: should the supplementary observations be plotted?
alpha, colour, fill, linetype, shape, size	A character string specifying the information to be highlighted (will be mapped

to the corresponding aesthetic). It must be one of "observation", "mass", "sum", "contribution", "cos2" or "group" (see details). Any unambiguous substring can be given. If NULL (the default), no highlighting is applied.

group A vector of categories specifying the categorical variable from which to highlight the individuals (only used if at least one of colour, fill, linetype or shape is set to group; see details).

Details

observation Whether an observation is active or supplementary.

mass Weight/mass of each observation.

sum Sum of squared coordinates along axes.

contribution Joint contributions to the definition of axes.

cos2 Joint \cos^2 along axes.

Value

A `ggplot2::ggplot` object.

Author(s)

N. Frerebeau

See Also

Other plot methods: [biplot\(\)](#), [envelopes](#), [plot_contributions\(\)](#), [plot_eigenvalues](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
Y <- pca(iris, scale = TRUE)

## Plot results
plot_individuals(Y, colour = "group", shape = "group", group = iris$Species) +
  khroma::scale_colour_highcontrast()

plot_individuals(Y, colour = "group", size = "cos2", group = iris$Sepal.Width) +
  khroma::scale_color_YlOrBr()

plot_individuals(Y, colour = "contribution", size = "contribution") +
  khroma::scale_color_iridescent(range = c(0.5, 1))

plot_variables(Y, colour = "contribution") +
  ggrepel::geom_label_repel() +
  khroma::scale_color_YlOrBr(range = c(0.5, 1))
```

plot_eigenvalues *Visualize Eigenvalues*

Description

Plot eigenvalues or variances histogram.

Usage

```
plot_variance(object, ...)  
  
## S4 method for signature 'MultivariateAnalysis'  
plot_variance(  
  object,  
  variance = TRUE,  
  cumulative = TRUE,  
  fill = "grey30",  
  border = "grey10",  
  colour = "red"  
)
```

Arguments

object	A CA or PCA object.
...	Currently not used.
variance	A logical scalar: should the percentages of variance be plotted instead of the eigenvalues?
cumulative	A logical scalar: should the cumulative percentages of variance be plotted?
fill, border	A character string specifying the bars infilling and border colors.
colour	A character string specifying the line color.

Value

A [ggplot2::ggplot](#) object.

Author(s)

N. Frerebeau

See Also

Other plot methods: [biplot\(\)](#), [envelopes](#), [plot_contributions\(\)](#), [plot_coordinates](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
Y <- pca(iris, scale = TRUE)

## Plot results
plot_individuals(Y, colour = "group", shape = "group", group = iris$Species) +
  khroma::scale_colour_highcontrast()

plot_individuals(Y, colour = "group", size = "cos2", group = iris$Sepal.Width) +
  khroma::scale_color_YlOrBr()

plot_individuals(Y, colour = "contribution", size = "contribution") +
  khroma::scale_color_iridescent(range = c(0.5, 1))

plot_variables(Y, colour = "contribution") +
  ggrepel::geom_label_repel() +
  khroma::scale_color_YlOrBr(range = c(0.5, 1))
```

predict

Predict New Coordinates

Description

Predict the projection of new individuals/rows or variables/columns.

Usage

```
## S4 method for signature 'CA'
predict(object, newdata, margin = 1)

## S4 method for signature 'PCA'
predict(object, newdata, margin = 1)
```

Arguments

object	A CA or PCA object.
newdata	An object of supplementary points coercible to a matrix for which to compute principal coordinates.
margin	A length-one numeric vector giving the subscript which the data will be predicted: 1 indicates individuals/rows (the default), 2 indicates variables/columns.

Value

A [data.frame](#) of coordinates.

Author(s)

N. Frerebeau

See AlsoOther multivariate analysis: [ca\(\)](#), [pca\(\)](#)**Examples**

```
## Create a matrix
A <- matrix(data = sample(1:10, 100, TRUE), nrow = 10, ncol = 10)

## Compute correspondence analysis
X <- ca(A, sup_row = 8:10, sup_col = 7:10)

## Predict new row coordinates
Y <- matrix(data = sample(1:10, 120, TRUE), nrow = 20, ncol = 6)
predict(X, Y, margin = 1)

## Predict new column coordinates
Z <- matrix(data = sample(1:10, 140, TRUE), nrow = 7, ncol = 20)
predict(X, Z, margin = 2)
```

subset

Extract Parts of an Object

Description

Operators acting on objects to extract parts.

Usage

```
## S4 method for signature 'CA,ANY,missing'
x[[i]]

## S4 method for signature 'PCA,ANY,missing'
x[[i]]
```

Arguments

x An object from which to extract element(s) or in which to replace element(s).

i A [character](#) string specifying elements to extract. Any unambiguous substring can be given (see details).

Details

If `i` is "data", returns a list with the following elements:

`data` A **numeric** matrix of raw data.

`mean` A **numeric** vector giving the variables means (PCA).

`sd` A **numeric** vector giving the variables standard deviations (PCA).

If `i` is "rows", returns a list with the following elements:

`coord` A **numeric** matrix of rows/individuals coordinates.

`cos2` A **numeric** matrix of rows/individuals squared cosine.

`masses` A **numeric** vector giving the rows masses/individual weights.

`sup` A **logical** vector specifying whether a point is a supplementary observation or not.

If `i` is "columns", returns a list with the following elements:

`coord` A **numeric** matrix of columns/variables coordinates.

`cor` A **numeric** matrix of correlation between variables and the dimensions (PCA).

`cos2` A **numeric** matrix of columns/variables squared cosine.

`masses` A **numeric** vector giving the columns masses/variable weights.

`sup` A **logical** vector specifying whether a point is a supplementary observation or not.

If `i` is "eigenvalues", returns a **numeric** vector of eigenvalues.

Value

A **list**.

Author(s)

N. Frerebeau

See Also

Other mutators: [get_contributions\(\)](#), [get_coordinates\(\)](#), [get_data\(\)](#), [get_distances\(\)](#), [get_eigenvalues\(\)](#), [mutators](#)

Examples

```
## Load data
data("iris")

## Compute principal components analysis
X <- pca(iris, scale = TRUE, sup_row = 8:10, sup_col = 1)

## Get results for the individuals
X[["rows"]]
```

summary

Object Summaries

Description

Provides a summary of the results of a multivariate data analysis.

Usage

```
## S4 method for signature 'CA'  
summary(object, margin = 1, active = TRUE, sup = TRUE, rank = 3)
```

```
## S4 method for signature 'PCA'  
summary(object, margin = 1, active = TRUE, sup = TRUE, rank = 3)
```

Arguments

object	A CA or PCA object.
margin	A length-one numeric vector giving the subscript which the data will be summarized: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
active	A logical scalar: should the active observations be summarized?
sup	A logical scalar: should the supplementary observations be summarized?
rank	An integer value specifying the maximal number of components to be kept in the results.

Author(s)

N. Frerebeau

Examples

```
## Data from Lebart et al. 2006, p. 170-172  
data("colours")  
  
## Compute correspondence analysis  
X <- ca(colours)  
  
## Rows summary  
summary(X, margin = 1)  
  
## Columns summary  
summary(X, margin = 2)
```

tidy	<i>Tidy Coordinates</i>
------	-------------------------

Description

Tidy Coordinates

Usage

```
tidy(x, ...)

augment(x, ...)

## S4 method for signature 'MultivariateAnalysis'
tidy(x, margin = 1, principal = TRUE, ...)

## S4 method for signature 'MultivariateAnalysis'
augment(x, margin = 1, axes = c(1, 2), principal = TRUE, ...)
```

Arguments

x	A CA or PCA object.
...	Currently not used.
margin	A length-one numeric vector giving the subscript which the data will be returned: 1 indicates individuals/rows (the default), 2 indicates variables/columns.
principal	A logical scalar: should principal coordinates be returned? If FALSE, standard coordinates are returned.
axes	A length-two numeric vector giving the dimensions to be for which to compute results.

Value

- tidy() returns a long [data.frame](#) with the following columns:
 - label Row/column names of the original data.
 - component Component.
 - supplementary Whether an observation is active or supplementary.
 - coordinate Coordinates.
 - contribution Contributions to the definition of the components.
 - cos2 \cos^2 .
- augment() returns a wide [data.frame](#) of the row/column coordinates along axes and the following columns:
 - label Row/column names of the original data.
 - supplementary Whether an observation is active or supplementary.
 - mass Weight/mass of each observation.

sum Sum of squared coordinates along axes.
contribution Joint contributions to the definition of axes.
cos2 Joint \cos^2 along axes.

Author(s)

N. Frerebeau

Examples

```
## Load data
data("iris")

## Compute principal components analysis
X <- pca(iris, scale = TRUE, sup_row = 5:10)

## Get row principal coordinates
head(get_coordinates(X, margin = 1, principal = TRUE))

## Get row standard coordinates
head(get_coordinates(X, margin = 1, principal = FALSE))

## Tidy principal coordinates
head(tidy(X, margin = 1))
head(tidy(X, margin = 2))

head(augment(X, margin = 1, axes = c(1, 2)))
head(augment(X, margin = 2, axes = c(1, 2)))
```

Index

- * **class**
 - CA-class, 9
 - MultivariateAnalysis, 18
 - MultivariateBootstrap, 19
 - MultivariateResults, 19
 - MultivariateSummary, 20
 - PCA-class, 24
- * **datasets**
 - benthos, 3
 - colours, 10
 - countries, 10
- * **multivariate analysis**
 - ca, 7
 - pca, 22
 - predict, 31
- * **mutators**
 - get_contributions, 13
 - get_coordinates, 14
 - get_data, 16
 - get_distances, 16
 - get_eigenvalues, 17
 - mutators, 21
 - subset, 32
- * **plot methods**
 - biplot, 3
 - envelopes, 11
 - plot_contributions, 25
 - plot_coordinates, 27
 - plot_eigenvalues, 30
- * **resampling methods**
 - bootstrap, 6
- * **summary**
 - summary, 34
- * **tidy methods**
 - tidy, 35
- .BootstrapCA (CA-class), 9
- .BootstrapPCA (PCA-class), 24
- .CA (CA-class), 9
- .MultivariateAnalysis
 - (MultivariateAnalysis), 18
 - .MultivariateBootstrap
 - (MultivariateBootstrap), 19
 - .MultivariateResults
 - (MultivariateResults), 19
 - .MultivariateSummary
 - (MultivariateSummary), 20
 - .PCA (PCA-class), 24
 - .SummaryCA (MultivariateSummary), 20
 - .SummaryPCA (MultivariateSummary), 20
 - [[, CA, ANY, missing-method (subset), 32
 - [[, PCA, ANY, missing-method (subset), 32
- aes(), 11
- aes_(), 11
- array, 15
- augment (tidy), 35
- augment, MultivariateAnalysis-method
 - (tidy), 35
- augment-method (tidy), 35

- benthos, 3, 10, 11
- biplot, 3, 12, 26, 29, 30
- biplot, CA-method (biplot), 3
- biplot, PCA-method (biplot), 3
- bootstrap, 6
- bootstrap, CA-method (bootstrap), 6
- bootstrap, PCA-method (bootstrap), 6
- bootstrap-method (bootstrap), 6
- BootstrapCA, 6
- BootstrapCA-class (CA-class), 9
- BootstrapPCA, 6
- BootstrapPCA-class (PCA-class), 24
- borders(), 12

- CA, 4, 6, 8, 11, 13, 15–18, 21, 25, 28, 30, 31, 34, 35
- ca, 7, 23, 32
- ca, data.frame-method (ca), 7
- ca, matrix-method (ca), 7

- CA-class, 9
- ca-method (ca), 7
- character, 4, 14, 15, 18–20, 26, 28, 30, 32
- colnames, MultivariateAnalysis-method (mutators), 21
- colours, 3, 10, 11
- countries, 3, 10, 10
- data.frame, 3, 8, 10–12, 14–16, 18, 22, 31, 35
- dim, MultivariateAnalysis-method (mutators), 21
- dimnames, MultivariateAnalysis-method (mutators), 21
- envelopes, 5, 11, 26, 29, 30
- fortify(), 12
- get_contributions, 13, 15–18, 21, 33
- get_contributions, MultivariateAnalysis-method (get_contributions), 13
- get_contributions-method (get_contributions), 13
- get_coordinates, 14, 14, 16–18, 21, 33
- get_coordinates, MultivariateAnalysis-method (get_coordinates), 14
- get_coordinates-method (get_coordinates), 14
- get_correlations (get_contributions), 13
- get_correlations, PCA-method (get_contributions), 13
- get_correlations-method (get_contributions), 13
- get_cos2 (get_contributions), 13
- get_cos2, MultivariateAnalysis-method (get_contributions), 13
- get_cos2-method (get_contributions), 13
- get_data, 14, 15, 16, 17, 18, 21, 33
- get_data, MultivariateAnalysis-method (get_data), 16
- get_data-method (get_data), 16
- get_distances, 14–16, 16, 18, 21, 33
- get_distances, MultivariateAnalysis-method (get_distances), 16
- get_distances-method (get_distances), 16
- get_eigenvalues, 14–17, 17, 21, 33
- get_eigenvalues, MultivariateAnalysis-method (get_eigenvalues), 17
- get_eigenvalues-method (get_eigenvalues), 17
- get_inertia (get_eigenvalues), 17
- get_inertia, MultivariateAnalysis-method (get_eigenvalues), 17
- get_inertia-method (get_eigenvalues), 17
- get_replications (get_coordinates), 14
- get_replications, BootstrapPCA-method (get_coordinates), 14
- get_replications, MultivariateBootstrap-method (get_coordinates), 14
- get_replications-method (get_coordinates), 14
- get_variance (get_eigenvalues), 17
- get_variance, MultivariateAnalysis-method (get_eigenvalues), 17
- get_variance-method (get_eigenvalues), 17
- ggplot(), 12
- ggplot2::ggplot, 4, 26, 29, 30
- ggplot2::layer(), 12
- ggrepel::geom_label_repel(), 4
- integer, 6, 8, 18–20, 22, 26, 34
- list, 33
- loadings, PCA-method (mutators), 21
- logical, 4, 8, 12, 15, 20, 22, 23, 26, 28, 30, 33–35
- matrix, 8, 18–20, 22, 31
- MultivariateAnalysis, 9, 18, 19, 20, 24
- MultivariateAnalysis-class (MultivariateAnalysis), 18
- MultivariateBootstrap, 9, 19, 19, 20, 24
- MultivariateBootstrap-class (MultivariateBootstrap), 19
- MultivariateResults, 9, 18, 19, 19, 20, 24
- MultivariateResults-class (MultivariateResults), 19
- MultivariateSummary, 9, 19, 20, 20, 24
- MultivariateSummary-class (MultivariateSummary), 20
- mutators, 14–18, 21, 33
- numeric, 4, 8, 12, 14, 15, 17–20, 22–25, 28, 31, 33–35
- PCA, 4, 6, 11, 13, 15–18, 21, 23, 25, 28, 30, 31, 34, 35
- pca, 8, 22, 32

- pca, data.frame-method (pca), 22
- pca, matrix-method (pca), 22
- PCA-class, 24
- pca-method (pca), 22
- plot_columns (plot_coordinates), 27
- plot_columns, BootstrapPCA-method (plot_coordinates), 27
- plot_columns, MultivariateAnalysis-method (plot_coordinates), 27
- plot_columns-method (plot_coordinates), 27
- plot_contributions, 5, 12, 25, 29, 30
- plot_contributions, MultivariateAnalysis-method (plot_contributions), 25
- plot_contributions-method (plot_contributions), 25
- plot_coordinates, 5, 12, 26, 27, 30
- plot_cos2 (plot_contributions), 25
- plot_cos2, MultivariateAnalysis-method (plot_contributions), 25
- plot_cos2-method (plot_contributions), 25
- plot_eigenvalues, 5, 12, 26, 29, 30
- plot_individuals (plot_coordinates), 27
- plot_individuals, PCA-method (plot_coordinates), 27
- plot_individuals-method (plot_coordinates), 27
- plot_rows (plot_coordinates), 27
- plot_rows, MultivariateAnalysis-method (plot_coordinates), 27
- plot_rows-method (plot_coordinates), 27
- plot_variables (plot_coordinates), 27
- plot_variables, PCA-method (plot_coordinates), 27
- plot_variables-method (plot_coordinates), 27
- plot_variance (plot_eigenvalues), 30
- plot_variance, MultivariateAnalysis-method (plot_eigenvalues), 30
- plot_variance-method (plot_eigenvalues), 30
- predict, 8, 23, 31
- predict, CA-method (predict), 31
- predict, PCA-method (predict), 31
- rownames, MultivariateAnalysis-method (mutators), 21
- stat_hull (envelopes), 11
- subset, 14–18, 21, 32
- summary, 34
- summary, CA-method (summary), 34
- summary, PCA-method (summary), 34
- SummaryCA-class (MultivariateSummary), 20
- SummaryPCA-class (MultivariateSummary), 20
- svd(), 8, 23
- tidy, 35
- tidy, MultivariateAnalysis-method (tidy), 35
- tidy-method (tidy), 35
- wrap_hull (envelopes), 11
- wrap_hull, BootstrapPCA-method (envelopes), 11
- wrap_hull, MultivariateAnalysis-method (envelopes), 11
- wrap_hull-method (envelopes), 11