Package ‘aweSOM’

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Title Interactive Self-Organizing Maps

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Description
Self-organizing maps (also known as SOM, see Kohonen (2001) <doi:10.1007/978-3-642-56927-2>) are a method for dimensionality reduction and clustering of continuous data. This package introduces interactive (html) graphics for easier analysis of SOM results. It also features an interactive interface, for push-button training and visualization of SOM on numeric, categorical or mixed data, as well as tools to evaluate the quality of SOM.

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Depends R (>= 3.1.0)

Imports kohonen (>= 2.0), shiny (>= 1.6), htmlwidgets, bslib, markdown, htmltools, rclipboard, ggplot2, RColorBrewer, viridis, data.table, DT, kernlab, fields, stats, cluster, e1071, haven, foreign, readxl, readODS

Suggests knitr

VignetteBuilder knitr

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  - Launches the (offline) web-based interface for training and visualizing self-organizing maps.

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**Description**

Interactive plots and interface for Kohonen self-organizing maps.

**References**


**See Also**

aweSOM, aweSOMplot, somInit, somQuality.

**Description**

Launches the (offline) web-based interface for training and visualizing self-organizing maps.

**Usage**

aweSOM()
Details

If the interface does not open automatically, open the printed link in a web browser.
To open large files within the interface, use `options(shiny.maxRequestSize=2^30)` (or a suitably large file size) before launching the interface.

Value

No return value, used for side effects.

References


Description

Plots the dendogram of a hierarchical clustering of the SOM prototypes.

Usage

`aweSOMdendrogram(clust, nclass)`

Arguments

- `clust`: an object of class `hclust`, the result of a hierarchical clustering performed by `stats::hclust`.
- `nclass`: an integer, number of superclasses

Value

Returns NULL if `nclass` is 1, or else a list containing the indices of the SOM cells in each superclass.

Examples

```r
## Build training data
### Scale training data
dat <- scale(dat)
## Train SOM
### Initialization (PCA grid)
init <- somInit(dat, 4, 4)
ok.som <- kohonen::som(dat, grid = kohonen::somgrid(4, 4, 'hexagonal'),
rlen = 100, alpha = c(0.05, 0.01),
radius = c(2.65,-2.65),
```
init = init, dist.fcts = 'sumofsquares')
## Group cells into superclasses (hierarchical clustering)
supertclus <- hclust(dist(ok.som$codes[[1]]), 'complete')
## Plot superclasses dendrogram
aweSOMdendrogram(supertclus, 2)

## Interactive SOM plots

### Description
Plot interactive visualizations of self-organizing maps (SOM), as an html page. The plot can represent general map informations, or selected categorical or numeric variables (not necessarily the ones used during training). Hover over the map to focus on the selected cell or variable, and display further information.

### Usage
aweSOMplot(
som,
data = NULL,
variables = NULL,
superclass = NULL,
obsNames = NULL,
scales = c("contrast", "range", "same"),
values = c("mean", "median", "prototypes"),
size = 400,
palsc = c("Set3", "viridis", "grey", "rainbow", "heat", "terrain", "topo", "cm",
rownames(RColorBrewer::brewer.pal.info)),
palvar = c("viridis", "grey", "rainbow", "heat", "terrain", "topo", "cm",
rownames(RColorBrewer::brewer.pal.info)),
palrev = FALSE,
showAxes = TRUE,
transparency = TRUE,
boxOutliers = TRUE,
showSC = TRUE,
pieEqualSize = FALSE,
showNames = TRUE,
legendPos = c("beside", "below", "none"),
legendFontsize = 14,
cloudType = c("cellPCA", "kPCA", "PCA", "proximity", "random"),
cloudSeed = NA,
elementId = NULL
)
Arguments

som
kohonen object, a SOM created by the kohonen::som function.

type
character, the plot type. The default "Hitmap" is a population map. "Cloud"
plots the observations as a scatterplot within each cell (see Details). "UMa-
trix" plots the average distance of each cell to its neighbors, on a color scale.
"Circular" (barplot), "Barplot", "Boxplot", "Radar" and "Line" are for numeric
variables. "Color" (heat map) is for a single numeric variable. "Pie" (pie chart)
and "CatBarplot" are for a single categorical (factor) variable.

data
data.frame containing the variables to plot. This is typically not the training
data, but rather the unscaled original data, as it is easier to read the results in the
original units, and this allows to plot extra variables not used in training. If not
provided, the training data is used.

variables
character vector containing the names of the variable(s) to plot. See Details.

superclass
integer vector, the superclass of each cell of the SOM.

obsNames
character vector, names of the observations to be displayed when hovering over
the cells of the SOM. Must have a length equal to the number of data rows. If
not provided, the row names of data will be used.

scales
character, controls the scaling of the variables on the plot. See Details.

values
character, the type of value to be displayed. The default "mean" uses the ob-
servation means (from data) for each cell. Alternatively, "median" uses the ob-
servation medians for each cell, and "prototypes" uses the SOM's prototypes
values.

size
numeric, plot size, in pixels. Default 400.

palsc
character, the color palette used to represent the superclasses as background
of the cells. Default is "Set3". Can be "viridis", "grey", "rainbow", "heat",
"terrain", "topo", "cm", or any palette name of the RColorBrewer package.

palvar
character, the color palette used to represent the variables. Default is "viridis",
available choices are the same as for palsc.

palrev
logical, whether color palette for variables is reversed. Default is FALSE.

showAxes
logical, whether to display the axes (for "Circular", "Barplot", "Boxplot", "Star",
"Line", "CatBarplot"), default TRUE.

transparency
logical, whether to use transparency when focusing on a variable, default TRUE.

boxOutliers
logical, whether outliers in "Boxplot" are displayed, default TRUE.

showSC
logical, whether to display superclasses as labels in the "Color" and "UMatrix"
plots, default TRUE.

pieEqualSize
logical, whether "Pie" should display pies of equal size. The default FALSE
displays pies with areas proportional to the number of observations in the cells.

showNames
logical, whether to display the observations names in a box below the plot.

legendPos
character, whether and where to display the legend (if applicable). Possible
values are "beside", "below" or "none".

legendFontSize
numeric, font size to use for the legend, and for the tooltip information of the
"Cloud" plot. Default is 14.
cloudType character, for "Cloud" type, controls how the point coordinates are computed, see Details.

cloudSeed numeric, for "random Cloud" type, seed for the pseudo-random placement of the points. If NA (the default), no seed will be set.

elementId character, user-defined elementId of the widget. Can be useful for user extensions when embedding the result in an html page.

Details

The selected variables must be numeric for types "Circular", "Barplot", "Boxplot", "Radar", "Color" and "Line", or factor for types "Pie" and "CatBarplot". If not provided, all columns of data will be selected. If a numeric variable is provided to a "Cloud", "Pie" or "CatBarplot", it will be split into a maximum of 8 classes. For "Cloud" plots, the first element of variables is used to color the points (and can be "None" for no coloring), the following elements (if any) are used in the information box of each point.

Variables scales: All values that are used for the plots (means, medians, prototypes) are scaled to 0-1 for display (minimum height to maximum height). The scales parameter controls how this scaling is done.

- "contrast": for each variable, the minimum height is the minimum observed mean/median/prototype on the map, the maximum height is the maximum on the map. This ensures maximal contrast on the plot.
- "range": observation range; for each variable, the minimum height corresponds to the minimum of that variable over the whole dataset, the maximum height to the maximum of the variable on the whole dataset.
- "same": same scales; all heights are displayed on the same scale, using the global minimum and maximum of the dataset.

Cloud plot: three types of cloud plots are available, controlled by the cloudType argument:

- "cellPCA": (default) the point coordinates are computed cell by cell, by computing a PCA on the training data of that cell only. Points close to the center of the cell are close to the mean of its observations. Points far apart within a cell are likely to have different characteristics.
- "kPCA": the point coordinates are computed globally, by a kernel PCA performed on all the differences between the training data and their winning prototypes. Points close to the center of their cell are close to their prototype, and points with similar placements in the clouds thus have a similar difference to their prototype. Not recommended for large datasets (eg. > 1000 observations), as it tends to take too much memory.
- "PCA": the point coordinates are computed globally, by a PCA performed on all the differences between the training data and their winning prototypes. Points close to the center of their cell are close to their prototype, and points with similar placements in the clouds thus have a similar difference to their prototype.
- "proximity": the point coordinates are computed one by one, based on the distances of the observation’s training data to its cell’s prototype and to its second best matching prototypes among its cell’s neighbors. Points close to their cell’s center are close to their closest prototype, while points close to another cell are close to that cell’s prototype.
- "random": the point coordinates are random samples from a uniform distribution.
Value

Returns an object of class htmlwidget.

Examples

```r
## Build training data
## Scale training data
data <- scale(data)
## Train SOM
### Initialization (PCA grid)
init <- somInit(data, 4, 4)
ok.som <- kohonen::som(data, grid = kohonen::somgrid(4, 4, "hexagonal"),
rlen = 100, alpha = c(0.05, 0.01),
radius = c(2.65,-2.65), init = init,
dist.fcts = "sumofsquares")
## Group cells into superclasses (PAM clustering)
superclust <- cluster::pam(ok.som$codes[[1]], 2)
superclasses <- superclust$clustering
## Observations cloud ('Cloud')
aweSOMplot(som = ok.som, type = "Cloud", data = iris,
variables = c("Species", variables), superclass = superclasses)
## Population map ('Hitmap')
aweSOMplot(som = ok.som, type = "Hitmap", superclass = superclasses)
## Plots for numerical variables
## Circular barplot
aweSOMplot(som = ok.som, type = "Circular", data = iris,
variables = variables, superclass = superclasses)
## Barplot (numeric variables)
aweSOMplot(som = ok.som, type = "Barplot", data = iris,
variables = variables, superclass = superclasses)
## Plots for categorical variables (iris species, not used for training)
## Pie
aweSOMplot(som = ok.som, type = "Pie", data = iris,
variables = "Species", superclass = superclasses)
## Barplot (categorical variables)
aweSOMplot(som = ok.som, type = "CatBarplot", data = iris,
variables = "Species", superclass = superclasses)
```

Description

Reorders a set of variables for prettier display on SOM plots. Variables that have similar variations along the cell plots while be ordered close together. Reordering is computed from the first component of a kernel PCA performed on the matrix of displayed values (with the variables as rows, and the cells as columns).

Usage

aweSOMreorder(
  som,
  data = NULL,
  variables = NULL,
  scales = c("contrast", "range", "same"),
  values = c("mean", "median", "prototypes")
)

Arguments

som
  kohonen object, a SOM created by the kohonen::som function.
data
  data.frame containing the variables to plot. This is typically not the training data, but rather the unscaled original data, as it is easier to read the results in the original units, and this allows to plot extra variables not used in training. If not provided, the training data is used.
variables
  character vector containing the names of the variables to plot. If not provided, all columns of data will be selected. All variables must be numeric.
scales
  character, controls the scaling of the variables on the plot. The default "contrast" maximizes the displayed contrast by scaling the displayed heights of each variable from minimum to maximum of the displayed value. Alternatively, "range" uses the minimum and maximum of the observations for each variable, and "same" displays all variables on the same scale, using the global minimum and maximum of the data.
values
  character, the type of value to be displayed. The default "mean" uses the observation means (from data) for each cell. Alternatively, "median" uses the observation medians for each cell, and "prototypes" uses the SOM's prototypes values.

Value

Returns a character vector containing the reordered variables names.

Examples

## Build training data
### Scale training data
dat <- scale(dat)
## Train SOM
### Initialization (PCA grid)
init <- somInit(dat, 4, 4)
ok.som <- kohonen::som(dat, grid = kohonen::somgrid(4, 4, 'hexagonal'),
rlen = 100, alpha = c(0.05, 0.01),
radius = c(2.65,-2.65), init = init,
dist.fcts = 'sumofsquares')

## Reorder variables
ordered.vars <- aweSOMreorder(ok.som)
## Plot with reordered variables
aweSOMplot(som = ok.som, type = 'Circular', data = iris,
variables= ordered.vars)

aweSOMscreeplot  Screeplot of SOM superclasses

Description

The screeplot, helps deciding the optimal number of superclasses. Available for both PAM and hierarchical clustering.

Usage

aweSOMscreeplot(
  som,
  nclass = 2,
  method = c("hierarchical", "pam"),
hmethod = c("complete", "ward.D2", "ward.D", "single", "average", "mcquitty", "median", "centroid"
)
)

Arguments

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>som</td>
<td>kohonen object, a SOM created by the kohonen::som function.</td>
</tr>
<tr>
<td>nclass</td>
<td>number of superclasses to be visualized in the screeplot. Default is 2.</td>
</tr>
<tr>
<td>method</td>
<td>Method used for clustering. Hierarchical clustering (&quot;hierarchical&quot;) and Partitioning around medoids (&quot;pam&quot;) can be used. Default is hierarchical clustering.</td>
</tr>
<tr>
<td>hmethod</td>
<td>For hierarchicical clustering, the clustering method, by default &quot;complete&quot;. See the stats::hclust documentation for more details.</td>
</tr>
</tbody>
</table>

Value

No return value, called for side effects.
Examples

```r
## Build training data
## Scale training data
dat <- scale(dat)
## Train SOM
### Initialization (PCA grid)
init <- somInit(dat, 4, 4)
ok.som <- kohonen::som(dat, grid = kohonen::somgrid(4, 4, "hexagonal"),
  rlen = 100, alpha = c(0.05, 0.01),
  radius = c(2.65,-2.65),
  init = init, dist.fcts = 'sumofsquares')
## Group cells into superclasses (PAM clustering)
superclust <- cluster::pam(ok.som$codes[[1]], 2)
superclasses <- superclust$clustering
aweSOMscreeplot(ok.som, method = 'hierarchical',
  hmethod = 'complete', nclass = 2)
```

aweSOMsilhouette  
Silhouette plot of SOM superclasses

Description

Plots a silhouette plot, used to assess the quality of the super-clustering of SOM prototypes into superclasses. Available for both PAM and hierarchical clustering.

Usage

`aweSOMsilhouette(som, clust)`

Arguments

- **som**  
  kohonen object, a SOM created by the `kohonen::som` function.
- **clust**  
  object containing the result of the super-clustering of the SOM prototypes (either a `hclust` or a `pam` object).

Value

No return value, called for side effects.

Examples

```r
## Build training data
## Scale training data
dat <- scale(dat)
## Train SOM
### Initialization (PCA grid)
init <- somInit(dat, 4, 4)
```
aweSOMsmoothdist

ok.som <- kohonen::som(dat, grid = kohonen::somgrid(4, 4, 'hexagonal'),
rlen = 100, alpha = c(0.05, 0.01),
radius = c(2.65, -2.65), init = init,
dist.fcts = 'sumofsquares')
## Group cells into superclasses (PAM clustering)
superclust <- cluster::pam(ok.som$somcodes[[1]], 2)
superclasses <- superclust$clustering
aweSOMsilhouette(ok.som, superclasses)

aweSOMsmoothdist Smooth Distance Plot for SOM

Description

Plots a visualization of the distances between the SOM cells. Based on the U-Matrix, which is computed for each cell as the mean distance to its immediate neighbors.

Usage

aweSOMsmoothdist(
  som,
pal = c("viridis", "grey", "rainbow", "heat", "terrain", "topo", "cm",
         rownames(RColorBrewer::brewer.pal.info)),
reversePal = FALSE,
legendFontsize = 14
)

Arguments

som kohonen object, a SOM created by the kohonen::som function.
pal character, the color palette. Default is "viridis". Can be "viridis", "grey", "rainbow", "heat", "terrain", "topo", "cm", or any palette name of the RColorBrewer package.
reversePal logical, whether color palette should be reversed. Default is FALSE.
legendFontsize numeric, the font size for the legend. Default 14.

Value

Returns an object of classes gg and ggplot.

Examples

## Build training data
### Scale training data
dat <- scale(dat)
## Train SOM
### Initialization (PCA grid)
init <- somInit(dat, 4, 4)
ok.som <- kohonen::som(dat, grid = kohonen::somgrid(4, 4, 'rectangular'), init = init)
aweSOMsmoothdist(ok.som)

---

**cdt**

*Complete disjunctive table*

**Description**

Computes the complete disjunctive table of a set of factors, where each factor (i.e., categorical variable) is encoded as a set of dummy variables, one for each level (category).

**Usage**

cdt(x)

**Arguments**

- **x** data.frame on which the table is computed. All columns will be treated as factors.

**Value**

A matrix of dummy variables, with nrow(x) rows and a number of columns equal to the sum of numbers of levels in all the variables of x.

---

**somDist**

*Distance measures on a SOM*

**Description**

Several distance measures between cells or prototypes of a trained SOM (in grid space, in data space).

**Usage**

somDist(som)

**Arguments**

- **som** kohonen object, a SOM created by the som function.

**Value**

A list with distance measures: between cells on the grid, between prototypes in data space, and the neighborhood matrix on the grid.
somInit

Initialize SOM prototypes

Description

Prototypes are the artificial points in data space that are used to cluster observations: each observation is assigned to the cluster of its closest prototype. In self-organizing maps, each cell of the map has its own prototype, and training is performed by iteratively adjusting the prototypes. This function creates an initial guess for the prototypes of a SOM grid, to be used as the init argument to the kohonen::som function (see example).

Usage

somInit(traindat, nrows, ncols, method = c("pca.sample", "pca", "random"))

Arguments

traindat Matrix of training data, that will also be used to train the SOM.
nrows Number of rows on the map.
ncols Number of columns on the map.
method Method used, see Details. "pca" or "random"

Details

The default method "pca.sample" takes as prototypes the observations that are closest to the nodes of a 2d grid placed along the first two components of a PCA. The "pca" method uses the nodes instead of the observations. The "random" method samples random observations.

Value

A matrix of prototype coordinates.

Examples

### Scale training data
dat <- scale(dat)
## Train SOM
### Initialization (PCA grid)
init <- somInit(dat, 4, 4)
the.som <- kohonen::som(dat, grid = kohonen::somgrid(4, 4, 'hexagonal'),
rlen = 100, alpha = c(0.05, 0.01),
radius = c(2.65,-2.65), init = init,
dist.fcts = 'sumofsquares')
somQuality {SOM quality measures}

Description

Computes several quality measures on a trained SOM (see Details).

Usage

somQuality(som, traindat)

Arguments

som kohonen object, a SOM created by the kohonen::som function.
traindat matrix containing the training data.

Details

Four measures of SOM quality are returned:

- **Quantization error**: Average squared distance between the data points and the map’s prototypes to which they are mapped. Lower is better.
- **Percentage of explained variance**: Similar to other clustering methods, the share of total variance that is explained by the clustering (equal to 1 minus the ratio of quantization error to total variance). Higher is better.
- **Topographic error**: Measures how well the topographic structure of the data is preserved on the map. It is computed as the share of observations for which the best-matching node is not a neighbor of the second-best matching node on the map. Lower is better: 0 indicates excellent topographic representation (all best and second-best matching nodes are neighbors), 1 is the maximum error (best and second-best nodes are never neighbors).
- **Kaski-Lagus error**: Combines aspects of the quantization and topographic error. It is the sum of the mean distance between points and their best-matching prototypes, and of the mean geodesic distance (pairwise prototype distances following the SOM grid) between the points and their second-best matching prototype.

Value

A list containing quality measures: quantization error, share of explained variance, topographic error and Kaski-Lagus error (see Details).

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