Package ‘dimensio’

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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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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

A BootstrapCA or BootstrapPCA object.
Author(s)

N. Frerebeau

References


See Also

Other multivariate analysis: ca(), pca(), predict()

Examples

library(ggrepel)

## Partial bootstrap on CA
## Data from Lebart et al. 2006, p. 170-172
color <- data.frame(
  brun = c(68, 15, 5, 20),
  chatain = c(119, 54, 29, 84),
  roux = c(26, 14, 14, 17),
  blond = c(7, 10, 16, 94),
  row.names = c("marron", "noisette", "vert", "bleu")
)

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

## Plot results
plot(X) +
  ggrepel::geom_label_repel()

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

## Get replicated coordinates
get_replications(Y, margin = 1)
get_replications(Y, margin = 2)

## Plot with ellipses
plot_rows(Y) +
  ggplot2::stat_ellipse()

plot_columns(Y) +
  ggplot2::stat_ellipse()
## Partial bootstrap on PCA
## Compute principal components analysis
```r
data(iris)
X <- pca(iris)
```

## Plot results
```r
plot_columns(X) +
  ggrepel::geom_label_repel()
```

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

## Plot with ellipses
```r
plot_columns(Y) +
  ggplot2::stat_ellipse()
```

---

**ca**

*Correspondence Analysis*

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

### Usage
```r
cia(object, ...)  
```

### 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


See Also

get_*(), stats::predict(), svd()

Other multivariate analysis: bootstrap(), pca(), predict()

Examples

## Load data
data("zuni", package = "folio")

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

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

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

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

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

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

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

## Get eigenvalues
get_eigenvalues(X)
CA-class

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

```r
## Load data
data("zuni", package = "folio")

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

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

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

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

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

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

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

## Get eigenvalues
get_eigenvalues(X)
```
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

mutator Get Results

Description
Getters to retrieve parts of an object.

Usage
get_coordinates(x, ...)
get_replications(x, ...)
get_contributions(x, ...)
get_correlations(x, ...)
get_cos2(x, ...)
get_data(x, ...)
get_distances(x, ...)
get_eigenvalues(x)
get_inertia(x, ...)
get_variance(x, ...)

## 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 'MultivariateAnalysis'
get_contributions(x, margin = 1)

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

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

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

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

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

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

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

## 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)

## S4 method for signature 'PCA'
loadings(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.
- **sup_name**: A character string specifying the name of the column to create for supplementary points attribution (see below).
- **digits**: An integer indicating the number of decimal places to be used.

### Details

- **get_data()** returns a data.frame of original data.
- **get_contributions()** returns a data.frame of contributions to the definition of the principal dimensions.
- **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 replicated coordinates (see bootstrap()).
- **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.
- **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.
- **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].

### Value

- **get_*()** returns a numeric vector or a data.frame.
- **loadings()** returns a matrix of class stats::loadings.
Author(s)
N. Frerebeau

See Also
Other mutator: subset()

---

**pca**  
*Principal Components Analysis*

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

**Usage**

```r
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), no weights are used.
weight_col  A numeric vector specifying the active column (variable) weights. If NULL (the
            default), no weights are used.

Value
A PCA object.

Author(s)
N. Frerebeau

References
Lebart, L., Piron, M. and Morineau, A. Statistique exploratoire multidimensionnelle: visualisation

See Also
get_*, stats::predict(), svd()
Other multivariate analysis: bootstrap(), ca(), predict()

Examples
## Load data
data("compiegne", package = "folio")

## Compute principal components analysis
X <- pca(compiegne, scale = TRUE, sup_col = 7:10)

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

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

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

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

## Get eigenvalues
get_eigenvalues(X)

### 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

```r
## Load data
data("compiegne", package = "folio")

## Compute principal components analysis
X <- pca(compiegne, scale = TRUE, sup_col = 7:10)

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

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

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

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

## Get eigenvalues
generate_eigenvalues(X)
```
plot_contributions

Visualize Contributions and cos²

Description

Plots contributions histogram and cos² 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?

Author(s)
N. Frerebeau

See Also
ggplot2::ggplot()
Other plot: plot_coordinates, plot_eigenvalues

Examples

## Load data
data("zuni", package = "folio")

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

## Plot observations
plot(X)

## Screeplot
plot_variance(X)

plot_coordinates

--

Visualization Factor Map

---

Description
Plots factor map.

Usage

plot_rows(object, ...)
plot_columns(object, ...)

## S4 method for signature 'MultivariateAnalysis'
plot_rows(
  object,
plot_coordinates

axes = c(1, 2),
active = TRUE,
sup = TRUE,
highlight = NULL,
group = NULL
)

## S4 method for signature 'CA,missing'
plot(
    x,
    margin = c(1, 2),
    axes = c(1, 2),
    active = TRUE,
    sup = TRUE,
    highlight = NULL,
    group = NULL
)

## S4 method for signature 'CA'
plot_columns(
    object,
    axes = c(1, 2),
    active = TRUE,
    sup = TRUE,
    highlight = NULL,
    group = NULL
)

## S4 method for signature 'PCA,missing'
plot(
    x,
    margin = 1,
    axes = c(1, 2),
    active = TRUE,
    sup = TRUE,
    highlight = NULL,
    group = NULL
)

## S4 method for signature 'PCA'
plot_columns(
    object,
    axes = c(1, 2),
    active = TRUE,
    sup = TRUE,
    highlight = NULL,
    group = NULL
)
## S4 method for signature 'BootstrapPCA'

```r
plot_columns(
  object,
  axes = c(1, 2),
  active = TRUE,
  sup = TRUE,
  highlight = NULL,
  group = NULL
)
```

### Arguments

- **object, x**
  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?
- **highlight**
  A character string giving XXX. It must be one of "coordinates", "contributions" or "cos2". 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 color the individuals (only used if highlight is NULL; see below).
- **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, c(1,2) indicates rows and columns (CA).

### Aesthetic

Point shapes and line types are set whether an observation is a row/individual or a column/variable and is active or supplementary.

Colors are set according to highlight and group:

- If highlight is not NULL, the color gradient will vary according to the value of the selected parameter.
- If group is a numeric vector, the color gradient and size will vary by the value of group.
- If group is not a numeric vector, the colors will be mapped to the levels of group.
- If both are NULL (the default), then the same rule as for shapes is used.

### Author(s)

N. Frerebeau

### See Also

- `ggplot2::ggplot()`
- Other plot: `plot_contributions()`, `plot_eigenvalues`
Examples

```r
## Load data
data("zuni", package = "folio")

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

## Plot observations
plot(X)

## Screeplot
plot_variance(X)
```

Description

Plot eigenvalues or variances histogram.

Usage

```r
plot_variance(object, ...)
```

## S4 method for signature 'MultivariateAnalysis'
```r
plot_variance(
    object,
    variance = TRUE,
    cumulative = TRUE,
    fill = "grey30",
    border = "grey10",
    color = "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.
- `color`: A `character` string specifying the line color.

Author(s)

N. Frerebeau
predict

See Also

- ggplot2::ggplot()
- Other plot: plot_contributions(), plot_coordinates

Examples

```r
## Load data
data("zuni", package = "folio")

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

## Plot observations
plot(X)

## Screeplot
plot_variance(X)
```

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
subset

See Also

Other multivariate analysis: `bootstrap()`, `ca()`, `pca()`

Examples

```r
## 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

```r
## 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 mutator: `mutator`

**Examples**

```r
## Load data
data("mississippi", package = "folio")

## Compute principal components analysis
X <- pca(mississippi, scale = TRUE, sup_row = 8:10, sup_col = 7:10)

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

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

## Get results for the rows
Y["rows"]
```
Object Summaries

Description

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

Usage

```r
## 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

```r
## Load data
data("zuni", package = "folio")

## Compute correspondence analysis
X <- ca(zuni, rank = 5, sup_row = 1:50)

## Rows summary
summary(X, margin = 1)

## Columns summary
summary(X, margin = 2)
```
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