Package 'DiscreteGapStatistic'

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Type Package

Title An Extension of the Gap Statistic for Ordinal/Categorical Data

Version 1.1.2

Description The gap statistic approach is extended to estimate the number of clusters for categorical response format data. This approach and accompanying software is designed to be used with the output of any clustering algorithm and with distances specifically designed for categorical (i.e. multiple choice) or ordinal survey response data.

URL https://github.com/ecortesgomez/DiscreteGapStatistic

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Contents

`BhattacharyyaDist` *Bhattacharyya distance*

Description

Bhattacharyya distance core function

Usage

```
BhattacharyyaDist(x, adj = 0.01)
```

Arguments

`x`	Matrix
`adj`	Small quantity added to avoid indefinite log(0) values. DEFAULT=0.001

Value

Distance R object

ChisqDist *Chi-square distance*

Description

Chi-square distance core function

Usage

```
ChisqDist(x)
```

Arguments

x	Matrix

Value

Distance R object

clusGapDiscr *Discrete application of clusGap*

Description

Based on the implementation of the function found in the ‘cluster‘ R package.

Usage

```
clusGapDiscr(
  x,
  clusterFUN,
  K.max,
  B = nrow(x),
  value.range = "DS",
  verbose = interactive(),
  distName = "hamming",
  useLog = TRUE,
  ...
)
```

Arguments

x	A matrix object specifying category attributes in the columns and observations in the rows.
clusterFUN	Character string with one of the available clustering implementations. Available options are: 'pam' (default) from 'cluster::pam', 'diana' from 'cluster::diana', 'fanny' from 'cluster::fanny', 'agnes-{average, single, complete, ward, weighted}' from 'cluster::fanny', 'hclust-{ward.D, ward.D2, single, complete, average, mcquitty, median, centroid}' from 'stats::hclust', 'kmodes' from 'klar::kmodes' ('iter.max = 10', 'weighted = FALSE' and 'fast= TRUE'). 'kmodes-N' enables to run the 'kmodes' algorithm with a given number N of iterations where 'iter.max = N'.
K.max	Integer. Maximum number of clusters 'k' to consider
B	Number of bootstrap samples. By default B = nrow(x).
value.range	String character vector or a list of character vector with the length matching the number of columns (nQ) of the array. A vector with all categories to consider when bootstrapping the null distribution sample (KS: Known Support option). By DEFAULT vals=NULL, meaning unique range of categories found in the data will be used when drawing the null (DS: Data Support option). If a character vector of categories is provided, these values would be used for the null distribution drawing across the array. If a list with category character vectors is provided, it has to have the same number of columns as the input array. The order of list element corresponds to the array's columns.
verbose	Integer or logical. Determines whether progress output should printed while running. By DEFAULT one bit is printed per bootstrap sample.
distName	String. Name of categorical distance to apply. Available distances: 'bhattacharyya', 'chisquare', 'cramerV', 'hamming' and 'hellinger'.
useLog	Logical. Use log function after estimating 'W.k'. Following the original formulation 'useLog=TRUE' by default.
...	optionally further arguments for 'FUNcluster()'

Value

a matrix with K.max rows and 4 columns, named "logW", "E.logW", "gap", and "SE.sim", where gap = E.logW - logW, and SE.sim correspond to the standard error of 'gap'.

`clusGapDiscr0` *Discrete application of clusGap - core function.*

Description

Based on the implementation of the function found in the 'cluster' R package.

Usage

```
clusGapDiscr0(
  x,
  FUNcluster,
  K.max,
  B = nrow(x),
  value.range = "DS",
  verbose = interactive(),
  distName = "hamming",
  useLog = TRUE,
  Input2Alg = "distMatr",
  ...
)
```

Arguments

x	A matrix object specifying category attributes in the columns and observations in the rows.
FUNcluster	a function that accepts as first argument a matrix like 'x'; second argument specifies number of 'k' (k=>2) clusters This function should return a list with a component named 'cluster', a vector of length 'n=nrow(x)' of integers from '1:k' indicating observation cluster assignment. Make sure 'FUNcluster' and 'Input2Alg' agree.
K.max	Integer. Maximum number of clusters 'k' to consider
B	Number of bootstrap samples. By default B = nrow(x).
value.range	String, character vector or a list of character vectors with the length matching the number of columns (nQ) of the array. A vector with all categories to consider when bootstrapping the null distribution sample (KS: Known Support option). By DEFAULT vals=NULL, meaning unique range of categories found in the data will be used when drawing the null (DS: Data Support option). If a character vector of categories is provided, these values would be used for the null distribution drawing across the array. If a list with category character vectors is provided, it has to have the same number of columns as the input array. The order of list element corresponds to the array's columns.
verbose	Integer or logical. Determines whether progress output should printed while running. By DEFAULT one bit is printed per bootstrap sample.
distName	String. Name of categorical distance to apply. Available distances: 'bhattacharyya', 'chisquare', 'cramerV', 'hamming' and 'hellinger'.
useLog	Logical. Use log function after estimating 'W.k'. Following the original formulation 'useLog=TRUE' by default.
Input2Alg	Specifies the kind of input provided to the algorithm function in 'FUNcluster'. For algorithms that only accept a distance matrix use ''distMatr'' option (default). For algorithms that require the dataset and a prespecified distance function (e.g. 'stats::dist') use the ''distFun'' option. This case the distance function is defined internally and determined by parameter 'distName'.
...	optionally further arguments for 'FUNcluster()'

Value

a matrix with K.max rows and 4 columns, named "logW", "E.logW", "gap", and "SE.sim", where gap = E.logW - logW, and SE.sim correspond to the standard error of ‘gap‘.

`clusterFunSel` *Clustering generating function*

Description

A function that generates formatted algorithmic functions that can be plugged to enable run a wide variety of clustering algorithm for ‘clusGapDiscr‘ function.

Usage

```
clusterFunSel(clustFun)
```

Arguments

`clustFun`	A character string with the following possible options: ’pam’ (default) from ‘cluster::pam‘, ’diana’ from ‘cluster::diana‘, ’fanny’ from ‘cluster::fanny‘, ’agnes-{average, single, complete, ward, weighted}’ from ‘cluster::agnes‘, ’hclust-{ward.D, ward.D2, single, complete, average, mcquitty, median, centroid}’ from ‘base::hclust‘, ’kmodes’ from ‘klar::kmodes‘ (‘iter.max = 10‘, ‘weighted = FALSE‘ and ‘fast= TRUE‘). ’kmodes-N’ enables to run the ‘kmodes‘ algorithm with a given number N of iterations where ‘iter.max = N‘.

Value

An object of class kmodes as found in ‘klaR‘ packages. An additional component specifies the categorical distance function found in ‘distFun‘.

`concussion` *Concussion Data*

Description

A data frame with 109 observations and 21 questions. Severity rating recorded as categorical responses from c1 (none) to c7 (severe).

Usage

```
concussion
```

Format

'data.frame'

Q1: Headache Headache

Q2: Nausea Nausea

Q3: Balance problems Balance problems

Q4: Dizziness Dizziness

Q5: Fatigue Fatigue

Q6: Sleep more Sleeping more than usual

Q7: Drowsiness Drowsiness

Q8: Sensibility to light Sensibility to light

Q9: Sensibility to noice Sensibility to noice

Q10: Irritability Irritability

Q11: Sadness Sadness

Q12: Nervousness Nervousness/Anxiousness

Q13: More emotional Feeling more emotional

Q14: Feeling slowed down Feeling slowed down

Q15: Feeling mentally foggy Feeling mentally foggy

Q16: Difficulty concentrating Difficulty concentrating

Q17: Difficulty remembering Difficulty remembering

Q18: Visual problem Visual problems

Q19: Confusion Confusion

Q20: Feeling clumsy Feeling clumsy

Q21: Answer slowlier Answer slowlier

`cramersVmod` *Cramer's V modified pairwise vector function based on the function found in lsr package*

Description

This is simple wrapper of the usual chisq.test function. This is actually an adjusted version of the pi = sqrt(Chisq2/N) guaranteeing that values are within 0 (no association) and 1 (association)

Usage

```
cramersVmod(x, y)
```

Arguments

x	vector of size n
y	vector of size n

Value

numerical value

`CramerV` *Cramer's V distance*

Description

Cramer's V core function

Usage

```
CramerV(X)
```

Arguments

`X`	matrix

Value

Distance matrix

`dissbhattacharyya` *Bhattacharyya's distance (wrapper)*

Description

Wrapper of 'BhattacharyyaDist'

Usage

```
dissbhattacharyya(X)
```

Arguments

`X`	Matrix

Value

Distance R object

disschisquare *Chi-square distance (wrapper)*

Description

Wrapper of 'ChisqDist'

Usage

```
disschisquare(X)
```

Arguments

X	Matrix

Value

Distance R object

disscramerv *Cramer's V distance (wrapper)*

Description

Wrapper of 'CramerV'

Usage

```
disscramerv(X)
```

Arguments

X	Matrix

Value

Distance R object

disshamming *Hamming distance wrapper function*

Description

Function based on cultevo's package implementation

Usage

```
disshamming(X)
```

Arguments

X	matrix

Value

Distance matrix

disshellinger *Hellinger distance (wrapper)*

Description

Wrapper of 'HellingerDist'

Usage

```
disshellinger(X)
```

Arguments

X	Matrix

Value

Distance R object

`distanceHeat` *Sample-to-sample heatmap*

Description

sample-to-sample heatmap clustering samples according to a given categorical distance Exploratory tool that helps to visualize/cluster blocks of observations across columns ordered according to given categorical distance. The final output is a clustered distance matrix. This plot is aimed to guide the 'DiscreteClusGap' user to give an idea which type of categorical distance would accommodate better to the inputted data. 'sample2sampleHeat' is based on the 'pheatmap' function from the 'pheatmap' R package. Thus, any parameter found in pheatmap can be specified to 'sample2sampleHeat'.

Usage

```
distanceHeat(
  x,
  distName,
  clustering_method = "complete",
  border_color = NA,
  ...
)
```

Arguments

`x`	matrix object or data.frame
`distName`	Name of categorical distance to apply.
`clustering_method`	string; clustering method used by pheatmap
`border_color`	string; color cell borders. By default, border_color = NA, where no border colors are shown.
`...`	other valid arguments in pheatmap function Available distances: 'bhattacharyya', 'chisquare', 'cramerV', 'hamming' and 'hellinger'.

Value

clustered heatmap

distancematrix *Calculate categorical distance matrix for discrete data*

Description

Function invoking discrete distance functions. Available distances: 'bhattacharyya', 'chisquare', 'cramerV', 'hamming' and 'hellinger'

Usage

```
distancematrix(X, d)
```

Arguments

X	Matrix where rows are the observations and columns are discrete features
d	Name of distance. Distances available: bhattacharyya, chisquare, cramerV, hamming and hellinger

Value

R distance object

Examples

```
X = rbind(matrix(paste0("a", rpois(7*5, 1)), nrow=5),
          matrix(paste0("a", rpois(7*5, 3)), nrow=5))
distancematrix(X = X, d = "hellinger")
```

findK *Criteria to determine number of clusters k*

Description

Same function as found in 'cluster' package.

Usage

```
findK(cG_obj, meth = "Tibs2001SEmax")
```

Arguments

cG_obj	Output object obtained from 'clusGapDiscr'
meth	Method to use to determine optimal k number of clusters.

Value

A numerical value from 1 to K.max, contained in the input 'cG_obj' object.

HellingerDist *Hellinger distance*

Description

Hellinger distance core function

Usage

```
HellingerDist(x)
```

Arguments

x	matrix

Value

Distance matrix

kmodesD *Adapted k-modes algorithm*

Description

K-modes function to accept any categorical distance based on the function found in ‘klaR:kmodes‘.

Usage

```
kmodesD(data, modes, distFun, iter.max = 10)
```

Arguments

data	A matrix or data frame of categorical data. Objects have to be in rows, variables in columns.
modes	The number of modes
distFun	Pairwise categorical distance function. A function accepting two categorical vectors.
iter.max	The maximum number of iterations allowed.

Value

An object of class kmodes as found in ‘klaR‘ packages. An additional component specifies the categorical distance function found in ‘distFun‘.

`likert.heat.plot2` *Summary Heatmap for categorical data*

Description

Heatmap representation summarizing categorical/likert data. Modified version of 'likert.heat.plot' from 'likert' package. Does not allow different categorical ranges across questions. The function outputs a ggplot object where additional layers can be added for customization purposes. The output plot preserves the question order given by columns of 'x'.

Usage

```
likert.heat.plot2(
  x,
  allLevels,
  low.color = "white",
  high.color = "blue",
  text.color = "black",
  text.size = 4,
  textLen = 50
)
```

Arguments

`x`	matrix object or data.frame with categorical data. Columns are questions and rows are observations.
`allLevels`	vector with all categorical (ordered) levels.
`low.color`	string; name of color assigned to the first level found in 'allLevels'.
`high.color`	string; name of color assigned to the last level found in 'allLevels'.
`text.color`	string; text color of numbers within cells.
`text.size`	string; text size for numbers within cells.
`textLen`	string; maximum length of text-length for question labels (column names)

Value

ggplot object.

`mass` *mass data*

Description

Data extracted from the 'likert' R package. Results from an administration of the Math Anxiety Scale Survey. First Column records student gender either Female or Male. All statement answers have 5 possible ordinal categorical items: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.

Usage

```
mass
```

Format

'data.frame'

Gender Gender

I find math interesting. Math interesting

I get uptight during math tests. Uptight with math tests

I think that I will use math in the future. Use math in the future

Mind goes blank and I am unable to think clearly when doing my math test. Mind goes blank in math tests

Math relates to my life. Math relates to own life

I worry about my ability to solve math problems. Worry about ability math problem solving

I get a sinking feeling when I try to do math problems. Sinking feeling doing math problems

I find math challenging. Math is challenging

Mathematics makes me feel nervous. Nervousness with math

I would like to take more math classes. Take more math classes

Mathematics makes me feel uneasy. Uneasy feeling with math

Math is one of my favorite subjects. Favorite subject is math

I enjoy learning with mathematics. Enjoy learning math

Mathematics makes me feel confused. Confused with math

Source

<https://rdrr.io/cran/likert/man/mass.html>

`ResHeatmap` *Discrete Data Heatmap*

Description

Heatmap assuming a given a distance function and a known number of clusters. Function to display a categorical data matrix given a user defined number of clusters 'nCl', a categorical distance 'distName' and a predefined clustering method 'FUNcluster'. The output displays a heatmap separating and color-labelling resulting clusters vertically in the rows and allowing unsupervised clustering on questions in the columns. Each cell is colored according to the categorical values provided or found in the data. The clustergram is based on the 'pheatmap' function from the pheatmap R package. Thus, any parameter found in pheatmap can be specified to 'clusGapDiscrHeat'. This function can be used to examine number of clusters before running 'clusGapDiscrHeat' but also after the number of clusters is determined.

Usage

```
ResHeatmap(
  x,
  nCl,
  distName,
  catVals,
  clusterFUN,
  out = "heatmap",
  seed = NULL,
  clusterNames = NULL,
  prefObs = NULL,
  rowNames = rownames(x),
  filename = NULL,
  outDir = NULL,
  height = 10,
  width = 6
)
```

Arguments

`x`	matrix object or data.frame
`nCl`	number of clusters to plot; if 'nCl' is a permutation vector of the first lN integers will rearrange clusters according to the original given ordering.
`distName`	Name of categorical distance to apply. Available distances: 'bhattacharyya', 'chisquare', 'cramerV', 'hamming' and 'hellinger'.
`catVals`	character string vector with (ordered) categorical values
`clusterFUN`	Character string with one of the available clustering implementations. Available options are: 'pam' (default) from 'cluster::pam', 'diana' from 'cluster::diana', 'fanny' from 'cluster::fanny'. 'agnes-{average, single, complete, ward, weighted}'

	from ‘cluster::agnes‘, ’hclust-{ward.D, ward.D2, single, complete, average, mcquitty, median, centroid}’ from ‘stats::hclust‘, ’kmodes’ from ‘klar::kmodes‘ (‘weighted = FALSE‘ and ‘fast= TRUE‘).
out	Specifies the desired output between "heatmap" (default; produce a heatmap), "clusters" (return a ‘data.frame‘ with clustering assignments) or "clustersReord" (return a ‘data.frame‘ with reorganized clusters)
seed	Seed number.
clusterNames	Either ‘null‘ or ’renumber’. When ‘nCl‘ is a numerical vector, the cluster ordering is rearranged. ‘NULL‘ leaves cluster names as their original cluster assignment. ’renumber’ respects the rearrangements but relabels the cluster numbers from top to bottom in ascending order.
prefObs	character string vector of length 1 with a prefix for the observations, in case they come unlabelled or the user wants to anomymize sample IDs.
rowNames	character vector with names of rows according to ‘x‘. By default, ‘rownames(x)‘ will be printed in the plot. ‘rowNames=NULL‘ prevents from showing names. ‘prefObs‘ option takes precedence if is different to ‘NULL‘.
filename	character string with name of file output
outDir	character string with the directory path to save output file
height	numeric height of output plot in inches
width	numeric width of output plot in inches

Value

png file or ComplexHeatmap object

`SimData` *Simulate Data*

Description

A function to simulate data based on a multinomial vector parameter vector or a list of parameter vectors.

Usage

```
SimData(N, nQ, pi)
```

Arguments

N	Integer. Number of observations.
nQ	Integer. Number of questions.
pi	Numeric vector. Vector of probabilities adding up to 1; it is recommended that names of elements are character strings. Alternatively, pi can be list of vectors as previously described with length equal to ‘nQ‘. Notice that the list elements need not have same vector names. The order of pi vectors in the list will be reflected in the resulting simulated matrix. This alternative ideally assumes that questions are independently distributed.

Value

N x nQ matrix with simulated categories distributed according to vector pi

Examples

```
Pix <- setNames(c(0.1, 0.2, 0.3, 0.4, 0), paste0('a', 1:5))
X <- SimData(N=10, nQ=5, Pix)
head(X)

Piy <- setNames(c(0.3, 0.2, 0.4, 0, 0.1), paste0('a', 1:5))
Y <- SimData(N=10, nQ=3, Piy)
head(Y)

PiZ <- list(x1 = Pix, x2 = Pix, y1 = Piy, y2 = Piy)
Z <- SimData(N=10, nQ=length(PiZ), PiZ)
```

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