Package 'TraMineR'

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Title Trajectory Miner: a Sequence Analysis Toolkit

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Suggests xtable, TraMineRextras, WeightedCluster

Description Set of sequence analysis tools for manipulating, describing and rendering categorical sequences, and more generally mining sequence data in the field of social sciences. Although this sequence analysis package is primarily intended for state or event sequences that describe time use or life courses such as family formation histories or professional careers, its features also apply to many other kinds of categorical sequence data. It accepts many different sequence representations as input and provides tools for converting sequences from one format to another. It offers several functions for describing and rendering sequences, for computing distances between sequences with different metrics (among which optimal matching), original dissimilarity-based analysis tools, and functions for extracting the most frequent event subsequences and identifying the most discriminating ones among them. A user's guide can be found on the TraMineR web page.

License GPL (>= 2)

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`TraMineR-package` *Trajectory Miner: Sequence Analysis Toolkit*

Description

(Version: 2.2-11) Set of sequence analysis tools for manipulating, describing and rendering categorical sequences, and more generally mining sequence data in the field of social sciences. Although this sequence analysis package is primarily intended for state or event sequences that describe time use or life courses such as family formation histories or professional careers, its features also apply to many other kinds of categorical sequence data. It accepts many different sequence representations as input and provides tools for converting sequences from one format to another. It offers several functions for describing and rendering sequences, for computing distances between sequences with different metrics (among which optimal matching), original dissimilarity-based analysis tools, and functions for extracting the most frequent event subsequences and identifying the most discriminating ones among them. A user's guide can be found on the TraMineR web page.

Details

TraMineR provides tools for both state sequences and event sequences. The first step when using the package is to define a state sequence object (with `seqdef`) if you want to explore state sequences, and an event sequence object (with `seqecreate`) if you are interested in event sequencing.

State sequences are defined from a series of variables giving the states at the successive positions, while event sequences are defined from (vertical) time stamped event data. The package, however, can handle many other different data organizations and provides tools to help converting state sequences into event sequences and vice versa.

Author(s)

Alexis Gabadinho, Matthias Studer, Nicolas S. Müller, Reto Bürgin, Pierre-Alexandre Fonta, and Gilbert Ritschard

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37. doi:10.18637/jss.v040.i04.

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. Department of Econometrics and Laboratory of Demography, University of Geneva

Examples

```
## load the mvad data
library(TraMineR)
data(mvad)

## create a state sequence object from columns 17 to 86
mvad.seq <- seqdef(mvad[,17:86])

## distribution plot by sex (male)
seqdplot(mvad.seq, group=mvad$male, border=NA)

## compute the LCS pairwise distance matrix
## among the first 10 sequences
mvad.lcs <- seqdist(mvad.seq[1:10,], method="LCS")
```

---

actcal *Example data set: Activity calendar from the Swiss Household Panel*

Description

This data set contains 2000 individual sequences of monthly activity statuses from January to December 2000.

Usage

```
data(actcal)
```

Format

A data frame with 2000 rows, 12 state variables, 1 id variable and 11 covariates.

Details

The data set is a subsample of the data collected by the Swiss Household Panel (SHP).

The state column (variable) names are '`jan00`', '`feb00`', etc... and correspond to columns 13 to 24.

There are four possible states:

A = Full-time paid job (> 37 hours)

B = Long part-time paid job (19-36 hours)
C = Short part-time paid job (1-18 hours)
D = Unemployed (no work)

The data set contains also the following covariates:

`age00`	(age in 2000)
`educat00`	(education level)
`civsta00`	(civil status)
`nbadul00`	(number of adults in household)
`nbkid00`	(number of children)
`aoldki00`	(age of oldest kid)
`ayouki00`	(age of youngest kid)
`region00`	(residence region)
`com2.00`	(residence commune type)
`sex`	(sex of respondent)
`birthy`	(birth year)

Source

Swiss Household Panel

References

https://forscenter.ch/projects/swiss-household-panel/

`actcal.tse` *Example data set: Activity calendar from the Swiss Household Panel (time stamped event format)*

Description

This data set contains events defined from the state sequences in the actcal data set. It was created with the code shown in the examples section. It is provided to symplify example of event sequence mining.

Usage

```
data(actcal.tse)
```

Format

Time stamped events derived from state sequences in the actcal data set.

Source

Swiss Household Panel

See Also

seqformat, actcal

Examples

```
data(actcal)
actcal.seq <- seqdef(actcal[,13:24])

## Defining the transition matrix
transition <- seqetm(actcal.seq, method="transition")
transition[1,1:4] <- c("FullTime"         , "Decrease,PartTime",
     "Decrease,LowPartTime", "Stop")
transition[2,1:4] <- c("Increase,FullTime", "PartTime"         ,
     "Decrease,LowPartTime", "Stop")
transition[3,1:4] <- c("Increase,FullTime", "Increase,PartTime",
    "LowPartTime"         , "Stop")
transition[4,1:4] <- c("Start,FullTime"   , "Start,PartTime"   ,
    "Start,LowPartTime"   , "NoActivity")
transition

## Converting STS data to TSE
actcal.tse <- seqformat(actcal, 13:24, from = "STS",to = "TSE",
  tevent = transition)

## Defining the event sequence object
actcal.eseq <- seqecreate(id=actcal.tse$id,
time=actcal.tse$time, event=actcal.tse$event)
```

---

alphabet *Get or set the alphabet of a state or event sequence object*

Description

For state sequences, the function gets or sets the (short) labels associated to the states in the alphabet of a state sequence object (the list of all possible states). The get form also applies to event sequences, while the set form does not work with event sequences.

Usage

```
alphabet(seqdata, with.missing=FALSE)
alphabet(seqdata) <- value
```

Arguments

seqdata	a state sequence object of class stslist as defined with the seqdef function or, for the get form only, an event sequence object as defined with seqecreate or a probabilistic suffix tree generated with the PST package.
value	For state sequences only. Vector of characters of the same length as the vector returned by the alphabet function, i.e. one label for each state in the alphabet.
with.missing	Logical. When seqdata is a state sequence object (stslist), should the returned alphabet include the nr symbol standing for missing states?

Details

A state sequence object—created with the seqdef function—stores sequences as a matrix where columns are factors. The levels of the factors include the alphabet plus the codes for missing values and void elements. The alphabet function retrieves or sets the "alphabet" attribute of the state sequence object. The state names composing the alphabet are preferably short labels, since they are used for printing sequences. Longer labels for describing more precisely each state in legend are stored in the "labels" attribute of the sequence object.

For an event sequence object—created with seqecreate—the get form of alphabet works as an alias for levels. The set form alphabet <- does not work and should not be used.

Value

For 'alphabet' a character vector containing the alphabet.

For 'alphabet <-' the updated state sequence object.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

See Also

seqdef

Examples

```
## Creating a sequence object with the columns 13 to 24
## in the 'actcal' example data set
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## Retrieving the alphabet
alphabet(actcal.seq)

## Setting the alphabet
alphabet(actcal.seq) <- c("FT", "PT", "LT", "NO")

## Event sequences
actcal.eseq <- seqecreate(actcal.seq)
alphabet(actcal.eseq)
```

bfspell — *Example data set: First 20 biofam sequences in SPELL form*

Description

First 20 sequences of the biofam data set in SPELL form. The data serve to illustrate the use of seqformat for converting SPELL data into STS (horizontal) form.

Usage

```
data(bfspell)
```

Format

A data set with two data frames: bfspell20 with one row per spell and bfpdata20 with one row per id. The bfspell20 data frame contains the spell data themselves (4 variables id, begin, end, states) and bfpdata20 the year when aged 15 (2 variables id, when15).

Details

The states are coded with the following short labels

P = "Parent"
L = "Left"
M = "Married"
LM = "Left+Marr"
C = "Child"
LC = "Left+Child"
LMC = "Left+Marr+Child"
D = "Divorced"

The data is a SPELL representation of biofam[1:20,10:25], corresponding to 20 family life sequences between ages 15 and 30.

See Also

biofam

biofam — *Example data set: Family life states from the Swiss Household Panel biographical survey*

Description

2000 16 year-long family life sequences built from the retrospective biographical survey carried out by the Swiss Household Panel (SHP) in 2002.

Usage

```
data(biofam)

data(bfspell)
```

Format

A data frame with 2000 rows, 16 state variables, 1 id variable and 7 covariates and 2 weights variables.

Details

The *biofam* data set was constructed by Müller et al. (2007) from the data of the retrospective biographical survey carried out by the Swiss Household Panel (SHP) in 2002.

The data set contains (in columns 10 to 25) sequences of family life states from age 15 to 30 (sequence length is 16) and a series of covariates. The sequences are a sample of 2000 sequences of those created from the SHP biographical survey. It includes only individuals who were at least 30 years old at the time of the survey. The *biofam* data set describes family life courses of 2000 individuals born between 1909 and 1972.

The states numbered from 0 to 7 are defined from the combination of five basic states, namely Living with parents (Parent), Left home (Left), Married (Marr), Having Children (Child), Divorced:

0 = "Parent"
1 = "Left"
2 = "Married"
3 = "Left+Marr"
4 = "Child"
5 = "Left+Child"
6 = "Left+Marr+Child"
7 = "Divorced"

The covariates are:

`sex`	
`birthyr`	(birth year)
`nat_1_02`	(first nationality)
`plingu02`	(language of questionnaire)
`p02r01`	(religion)
`p02r04`	(religious participation)
`cspfaj`	(father's social status)
`cspmoj`	(mother's social status)

Two additional weights variables are inserted for illustrative purpose ONLY (since `biofam` is a subsample of the original data, these weights are not adapted to the actual data):

wp00tbgp	(weights inflating to the Swiss population)
wp00tbgs	(weights respecting sample size)

Source

Swiss Household Panel https://forscenter.ch/projects/swiss-household-panel/

References

Müller, N. S., M. Studer, G. Ritschard (2007). Classification de parcours de vie à l'aide de l'optimal matching. In *XIVe Rencontre de la Société francophone de classification (SFC 2007), Paris, 5 - 7 septembre 2007*, pp. 157–160.

---

cpal *Get or set the color palette of a sequence object*

Description

This function gets or sets the color palette of a sequence object, that is, the list of colors used to represent the states.

Usage

```
cpal(seqdata)
cpal(seqdata) <- value
```

Arguments

seqdata	a state sequence object as defined by the seqdef function.
value	a vector containing the colors, of length equal to the number of states in the alphabet. The colors can be passed as character strings representing color names such as returned by the colors function, as hexadecimal values or as RGB vectors using the rgb function. Each color is attributed to the corresponding state in the alphabet, the order being the one returned by the alphabet.

Details

In the plot functions provided for visualizing sequence objects, a different color is associated to each state of the alphabet. The color palette is defined when creating the sequence object, either automatically or by specifying a user defined color vector. The cpal function can be used to get or set the color palette of a previously defined sequence object.

Value

For 'cpal(seqdata)' a vector containing the colors.

For 'cpal(seqdata) <-' the updated sequence object.

Author(s)

Alexis Gabadinho

See Also

seqdef

Examples

```
## Creating a sequence object with the columns 13 to 24
## in the 'actcal' example data set
## The color palette is automatically set
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## Retrieving the color palette
cpal(actcal.seq)
seqiplot(actcal.seq)

## Setting a user defined color palette
cpal(actcal.seq) <- c("blue","red", "green", "yellow")
seqiplot(actcal.seq)
```

---

dissassoc *Analysis of discrepancy from dissimilarity measures*

Description

Compute and test the share of discrepancy (defined from a dissimilarity matrix) explained by a categorical variable.

Usage

```
dissassoc(diss, group, weights=NULL, R=1000,
          weight.permutation="replicate", squared=FALSE)
```

Arguments

diss	A dissimilarity matrix or a dist object (see dist)
group	A categorical variable. For a numerical variable use dissmfacw.
weights	optional numerical vector containing weights.
R	Number of permutations for computing the p-value. If equal to 1, no permutation test is performed.
weight.permutation	Weighted permutation method: "diss" (attach weights to the dissimilarity matrix), "replicate" (replicate case using weights), "rounded-replicate" (replicate case using rounded weights), "random-sampling" (random assignment of covariate profiles to the objects using distributions defined by the weights.)
squared	Logical. If TRUE the dissimilarities diss are squared.

Details

The dissassoc function assesses the association between objects characterized by their dissimilarity matrix and a discrete covariate. It provides a generalization of the ANOVA principle to any kind of distance metric. The function returns a pseudo F statistic, a pseudo Brown-Forsythe Fbf statistic, and a pseudo R-square that can be interpreted as a usual R-square. The statistical significance of the association is computed by means of permutation tests. The function performs also a test of discrepancy homogeneity (equality of within variances) using a generalization of the Levene statistic and the Bartlett statistic.
There are print and hist methods (the latter producing an histogram of the permuted values used for testing the significance).

If a numeric group variable is provided, it will be treated as categorical, i.e., each different value will be considered as a different category. To measure the 'linear' effect of a numerical variable, use dissmfacw.

Value

An object of class dissassoc with the following components:

groups	A data frame with the number of cases and the discrepancy of each group
anova.table	The pseudo ANOVA table
stat	The value of the statistics (Pseudo F, Pseudo Fbf, Pseudo R2, Bartlett, and Levene) and their p-values
perms	The permutation object, containing the values computed for each permutation

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2010) Discrepancy analysis of complex objects using dissimilarities. In F. Guillet, G. Ritschard, H. Briand, and D. A. Zighed (Eds.), *Advances in Knowledge Discovery and Management*, Studies in Computational Intelligence, Volume 292, pp. 3-19. Berlin: Springer.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2009). Analyse de dissimilarités par arbre d'induction. In EGC 2009, *Revue des Nouvelles Technologies de l'Information*, Vol. E-15, pp. 7–18.

Anderson, M. J. (2001) A new method for non-parametric multivariate analysis of variance. *Austral Ecology* **26**, 32–46.

Batagelj, V. (1988) Generalized Ward and related clustering problems. In H. Bock (Ed.), *Classification and related methods of data analysis*, Amsterdam: North-Holland, pp. 67–74.

See Also

dissvar to compute the pseudo variance from dissimilarities and for a basic introduction to concepts of pseudo variance analysis.
disstree for an induction tree analyse of objects characterized by a dissimilarity matrix.
disscenter to compute the distance of each object to its group center from pairwise dissimilarities.
dissmfacw to perform multi-factor analysis of variance from pairwise dissimilarities.

Examples

```
## Defining a state sequence object
data(mvad)
mvad.seq <- seqdef(mvad[, 17:86])

## Building dissimilarities (any dissimilarity measure can be used)
mvad.ham <- seqdist(mvad.seq, method="HAM")

## R=1 implies no permutation test
da <- dissassoc(mvad.ham, group=mvad$gcse5eq, R=10)
print(da)
hist(da)
```

---

disscenter *Compute distances to the center of a group*

Description

Computes the dissimilarity between objects and their group center from their pairwise dissimilarity matrix.

Usage

```
disscenter(diss, group=NULL, medoids.index=NULL,
           allcenter = FALSE, weights=NULL, squared=FALSE)
```

Arguments

diss	a dissimilarity matrix such as generated by seqdist, or a dist object (see dist)
group	if NULL (default), the whole data set is considered. Otherwise a different center is considered for each distinct value of the group variable
medoids.index	if NULL, returns the dissimilarity to the center. If set to "first", returns the index of the first encountered most central sequence. If group is set, an index is returned per group. When set to "all", indexes of all medoids (one list per group) are returned.
allcenter	logical. If TRUE, returns a data.frame containing the dissimilarity between each object and its group center, each column corresponding to a group.
weights	optional numerical vector containing weights.
squared	Logical. If TRUE diss is squared.

Details

This function computes the dissimilarity between given objects and their group center. It is possible that the group center does not belong to the space formed by the objects (in the same way as the average of integer numbers is not necessarily an integer itself). This distance can also be understood as the contribution to the discrepancy (see dissvar). Note that when the dissimilarity measure does not respect the triangle inequality, the dissimilarity between a given object and its group center may be negative

It can be shown that this dissimilarity is equal to (see *Batagelj 1988*):

$$d_{x\tilde{g}} = \frac{1}{n}\left(\sum_{i=1}^{n} d_{xi} - SS\right)$$

where SS is the sum of squares (see dissvar).

Value

A vector with the dissimilarity to the group center for each object, or a list of medoid indexes.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2010) Discrepancy analysis of complex objects using dissimilarities. In F. Guillet, G. Ritschard, D. A. Zighed and H. Briand (Eds.), *Advances in Knowledge Discovery and Management*, Studies in Computational Intelligence, Volume 292, pp. 3-19. Berlin: Springer.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2009) Analyse de dissimilarités par arbre d'induction. In EGC 2009, *Revue des Nouvelles Technologies de l'Information*, Vol. E-15, pp. 7–18.

Batagelj, V. (1988) Generalized ward and related clustering problems. In H. Bock (Ed.), *Classification and related methods of data analysis*, Amsterdam: North-Holland, pp. 67–74.

See Also

dissvar to compute the pseudo variance from dissimilarities and for a basic introduction to concepts of pseudo variance analysis
dissassoc to test association between objects represented by their dissimilarities and a covariate.
disstree for an induction tree analyse of objects characterized by a dissimilarity matrix.
dissmfacw to perform multi-factor analysis of variance from pairwise dissimilarities.

Examples

```
## Defining a state sequence object
data(mvad)
mvad.seq <- seqdef(mvad[, 17:86])

## Building dissimilarities (any dissimilarity measure can be used)
mvad.ham <- seqdist(mvad.seq, method="HAM")

## Compute distance to center according to group gcse5eq
dc <- disscenter(mvad.ham, group=mvad$gcse5eq)

## Ploting distribution of dissimilarity  to center
boxplot(dc~mvad$gcse5eq, col="cyan")

## Retrieving index of the first medoids, one per group
dc <- disscenter(mvad.ham, group=mvad$Grammar, medoids.index="first")
print(dc)

## Retrieving index of all medoids in each group
dc <- disscenter(mvad.ham, group=mvad$Grammar, medoids.index="all")
print(dc)
```

`dissdomassoc` *Domain association measures*

Description

Measures of association between domains are computed as the association between the pairwise dissimilarities in the domains. Measures are: Pearson correlation, Spearman correlation, global Cronbach alpha, and Cronbach alpha for each subset of the domains. The function can also return the share of variance (R-square) of the dissimilarities in one domain that can be reproduced from the dissimilarities in the other domains.

Usage

```
dissdomassoc(domdiss, jointdiss = NULL, what = c("pearson","R2"),
      dnames=names(domdiss), weights=NULL, w.rank=FALSE)
```

Arguments

`domdiss`	List of symmetrical matrices or dist objects: the pairwise dissimilarities per domain.
`jointdiss`	`NULL` (default), matrix or dist object: pairwise dissimilarities for joint dimensions.
`what`	String or vector of strings: requested association measures among `'pearson'`, `'spearman'`, `'R2'` `'cronbach'`, `'cron.subsets'`. Can also be `'all'` for all measures but `'spearman'`.

dnames	String vector of length equal to number of domains. Names of domains. Default is names(domdiss).
weights	Vector of non-negative weights. If NULL, no weights are applied. (Currently Cronbach measures ignore weights!).
w.rank	Logical. If weights are provided and 'spearman' is selected, should we use weighted ranks. Caution: computation of weighted ranks considerably increases computation time!

Details

The dissdomassoc function computes the domain association measures proposed by *Piccarreta (2017)*. These are for each pair of domains the correlation (Pearson or Spearman) between the domain specific pairwise dissimilarities. When 'R2' is requested, the function computes the share of variance of the dissimilarities in one domain that is reproduced by the dissimilarities in all other domains. The Cronbach alpha measures the coherence between the domains. With 'cron.subsets', Cronbach alpha is computed for the entire set of domains as well as for each possible subset of two or more domains.

When a jointdiss distance matrix or object is provided, correlations of each individual with this joint domain are also computed. The R2 of the joint domain takes account of all domains. However, R2's for the domains remain unchanged, i.e. they ignore the joint domain. Likewise, jointdiss does not affect the Cronbach alpha.

Spearman correlations are based on rank values of the distances. The computation of weighted ranks may take a while for large number of sequences (> 500, i.e. 124750 distances per domain). Therefore, weighted ranks are only used when explicitly requested by setting w.rank = TRUE. When w.rank = FALSE (default), Spearman is computed as the weighted Pearson correlation between non-weighted ranks.

When "pearson" and/or "spearman" correlations are requested, p-values (probability to get a stronger correlation under the zero correlation assumption) are automatically computed.

Value

An object of class ddomassoc, which is a list of tables of the requested association measures and tables of p-values of the Pearson and Spearman correlations when applicable. The summary method organizes the correlations and their p-values in table form.

Author(s)

Gilbert Ritschard

References

Piccarreta (2017). Joint Sequence Analysis: Association and Clustering. *Sociological Methods and Research*, 46(2), 252–287. doi:10.1177/0049124115591013.

See Also

seqdomassoc

Examples

```
data(biofam)

## Building one channel per type of event left, children or married
## Using only first 200 sequences
bf <- as.matrix(biofam[1:200, 10:25])
children <-  bf==4 | bf==5 | bf==6
married <- bf == 2 | bf== 3 | bf==6
left <- bf==1 | bf==3 | bf==5 | bf==6
## weights
weights <- biofam[1:200,"wp00tbgs"]

## Building sequence objects
child.seq <- seqdef(children)
marr.seq <- seqdef(married)
left.seq <- seqdef(left)
## distances by channel
dchild <- seqdist(child.seq, method="OM", sm="INDELSLOG")
dmarr <- seqdist(marr.seq, method="OM", sm="INDELSLOG")
dleft <- seqdist(left.seq, method="OM", sm="INDELSLOG")
dbiofam <- list(dchild,dmarr,dleft)
names(dbiofam) <- c("child","marr","left")

## Association between domains and R2 by domain
rass <- dissdomassoc(dbiofam, weights=weights)

## Joint distances using additive trick with domain INDELSLOG costs.
mcdist <- seqMD(channels=list(child.seq, marr.seq, left.seq), what="diss",
                    method="OM", sm =list("INDELSLOG", "INDELSLOG", "INDELSLOG"))

rassj <- dissdomassoc(dbiofam, jointdiss=mcdist, what=c("all"), weights=weights)
rassj[["Pearson.Rsquare"]]
rass[["Pearson.Rsquare"]]
summary(rassj)
```

`dissmergegroups` *Merging groups by minimizing loss of partition quality.*

Description

Merging groups by minimizing loss of partition quality.

Usage

```
dissmergegroups(
  diss,
  group,
  weights = NULL,
  measure = "ASW",
```

```
  crit = 0.2,
  ref = "max",
  min.group = 4,
  small = 0.05,
  silent = FALSE
)
```

Arguments

diss	A dissimilarity matrix or a distance object.
group	Group membership. Typically, the outcome of a clustering function.
weights	Vector of non-negative case weights.
measure	Character. Name of quality index. One of those returned by wcClusterQuality
crit	Real in the range [0,1]. Maximal allowed proportion of quality loss.
ref	Character. Reference for proportion crit. One of "initial", "max" (default), and "previous".
min.group	Integer. Minimal number of end groups.
small	Real. Percentage of sample size under which groups are considered as small.
silent	Logical. Should merge steps be displayed during computation?

Details

The procedure is greedy. The function iteratively searches for the pair of groups whose merge minimizes quality loss. As long as the smallest group is smaller than small, it searches among the pairs formed by that group with one of the other groups. Once all groups have sizes larger than small, the search is done among all possible pairs of groups. There are two stopping criteria: the minimum number of groups (min.group) and maximum allowed quality deterioration (crit). The percentage specified with crit applies either to the quality of the initial partition (ref="initial"), the quality after the previous iteration (ref="previous"), or the maximal quality achieved so far (ref="max"), the latter being the default. The process stops when any of the criteria is reached.

Value

Vector of merged group memberships.

Author(s)

Gilbert Ritschard

References

Ritschard, G., T.F. Liao, and E. Struffolino (2023). Strategies for multidomain sequence analysis in social research. *Sociological Methodology*, 53(2), 288-322. doi:10.1177/00811750231163833

See Also

wcClusterQuality

Examples

```
data(biofam)

## Building one channel per type of event (children, married, left home)
cases <- 1:40
bf <- as.matrix(biofam[cases, 10:25])
children <-  bf==4 | bf==5 | bf==6
married <- bf == 2 | bf== 3 | bf==6
left <- bf==1 | bf==3 | bf==5 | bf==6

## Creating sequence objects
child.seq <- seqdef(children, weights = biofam[cases,'wp00tbgs'])
marr.seq <- seqdef(married, weights = biofam[cases,'wp00tbgs'])
left.seq <- seqdef(left, weights = biofam[cases,'wp00tbgs'])

## distances by domain
dchild <- seqdist(child.seq, method="OM", sm="INDELSLOG")
dmarr <- seqdist(marr.seq, method="OM", sm="INDELSLOG")
dleft <- seqdist(left.seq, method="OM", sm="INDELSLOG")
dnames <- c("child","marr","left")

## clustering each domain into 2 groups
child.cl2 <- cutree(hclust(as.dist(dchild)),k=2)
marr.cl2 <- cutree(hclust(as.dist(dmarr)),k=2)
left.cl2 <- cutree(hclust(as.dist(dleft)),k=2)

## Multidomain sequences
MD.seq <- seqMD(list(child.seq,marr.seq,left.seq))
d.expand <- seqdist(MD.seq, method="LCS")
clust.comb <- interaction(child.cl2,marr.cl2,left.cl2)
merged.grp <- dissmergegroups(d.expand, clust.comb,
                              weights=biofam[cases,'wp00tbgs'])

## weighted size of merged groups
xtabs(biofam[cases,'wp00tbgs'] ~ merged.grp)
```

---

dissmfacw *Multi-factor ANOVA from a dissimilarity matrix*

Description

Perform a multi-factor analysis of variance from a dissimilarity matrix.

Usage

```
dissmfacw(formula, data, R = 1000, gower = FALSE, squared = FALSE,
    weights = NULL)

gower_matrix(diss, squared=TRUE, weights=NULL)
```

```
## S3 method for class 'dissmultifactor'
print(x, pvalue.confint=0.95, digits = NULL, ...)
```

Arguments

formula	A regression-like formula. The left hand side term should be a dissimilarity matrix or a dist object.
data	A data frame from which the variables in formula should be taken.
R	Number of permutations used to assess significance.
gower	Logical: Is the dissimilarity matrix already a Gower matrix?
squared	Logical: Should we square the provided dissimilarities?
weights	Optional numerical vector of case weights.
diss	Dissimilarity matrix
x	a dissmultifactor object as returned by dissmfacw
pvalue.confint	Real in range [0,1]. Confidence probability.
digits	Integer or NULL. Number of digits.
...	Other generic print arguments.

Details

Function dissmfacw is, in some way, a generalization of dissassoc to account for several explanatory variables. The function computes the part of discrepancy explained by the list of covariates specified in the formula. It provides for each covariate the Type-II effect, i.e. the effect measured when removing the covariate from the full model with all variables included.

(The returned F values may slightly differ from those obtained with TraMineR versions older than 1.8-9. Since 1.8-9, the within sum of squares at the denominator is divided by $n - m$ instead of $n - m - 1$, where n is the sample size and m the total number of predictors and/or contrasts used to represent categorical factors.)

For a single factor dissmfacw is slower than dissassoc. Moreover, the latter performs also tests for homogeneity in within-group discrepancies (equality of variances) with a generalization of Levene's and Bartlett's statistics.

Part of the function is based on the Multivariate Matrix Regression with qr decomposition algorithm written in SciPy-Python by Ondrej Libiger and Matt Zapala (See *Zapala and Schork*, 2006, for a full reference.) The algorithm has been adapted for Type-II effects and extended to account for case weights.

Function gower_matrix transforms the provided dissimilarity matrix into a Gower matrix.

Value

A dissmultifactor object with the following components:

mfac	The part of variance explained by each variable (comparing full model to model without the specified variable) and its significance using permutation test
call	Function call
perms	Permutation values as a boot object

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2010) Discrepancy analysis of complex objects using dissimilarities. In F. Guillet, G. Ritschard, D. A. Zighed and H. Briand (Eds.), *Advances in Knowledge Discovery and Management*, Studies in Computational Intelligence, Volume 292, pp. 3-19. Berlin: Springer.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2009). Analyse de dissimilarités par arbre d'induction. In EGC 2009, *Revue des Nouvelles Technologies de l'Information*, Vol. E-15, pp. 7-18.

Anderson, M. J. (2001). A new method for non-parametric multivariate analysis of variance. *Austral Ecology* 26, 32-46.

McArdle, B. H. and M. J. Anderson (2001). Fitting multivariate models to community data: A comment on distance-based redundancy analysis. *Ecology* 82(1), 290-297.

Zapala, M. A. and N. J. Schork (2006). Multivariate regression analysis of distance matrices for testing associations between gene expression patterns and related variables. *Proceedings of the National Academy of Sciences of the United States of America* 103(51), 19430-19435.

See Also

dissvar to compute a pseudo variance from dissimilarities and for a basic introduction to concepts of discrepancy analysis.
dissassoc to test association between objects represented by their dissimilarities and a covariate.
disstree for an induction tree analysis of objects characterized by a dissimilarity matrix.
disscenter to compute the distance of each object to its group center from pairwise dissimilarities.

Examples

```
## Define the state sequence object
data(mvad)
mvad.seq <- seqdef(mvad[, 17:86])
## Here, we use only first 100 sequences
mvad.seq <- mvad.seq[1:100,]

## Compute dissimilarities (any dissimilarity measure can be used)
mvad.ham <- seqdist(mvad.seq, method="HAM")

## And now the multi-factor analysis
print(dissmfacw(mvad.ham ~ male + Grammar + funemp +
gcse5eq + fmpr + livboth, data=mvad[1:100,], R=10))
```

dissrep *Extracting sets of representative objects using a dissimilarity matrix*

Description

The function extracts a set of representative objects that exhibits the key features of the whole data set, the goal being to get easy sounded interpretation of the latter. The user can set either the desired coverage level (the proportion of objects having a representative in their neighborhood) or the desired number of representatives.

Usage

```
dissrep(diss, criterion = "density", score = NULL, decreasing = TRUE,
  coverage = 0.25, nrep = NULL, pradius = 0.10, dmax = NULL,
  weights = NULL, trep, tsim)
```

Arguments

diss	A dissimilarity matrix or a dist object (see dist)
criterion	the representativeness criterion for sorting the candidate list. One of "freq" (frequency), "density" (neighborhood density) or "dist" (centrality). An optional vector containing the scores for sorting the candidate objects may also be provided. See below and details.
score	an optional vector containing the representativeness scores used for sorting the objects in the candidate list. The length of the vector must be equal to the number of rows/columns in the distance matrix, i.e the number of objects.
decreasing	logical. If a score vector is provided, should the objects in the candidate list be sorted in ascending order of the score. If FALSE, sort is in descending order. The first object in the candidate list is supposed to be the most representative.
coverage	controls the size of the representative set by setting the desired coverage level, i.e the proportion of objects having a representative in their neighborhood. Neighborhood radius is defined by pradius.
nrep	number of representatives. If NULL (default), coverage argument is used to control the size of the representative set.
pradius	neighborhood radius as a percentage of the maximum (theoretical) distance dmax. Defaults to 0.1 (10%). Object y is redundant to object x when it is in the neighborhood of x, i.e., within a distance pradius*dmax from x.
dmax	maximum theoretical distance. The dmax value is used to derive the neighborhood radius as pradius*dmax. If NULL, the value of dmax is derived from the dissimilarity matrix.
weights	vector of weights of length equal to the number of rows of the dissimilarity matrix. If NULL, equal weights are assigned.
trep	Deprecated. Use coverage instead.
tsim	Deprecated. Use pradius instead.

Details

The representative set is obtained by an heuristic. Representatives are selected by successively extracting from the sequences sorted by their representativeness score those which are not redundant with already retained representatives. The selection stops when either the desired coverage or the wanted number of representatives is reached. Objects are sorted either by the values provided as `score` argument, or by specifying one of the following as `criterion` argument: `"freq"` (*sequence frequency*), `"density"` (*neighborhood density*), `"dist"` (*centrality*).

The *frequency* criterion uses the frequencies as representativeness score. The frequency of an object in the data is computed as the number of other objects with whom the dissimilarity is equal to 0. The more frequent an object the more representative it is supposed to be. Hence, objects are sorted in decreasing frequency order. This criterion is equivalent to the neighborhood (see below) criterion with a neighborhood radius equal to 0.

The *neighborhood density* is the number—density—of objects in the neighborhood of the object. This requires to set the neighborhood radius `pradius`. Objects are sorted in decreasing density order.

The *centrality* criterion is the sum of distances to all other objects. The smallest the sum, the most representative the object.

Use `criterion="dist"` (centrality) and `nrep=1` to get the medoid and `criterion="density"` and `nrep=1` to get the densest object pattern.

For more details, see *Gabadinho and Ritschard, 2013.*

Value

An object of class `diss.rep`. This is a vector containing the indexes of the representative objects with the following additional attributes:

`Scores`	vector with the representative score of each object given the chosen criterion.
`Distances`	matrix with the distance of each object to its nearest representative.
`Rep.group`	vector with, for each object, the representative that represents it.
`idx.rep`	list with indexes of occurrences of each representative in original data.
`Statistics`	a data frame with quality measures for each representative: number of objects assigned to the representative, number of objects in the representative's neighborhood, mean distance to the representative.
`Quality`	overall quality measure.

Print and summary methods are available.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

References

Gabadinho A, Ritschard G (2013). "Searching for typical life trajectories applied to child birth histories", In R Lévy, E. Widmer (eds.), *Gendered Life Courses*, pp. 287-312. Vienna: LIT.

Gabadinho A, Ritschard G, Studer M, Müller NS (2011). "Extracting and Rendering Representative Sequences", In A Fred, JLG Dietz, K Liu, J Filipe (eds.), *Knowledge Discovery, Knowledge Engineering and Knowledge Management*, volume 128 of *Communications in Computer and Information Science (CCIS)*, pp. 94-106. Springer-Verlag.

See Also

seqrep, disscenter

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
"Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam[, 10:25], labels=biofam.lab)

## Computing the distance matrix
costs <- seqsubm(biofam.seq, method="TRATE")
biofam.om <- seqdist(biofam.seq, method="OM", sm=costs)

## Representative set using the neighborhood density criterion
biofam.rep <- dissrep(biofam.om)
biofam.rep
summary(biofam.rep)
## indexes of first occurrence of second representatives in original data
attr(biofam.rep,"idx.rep")[[2]][1]
```

---

dissrf *Relative Frequency Groups.*

Description

Relative Frequency (RF) groups are equally sized groups obtained by partitioning sorted cases into k consecutive groups. Function `dissrf` returns the medoid indexes of the RF groups and related statistics. Function `seqrf` is for sequence data and returns in addition the RF medoid sequences.

Usage

```
dissrf(diss,
       k=NULL,
       sortv="mds",
       weights=NULL,
       grp.meth = "prop",
       squared = FALSE,
       pow = NULL)
```

```
seqrf(seqdata,
       diss,
       k=NULL,
       sortv="mds",
       weights=NULL,
       weighted=TRUE,
       grp.meth = "prop",
       squared = FALSE,
       pow = NULL)

## S3 method for class 'dissrf'
summary(object, dist.idx = 1:10, ...)

## S3 method for class 'seqrf'
summary(object, format="SPS", dist.idx = 1:10, ...)
```

Arguments

diss	Matrix or distance object. Pairwise dissimilarities between analyzed cases.
seqdata	State sequence stslist object as produced by seqdef.
k	Integer: Number of groupings (RF groups). When NULL, k is set as the minimum between 100 and the sum of weights over 10.
sortv	Real vector (of length nrow(diss)), character string, or NULL. Sorting variable used to compute the frequency groups. If NULL, the original data order is used. If "mds" (default), the first MDS factor of diss (diss^2 when squared=TRUE) is used. Ties are randomly ordered. For seqrf only, can also be one of "from.start" and "from.end".
weights	Vector (of length nrow(diss)) of non-negative weights. If NULL (default), equal weights except when weighted is set as TRUE in seqrf.
weighted	Logical. Should weights be used when there are weights in seqdata? (default is TRUE)
grp.meth	Character string. One of "prop", "first", and "random". Grouping method. See details.
squared	Logical. Should medoids (and computation of sortv when applicable) be based on squared dissimilarities? (default is FALSE)
pow	Double. Dissimilarity power exponent (typically 1 or 2) for computation of pseudo R2 and F. When NULL, pow is set as 1 when squared = FALSE, and as 2 otherwise.
...	further arguments passed to or from other methods such as print.stslist
object	Object of class dissrf or seqrf
format	String. One of "SPS" (default) or "STS". Display format of the medoid sequences.
dist.idx	Indexes of RF groups for which summary statistics of distances to the medoids are displayed. Default is 1:10. Set as 0 to plot statistics for all RF groups.

Details

Function dissrf partitions the n cases (rows of the diss matrix) into k equally sized groups (RF groups). First, the cases are sorted according to the sortv variable. Then the groups are built by consecutively grouping the first n/k cases, then the next n/k cases, and so on. In seqrf, one of sort methods "from.start" and "from.end" can be specified as sortv argument.

Ties in the sortv variable are handled by order using the default method, which produces stable outcome. To use a different method, compute a suited variable without ties (e.g. using order with the wanted method for ties) and pass it as sortv argument.

The grp.meth argument applies when the group size (n/k) is not integer. With grp.meth="first", the integer part of n/k is used as basic group size and the size of the first groups is augmented by one unit so that the sum of the group sizes equals n. With grp.meth="random", randomly selected groups have their size augmented by one unit, and with grp.meth="prop" (default), cases at the limit between groups are proportionally assigned to each of the two groups.

For seqrf, when weights=NULL and weighted=TRUE, weights is set as the weights attribute of seqdata.

When weights is non-null (dissrf) or when wheighted=TRUE and there are weights in seqdata (seqrf), only grp.meth="prop" applies.

The function computes indicative statistics of the resulting partition, namely a pseudo R2 and a pseudo F statistics. These statistics compare the mean distance to the group medoid with the mean distance to the overall medoid. When pow is 2, mean squared dissimilarities are used and when pow is 1 the R2 and F ratios are based on mean of non-squared dissimilarities. An indicative p-value of the F statistics is computed using the F distribution. This p-value should be interpreted with caution since F is not a true F value.

Value

dissrf returns a list of class dissrfprop when grp.meth="prop" and of class dissrfcrisp otherwise. In both cases the list also receives class "dissrf". The elements of the list are:

medoids	index of the group medoids
med.names	names (diss colnames) of the group medoids
wg	working matrix used by the "prop" procedure (class dissrfprop only)
dist.list	list with for each successive group the distances from its elements to the group medoid
index.list	list with for each successive group the index of its elements
weights.list	list with for each successive group the weights of its elements in the group
heights	relative group size, which may be different when grp.meth is "first" or "random"
kmedoid.index	vector with for each case the index of its group medoid (class dissrfcrisp only)
kmedoid.dist	vector with for each case the distance to its group medoid (class dissrfcrisp only)
mdsk	vector of group membership (class dissrfcrisp only)
at	positions for the boxplots of distances to group medoids

R2	Pseudo R2: Mean distance to the group medoids over mean distance to the overall medoid
Fstat	Pseudo F statistics
pvalue	p-value of the pseudo F (to be used with caution since F is not a true F value)
sizes	ncase (number of cases), wsum (sum of weights), k (number of groups), gsize (group size)
grp.meth	grouping method used

seqrf returns a list of class seqrfprop when grp.meth="prop" and of class seqrfcrisp otherwise. In both cases the list also receives class "seqrf". The elements of the list are:

seqtoplot	RF medoid sequences as a state sequence stslist object
rf	the associated dissrf object

There are print and summary methods for objects of class dissrf and seqrf, and a plot method for objects of class seqrf

Author(s)

Gilbert Ritschard.

References

Fasang, Anette Eva and Tim F. Liao. 2014. "Visualizing Sequences in the Social Sciences: Relative Frequency Sequence Plots." Sociological Methods & Research 43(4):643-676.

See Also

plot.seqrf, seqrfplot, dissrep, and seqrep

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
"Child", "Left+Child", "Left+Marr+Child", "Divorced")

## Here, we use only 100 cases selected such that all elements
## of the alphabet be present.
## (More cases and a larger k would be necessary to get a meaningful example.)
biofam.seq <- seqdef(biofam[501:600, 10:25], labels=biofam.lab,
                     weights=biofam[501:600,"wp00tbgs"])
diss <- seqdist(biofam.seq, method="LCS")

## Using 12 groups, default MDS sorting,
##  and original method by Fasang and Liao (2014)
dissrf(diss=diss, k=12, grp.meth="first")

## Using 12 groups, weights, default MDS sorting,
```

```
##  and default "prop" method
w <- attr(biofam.seq, "weights")
dissrf(diss=diss, k=12, weights=w)

## With a user specified sorting variable
## Here time spent in parental home, which has ties
parentTime <- seqistatd(biofam.seq)[, 1]
b.srf <- seqrf(biofam.seq, diss=diss, k=12, sortv=parentTime)

## print, summary, and plot methods
b.srf
summary(b.srf)
plot(b.srf)
plot(b.srf, which.plot="both")
```

`disstree` *Dissimilarity Tree*

Description

Tree structured discrepancy analysis of objects described by their pairwise dissimilarities.

Usage

```
disstree(formula, data = NULL, weights = NULL, min.size = 0.05,
  max.depth = 5, R = 1000, pval = 0.01, object = NULL,
  weight.permutation = "replicate", squared = FALSE, first = NULL,
  minSize, maxdepth)
```

Arguments

`formula`	Formula with a dissimilarity matrix as left hand side and the candidate partitioning variables on the right side.
`data`	Data frame where variables in formula will be searched for.
`weights`	Optional numerical vector of weights.
`min.size`	Minimum number of cases in a node, will be treated as a proportion if less than 1.
`max.depth`	Maximum depth of the tree
`R`	Number of permutations used to assess the significance of the split.
`pval`	Maximum allowed p-value for a split
`object`	An optional R object represented by the dissimilarity matrix. This object may be used by the `print` method or `disstree2dot` to render specific object type.

`weight.permutation`
: Weight permutation method: `"diss"` (attach weights to the dissimilarity matrix), `"replicate"` (replicate cases using `weights`), `"rounded-replicate"` (replicate case using rounded `weights`), `"random-sampling"` (random assignment of covariate profiles to the objects using distributions defined by the weights.)

`squared`
: Logical: Should the `diss` dissimilarities be squared?

`first`
: One of the variable in the right-hand side of the formula. This forces the first node of the tree to be split by this variable.

`minSize`
: Deprecated. Use `min.size` instead.

`maxdepth`
: Deprecated. Use `max.depth` instead.

Details

The procedure iteratively splits the data. At each step, the procedure selects the variable and split that explain the greatest part of the discrepancy, i.e., the split for which we get the highest pseudo R2. The significance of the retained split is assessed through a permutation test.

`seqtree` provides a simpler interface if you plan to use `disstree` for state sequence objects.

Value

An object of class `disstree` that contains the following components:

`root`
: A node object, root of the tree

`info`
: General information such as parameters used to build the tree

`info$adjustment`
: A `dissassoc` object providing global statistics for tree.

`formula`
: The formula used to generate the tree

`data`
: data used to build the tree

`weights`
: weights

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2010) Discrepancy analysis of complex objects using dissimilarities. In F. Guillet, G. Ritschard, D. A. Zighed and H. Briand (Eds.), *Advances in Knowledge Discovery and Management*, Studies in Computational Intelligence, Volume 292, pp. 3-19. Berlin: Springer.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2009) Analyse de dissimilarités par arbre d'induction. In EGC 2009, *Revue des Nouvelles Technologies de l'Information*, Vol. E-15, pp. 7-18.

Anderson, M. J. (2001) A new method for non-parametric multivariate analysis of variance. *Austral Ecology* **26**, 32-46.

Batagelj, V. (1988) Generalized ward and related clustering problems. In H. Bock (Ed.), *Classification and related methods of data analysis*, Amsterdam: North-Holland, pp. 67-74.

Piccarreta, R. et F. C. Billari (2007) Clustering work and family trajectories by using a divisive algorithm. *Journal of the Royal Statistical Society A* **170**(4), 1061–1078.

See Also

`seqtree` to generate a specific `disstree` objects for analyzing state sequences.
`seqtreedisplay` to generate graphic representation of `seqtree` objects when analyzing state sequences.
`disstreedisplay` is a more general interface to generate such representation for other type of objects.
`disstreeleaf` to get leaf membership of each case.
`disstree.get.rules` to get the list of classification rules as R commands.
`disstree.assign` for the index of the rules applying to provided profiles.
`dissvar` to compute discrepancy using dissimilarities and for a basic introduction to discrepancy analysis.
`dissassoc` to test association between objects represented by their dissimilarities and a covariate.
`dissmfacw` to perform multi-factor analysis of variance from pairwise dissimilarities.
`disscenter` to compute the distance of each object to its group center from pairwise dissimilarities.

Examples

```
data(mvad)

## Defining a state sequence object
mvad.seq <- seqdef(mvad[, 17:86])

## Computing dissimilarities (any dissimilarity measure can be used)
mvad.ham <- seqdist(mvad.seq, method="HAM")
## Grow the tree using a low R value for illustration.
## For R=10, pval cannot be lower than 0.1
dt <- disstree(mvad.ham~ male + Grammar + funemp + gcse5eq + fmpr + livboth,
               data=mvad, R = 10, pval = 0.1)
print(dt)


## Will only work if GraphViz is properly installed
## See seqtree for a simpler way to plot a sequence tree.
## Not run:
disstreedisplay(dt, image.fun = seqdplot, image.data = mvad.seq,
                ## Additional parameters passed to seqdplot
                with.legend = FALSE, xaxis = FALSE, ylab = "", border=NA)

## End(Not run)

## Second method, using a specific function
myplotfunction <- function(individuals, seqs, ...) {
```

```
  par(font.sub=2, mar=c(3,0,6,0), mgp=c(0,0,0))
  ## using mds to order sequence in seqIplot
  mds <- suppressMessages(cmdscale(seqdist(seqs[individuals,], method="HAM"),k=1))
  seqIplot(seqs[individuals,], sortv=mds,...)
}

## If image.data is not set, indexes of individuals are sent to image.fun
## Not run:
disstreedisplay(dt, image.fun = myplotfunction, cex.main = 3,
                ## additional parameters passed to myplotfunction
                seqs = mvad.seq,
                ## additional parameters passed to seqIplot (through myplotfunction)
                with.legend = FALSE, xaxis = FALSE, ylab = "")

## End(Not run)

## Retrieving terminal node membership
term.leaf <- disstreeleaf(dt)
table(term.leaf)

## Retrieving classification rules
rules <- disstree.get.rules(dt)

## Index of rule (terminal leaf) that applies to a specified profile
## covariates are: male, Grammar, funemp, gcse5eq, fmpr, livboth

profile <- data.frame(male="no", Grammar="yes", funemp="no", gcse5eq="yes", fmpr="no", livboth="no")
rules[disstree.assign(rules, profile=profile)]
```

`disstree.assign` *Assign rules to profiles provided*

Description

Find the tree classification rule that applies to provided cases.

Usage

```
disstree.assign(rules, profile, covar=attr(rules,"covariates"))
```

Arguments

`rules`	Character vector. List of classification rules such as those returned by `disstree.get.rules`.
`profile`	Data frame. Profiles of cases to be classified with the rules.
`covar`	Character vector. List of names of covariates used by the rules.

Details

`rules` must be given as strings of R commands. Use `disstree.get.rules` to get the classification rules of a tree of class `disstree`.

Rules are expected to create a full partition of the space of possible values of the covariates, i.e., any profile must satisfy one and only one of the rules.

Value

A vector of length equal to the number of rows of `profile` with for each case the index of the rule that applies.

Author(s)

Gilbert Ritschard)

See Also

`disstree`, `disstreeleaf`, `disstree.get.rules`

`disstree.get.rules` *Tree classification rules*

Description

Tree classification rules.

Usage

```
disstree.get.rules(tree, collapse="; ")
```

Arguments

`tree`	A tree (`disstree` or `DissTreeNode` object).
`collapse`	Character string. Separator between categories in class of categorical values.

Details

`disstree.get.rules` extracts the classification rules defined by a tree grown from a dissimilarity matrix and returns them as a vector of character strings. The rules are expressed as R commands and the i-th rule, for example, can be applied using `eval(parse(text=rule[i]))`. Rules are built through a call to `disstreeleaf`.

Value

Character vector with the rules as R commands and an attribute `covariates` providing the names of the variables involved in the rules.

Author(s)

Gilbert Ritschard)

See Also

disstree, disstreeleaf, disstree.assign

---

disstree2dot *Graphical representation of a dissimilarity tree*

Description

Functions to generate a "dot" file and associated images files that can be used in GraphViz to get a graphical representation of the tree.

Usage

```
disstree2dot(tree, filename, digits = 3, image.fun = NULL, image.data = NULL,
  only.leaf = FALSE, device = "jpeg", image.format = "jpg",
  device.args = list(), use.title = TRUE, label.pos = "main",
  node.pos = "main", split.pos = "sub", cex.main = 1,
  legend.text = NULL, image.legend = NULL, image.quality = NULL,
  show.depth = FALSE, title.outer = FALSE,
  imagefunc, imagedata, imgLeafOnly, devicefunc, imageext,
  device.arg, label.loc, node.loc, split.loc, title.cex, legendtext,
  legendimage, qualityimage, showdepth, ...)

disstree2dotp(tree, filename, image.data = NULL, only.leaf = FALSE,
  image.fun = plot, cex.main = 3, with.quality = TRUE,
  cex.quality = cex.main, title.outer = FALSE,
  imagedata, imgLeafOnly, imagefunc, title.cex, withquality,
  quality.fontsize, ...)

seqtree2dot(tree, filename, seqdata = tree$info$object, only.leaf = FALSE,
  sortv = NULL, diss = NULL, cex.main = 3, with.legend = "auto",
  cex.legend = cex.main, with.quality = FALSE,
  cex.quality = cex.main, xaxis = FALSE,
  imgLeafOnly, dist.matrix, title.cex,
  withlegend, withquality, axes,  ...)
```

Arguments

tree	The tree to be plotted.
filename	A filename, without extension, that will be used to generate image and dot files.
digits	Number of significant digits to plot.
image.fun	A function to plot the individuals in a node, see details.

image.data	a data.frame that will be passed to image.fun, see details.
only.leaf	Logical: If TRUE, only terminal node will be plotted.
device	A device function, "jpeg" by default.
image.format	extension for image files.
device.args	Argument passed to device.
use.title	Logical: If TRUE, node information will be printed using title command, see details.
label.pos	Location of the node label, see title for possible values.
node.pos	Node content location, see title for possible values.
split.pos	Split information location, see title for possible values.
cex.main	cex applied to all calls to title (see use.title).
title.outer	Logical: If TRUE, the title (see use.title) is printed in the outer margins.
legend.text	An optional text appearing in a distinct node.
image.legend	An optional image file appearing in a distinct node.
image.quality	An optional image file appearing in a distinct node.
show.depth	Logical. If TRUE, information about depth of the tree is added to the plot.
with.quality	If TRUE, a node displaying fitting measures of the tree is added to the plot.
cex.quality	Numeric. Size of the font of the fitting measures node.
seqdata	a sequence object as defined by the the seqdef function.
sortv	The name of an optional variable used to sort the data before plotting, see seqplot.
diss	The name of an optional dissimilarity matrix used to find representative sequences, seqrplot.
with.legend	defines if and where the legend of the state colors is plotted. The default value "auto" sets the position of the legend automatically. Other possible value is "right". Obsolete value TRUE is equivalent to "auto".
cex.legend	Size of the font of the legend.
xaxis	Logical. Should the x-axis be drawn on the plots?
imagefunc	Deprecated. Use image.fun instead.
imagedata	Deprecated. Use image.data instead.
imgLeafOnly	Deprecated. Use only.leaf instead.
devicefunc	Deprecated. Use device instead.
imageext	Deprecated. Use image.format instead.
device.arg	Deprecated. Use device.args instead.
label.loc	Deprecated. Use label.pos instead.
node.loc	Deprecated. Use node.pos instead.
split.loc	Deprecated. Use split.pos instead.
title.cex	Deprecated. Use cex.main instead.

legendtext	Deprecated. Use legend.text instead.
legendimage	Deprecated. Use image.legend instead.
qualityimage	Deprecated. Use image.quality instead.
showdepth	Deprecated. Use show.depth instead.
withquality	Deprecated. Use with.quality instead.
quality.fontsize	Deprecated. Use cex.quality instead.
dist.matrix	Deprecated. Use diss instead.
withlegend	Deprecated. Use with.legend instead.
axes	Deprecated. Use xaxis instead.
...	other parameters that will be passed to image.fun or seqplot (for seqtree2dot).

Details

These functions generate a "dot" file that can be used in GraphViz (http://www.graphviz.org). It also generates one image per node through a call to image.fun passing the selected lines of image.data if present or otherwise a list of indexes (of individuals belonging to a node). These functions are not intended to be used by end-user. See seqtreedisplay and disstreedisplay for a much simpler way to generate a graphical representation of a tree (seqtree or disstree).

If the path to GraphViz is not found, pass the path as gvpath argument among the ... list.

seqtree2dot is a shortcut for sequences objects using the plot function seqplot. For each node, it calls seqplot with the corresponding subset of rows of seqdata and the provided seqplot's arguments. You should at least specify the type of the plot (e.g. type="d", see seqplot for more details).

If use.title is TRUE, image.fun should take care to leave enough space for the title.

disstree2dotp is a simplified interface of disstree2dot which automatically leaves enough space for the title and subtitles. These functions are intended to be generic.

Value

Nothing but generates a "dot" and several image files (one per node) in the current working directory (see getwd and setwd).

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqtree and seqtreedisplay, disstree and disstreedisplay.

`disstreeleaf` *Terminal node membership*

Description

Get the terminal node membership of each case.

Usage

```
disstreeleaf(tree, label=FALSE, collapse=", ")
```

Arguments

`tree`	A tree (`disstree` or `DissTreeNode` object).
`label`	Logical. Should leaf memberships be labelled with classification rules?
`collapse`	Character string. Separator between categories in class of categorical values.

Details

`disstreeleaf` returns the terminal node membership of the cases either as the leaf number of the terminal node to which the cases are assigned or, when `label=TRUE`, as the classification rule leading to the assigned terminal node. In the latter case, `collapse` is used as separator between categorical values in classes of categorical values. The default `collapse` is `", "`. It is advisable to change this default when categorical values contain commas.

Value

Either a vector of leaf numbers or a factor. When `label=FALSE` (default), vector of assigned terminal node numbers. When `label=TRUE`, a factor with levels labelled with classification rules.

Author(s)

Matthias Studer and Gilbert Ritschard)

See Also

`disstree` for examples, `disstree.get.rules`, and `disstree.assign`.

`dissvar` *Dissimilarity based discrepancy*

Description

Compute the discrepancy from the pairwise dissimilarities between objects. The discrepancy is a measure of dispersion of the set of objects.

Usage

```
dissvar(diss, weights=NULL, squared = FALSE)
```

Arguments

`diss`	A dissimilarity matrix or a `dist` object (see `dist`)
`weights`	optional numerical vector containing weights.
`squared`	Logical. If `TRUE` `diss` is squared.

Details

The discrepancy is an extension of the concept of variance to any kind of objects for which we can compute pairwise dissimilarities. The discrepancy s^2 is defined as:

$$s^2 = \frac{1}{2n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij}$$

Mathematical ground: In the Euclidean case, the sum of squares can be expressed as:

$$SS = \sum_{i=1}^{n} (y_i - \bar{y})^2 = \frac{1}{2n} \sum_{i=1}^{n} \sum_{j=1}^{n} (y_i - y_j)^2$$

The concept of discrepancy generalizes the equation by allowing to replace the $(y_i - y_j)^2$ term with any measure of dissimilarity d_{ij}.

Value

The discrepancy.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2010) Discrepancy analysis of complex objects using dissimilarities. In F. Guillet, G. Ritschard, D. A. Zighed and H. Briand (Eds.), *Advances in Knowledge Discovery and Management*, Studies in Computational Intelligence, Volume 292, pp. 3-19. Berlin: Springer.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2009) Analyse de dissimilarités par arbre d'induction. In EGC 2009, *Revue des Nouvelles Technologies de l'Information*, Vol. E-15, pp. 7-18.

Anderson, M. J. (2001) A new method for non-parametric multivariate analysis of variance. *Austral Ecology* **26**, 32-46.

Batagelj, V. (1988) Generalized ward and related clustering problems. In H. Bock (Ed.), *Classification and related methods of data analysis*, Amsterdam: North-Holland, pp. 67-74.

See Also

`dissassoc` to test association between objects represented by their dissimilarities and a covariate.
`disstree` for an induction tree analyse of objects characterized by a dissimilarity matrix.
`disscenter` to compute the distance of each object to its group center from pairwise dissimilarities.
`dissmfacw` to perform multi-factor analysis of variance from pairwise dissimilarities.

Examples

```
## Defining a state sequence object
data(mvad)
mvad.seq <- seqdef(mvad[, 17:86])

## Building dissimilarities (any dissimilarity measure can be used)
mvad.ham <- seqdist(mvad.seq, method="HAM")

## Pseudo variance of the sequences
print(dissvar(mvad.ham))
```

`ex1` *Example data set with missing values and weights*

Description

Example data set used to demonstrate the handling of missing values and weights.

The state columns (variable) are named `'P1'` to `'P13'`.

The alphabet is made of four possible states: `A`, `B`, `C` and `D`.

The data set contains also case weights (variable `weights`). The sum of the weights is 60.

Usage

```
data(ex1)
```

Format

A data frame with 7 rows, 13 state variables, 1 weight variable.

Source

The brain of the TraMineR package team.

---

ex2 *Example data sets with weighted and unweighted sequence data*

Description

Example data sets used to demonstrate the handling of weights. The 'ex2.weighted' data set contains 6 sequences with weights inflating to 100 sequences (sum of weights is 100). The second data frame 'ex2.unweighted' contains the corresponding 100 sequences.

The sequences are, in both data frames, in the 'seq' column, and weights in the 'weight' column of 'ex2.weighted'.

The alphabet is made of four possible states: A, B, C and D.

These data sets are mainly intended to test and illustrate the handling of weights in TraMineR's functions. Weighted results obtained with 'ex2.weighted' data set should be exactly the same as unweighted results obtained with the 'ex2.unweighted' data set.

Usage

```
data(ex2)
```

Format

The command data(ex2) generates two data frames:
ex2.weighted: a data frame with 6 rows, 1 variable containing sequences as character strings, 1 weight variable.
ex2.unweighted: a data frame with 100 rows, 1 variable containing sequences as character strings.

Source

The brain of the TraMineR package team.

Examples

```
data(ex2)

ex2w.seq <- seqdef(ex2.weighted, 1, weights=ex2.weighted$weight)
ex2u.seq <- seqdef(ex2.unweighted)
```

famform *Example data set: sequences of family formation*

Description

This data set contains 5 sequences of family formation histories, used by Elzinga (2008) to introduce several metrics for computing distances between sequences. These sequences don't contain information about the duration spent in each state, they contain only distinct successive states.

Usage

```
data(famform)
```

Format

A data frame with 5 rows and 1 variable.

Details

The sequences are in 'STS' format and stored in character strings with states separated with '-'.

This data set is used in TraMineR's manual to crosscheck some results with those presented by Elzinga.

Source

Elzinga (2008)

References

Elzinga, Cees H. (2008). Sequence analysis: Metric representations of categorical time series. Non published manuscript. VU University, Amsterdam.

is.stslist *Test if is a proper state sequence (stslist) object*

Description

The function tests whether x is of class stslist and if its weights attribute has the expected length and names.

Usage

```
is.stslist(x)
```

Arguments

x	object to be tested.

Value

Logical: result of the test.

Author(s)

Gilbert Ritschard

See Also

seqdef

Examples

```
## Creating a sequence object with the columns 13 to 24
## in the 'actcal' example data set
data(biofam)
biofam <- biofam[sample(nrow(biofam),300),]
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
                "Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam[,10:25], weights=biofam$wp00tbgs)

is.stslist(biofam.seq) #TRUE

attr(biofam.seq,"weights") <- NULL
is.stslist(biofam.seq) #TRUE

attr(biofam.seq,"weights") <- rep(1, nrow(biofam.seq))
is.stslist(biofam.seq) #FALSE

w <- rep(1, nrow(biofam.seq))
names(w) <- rownames(biofam.seq)
attr(biofam.seq,"weights") <- w
is.stslist(biofam.seq) #TRUE
```

---

mvad *Example data set: Transition from school to work*

Description

The data comes from a study by McVicar and Anyadike-Danes on transition from school to work. The data consist of static background characteristics and a time series sequence of 72 monthly labour market activities for each of 712 individuals in a cohort survey. The individuals were followed up from July 1993 to June 1999. The monthly states are recorded in columns 15 (Jul.93) to 86 (Jun.99).

States are:

employment	(EM)
FE	further education (FE)
HE	higher education (HE)
joblessness	(JL)
school	(SC)
training	(TR)

The data set contains also ids (id) and sample weights (weight) as well as the following binary covariates:

male
catholic
Belfast, N.Eastern, Southern, S.Eastern, Western (location of school, one of five Education and Library Board areas in Northern Ireland)
Grammar (type of secondary education, 1=grammar school)
funemp (father's employment status at time of survey, 1=father unemployed)
gcse5eq (qualifications gained by the end of compulsory education, 1=5+ GCSEs at grades A-C, or equivalent)
fmpr (SOC code of father's current or most recent job, 1=SOC1 (professional, managerial or related))
livboth (living arrangements at time of first sweep of survey (June 1995), 1=living with both parents)

Usage

```
data(mvad)
```

Format

A data frame containing 712 rows, 72 state variables, 1 id variable and 13 covariates.

Source

McVicar and Anyadike-Danes (2002)

References

McVicar, Duncan and Anyadike-Danes, Michael (2002). Predicting Successful and Unsuccessful Transitions from School to Work by Using Sequence Methods, *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 165, 2, pp. 317–334.

`plot.seqdiff` *Plotting a seqdiff object.*

Description

Plot method for the sliding values returned by `seqdiff`. Plots a statistic (the Pseudo R2 by default) along the position axis.

Usage

```
## S3 method for class 'seqdiff'
plot(x, stat = "Pseudo R2", type = "l", ylab = stat,
  xlab = "", legend.pos = "top", ylim = NULL, xaxis = TRUE, col = NULL,
  xtstep = NULL, tick.last = NULL, legendposition, xaxt, ...)
```

Arguments

`x`	an object produced by `seqdiff`
`stat`	character. Name of the statistic to be plotted. Can be any of the statistics returned by `seqdiff` or `"discrepancy"`. See details.
`type`	the line `type`, see `lines`
`ylab`	character: y-axis label.
`xlab`	character: x-axis label.
`legend.pos`	character: position of the line legend, see `legend`
`ylim`	numeric: if not `NULL`, range of the y-axis.
`xaxis`	logical: if `TRUE` an x-axis is plotted.
`col`	list of colors to use for each line.
`xtstep`	integer: optional step between tick-marks and labels on the x-axis. If unspecified, the `xtstep` attribute of the sequence object `x` is used. (see `seqdef`)
`tick.last`	Logical. Should a tick mark be enforced at the last position on the x-axis? If unspecified, the `tick.last` attribute of the `x` object is used.
`legendposition`	Deprecated. Use `legend.pos` instead.
`xaxt`	Deprecated. Use `xaxis` instead.
`...`	Additional parameters passed to `lines`

Details

The function plots the sliding values of the requested statistic.

You can plot the evolution of two statistics by providing for instance `stat=c("Pseudo R2", "Levene")`.

Use `stat="discrepancy"` to plot the within-discrepancies.

For `"discrepancy"`, a separate line is drawn for the whole set of sequences and for each group. Those two values cannot be paired with another statistic.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqdiff

---

plot.seqrf *Plot method for seqrf objects of relative frequency groups of sequences.*

Description

Plots the medoids of the RF groups of sequences and/or the boxplots of the distribution of the distances from the sequences to their group medoid.

Usage

```
## S3 method for class 'seqrf'
plot(x,
        space=0,
        border=NA,
        which.plot="medoids",
        ylab=NA,
        main=NULL,
        frame.plot=FALSE,
        info="all",
        skipar=FALSE,
        ...)
```

Arguments

x	a seqrf object
space	space between horizontal bars representing medoid sequences (see barplot)
border	the color to be used for the border of the bars. Use border = NA to omit borders. (see barplot)
which.plot	string. One of "both", "medoids", "diss.to.med". When "medoids", only the index plot of the medoids is displayed, when "diss.to.med", the grouped boxplots of the distances to the medoids is displayed, and when "both" a combined plot of the two plots is displayed.
ylab	string. An optional label for the y-axis. If set as NA (default), no label is drawn.
main	main graphic title. Default is NULL.
frame.plot	logical. Should a frame be plotted around the grouped boxplots?
info	string. One of "all" (default), "subtitle", "stat", and "none".

skipar	logical. Should plot skip internal par and layout commands. May be necessary to combine "medoids" or "diss.to.med" plots with layout or par(mfrow=...)
...	further arguments passed to plot.stslist including graphical parameters (par)

Details

The plot of the medoids is generated with the plot method for stslist objects and the boxplots with a slightly adapted version of the boxplot function for weighted data (wtd.boxplot) of the ENmisc package by Erich Neuwirth.

When which.plot="both", layout is used to produce the combined plot. Therefore, the resulting combined plot cannot be nested into other combinations using either par(mfrow=...) or layout. To combine with other plots, you must produce separately the plot of the medoids and the grouped boxplots using successively which.plot="medoids" and which.plot="diss.to.med".

When arguments xaxis and yaxis are on the ... list to be passed to plot.stslist, they are also used to control the display of the x and y axis of the boxplot.

With info="stat" or "all", the pseudo R2 and F statistics are displayed under the plot, but only when which.plot = "both".

Author(s)

Gilbert Ritschard.

See Also

seqrf, seqrfplot

---

plot.stslist *Plot method for state sequence objects*

Description

This is the plot method for state sequence objects of class stslist created by the seqdef function. It produces a sequence index plot.

Usage

```
## S3 method for class 'stslist'
plot(x, idxs = NULL, weighted = TRUE, sortv = NULL,
  cpal = NULL, missing.color = NULL, ylab = NULL,
  yaxis = TRUE, xaxis = TRUE, ytlab = NULL, las = par("las"),
  xtlab = NULL, xtstep = NULL, tick.last = NULL, cex.axis = par("cex.axis"),
  tlim, cex.plot, ylas, ...)
```

Arguments

x	A state sequence object created with the seqdef function.
idxs	Indexes of the sequences to be plotted (default value is 1:10), for instance 20:50 to plot sequences 20 to 50, c(2,8,12,25) to plot sequences 2,8,12 and 25 in seqdata. If set to 0, all sequences in seqdata are plotted.
weighted	Logical: Should the bar representing each sequence be proportional to its weight? Ignored when no weights are assigned to sequences (see seqdef.)
sortv	A sorting variable or a sort method (one of "from.start" or "from.end"). See details.
cpal	Color palette for the states. A vector of colors of length equal to the number of states in the alphabet. If NULL (default), the cpal attribute of the seqdata sequence object is used (see seqdef).
missing.color	Color for representing missing values inside the sequences. If NULL (default) the color is taken from the "missing.color" attribute of the x sequence object.
ylab	String. Optional label of the y-axis. If set to NA, no label is drawn.
yaxis	Logical. Should the y-axis be plotted. When set as TRUE, sequence indexes are displayed.
xaxis	Logical. Should the x-axis (time) be plotted? Default is TRUE.
ytlab	Character string or vector of length equal to the number of sequences. Labels of the plotted sequences to be used as tick labels on the y-axis. Default is the indexes of the sequences as defined by the idxs argument. Can be set to "id" for displaying the row names (id) of the sequences instead of their indexes; row names can be assigned to the sequence object with the id argument of the seqdef function or afterwards with rownames. Otherwise ytlab can be set to a vector of length equal to the number of sequences to be plotted.
las	numeric in {0,1,2,3}; the orientation of tick labels. 0: always parallel to the axis (default), 1: always horizontal, 2: always perpendicular to the axis, 3: always vertical.
xtlab	optional labels for the x-axis tick labels. If unspecified, the column names of the seqdata sequence object are used (see seqdef).
xtstep	optional interval at which tick marks and labels of the x-axis are displayed. For example, with xtstep=3 a tick mark is drawn at position 1, 4, 7, etc... The display of the corresponding labels depends on the available space and is dealt with automatically. If unspecified, the xtstep attribute of the x object is used.
tick.last	Logical. Should a tick mark be enforced at the last position on the x-axis? If unspecified, the tick.last attribute of the x object is used.
cex.axis	Axis annotation magnification. See par.
tlim	Deprecated. Use idxs instead.
cex.plot	Deprecated. Use cex.axis instead.
ylas	Deprecated. Use las instead.
...	further graphical parameters (see par) and barplot arguments.

Details

This is the default plot method for state sequence objects (produced by the seqdef function), i.e., for objects of class *stslist*. It produces a sequence index plot, where individual sequences are rendered with stacked bars depicting the successive states in each of the sequences.

This method is invoked by several advanced plot functions such as seqiplot and seqIplot (seqplot with type="i" or "I"), which, in addition to index plots, automatically display the state color legend and allow plotting by group.

When a sortv variable is provided, the sequences are sorted bottom-up according to its values. With sortv = "from.start", sequence are sorted by the elements of the alphabet at the successive positions starting from the beginning of the sequences. Method "from.end" proceeds similarly, but backward from the last position.

Index plots of thousands of sequences result in very heavy graphic files when stored in vectorial (PDF or POSTSCRIPT) format because each sequence, even if hidden, is drawn individually. To reduce the file size, we suggest saving the figures in bitmap format by using for instance png instead of postscript or pdf.

Author(s)

Gilbert Ritschard

See Also

seqplot

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam <- biofam[500:600,] ## using a subsample only
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
    "Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam, 10:25, labels=biofam.lab)

## Plot of the 10 most frequent sequences
## with bar width proportional to the frequency
plot(biofam.seq)

## Plotting the whole data set
## with no borders
plot(biofam.seq, idxs=0, space=0, border=NA)

## =======
## Weights
## =======
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)
```

```
plot(ex1.seq)
plot(ex1.seq, weighted=FALSE)
```

`plot.stslist.freq` *Plot method for sequence frequency tables*

Description

Plot method for output produced by the `seqtab` function, i.e objects of class `stslist.freq`.

Usage

```
## S3 method for class 'stslist.freq'
plot(x, cpal = NULL, missing.color = NULL, pbarw = TRUE,
  ylab = NULL, yaxis = TRUE, xaxis = TRUE,
  xtlab = NULL, xtstep = NULL, tick.last = NULL, cex.axis = par("cex.axis"),
  cex.plot, ...)
```

Arguments

`x`	an object of class `stslist.freq` as produced by the `seqtab` function.
`cpal`	alternative color palette to be used for the states. If user specified, a vector of colors with number of elements equal to the number of states in the alphabet. By default, the `cpal` attribute of the `x` object is used.
`missing.color`	alternative color for representing missing values inside the sequences. By default, the `missing.color` attribute of the `x` object is used.
`pbarw`	if `pbarw=TRUE` (default), the width of the bars are proportional to the sequence frequency in the dataset.
`ylab`	label of the y axis. If set to `NA`, no label is drawn.
`yaxis`	if `TRUE` or `"cum"`, the y axis is plotted with a label showing the cumulated percentage frequency of the displayed sequences. If `"pct"`, the percentage value for each sequence is displayed.
`xaxis`	if `TRUE` (default) the x-axis is plotted.
`xtlab`	tick labels of the x-axis. If unspecified, the `names` attribute of the `x` object is used.
`xtstep`	interval at which the tick-marks and labels of the x-axis are displayed. For example, with xtstep=3 a tick-mark is drawn at position 1, 4, 7, etc... The display of the corresponding labels depends on the available space and is dealt with automatically. If unspecified, the `xtstep` attribute of the `x` object is used.
`tick.last`	Logical. Should a tick mark be enforced at the last position on the x-axis? If unspecified, the `tick.last` attribute of the `x` object is used.
`cex.axis`	Axis annotation magnification. See `par`.
`...`	further graphical and `barplot` parameters. For example `border=NA` removes the bars borders, `space=0` removes space between sequences, `las` controls orientation of tick labels. See `barplot` and `par` for details.
`cex.plot`	Deprecated. Use `cex.axis` instead.

Details

This is the plot method for output of the seqtab function, i.e., for objects of class *stslist.freq*. It plots the sequences bottom-up according to their frequency in the data set.

The method is invoked by seqfplot (seqplot with type="f"), which produces frequency plots with automatic display of the state color legend and allows plotting by group.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

See Also

seqfplot

Examples

```
## Loading the 'actcal' example data set
data(actcal)

## Defining a sequence object with data in columns 13 to 24
## (activity status from january to december 2000)
actcal.lab <- c("> 37 hours", "19-36 hours", "1-18 hours", "no work")
actcal.seq <- seqdef(actcal, 13:24, labels=actcal.lab)

## 10 most frequent sequences in the data
actcal.freq <- seqtab(actcal.seq)

## Plotting the object
plot(actcal.freq, main="Sequence frequencies - actcal data set")

## Plotting all the distinct sequences without borders
## and space between sequences
actcal.freq2 <- seqtab(actcal.seq, idxs=0)
plot(actcal.freq2, main="Sequence frequencies - actcal data set",
  border=NA, space=0)
```

---

plot.stslist.meant *Plot method for objects produced by the seqmeant function*

Description

This is the plot method for objects of class *stslist.meant* produced by the seqmeant function.

Usage

```
## S3 method for class 'stslist.meant'
plot(x, cpal = NULL, ylab = NULL, yaxis = TRUE,
  xaxis = TRUE, cex.axis = par("cex.axis"), ylim = NULL, bar.labels = NULL,
  cex.barlab = cex.axis, offset.barlab = .1, cex.plot, ...)
```

Arguments

x	object of class stslist.meant as produced by the seqmeant function.
cpal	vector of colors of length the number of states in the alphabet. If NULL (default), the 'cpal' attribute of the 'seqdata' sequence object is used (see seqdef).
ylab	optional label of the y-axis. If set to NA, no label is drawn.
yaxis	should the y-axis be plotted. Default is TRUE.
xaxis	should the x-axis be plotted. Default is TRUE.
cex.axis	Tick labels magnification. See par.
ylim	optional vector of length 2 setting the limits of the y-axis. If NULL (default), limits are set to (0, max. sequence length).
bar.labels	Vector of bar labels of length equal to size of alphabet.
cex.barlab	Real. Bar labels magnification. Defaults to cex.axis
offset.barlab	Real. Vertical offset of bar labels as a proportion of max(ylim). Default is 0.1.
cex.plot	Deprecated. Use cex.axis instead.
...	further graphical parameters. For more details about the graphical parameter arguments, see barplot and par.

Details

This is the plot method for the output produced by the seqmeant function, i.e., objects of class *stslist.meant*. It produces a plot showing the mean times spent in each state of the alphabet.

When the "se" attribute of x is TRUE, i.e., when x contains also the standard errors of the mean times, error bars are automatically displayed on the plot. See the serr argument of seqmeant.

The method is invoked by seqmtplot (seqplot with type="mt"), which plots mean times with automatic display of the state color legend and allows plotting by group.

Examples

```
## Loading the mvad data set and creating a sequence object
data(mvad)
mvad.labels <- c("employment", "further education", "higher education",
                 "joblessness", "school", "training")
mvad.scodes <- c("EM","FE","HE","JL","SC","TR")
mvad.seq <- seqdef(mvad, 15:86, states=mvad.scodes, labels=mvad.labels)

## Computing the mean times
mvad.meant <- seqmeant(mvad.seq)

## Plotting
plot(mvad.meant, main="Mean durations in each state of the alphabet")

## Changing the y axis limits
plot(mvad.meant, main="Mean durations in each state of the alphabet",
 ylim=c(0,40))

## Displaying error bars
```

```
mvad.meant.e <- seqmeant(mvad.seq, serr=TRUE)
plot(mvad.meant.e, main="Mean durations in each state of the alphabet",
 ylim=c(0,40))
```

`plot.stslist.modst` *Plot method for modal state sequences*

Description

Plot method for output produced by the seqmodst function, i.e objects of class stslist.modst.

Usage

```
## S3 method for class 'stslist.modst'
plot(x, cpal = NULL, ylab = NULL, yaxis = TRUE,
  xaxis = TRUE, xtlab = NULL, xtstep = NULL, tick.last = NULL,
  info = TRUE, cex.axis = par("cex.axis"), las = 1, cex.plot, ...)
```

Arguments

`x`	an object of class `stslist.modst` as produced by the `seqmodst` function.
`cpal`	alternative color palette to use for the states. If user specified, a vector of colors with number of elements equal to the number of states in the alphabet. By default, the 'cpal' attribute of the `x` object is used.
`ylab`	an optional label for the y axis. If set to NA, no label is drawn.
`yaxis`	if TRUE (default) the y axis is plotted.
`xaxis`	if TRUE (default) the x axis is plotted.
`xtlab`	optional labels for the x axis ticks. If unspecified, the `names` attribute of the `x` object is used.
`xtstep`	optional interval at which the tick-marks and labels of the x-axis are displayed. For example, with xtstep=3 a tick-mark is drawn at position 1, 4, 7, etc... The display of the corresponding labels depends on the available space and is dealt with automatically. If unspecified, the `xtstep` attribute of the `x` object is used.
`tick.last`	Logical. Should a tick mark be enforced at the last position on the x-axis? If unspecified, the `tick.last` attribute of the `x` object is used.
`info`	Logical: should info about frequency of occurrence of the sequence of modal states be displayed?
`cex.axis`	Axis annotation magnification. See `par`.
`las`	Integer in {0, 1, 2, 3}. Orientation of tick labels. See `par`.
`cex.plot`	Deprecated. Use `cex.axis` instead.
`...`	further graphical and `barplot` parameters. See `barplot` and `par`.

Details

This is the plot method for output of seqmodst, i.e., for objects of class *stslist.modst*. It plots the sequence of modal states with bar height proportional to the frequency of the modal state at each successive position.

The method is invoked by seqmsplot (seqplot with type="ms"), which in addition to the modal states automatically displays of the state color legend and allows plotting by group.

See Also

seqmsplot

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
"Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam, 10:25, labels=biofam.lab)

## Modal state sequence
biofam.modst <- seqmodst(biofam.seq)
plot(biofam.modst)
```

---

plot.stslist.rep *Plot method for representative sequence sets*

Description

This is the plot method for output produced by the seqrep function, i.e, for objects of class *stslist.rep*. It produces a representative sequence plot.

Usage

```
## S3 method for class 'stslist.rep'
plot(x, cpal = NULL, missing.color = NULL, pbarw = TRUE,
  dmax = NULL, stats = TRUE, ylab = NULL, xaxis = TRUE, xtlab = NULL,
  xtstep = NULL, tick.last = NULL, seq.alt = NULL, info = TRUE,
  cex.with.axis = 1, cex.plot, ...)
```

Arguments

x	an object of class *stslist.rep* as produced by the seqrep function.
cpal	alternative color palette to use for the states. If user specified, a vector of colors with number of elements equal to the number of states in the alphabet. By default, the 'cpal' attribute of the x object is used.

missing.color	alternative color for representing missing values inside the sequences. By default, this color is taken from the "missing.color" attribute of the sequence object being plotted.
pbarw	when TRUE, the bar heights are set proportional to the number of represented sequences.
dmax	maximal theoretical distance, used for the x axis limits.
stats	if TRUE (default), mean discrepancy in each subset defined by all sequences attributed to one representative sequence and the mean distance to this representative sequence are displayed.
ylab	an optional label for the y axis. If set to NA, no label is drawn.
xaxis	controls whether a x axis is plotted.
xtlab	optional labels for the x axis ticks labels. If unspecified, the column names of the object being plotted.
xtstep	optional interval at which the tick-marks and labels of the x-axis are displayed. For example, with xtstep=3 a tick-mark is drawn at position 1, 4, 7, etc... The display of the corresponding labels depends on the available space and is dealt with automatically. If unspecified, the xtstep attribute of the x object is used.
tick.last	Logical. Should a tick mark be enforced at the last position on the x-axis? If unspecified, the tick.last attribute of the x object is used.
seq.alt	an object of class *stslist* with same number of sequences than the sequence object for which the representatives x are provided. When not NULL, representatives are plotted in this alternative domain.
info	Logical. Should coverage info be displayed? Default is TRUE.
cex.with.axis	Text and symbols magnification.
cex.plot	Deprecated. Use cex.with.axis instead.
...	further graphical parameters such as las to control orientation of tick labels (see par) and barplot arguments such as border=NA to remove the borders of the bars.

Details

This is the plot method for the output produced by the seqrep function, i.e. objects of class *stslist.rep*. It produces a plot where the representative sequences are displayed as horizontal bars with width proportional to the number of sequences assigned to them. Sequences are plotted bottom-up according to their representativeness score.
Above the plot, two parallel series of symbols associated to each representative are displayed horizontally on a scale ranging from 0 to the maximal theoretical distance D_{max}. The location of the symbol associated to the representative r_i indicates on axis A the (pseudo) variance (V_i) within the subset of sequences assigned to r_i and on the axis B the mean distance MD_i to the representative.

This method is called by the generic seqplot function (if type="r") that produces more sophisticated plots with group splits and automatic display of the color legend. The seqrplot function is a shortcut for calling seqplot with type="r".

Author(s)

Alexis Gabadinho and Gilbert Ritschard

Examples

```
## Loading the mvad data set and creating a sequence object
data(mvad)
mvad.labels <- c("employment", "further education", "higher education",
                   "joblessness", "school", "training")
mvad.scodes <- c("EM","FE","HE","JL","SC","TR")

## First 36 months trajectories
mvad.seq <- seqdef(mvad, 15:50, states=mvad.scodes, labels=mvad.labels)

## Computing Hamming distances
##
dist.ham <- seqdist(mvad.seq, method="HAM")

## Extracting a representative set using the sequence frequency
## as a representativeness criterion
mvad.rep <- seqrep(mvad.seq, diss=dist.ham)

## Plotting the representative set
plot(mvad.rep)
```

---

plot.stslist.statd *Plot method for objects produced by the seqstatd function*

Description

This is the plot method for output produced by the seqstatd function, i.e for objects of class *stslist.statd*.

Usage

```
## S3 method for class 'stslist.statd'
plot(x, type = "d", cpal = NULL,
  ylab = NULL, yaxis = TRUE,
  xaxis = TRUE, xtlab = NULL, xtstep = NULL,
  tick.last = NULL,
  cex.axis = par("cex.axis"),
  space = 0, xlab = NULL, lwd=3.5, col="blue",
  ylim=NULL, cex.plot, ...)
```

Arguments

x	an object of class stslist.statd as produced by the seqstatd function.
type	if "d" (default), a state distribution plot is produced. If "Ht" an entropy index plot is produced.
cpal	alternative color palette to be used for the states. If user specified, a vector of colors with number of elements equal to the number of states in the alphabet. By default, the 'cpal' attribute of the x object is used.

ylab	an optional label for the y axis. If set to NA, no label is drawn.
yaxis	Logical. Should the y axis be displayed? Default is TRUE.
xaxis	Logical. Should the x-axis be displayed? Default is TRUE.
xtlab	optional labels for the ticks of the x-axis. If unspecified, the names attribute of the input x object is used.
xtstep	optional interval at which the tick-marks and labels of the x-axis are displayed. For example, with xtstep=3 a tick-mark is drawn at position 1, 4, 7, etc... The display of the corresponding labels depends on the available space and is dealt with automatically. If unspecified, the xtstep attribute of the x object is used.
tick.last	Logical. Should a tick mark be enforced at the last position on the x-axis? If unspecified, the tick.last attribute of the x object is used.
cex.axis	Axis annotation magnification. See par.
space	the space between the stacked bars. Default is 0, i.e. no space.
xlab	Optional title for the x axis. See title.
lwd	Width of entropy line. Default is 3.5. Ignored when type="d".
col	Color of entropy line. Default is "blue". Ignored when type="d".
ylim	Real vector of length two. Limits of the y-axis for the entropy line. Default is NULL. Ignored when type="d".
cex.plot	Deprecated. Use cex.axis instead.
...	further graphical parameters such as las to control orientation of tick labels (see par) and barplot arguments such as border=NA to remove the borders of the bars.

Details

This is the plot method for output produced by the seqstatd function, i.e. for objects of class *stslist.statd*. If type="d" it produces a state distribution plot presenting the sequence of the transversal state frequencies at each successive (time) position, as computed by the seqstatd function. With type="Ht", the series of entropies of the transversal state distributions is plotted. With type="dH" the entropy line is overlayed on the state distribution plot.

When ylim=NULL, ylim is set as c(0,1) when entropy is normalized and otherwise as c(0,1.1*max(entropy)).

This plot method is called by the generic seqplot function (if type="d", type="Ht", or "dH") that produces more sophisticated plots, allowing grouping and automatic display of the state color legend. The seqdplot, seqHtplot, and seqdHplot functions are aliases for calling seqplot with type="d", type="Ht", and dH respectively.

Value

The plotted values, i.e. for type="d" the cross-sectional distributions, for type="Ht" the cross-sectional entropies, and for type="dH" the x stslist.statd object.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
"Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam, 10:25, labels=biofam.lab)

## State distribution
biofam.statd <- seqstatd(biofam.seq)

## State distribution plot (default type="d" option)
plot(biofam.statd)

## Entropy index plot
plot(biofam.statd, type="Ht")

## State distribution and entropy line
plot(biofam.statd, type="dH")
```

---

plot.subseqelist *Plot frequencies of subsequences*

Description

Plot frequencies of subsequences.

Usage

```
## S3 method for class 'subseqelist'
plot(x, freq=NULL,cex=1,...)
```

Arguments

x	The subsequences to plot (a subseqelist object
freq	The frequencies to plot, support if NULL
cex	Plotting text and symbols magnification. See par.
...	arguments passed to barplot

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqefsub

Examples

```
## loading data
data(actcal.tse)

## creating sequences
actcal.eseq <- seqecreate(actcal.tse)

## Looking for frequent subsequences
fsubseq <- seqefsub(actcal.eseq,pmin.support=0.01)

## Frequence of first ten subsequences
plot(fsubseq[1:10], cex=2)
plot(fsubseq[1:10])
```

---

plot.subseqelistchisq *Plot discriminant subsequences*

Description

Plot the result of seqecmpgroup

Usage

```
## S3 method for class 'subseqelistchisq'
plot(x, ylim = "uniform", rows = NA, cols = NA,
  resid.levels = c(0.05,0.01),
  cpal = brewer.pal(1 + 2 * length(resid.levels), "RdBu"), vlegend = NULL,
  cex.legend = 1, ptype = "freq", legend.title = NULL,
  with.legend = TRUE, residlevels, legendcol, legend.cex, ...)
```

Arguments

x	The subsequences to plot (a subseqelist object).
ylim	if "uniform" all axes have same limits.
rows	Number of graphic rows
cols	Number of graphic columns
resid.levels	Significance levels used to colorize the Pearson residual
cpal	Color palette used to color the results
vlegend	When TRUE the legend is printed vertically, when FALSE it is printed horizontally. If NULL (default) the best position will be chosen.
cex.legend	Scale parameters for text legend.
ptype	If set to "resid", Pearson residuals are plotted instead of frequencies
legend.title	Legend title.
with.legend	Logical. Should legend be displayed?

residlevels	Deprecated. Use resid.levels instead.
legendcol	Deprecated. Use vlegend instead.
legend.cex	Deprecated. Use cex.legend instead.
...	Additional parameters passed to barplot

Value

nothing

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqecmpgroup

---

print.stslist *Print method for state sequence objects*

Description

This is the print method for state sequence objects of class stslist created by the seqdef function.

Usage

```
## S3 method for class 'stslist'
print(x, format='STS', extended=FALSE, ...)
```

Arguments

x	A state sequence (stslist) object.
format	String: print format. One of "STS" (default) or "SPS".
extended	Logical: should the output be printed in extended matrix form?
...	Additional print arguments.

Author(s)

Gilbert Ritschard

See Also

seqdef, plot.stslist

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam <- biofam[500:600,] ## using a subsample only
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
    "Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.shortlab <- c("P","L","M","LM","C","LC","LMC","D")
biofam.seq <- seqdef(biofam, 10:25, states=biofam.shortlab,
  labels=biofam.lab)

## Print of first 5 sequences
print(biofam.seq[1:5,])
print(biofam.seq[1:5,], extended=TRUE)
print(biofam.seq[1:5,], format="SPS")
print(biofam.seq[1:5,], format="SPS", SPS.out = list(xfix = "", sdsep = "/"))
```

`read.tda.mdist` *Read a distance matrix produced by TDA.*

Description

This function reads a distance matrix produced by TDA into an R object. When computing OM distances in TDA, the output is a 'half' matrix stored in a text file as a vector.

Usage

```
read.tda.mdist(file)
```

Arguments

`file`	the path to the file containing TDA output.

Value

a R matrix containing the distances.

seqalign *Computation details about a pairwise alignment*

Description

The function provides details about a pairwise alignment.

Usage

```
seqalign(seqdata, indices, indel=1, sm, with.missing = FALSE)

## S3 method for class 'seqalign'
plot(x, cpal = NULL, missing.color = NULL, ylab = NULL,
  yaxis = TRUE, xaxis = TRUE, ytlab = NULL, ylas = 0, xtlab = NULL,
  cex.axis = 1, cex.plot, ...)

## S3 method for class 'seqalign'
print(x, digits=3, ...)
```

Arguments

seqdata	a state sequence object defined with the seqdef function.
indices	a vector of length 2 giving the indexes of the two sequences
indel	indel cost (see seqdist)
sm	matrix of substitution costs or a method for computing the costs (see seqdist)
with.missing	logical: Should the missing state be considered as an element of the alphabet?
x	an object of class seqalign
cpal	color palette
missing.color	color for missing elements
ylab	y label
yaxis	yaxis
xaxis	xaxis
ytlab	ytlab
ylas	ylas
xtlab	xtlab
cex.axis	Axis annotation magnification. See par.
digits	number of digits for printed output
cex.plot	Deprecated. Use cex.axis instead.
...	additional arguments passed to other functions

Details

There are print and plot methods for seqalign objects.

Value

Object of class `seqalign`

Author(s)

Alexis Gabadinho (plot.seqalign) and Matthias Studer (seqalign) (with Gilbert Ritschard for the help page)

See Also

`seqdist`

Examples

```
data(biofam)
biofam.seq <- seqdef(biofam, 10:25)
costs <- seqsubm(biofam.seq, method="TRATE")
sa <- seqalign(biofam.seq, 1:2, indel=1, sm=costs)
print(sa)
plot(sa)
sa <- seqalign(biofam.seq, c(1,5), indel=0.5, sm=costs)
print(sa)
plot(sa)
```

---

seqcomp *Compare two state sequences*

Description

Check whether two state sequences are identical.

Usage

```
seqcomp(x, y)
```

Arguments

x	a state sequence object containing a single sequence (typically the row of a main sequence object, see `seqdef`)
y	a state sequence object containing a single sequence (typically the row of a main sequence object, see `seqdef`)

Value

`TRUE` if sequences are identical, `FALSE` otherwise

See Also

`seqfind`, `seqfpos`, `seqpm`

Examples

```
data(mvad)
mvad.shortlab <- c("EM", "FE", "HE", "JL", "SC", "TR")
mvad.seq <- seqdef(mvad, states=mvad.shortlab, 15:86)

## Comparing sequences 1 and 2 in mvad.seq
seqcomp(mvad.seq[1,],mvad.seq[2,])

## Comparing sequences 176 and 211 in mvad.seq
seqcomp(mvad.seq[176,],mvad.seq[211,])
```

---

seqconc *Concatenate vectors of states or events into a character string*

Description

Concatenate vectors of states or events into a character string. In the string, each state is separated by 'sep'. The void elements in the input sequences are eliminated.

Usage

```
seqconc(data, var=NULL, sep="-", vname="Sequence", void=NA)
```

Arguments

data	A data frame or matrix containing sequence data (tibble will be converted with as.data.frame).
var	List of the columns containing the sequences. Default is NULL in which case all columns are retained. Whether the sequences are in the compressed (character strings) or extended format is automatically detected by counting the number of columns.
sep	Character used as separator. By default, "-".
vname	an optional name for the variable containing the sequences. By default, "Sequence".
void	the code used for void elements appearing in the sequences (see *Gabadinho et al. (2009)* for more details on missing values and void elements in sequences). Default is NA.

Value

a vector of character strings, one for each row in the input data.

Author(s)

Alexis Gabadinho

References

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. *Department of Econometrics and Laboratory of Demography, University of Geneva*.

See Also

seqdecomp.

Examples

```
data(actcal)
actcal.string <- seqconc(actcal,13:24)
head(actcal.string)
```

---

seqcost *Generate substitution and indel costs*

Description

The function seqcost proposes different ways to generate substitution costs (supposed to represent state dissimilarities) and possibly indel costs. Proposed methods are: "CONSTANT" (same cost for all substitutions), "TRATE" (derived from the observed transition rates), "FUTURE" (Chi-squared distance between conditional state distributions lag positions ahead), "FEATURES" (Gower distance between state features), "INDELS", "INDELSLOG" (based on estimated indel costs). The substitution-cost matrix is intended to serve as sm argument in the seqdist function that computes distances between sequences. seqsubm is an alias that returns only the substitution cost matrix, i.e., no indel.

Usage

```
seqcost(seqdata, method, cval = NULL, with.missing = FALSE, miss.cost = NULL,
  time.varying = FALSE, weighted = TRUE, transition = "both", lag = 1,
  miss.cost.fixed = NULL, state.features = NULL, feature.weights = NULL,
  feature.type = list(), proximities = FALSE)

seqsubm(...)
```

Arguments

seqdata	A sequence object as returned by the seqdef function.
method	String. How to generate the costs. One of "CONSTANT" (same cost for all substitutions), "TRATE" (derived from the observed transition rates), "FUTURE" (Chi-squared distance between conditional state distributions lag positions ahead), "FEATURES" (Gower distance between state features), "INDELS", "INDELSLOG" (based on estimated indel costs).

`cval` Scalar. For method `"CONSTANT"`, the single substitution cost.
For method `"TRATE"`, a base value from which transition probabilities are subtracted.
If `NULL`, `cval=2` is used, unless `transition` is `"both"` and `time.varying` is `TRUE`, in which case `cval=4`.

`with.missing` Logical. Should an additional entry be added in the matrix for the missing states? If `TRUE`, the 'missing' state is also added to the alphabet. Set as `TRUE` if you want to use the costs for distances between sequences containing non deleted (non void) missing values. Forced as `FALSE` when there are no non-void missing values in `seqdata`. See *Gabadinho et al. (2010)* for more details on the options for handling missing values when creating the state sequence object with `seqdef`.

`miss.cost` Scalar or vector. Cost for substituting the missing state. Default is `cval`.

`miss.cost.fixed`
Logical. Should the substitution cost for missing be set as the `miss.cost` value. When `NULL` (default) it will be set as `FALSE` when `method = "INDELS"` or `"INDELSLOG"`, and `TRUE` otherwise.

`time.varying` Logical. If `TRUE` return an `array` with a distinct matrix for each time unit. Time is the third dimension (subscript) of the returned array. Time varying works only with `method='CONSTANT'`, `'TRATE'`, `'INDELS'`, and `'INDELSLOG'`.

`weighted` Logical. Should weights in `seqdata` be used when applicable?

`transition` String. Only used if `method="TRATE"` and `time.varying=TRUE`. On which transition are rates based? Should be one of `"previous"` (from previous state), `"next"` (to next state) or `"both"`.

`lag` Integer. For methods `TRATE` and `FUTURE` only. Time ahead to which transition rates are computed (default is `lag=1`).

`state.features` Data frame with features values for each state.

`feature.weights`
Vector of feature weights with a weight per column of `state.features`.

`feature.type` List of feature types. See `daisy` for details.

`proximities` Logical: should state proximities be returned instead of substitution costs?

`...` Arguments passed to `seqcost`

Details

The substitution-cost matrix has dimension $ns * ns$, where ns is the number of states in the alphabet of the sequence object. The element (i, j) of the matrix is the cost of substituting state i with state j. It represents the dissimilarity between the states i and j. The indel cost of the cost of inserting or deleting a state.

With method `CONSTANT`, the substitution costs are all set equal to the `cval` value, the default value being 2.

With method `TRATE` (transition rates), the transition probabilities between all pairs of states is first computed (using the seqtrate function). Then, the substitution cost between states i and j is obtained with the formula

$$SC(i,j) = cval - P(i|j) - P(j|i)$$

where $P(i|j)$ is the probability of transition from state j to i `lag` positions ahead. Default `cval` value is 2. When `time.varying=TRUE` and `transition="both"`, the substitution cost at position t is set as

$$SC(i,j,t) = cval - P(i|j,t-1) - P(j|i,t-1) - P(i|j,t) - P(j|i,t)$$

where $P(i|j,t-1)$ is the probability to transit from state j at $t-1$ to i at t. Here, the default `cval` value is 4.

With method `FUTURE`, the cost between i and j is the Chi-squared distance between the vector $(d(alphabet|i))$ of probabilities of transition from states i and j to all the states in the alphabet `lag` positions ahead:

$$SC(i,j) = ChiDist(d(alphabet|i), d(alphabet|j))$$

With method `FEATURES`, each state is characterized by the variables `state.features`, and the cost between i and j is computed as the Gower distance between their vectors of `state.features` values.

With methods `INDELS` and `INDELSLOG`, values of indels are first derived from the state relative frequencies f_i. For `INDELS`, $indel_i = 1/f_i$ is used, and for `INDELSLOG`, $indel_i = \log[2/(1+f_i)]$. Substitution costs are then set as $SC(i,j) = indel_i + indel_j$.

For all methods but `INDELS` and `INDELSLOG`, the indel is set as $\max(sm)/2$ when `time.varying=FALSE` and as 1 otherwise.

Value

For `seqcost`, a list of two elements, `indel` and `sm` or `prox`:

`indel`	The indel cost. Either a scalar or a vector of size ns. When `time.varying=TRUE` and `method` is one of `"INDELS"` or `"INDELSLOG"`, a matrix with indels per time point in columns.
`sm`	The substitution-cost matrix (or array) when `proximities = FALSE` (default).
`prox`	The state proximity matrix when `proximities = TRUE`.

`sm` and `prox` are, when `time.varying = FALSE`, a matrix of size $ns * ns$, where ns is the number of states in the alphabet of the sequence object. When `time.varying = TRUE`, they are a three dimensional array of size $ns * ns * L$, where L is the maximum sequence length.

For `seqsubm`, only one element, the matrix (or array) `sm`.

Author(s)

Gilbert Ritschard and Matthias Studer (and Alexis Gabadinho for first version of `seqsubm`)

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2010). Mining Sequence Data in R with the TraMineR package: A user's guide. Department of Econometrics and Laboratory of Demography, University of Geneva.

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Studer, M. and G. Ritschard (2014). "A Comparative Review of Sequence Dissimilarity Measures". *LIVES Working Papers*, **33**. NCCR LIVES, Switzerland, 2014. doi:10.12682/lives.2296-1658.2014.33

See Also

seqtrate, seqdef, seqdist.

Examples

```
## Defining a sequence object with columns 10 to 25
## of a subset of the 'biofam' example data set.
data(biofam)
biofam.seq <- seqdef(biofam[501:600,10:25])

## Indel and substitution costs based on log of inverse state frequencies
lifcost <- seqcost(biofam.seq, method="INDELSLOG")
## Here lifcost$indel is a vector
biofam.om <- seqdist(biofam.seq, method="OM", indel=lifcost$indel, sm=lifcost$sm)

## Optimal matching using transition rates based substitution-cost matrix
## and the associated indel cost
## Here trcost$indel is a scalar
trcost <- seqcost(biofam.seq, method="TRATE")
biofam.om <- seqdist(biofam.seq, method="OM", indel=trcost$indel, sm=trcost$sm)

## Using costs based on FUTURE with a forward lag of 4
fucost <- seqcost(biofam.seq, method="FUTURE", lag=4)
biofam.om <- seqdist(biofam.seq, method="OM", indel=fucost$indel, sm=fucost$sm)

## Optimal matching using a unique substitution cost of 2
## and an insertion/deletion cost of 3
ccost <- seqsubm(biofam.seq, method="CONSTANT", cval=2)
biofam.om.c2 <- seqdist(biofam.seq, method="OM",indel=3, sm=ccost)

## Displaying the distance matrix for the first 10 sequences
biofam.om.c2[1:10,1:10]

## ================================
## Example with weights and missings
## ================================
```

```
data(ex1)
ex1.seq <- seqdef(ex1[,1:13], weights=ex1$weights)

## Unweighted
subm <- seqcost(ex1.seq, method="INDELSLOG", with.missing=TRUE, weighted=FALSE)
ex1.om <- seqdist(ex1.seq, method="OM", indel=subm$indel, sm=subm$sm, with.missing=TRUE)

## Weighted
subm.w <- seqcost(ex1.seq, method="INDELSLOG", with.missing=TRUE, weighted=TRUE)
ex1.omw <- seqdist(ex1.seq, method="OM", indel=subm.w$indel, sm=subm.w$sm, with.missing=TRUE)

ex1.om == ex1.omw
```

---

seqdecomp *Convert a character string into a vector of states or events*

Description

States can be represented by any substring that does not include the sep value. An empty separator sep = "" can only be used when each state is coded with a single character.

Usage

```
seqdecomp(data, var=NULL, sep='-', miss="NA", vnames=NULL)
```

Arguments

data	a dataframe, matrix, or character string vector containing sequence data (tibble will be converted with as.data.frame).
var	the list of columns containing the sequences. Default is NULL, ie all the columns. Whether the sequences are in the compressed (character strings) or extended format is automatically detected by counting the number of columns.
sep	the between states/events separator used in the input data set. Default is '-'.
miss	the symbol for missing values (if any) used in the input data set. Default is NA.
vnames	optional names for the column/variables of the output data set. Default is NULL.

See Also

seqconc.

Examples

```
# 1 sequence of length 4
seqdecomp("A-BB-C-DD")

# 2 sequences of length 6
seqdecomp(c("ABBCDD","BBCCAD"),sep="")
```

seqdef *Create a state sequence object*

Description

Create a state sequence object with attributes such as alphabet, color palette and state labels. Most TraMineR functions for state sequences require such a state sequence object as input argument. There are specific methods for plotting, summarizing and printing state sequence objects.

Usage

```
seqdef(data, var=NULL, informat="STS", stsep=NULL,
       alphabet=NULL, states=NULL, id=NULL, weights=NULL, start=1,
       left=NA, right="DEL", gaps=NA, missing=NA, void="%", nr="*",
       cnames=NULL, xtstep=1, tick.last=FALSE, cpal=NULL,
       missing.color="darkgrey", labels=NULL, ...)
```

Arguments

data	a data frame, matrix, or character string vector containing sequence data (tibble will be converted with as.data.frame).
var	the list of columns containing the sequences. Default is NULL, i.e. all the columns. The function detects automatically whether the sequences are in the compressed (successive states in a character string) or extended format.
informat	format of the original data. Default is "STS". Other available formats are: "SPS" and "SPELL", in which case the seqformat function is called to convert the data into the "STS" format (see TraMineR user's manual (*Gabadinho et al., 2010*) for a description of these formats). A better solution is nonetheless to convert first your data with seqformat, so as to have better control over the conversion process and visualize the intermediate "STS" formatted data.
stsep	the character used as separator in the original data if input format is successive states in a character string. If NULL (default value), the seqfcheck function is called for detecting automatically a separator among "-" and ":". Other separators must be specified explicitly.
alphabet	optional vector containing the alphabet (the list of all possible states). Use this option if some states in the alphabet don't appear in the data or if you want to reorder the states. The specified vector MUST contain AT LEAST all the states appearing in the data. It may possibly contain additional states not appearing in the data. If NULL, the alphabet is set to the distinct states appearing in the data as returned by the seqstatl function. See details.
states	an optional vector containing the short state labels. Must have a length equal to the size of the alphabet and the labels must be ordered conformably with alphanumeric ordered values returned by the seqstatl function, or, when alphabet= is set, with the thus newly defined alphabet.

id	optional argument for setting the rownames of the sequence object. If NULL (default), the rownames are taken from the input data. If set to "auto", sequences are numbered from 1 to the number of sequences. A vector of rownames of length equal to the number of sequences may be specified as well.
weights	optional numerical vector containing weights, which are taken into account by plotting and statistical functions when applicable. Weights must be non-negative and cannot be NA.
start	starting time. For instance, if sequences begin at age 15, you can specify 15. At this stage, used only for labelling column names.
left	the behavior for missing values appearing before the first (leftmost) valid state in each sequence. When NA (default), left missing values are treated as 'real' missing values and converted to the internal missing value code defined by the nr option. Other options are "DEL" to delete the positions containing missing values or a state code (belonging to the alphabet or not) to replace the missing values. See *Gabadinho et al. (2010)* for more details on the options for handling missing values when defining sequence objects.
right	the behavior for missing values appearing after the last (rightmost) valid state in each sequence. Same options as for the left argument. Default is 'DEL'.
gaps	the behavior for missing values appearing inside the sequences, i.e. after the first (leftmost) valid state and before the last (rightmost) valid state of each sequence. Same options as for the left argument. Default is NA.
missing	the code used for missing values in the input data. Default is NA. When any other value, all cells containing this value are treated as NAs and replaced by nr or void code according to the left, gaps, and right options.
void	the internal code used by TraMineR for representing void elements in the sequences. Default is "%". Must be different from left, gaps, and right.
nr	the internal code used by TraMineR for representing real missing elements in the sequences. Default is "*".
cnames	optional names for the columns composing the sequence data. Those names will be used by default in the graphics as axis labels. If NULL (default), names are taken from the original column names in the data.
xtstep	step between displayed tick-marks and labels on the time x-axis of state sequence plots. If not overridden by the user, plotting functions retrieve this parameter from the xtstep attribute of the sequence object. For example, with xtstep=3 a tick-mark is displayed at positions 1, 4, 7, etc... Default value is 1; i.e., a tick mark is displayed at each position. The display of the corresponding labels depends on the available space and is dealt with automatically.
tick.last	Logical. Should a tick mark be enforced at the last position on the time x-axis?
cpal	an optional color palette for representing the states in the graphics. If NULL (default), a color palette is created by means of the brewer.pal function of the RColorBrewer package for number of states up to 12. When the number of states is less or equal than 8, the "Accent" palette is used. If number of states is between 8 and 12, the "Set3" palette is used. When the number of states is greater than 12, colors are set using hcl.colors with the "Set 3" palette. To specify your own palette use e.g. the colors function, or the RColorBrewer or colorspace packages.

missing.color	alternative color for representing missing values inside the sequences. Defaults to "darkgrey".
labels	optional state labels used for the color legend of TraMineR's graphics. If NULL (default), the state names in the alphabet are used as state labels as well.
...	options passed to the seqformat function for handling input data that is not in STS format.

Details

Applying subscripts to sequence objects (eg. seq[,1:5] or seq[1:10,]) returns a state sequence object with some attributes preserved (alphabet, missing) and some others (start, column names, weights) adapted to the selected column or row subset. When the number of columns selected is 1, the returned object is a factor.

For reordering the states use the alphabet argument. This may for instance be useful to compare data from different sources with different codings of similar states. Using alphabet permits to order the states conformably in all sequence objects. Otherwise, the default state order is the alphanumeric order returned by the seqstatl function which may differ when you have different original codings.

Value

An object of class stslist.

There are print, plot, rbind, summary, and subsetting [,] methods for such objects.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2010). Mining Sequence Data in R with the TraMineR package: A user's guide. *Department of Econometrics and Laboratory of Demography, University of Geneva*.

See Also

plot.stslist plot method for state sequence objects,
print.stslist print method for state sequence objects,
is.stslist to test whether an object is a proper stslist object,
seqplot for high level plots of state sequence objects,
seqecreate to create an event sequence object,
seqformat for converting between various longitudinal data formats.

Examples

```
## Creating a sequence object with the columns 13 to 24
## in the 'actcal' example data set
data(actcal)
actcal.seq <- seqdef(actcal,13:24,
labels=c("> 37 hours", "19-36 hours", "1-18 hours", "no work"))

## Displaying the first 10 rows of the sequence object
actcal.seq[1:10,]

## Displaying the first 10 rows of the sequence object
## in SPS format
print(actcal.seq[1:10,], format="SPS")

## Plotting the first 10 sequences
plot(actcal.seq)

## Re-ordering the alphabet
actcal.seq <- seqdef(actcal,13:24,alphabet=c("B","A","D","C"))
alphabet(actcal.seq)

## Adding a state not appearing in the data to the
## alphabet
actcal.seq <- seqdef(actcal,13:24,alphabet=c("A","B","C","D","E"))
alphabet(actcal.seq)

## Adding a state not appearing in the data to the
## alphabet and changing the states labels
actcal.seq <- seqdef(actcal,13:24,
  alphabet=c("A","B","C","D","E"),
  states=c("FT","PT","LT","NO","TR"))
alphabet(actcal.seq)

## rbind and summary
seq1 <- actcal.seq[1:10,]
seq2 <- actcal.seq[20:25,]
seq <- rbind(seq1,seq2)
summary(seq)

## ============================
## Example with missing values
## ============================
data(ex1)

## With right="DEL" default value
seqdef(ex1,1:13)

## Eliminating 'left' missing values
seqdef(ex1,1:13, left="DEL")

## Eliminating 'left' missing values and gaps
seqdef(ex1,1:13, left="DEL", gaps="DEL")
```

```
## ====================
## Example with weights
## ====================
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

## weighted sequence frequencies
seqtab(ex1.seq)
```

---

seqdiff *Position-wise discrepancy analysis between groups of sequences*

Description

The function analyses how the differences between groups of sequences evolve along the positions. It runs a sequence of discrepancy analyses on sliding windows.

Usage

```
seqdiff(seqdata, group, cmprange = c(0, 1),
  seqdist.args = list(method = "LCS", norm = "auto"), with.missing = FALSE,
  weighted = TRUE, squared = FALSE, seqdist_arg)
```

Arguments

seqdata	a state sequence object created with the seqdef function.
group	The group variable.
cmprange	Vector of two integers: Time range of the sliding windows. Comparison at t is computed on the window (t+cmprange[1], t+cmprange[2]).
seqdist.args	List of arguments passed to seqdist for computing the distances.
with.missing	Logical. If TRUE, missing values are considered as an additional state. If FALSE subsequences with missing values are removed from the analysis.
weighted	Logical. If TRUE, seqdiff uses the weights specified in seqdata.
squared	Logical. If TRUE the dissimilarities are squared for computing the discrepancy.
seqdist_arg	Deprecated. Use seqdist.args instead.

Details

The function analyses how the part of discrepancy explained by the group variable evolves along the position axis. It runs successively discrepancy analyses within a sliding time-window of range cmprange). At each position t, the method uses seqdist to compute a distance matrix over the time-window (t+cmprange[1], t+cmprange[2]) and then derives the explained discrepancy on that window with dissassoc.

There are print and plot methods for the returned value.

Value

A `seqdiff` object, with the following items:

`stat`	A `data.frame` with five statistics (Pseudo F, Pseudo Fbf, Pseudo R2, Bartlett, and Levene) for each time stamp of the sequence (see `dissassoc`)
`discrepancy`	A `data.frame` with, at each time position t, the discrepancy within the whole set of sequences and within each group (defined by the `group` variable).

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2010) Discrepancy analysis of complex objects using dissimilarities. In F. Guillet, G. Ritschard, D. A. Zighed and H. Briand (Eds.), *Advances in Knowledge Discovery and Management*, Studies in Computational Intelligence, Volume 292, pp. 3-19. Berlin: Springer.

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2009) Analyse de dissimilarités par arbre d'induction. In EGC 2009, *Revue des Nouvelles Technologies de l'Information*, Vol. E-15, pp. 7-18.

See Also

`dissassoc` to analyse the association of the `group` variable with the whole sequence

Examples

```
## Define a state sequence object
data(mvad)
## First 12 months of first 100 trajectories
mvad.seq <- seqdef(mvad[1:100, 17:28])

## Position-wise discrepancy analysis using
##  centered sliding windows of length 5.
mvad.diff <- seqdiff(mvad.seq, group=mvad$gcse5eq[1:100], cmprange=c(-2,2))
print(mvad.diff)
plot(mvad.diff, stat=c("Pseudo R2", "Levene"))
plot(mvad.diff, stat="discrepancy")
```

seqdim *Dimension of a set of sequences*

Description

Returns the number of sequences (rows) and the maximum length of a set of sequences.

Usage

```
seqdim(seqdata)
```

Arguments

seqdata	a set of sequences.

Details

The function will first search for separators '-' or ':' in the sequences in order to detect wether they are in the compressed or extended format.

Value

a vector with the number of sequences and the maximum sequence length.

Author(s)

Alexis Gabadinho

seqdist *Distances (dissimilarities) between sequences*

Description

Computes pairwise dissimilarities between sequences or dissimilarity from a reference sequence. Several dissimilarity measures can be chosen, including optimal matching (OM) and many of its variants, distance based on the count of common attributes, and distances between state distributions within sequences.

Usage

```
seqdist(seqdata, method, refseq = NULL, norm = "none", indel = "auto", sm = NULL,
  with.missing = FALSE, full.matrix = TRUE, kweights = rep(1.0, ncol(seqdata)),
  tpow = 1.0, expcost = 0.5, context, link = "mean", h = 0.5, nu,
  transindel = "constant", otto, previous = FALSE, add.column = TRUE,
  breaks = NULL, step = 1, overlap = FALSE, weighted = TRUE,
  global.pdotj = NULL, prox = NULL, check.max.size=TRUE,
  opt.args = list())
```

Arguments

seqdata	State sequence object of class stslist. The sequence data to use. Use seqdef to create such an object.
method	String. The dissimilarity measure to use. It can be "OM", "OMloc", "OMslen", "OMspell", "OMstran", "HAM", "DHD", "CHI2", "EUCLID", "LCS", "LCP", "RLCP", "NMS", "NMSMST", "SVRspell", or "TWED". See the Details section.
refseq	NULL, Integer, State Sequence Object, or List. Default: NULL. The baseline sequence to compute the distances from. When an integer, the index of a sequence in seqdata or 0 for the most frequent sequence. When a state sequence object, it must contain a single sequence and have the same alphabet as seqdata. When a list, it must be a list of two sets of indexes of seqdata rows.
norm	String. Default: "none". The normalization to use when method is one of "OM", "OMloc", "OMslen", "OMspell", "OMstran", "TWED", "HAM", "DHD", "LCS", "LCP", "RLCP", "CHI2", "EUCLID". It can be "none", "auto", or, except for "CHI2" and "EUCLID", "maxlength", "gmean", "maxdist", or "YujianBo". "auto" is equivalent to "maxlength" when method is one of "OM", "HAM", or "DHD", to "gmean" when method is one of "LCS", "LCP", or "RLCP", to YujianBo when method is one of "OMloc", "OMslen", "OMspell", "OMstran", "TWED". See the Details section.
indel	Double, Vector of Doubles, or String. Default: "auto". Insertion/deletion cost(s). Applies when method is one of "OM", "OMslen", "OMspell", or "OMstran". The single state-independent insertion/deletion cost when a double. The state-dependent insertion/deletion costs when a vector of doubles. The vector should contain an indel cost by state in the order of the alphabet. When "auto", the indel is set as max(sm)/2 when sm is a matrix and is computed by means of seqcost when sm is a string specifying a cost method.
sm	NULL, Matrix, Array, or String. Substitution costs. Default: NULL. The substitution-cost matrix when a matrix and method is one of "OM", "OMloc", "OMslen", "OMspell", "OMstran", "HAM", or "TWED". The series of the substitution-cost matrices when an array and method = "DHD". They are grouped in a 3-dimensional array with the third index referring to the position in the sequence. One of the strings "CONSTANT", "INDELS", "INDELSLOG", or "TRATE". Designates a seqcost method to build sm. "CONSTANT" is not relevant for "DHD". sm is mandatory when method is one of "OM", "OMloc", "OMslen", "OMspell", "OMstran", or "TWED". sm is autogenerated when method is one of "HAM" or "DHD" and sm = NULL. See the Details section. Note: With method = "NMS" or method = "SVRspell", use prox instead.
with.missing	Logical. Default: FALSE. Should the non-deleted missing value be added to the alphabet as an additional state? If FALSE and seqdata or refseq contains such gaps, an error is raised.

full.matrix — Logical. Default: TRUE. When refseq = NULL, if TRUE, the full distance matrix is returned, if FALSE, an object of class dist is returned, that is, a vector containing only values from the lower triangle of the distance matrix. Objects of class dist are smaller and can be passed directly as arguments to most clustering functions.

kweights — Double or vector of doubles. Default: vector of 1s. The weights applied to subsequences when method is one of "NMS", "NMSMST", or "SVRspell". It contains at position k the weight applied to the subsequences of length k. It must be positive. Its length should be equal to the number of columns of seqdata. If shorter, longer subsequences are ignored. If a scalar, it is transformed into rep(kweights,ncol(sedata)).

tpow — Double. Default: 1.0. The exponential weight of spell length when method is one of "OMspell", "NMSMST", or "SVRspell".

expcost — Double. Default: 0.5. The cost of spell length transformation when method = "OMloc" or method = "OMspell". It must be positive. The exact interpretation is distance-dependent.

context — Double. Default: 1-2*expcost. The cost of local insertion when method = "OMloc". It must be positive.

link — String. Default: "mean". The function used to compute substitution costs when method = "OMslen". One of "mean" (arithmetic average) or "gmean" (geometric mean as in the original proposition of Halpin 2010).

h — Double. Default: 0.5. It must be greater than or equal to 0.

The exponential weight of spell length when method = "OMslen".

The gap penalty when method = "TWED". It corresponds to the lambda in *Halpin (2014), p 88*. It is usually chosen in the range [0,1]

nu — Double. Stiffness when method = "TWED". It must be strictly greater than 0 and is usually less than 1. See *Halpin (2014), p 88*.

transindel — String. Default: "constant". Method for computing transition indel costs when method = "OMstran". One of "constant" (single indel of 1.0), "subcost" (based on substitution costs), or "prob" (based on transition probabilities).

otto — Double. The origin-transition trade-off weight when method = "OMstran". It must be in [0, 1].

previous — Logical. Default: FALSE. When method = "OMstran", should we also account for the transition from the previous state?

add.column — Logical. Default: TRUE. When method = "OMstran", should the last column (and also the first column when previous = TRUE) be duplicated? When sequences have different lengths, should the last (first) valid state be duplicated.

breaks — List of ordered pairs of integers. Default: NULL. The list of the possibly overlapping intervals when method = "CHI2" or method = "EUCLID". Each interval is defined by the pair c(t1,t2) of the start t1 and end t2 positions of the interval.

step — Integer. Default: 1. The length of the intervals when method = "CHI2" or method = "EUCLID" and breaks = NULL. It must be positive. It must also be even when overlap = TRUE.

overlap — Logical. Default: FALSE. When method = "CHI2" or method = "EUCLID" and breaks = NULL, should the intervals overlap?

weighted	Logical. Default: TRUE. When method is "CHI2" or when sm is a string (method), should the distributions of the states account for the sequence weights in seqdata? See seqdef.
global.pdotj	Numerical vector, "obs", or NULL. Default: NULL. Only for method = "CHI2". The vector of state proportions to be used as marginal distribution. When NULL, the state distribution on the corresponding interval is used. When "obs", the overall state distribution in seqdata is used for all intervals. When a vector of proportions, it is used as marginal distribution for all intervals.
prox	NULL or Matrix. Default: NULL. The matrix of state proximities when method = "NMS" or method = "SVRspell".
check.max.size	Logical. Should seqdist stop when maximum allowed number of unique sequences is exceeded? Caution, setting FALSE may produce unexpected results or even crash R.
opt.args	List. List of additional non-documented arguments for development usage.

Details

The seqdist function returns a matrix of distances between sequences or a vector of distances from the reference sequence when refseq is set. The available metrics (see method option) include:

- *Edit distances*: optimal matching ("OM"), localized OM ("OMloc"), spell-length-sensitive OM ("OMslen"), OM of spell sequences ("OMspell"), OM of transition sequences ("OMstran"), Hamming ("HAM"), dynamic Hamming ("DHD"), and the time warp edit distance ("TWED").
- *Metrics based on counts of common attributes*: distance based on the longest common subsequence ("LCS"), on the longest common prefix ("LCP"), on the longest common suffix ("RLCP"), on the number of matching subsequences ("NMS"), on the number of matching subsequences weighted by the minimum shared time ("NMSMST") and, the subsequence vectorial representation distance ("SVRspell").
- *Distances between state distributions*: Euclidean ("EUCLID"), Chi-squared ("CHI2").

See *Studer and Ritschard (2014, 2016)* for a description and the comparison of the above dissimilarity measures except "TWED" for which we refer to *Marteau (2009)* and *Halpin (2014)*.

Each method can be controlled with the following parameters:

method	parameters
OM	sm, indel, norm
OMloc	sm, expcost, context, norm
OMslen	sm, indel, link, h, norm
OMspell	sm, indel, norm, tpow, expcost, norm
OMstran	sm, indel, transindel, otto, previous, add.column, norm
HAM, DHD	sm, norm
CHI2	breaks, step, overlap, norm, weighted, global.pdotj, norm
EUCLID	breaks, step, overlap, norm
LCS, LCP, RLCP	norm
NMS	prox, kweights
NMSMST	kweights, tpow

SVRspell	prox, kweights, tpow
TWED	sm, (indel), h, nu, norm

"LCS" is "OM" with a substitution cost of 2 (sm = "CONSTANT", cval = 2) and an indel of 1.0. "HAM" is "OM" without indels. "DHD" is "HAM" with specific substitution costs at each position.

"HAM" and "DHD" apply only to sequences of equal length.

For "TWED", the (single) indel serves only for empty sequences. The distance to an empty sequence is set as $n*$indel, where n is the length of the non empty sequence. By default (indel="auto"), indel is set as 2 * max(sm) + nu + h.

When sm = NULL, the substitution-cost matrix is automatically created for "HAM" with a single substitution cost of 1 and for "DHD" with the costs derived from the transition rates at the successive positions, i.e. with sm = "TRATE".

Some distances can optionally be normalized by means of the norm argument. Let d be the distance, m the maximum possible of the distance given the lengths p and q of the two sequences, and k the length of the longer sequence. Normalization "maxlength" is d/k (Abbott's normalization), "gmean" is $1-(m-d)/(p*q)\cdot 5$ (Elzinga's normalization), "maxdist" is d/m, and "YujianBo" is $2*d/(m+d)$. For more details, see *Gabadinho et al. (2009, 2011)*. Actually, to avoid negative outcomes, the length p, q, and k are set as (max) indel times the corresponding length. For some distances, m is only a possibly non-reachable upper bound.

When norm="auto", "gmean" is applied to "LCS", "LCP" and "RLCP" distances, "maxlength" is applied to "OM", "HAM" and "DHD", and the normalization "YujianBo" of *Yujian and Bo (2007)* that preserves the triangle inequality is used in the other cases except "CHI2" and "EUCLID". For the latter two, the square of the distances are normalized by the number of intervals and the maximal distance on each interval. Note that for 'CHI2' the maximal distance on each interval depends on the state distribution on the interval.

When sequences contain gaps and the left = NA, gaps = NA, or right = NA option was passed to seqdef (i.e. when there are non deleted missing values), the with.missing argument should be set as TRUE. If left as FALSE the function stops when it encounters a gap. This is to make the user aware that there are gaps in the sequences. For methods that need an sm value, seqdist expects a substitution-cost matrix with a row and a column entry for the missing state (symbol defined with the nr option of seqdef). Substitution-cost matrices returned by seqcost (and so seqsubm) include these additional entries when the function is called with with.missing = TRUE. More details on how to compute distances with sequences containing gaps can be found in *Gabadinho et al. (2009)*.

Value

When refseq is NULL (default), the whole matrix of pairwise distances between sequences or, if full.matrix = FALSE, the corresponding dist object of pairwise distances between sequences.

When refseq is a list of two sets of indexes, the matrix of distances from the first set of sequences (rows) to the second set (columns).

Otherwise, a vector with distances from the sequences in the state sequence object to the reference sequence specified with refseq.

Author(s)

Matthias Studer, Gilbert Ritschard, Pierre-Alexandre Fonta, Alexis Gabadinho, Nicolas S. Müller.

References

Studer, M. and G. Ritschard (2016), "What matters in differences between life trajectories: A comparative review of sequence dissimilarity measures", *Journal of the Royal Statistical Society, Series A*. **179**(2), 481-511, doi:10.1111/rssa.12125

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Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. Department of Econometrics and Laboratory of Demography, University of Geneva

Halpin, B. (2014). Three Narratives of Sequence Analysis, in Blanchard, P., Bühlmann, F. and Gauthier, J.-A. (Eds.) *Advances in Sequence Analysis: Theory, Method, Applications*, Vol 2 of Series *Life Course Research and Social Policies*, pages 75–103, Heidelberg: Springer. doi:10.1007/9783319049694_5

Marteau, P.-F. (2009). Time Warp Edit Distances with Stiffness Adjustment for Time Series Matching. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, **31**(2), 306–318. doi:10.1109/TPAMI.2008.76

Yujian, L. and Bo, L. (2007). A normalized Levenshtein distance metric. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, **29**(6), 1091–1095. doi:10.1109/TPAMI.2007.1078

See also all references in *Studer and Ritschard (2014, 2016)*

See Also

seqcost, seqsubm, seqdef, and seqMD for multidomain (multichannel) distances using the cost additive trick.

Examples

```
## =========================
## Examples without missings
## =========================

## Defining a sequence object with columns 10 to 25
## of a subset of the 'biofam' data set
data(biofam)
biofam.seq <- seqdef(biofam[501:600, 10:25])

## OM distances using the vector of indels and substitution
## costs derived from the estimated state frequencies
costs <- seqcost(biofam.seq, method = "INDELSLOG")
biofam.om <- seqdist(biofam.seq, method = "OM",
                     indel = costs$indel, sm = costs$sm)

## OM between sequences of transitions
biofam.omstran <- seqdist(biofam.seq, method = "OMstran",
                     indel = costs$indel, sm = costs$sm,
                     otto=.3, transindel="subcost")
```

```
## Normalized LCP distances
biofam.lcp.n <- seqdist(biofam.seq, method = "LCP",
                        norm = "auto")

## Normalized LCS distances to the most frequent sequence
biofam.dref1 <- seqdist(biofam.seq, method = "LCS",
                        refseq = 0, norm = "auto")

## LCS distances to an external sequence
ref <- seqdef(as.matrix("(0,5)-(3,5)-(4,6)"), informat = "SPS",
              alphabet = alphabet(biofam.seq))
biofam.dref2 <- seqdist(biofam.seq, method = "LCS",
                        refseq = ref)

## LCS distances between two subsets of sequences
set1 <- 1:10
set2 <- 31:36
biofam.dref2 <- seqdist(biofam.seq, method = "LCS",
                        refseq = list(set1,set2))


## Chi-squared distance over the full observed timeframe
biofam.chi.full <- seqdist(biofam.seq, method = "CHI2",
                           step = max(seqlength(biofam.seq)))

## Chi-squared distance over successive overlapping
## intervals of length 4
biofam.chi.ostep <- seqdist(biofam.seq, method = "CHI2",
                            step = 4, overlap = TRUE)


## ======================
## Examples with missings
## ======================
data(ex1)
## Ignore empty row 7
ex1.seq <- seqdef(ex1[1:6, 1:13])

## OM with indel and substitution costs based on
## log of inverse state frequencies
costs.ex1 <- seqcost(ex1.seq, method = "INDELSLOG",
                     with.missing = TRUE)
ex1.om <- seqdist(ex1.seq, method = "OM",
                  indel = costs.ex1$indel, sm = costs.ex1$sm,
                  with.missing = TRUE)

## Localized OM
ex1.omloc <- seqdist(ex1.seq, method = "OMloc",
                     sm = costs.ex1$sm, expcost=.1, context = .4,
                     with.missing = TRUE)

## OMspell with a scalar indel
```

```
indel <- max(costs.ex1$indel)
## OM of spells
ex1.omspell <- seqdist(ex1.seq, method = "OMspell",
                       indel = indel, sm = costs.ex1$sm,
                       with.missing = TRUE)

## Distance based on number of matching subsequences
ex1.nms <- seqdist(ex1.seq, method = "NMS",
                   with.missing = TRUE)

## Using the sequence vectorial representation metric
costs.fut <- seqcost(ex1.seq, method = "FUTURE", lag = 4,
                     proximities = TRUE, with.missing = TRUE)
ex1.svr <- seqdist(ex1.seq, method = "SVRspell",
                   prox = costs.fut$prox, with.missing = TRUE)
```

---

seqdomassoc *Measures of association between domains of sequence data*

Description

The function computes pairwise domain association based on cross-tabulation of the states observed in the sequences of the two domains involved. The association measure returned can be Cramer's V or the likelihood ratio (LRT).

Usage

```
seqdomassoc(
  seqdata.dom,
  rep.method = "overall",
  assoc = c("LRT", "V"),
  diss.dom = NULL,
  wrange = NULL,
  p.value = TRUE,
  struct.zero = TRUE,
  cross.table = FALSE,
  with.missing = FALSE,
  weighted = TRUE,
  seqrep.args = list(coverage = 0.8, pradius = 0.1),
  seqrf.args = list(k = 20),
  dnames = names(seqdata.dom)
)
```

Arguments

seqdata.dom	List of stslist objects (one per dimension)
rep.method	Character string. Method for determining the sequences on which the association is computed. One of "rep" (representative sequences), "eq.group" (medoids of equally spaced groups), or "overall".

assoc	Character string. The association measure to be computed. One of "V" (Cramer V) or "LRT" or a vector with both.
diss.dom	List of dissimilarity matrices used for selecting representatives. Ignored when rep.method="overall".
wrange	Vector of two integers. Window range for count of co-occurrences. A state at p in the first domain is compared with states in [p+wrange[1], p+wrange[2]] in the second domain.
p.value	Logical. Should p-values be returned?
struct.zero	Logical. Should zeros in cross tables be treated as structural zeros?
cross.table	Logical. Should cross tables be returned? If TRUE, cross tables are returned as the list attribute cross.tables.
with.missing	Logical. Should missing be treated as a regular state.
weighted	Logical. Should sequence weights be taken into account when present in the sequence objects? When applicable, weights of the first domain are used.
seqrep.args	List of arguments passed to seqrep when rep.method="rep".
seqrf.args	List of arguments passed to seqrf when rep.method="eq.group".
dnames	String vector: names of dimensions.

Details

For each pair of domains, seqdomassoc cross-tabulates the position-wise states across domains using all sequences when rep.method = "overall". When rep.method = "rep", each observed sequence is first replaced by the closest representative sequence and, when rep.method = "eq.group", each observed sequence is replaced by the group medoid of its group. Then, the selected association measures are computed on the resulting cross-tables.

The "overall" method implies a strong position-wise association and will not detect association occurring after a small time warp. With representative sequences, the same holds, but for representatives only. Using dissimilarity measures that allow for time warp for identifying representatives, observed sequences may differ from their representatives in the timing of the states. Therefore, using representatives instead of all sequences relaxes somewhat the strong timing constraint.

Value

An object of class sdomassoc, which is the table (matrix) of association statistics with the list of cross tables in attribute cross.tables.

The print method for objects sdomassoc prints only the table of association statistics.

Author(s)

Gilbert Ritschard

References

Ritschard, G., T.F. Liao, and E. Struffolino (2023). Strategies for multidomain sequence analysis in social research. *Sociological Methodology*, 53(2), 288-322. doi:10.1177/00811750231163833.

See Also

dissdomassoc

Examples

```
data(biofam)

## Building one channel per type of event (left, children or married)
cases <- 1:50
bf <- as.matrix(biofam[cases, 10:25])
children <-  bf==4 | bf==5 | bf==6
married <- bf == 2 | bf== 3 | bf==6
left <- bf==1 | bf==3 | bf==5 | bf==6

## Building sequence objects
child.seq <- seqdef(children, weights = biofam[cases,'wp00tbgs'])
marr.seq <- seqdef(married, weights = biofam[cases,'wp00tbgs'])
left.seq <- seqdef(left, weights = biofam[cases,'wp00tbgs'])

## distances by channel
dchild <- seqdist(child.seq, method="OM", sm="INDELSLOG")
dmarr <- seqdist(marr.seq, method="OM", sm="INDELSLOG")
dleft <- seqdist(left.seq, method="OM", sm="INDELSLOG")
dbiofam <- list(dchild,dmarr,dleft)
dnames <- names(dbiofam) <- c("child","marr","left")


seqdomassoc(list(child.seq,marr.seq,left.seq), dnames=dnames)
seqdomassoc(list(child.seq,marr.seq,left.seq), diss.dom=dbiofam,
            rep.method="rep", assoc="V", dnames=dnames)
seqdomassoc(list(child.seq,marr.seq,left.seq), diss.dom=dbiofam,
            rep.method="eq.group", assoc="V", dnames=dnames)
```

---

seqdss *Extract sequences of distinct successive states*

Description

Extract the sequence of distinct successive states from each sequence in a object.

Usage

```
seqdss(seqdata, with.missing=FALSE)
```

Arguments

seqdata	a sequence object as defined by the seqdef function.
with.missing	Should non-void missing values be considered as regular states? See Details.

Details

Returns a sequence object containing the sequences of distinct successive states (DSS). The spell durations are not taken into account. E.g., the DSS contained in `'D-D-D-D-A-A-A-A-A-A-D'` is `'D-A-D'`. Associated durations can be extracted with the `seqdur` function.

When `{with.missing=TRUE}`, non-void missing values are considered as a regular state of the alphabet. For example, the DSS of `A-A-*-*-*-B-B-C-C-D` is `A-*-B-C-D`.

When `with.missing=FALSE` (default) missing values are ignored and a substring `A-A-*-*-*A` for example will be considered as a single spell in `A` while the DSS of this substring would be `A-*-A` whith `with.missing=TRUE`.

See seqdef on options for handling missing values when creating sequence objects.

Value

a sequence object containing the distinct state sequence (DSS) for each sequence in the object given as argument.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

See Also

`seqdur`.

Examples

```
## Creating a sequence object from columns 13 to 24
## in the 'actcal' example data set
## Here we retain the first 10 sequences only.
data(actcal)
actcal.seq <- seqdef(actcal[1:10,13:24])

## Retrieving the DSS
actcal.dss <- seqdss(actcal.seq)

## Displaying the DSS for the first 10 sequences
actcal.dss

## Example with with.missing argument
data(ex1)
ex1.seq <- seqdef(ex1[, 1:13])

seqdss(ex1.seq)
seqdss(ex1.seq, with.missing=TRUE)
```

seqdur *Extract state durations from a sequence object.*

Description

Extracts states durations from a sequence object. Returns a matrix containing the states durations for the sequences. The states durations in 'D-D-D-D-A-A-A-A-A-A-D' are 4,7,1. Distinct states can be extracted with the seqdss function.

Usage

```
seqdur(seqdata, with.missing=FALSE)
```

Arguments

seqdata	a sequence object as defined by the seqdef function.
with.missing	Should non-void missing values be considered as regular states? See Details.

Details

When with.missing=FALSE (default) missing values are ignored and a substring AA***A for example will be considered as a spell AAA of duration 3. When with.missing=TRUE, durations are also computed for spells of missing values (gaps in sequences).

See seqdef on options for handling missing values when creating sequence objects.

Value

a matrix containing the states durations for each distinct state in each sequence.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

See Also

seqdss.

Examples

```
## Creating a sequence object from columns 13 to 24
## in the 'actcal' example data set
## Here we retain the first 10 sequences only.
data(actcal)
actcal.seq <- seqdef(actcal[1:10,13:24])

## Retrieving the spell durations
actcal.dur <- seqdur(actcal.seq)
```

```
## Displaying the durations for the first 10 sequences
actcal.dur
```

---

seqeapplysub *Checking for the presence of given event subsequences*

Description

Checks occurrences of the subsequences `subseq` among the event sequences and returns the result according to the selected `method`.

Usage

```
seqeapplysub(subseq, method = NULL, constraint = NULL,
             rules=FALSE)
```

Arguments

`subseq`	list of subsequences (an event subsequence object) such as created by `seqefsub`
`method`	type of result, should be one of `"count"`, `"presence"` or `"age"`
`constraint`	Time constraints overriding those used to compute `subseq`. See `seqeconstraint`
`rules`	If set to `TRUE`, instead of checking occurrences of the subsequences among the event sequences, check the occurrence of the subsequences inside the subsequences (internally used by `seqerules`)

Details

There are three methods implemented: `"count"` counts the number of occurrence of each given subsequence in each event sequence; `"presence"` returns 1 if the subsequence is present, 0 otherwise; `"age"` returns the age of appearance of each subsequence in each event sequence. In case of multiple possibilities, the age of the first occurrence is returned. When the subsequence is not in the sequence, -1 is returned.

Value

The return value is a matrix where each row corresponds to a sequence (row names are set accordingly) and each column corresponds to a subsequence (col names are set accordingly). The cells of the matrix contain the requested values (count, presence-absence indicator or age).

Author(s)

Matthias Studer and Reto Bürgin (alternative counting methods) (with Gilbert Ritschard for the help page)

References

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. Department of Econometrics and Laboratory of Demography, University of Geneva.

See Also

seqecreate for more information on event sequence object and *Gabadinho et al. (2009)* on how to use the event sequence analysis module.

Examples

```
## Loading data
data(actcal.tse)

## Creating the event sequence object
actcal.eseq <- seqecreate(actcal.tse)

## Printing sequences
actcal.eseq[1:10]

## Looking for frequent subsequences
fsubseq <- seqefsub(actcal.eseq,pmin.support=0.01)

## Counting the number of occurrences of each subsequence
msubcount <- seqeapplysub(fsubseq,method="count")
## First lines...
msubcount[1:10,1:10]
## Presence-absence of each subsequence
msubpres <- seqeapplysub(fsubseq,method="presence")
## First lines...
msubpres[1:10,1:10]

## Age at first appearance of each subsequence
msubage <- seqeapplysub(fsubseq,method="age")

## First lines...
msubage[1:10,1:10]
```

---

seqecmpgroup *Identifying discriminating subsequences*

Description

Identify and sort the most discriminating subsequences by their discriminating power.

Usage

```
seqecmpgroup(subseq, group, method="chisq", pvalue.limit=NULL,
             weighted = TRUE)
```

Arguments

subseq	A subseqelist object (list of subsequences) such as produced by seqefsub
group	Group membership, i.e., a variable or factor defining the groups which we want to discriminate
method	The discrimination method; one of "bonferroni" or "chisq"
pvalue.limit	Can be used to filter the results. Only subsequences with a p-value lower than this parameter are selected. If NULL all subsequences are returned (regardless of their p-values).
weighted	Logical. If TRUE, seqecmpgroup uses the weights specified in subseq, (see seqefsub).

Details

The following discrimination test functions are implemented: chisq, the Pearson Independence Chi-squared test, and bonferroni, the Pearson Independence Chi-squared test with Bonferroni correction.

Value

An objet of type subseqelistchisq (subtype of subseqelist) with the following elements

subseq	Sorted list of found discriminating subsequences
eseq	The event sequence object on which the tests were computed
constraint	Time constraints used for searching the subsequences (see seqeconstraint)
labels	Levels (value labels) of the target group variable
type	Type of test used
data	A data frame with columns support, index (original rank of the subsequence, i.e., its position in the inputted subseq) and a pair of frequency and Pearson residual columns for each group

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., Müller, N.S., Ritschard, G. & Gabadinho, A. (2010), "Classer, discriminer et visualiser des séquences d'événements", In Extraction et gestion des connaissances (EGC 2010), *Revue des nouvelles technologies de l'information* RNTI. Vol. E-19, pp. 37-48.

Ritschard, G., Bürgin, R., and Studer, M. (2014), "Exploratory Mining of Life Event Histories", In McArdle, J.J. & Ritschard, G. (eds) *Contemporary Issues in Exploratory Data Mining in the Behavioral Sciences*. Series: Quantitative Methodology, pp. 221-253. New York: Routledge.

See Also

See also plot.subseqelistchisq to plot the results

Examples

```
data(actcal.tse)
actcal.eseq <- seqecreate(actcal.tse)

##Searching for frequent subsequences, that is, appearing at least 20 times
fsubseq <- seqefsub(actcal.eseq, pmin.support=0.01)

##searching for susbsequences discriminating the most men and women
data(actcal)
discr <- seqecmpgroup(fsubseq, group=actcal$sex, method="bonferroni")
##Printing the six most discriminating subsequences
print(discr[1:6])
##Plotting the six most discriminating subsequences
plot(discr[1:6])
```

---

seqeconstraint *Setting time constraints and the counting method*

Description

Function used to set time constraints and the counting method in methods (`seqe...`) for event sequences such as `seqefsub` for searching frequent subsequences or `seqeapplysub` for checking occurrences of subsequences.

Usage

```
seqeconstraint(max.gap = -1, window.size = -1, age.min = -1, age.max = -1,
  age.max.end = -1, count.method = 1, maxGap, windowSize, ageMin, ageMax,
ageMaxEnd, countMethod)
```

Arguments

`max.gap`	The maximum time gap between two events
`window.size`	The maximum time span accepted for subsequences
`age.min`	Minimal start time position allowed for subsequences. Ignored when equal to -1 (default).
`age.max`	Maximal start time position allowed for subsequences. Ignored when equal to -1 (default).
`age.max.end`	Maximal end time position allowed for subsequences. Ignored when equal to -1 (default).
`count.method`	By default, subsequences are counted only one time by sequence (`'COBJ'` method). Alternative counting methods are `'CDIST_O'`, `'CWIN'`, `'CMINWIN'` or `'CDIST'` respectively. See details.
`maxGap`	Deprecated. Use `max.gap` instead.
`windowSize`	Deprecated. Use `window.size` instead.

ageMin	Deprecated. Use age.min instead.
ageMax	Deprecated. Use age.max instead.
ageMaxEnd	Deprecated. Use age.max.end instead.
countMethod	Deprecated. Use count.method instead.

Details

max.gap, window.size, age.min, age.max and age.max.end. If so, two events should not be separated by more than max.gap and the whole subsequence should not exceed a window.size time span. The other parameters specify the start and end age of the subsequence, it should start between age.min and age.max and finish before age.max.end. Parameters age.min, age.max and age.max.end are interpreted as the number of positions (time units) from the beginning of the sequence.

There are 5 options for the count.method argument. (1) By default, the count is the number of sequences that contain the subsequence ("COBJ" method). Alternatives are (2) "CDIST_O" (counts all distinct occurrences in each sequence including possibly overlapping occurrences, i.e., occurrences sharing a same event occurrence), (3) "CWIN" (number of slidden windows of length window.size that contain an occurrence of the subsequence), (4) "CMINWIN" (number of minimal windows of occurrence) and (5) "CDIST" (distinct occurrences without event occurrences overlap). See references.

Value

A constraint object containing one item per constraint type.

Author(s)

Matthias Studer, Nicolas S. Müller and Reto Bürgin (alternative counting methods) (with Gilbert Ritschard for the help page)

References

Joshi, Mahesh V., George Karypis, and Vipin Kumar (2001) A Universal Formulation of Sequential Patterns *Proceedings of the KDD'2001 Workshop on Temporal Data Mining*, San Francisco.

Ritschard, G., A. Gabadinho, N.S. Müller and M. Studer (2008), Mining event sequences: A social science perspective, *International Journal of Data Mining, Modelling and Management, IJDMMM*, 1(1), 68-90.

See Also

seqefsub, seqeapplysub

seqecontain *Check if sequence contains events*

Description

Check if an event sequence or subsequence contains given events

Usage

```
seqecontain(eseq, event.list, unknown.exclude = FALSE,
  seq, eventList, exclude)
```

Arguments

eseq	A event sequence object (seqelist) or a an event subsequence object (subseqelist)
event.list	A list of events
unknown.exclude	if TRUE the search is exclusive and returns FALSE for any subsequence containing an event that is not in event.list
seq	Deprecated. Use eseq instead.
eventList	Deprecated. Use event.list instead.
exclude	Deprecated. Use unknown.exclude instead.

Details

Checks, for each provided event sequence, if it contains one of the events in event.list. If unknown.exclude is TRUE, seqecontain looks if all events of the subsequence are in event.list.

Value

A logical vector.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqecreate for creating event sequence objects and seqefsub for creating event subsequence objects.

Examples

```
data(actcal.tse)
actcal.eseq <- seqecreate(actcal.tse)

##Searching for frequent subsequences, that is appearing at least 20 times
fsubseq <- seqefsub(actcal.eseq,min.support=20)

##looking for subsequence with FullTime
seqecontain(fsubseq,c("FullTime"))
```

`seqecreate` *Create event sequence objects.*

Description

Create an event sequence object either from time stamped events or from a state sequence object.

Usage

```
seqecreate(data = NULL, id = NULL,timestamp = NULL, event = NULL,
  end.event = NULL, tevent = "transition", use.labels = TRUE,
  weighted = TRUE, endEvent)
```

Arguments

`data`	A state sequence object (see `seqdef`) or a data frame
`id`	Integer. The sequence 'id' column when data are provided in TSE format (ignored if `data` argument is provided).
`timestamp`	Double. The event 'timestamp' column when data are provided in TSE format, i.e., the time at which events occur (ignored if `data` argument is provided).
`event`	Character or factor. The 'event' column when data are provided in TSE format, i.e., the events occurring at the specified time stamps (ignored if `data` argument is provided).
`end.event`	Character. If specified this event indicates the end of observation time (total length of event sequences) when it is not followed by any other valid event. The event is ignored when occurring in between two valid events.
`tevent`	Either a transition matrix or a method to generate events from state sequences (see `seqetm`). Used only when `data` is a state sequence object.
`use.labels`	Logical. If `TRUE`, transitions names are built from long state labels rather than from the short state names of the alphabet.
`weighted`	Logical. If `TRUE` and `data` is a state sequence object, use the weights specified in `data` (see `seqdef`)
`endEvent`	Deprecated. Use `end.event` instead.

Details

There are several ways to create an event sequence object. The first one is by providing the events in TSE format (see seqformat), i.e. by providing three paired lists: id, timestamp and event, such that each triplet (id, timestamp, event) defines the event that occurs at time timestamp for case id. Several events at the same time for a same id are allowed. The lists can be provided with the arguments id, timestamp and event. An alternative is by providing a data frame as data argument in which case the function takes the required information from the "id", "timestamp" and "event" columns of that data frame. In any case with TSE format, **listed events should be grouped by id** and an error will be thrown otherwise. Such grouping can be achieved by ordering the data according to the id column using the order function (e.g., data[order(data$id),]).

The other way is to pass a state sequence object (as data argument) and to perform an automatic state-to-event conversion. The simplest way to make a conversion is by means of a predefined method (see seqetm), such as "transition" (one distinct event per possible transition), "state" (a new event for each entering in a new state) and "period" (a pair of events, one start-state event and one end-state event for each found transition). For a more customized conversion, you can specify a transition matrix in the same way as in seqformat. Function seqetm can help you in creating your transition matrix.

Event sequence objects as created by seqecreate are required by most other 'seqe' methods, such as seqefsub or seqeapplysub for example.

Value

An object of class seqelist. There are print, and plot methods for such objects.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Ritschard, G., Bürgin, R., and Studer, M. (2014), "Exploratory Mining of Life Event Histories", In McArdle, J.J. & Ritschard, G. (eds) *Contemporary Issues in Exploratory Data Mining in the Behavioral Sciences*. Series: Quantitative Methodology, pp. 221-253. New York: Routledge.

Ritschard, G., A. Gabadinho, M. Studer and N. S. Müller. Converting between various sequence representations. in Ras, Z. & Dardzinska, A. (eds.) *Advances in Data Management*, Springer, 2009, 223, 155-175.

See Also

seqformat for converting between sequence formats, seqeweight for retrieving or assigning weights, seqefsub for searching frequent subsequences, seqecmpgroup to search for discriminant subsequences, seqeapplysub for counting subsequence occurrences, seqelength for information about length (observation time) of event sequences, seqdef to create a state sequence object.

Examples

```
##Starting with states sequences
##Loading data
```

```
data(biofam)
## Creating state sequences
biofam.seq <- seqdef(biofam,10:25, informat='STS')
## Creating event sequences from biofam
biofam.eseq <- seqecreate(biofam.seq)

## Loading data
data(actcal.tse)
## Creating sequences
actcal.eseq <- seqecreate(id=actcal.tse$id, timestamp=actcal.tse$time,
event=actcal.tse$event)
##printing sequences
actcal.eseq[1:10]
## Using the data argument
actcal.eseq <- seqecreate(data=actcal.tse)

## Example with missings
data(ex1) ## STS data with missing values

## Creating the state sequence object with by default
## the left missings and gaps coded as '*' and
## end missings coded as void ('%')
sqex1 <- seqdef(ex1[,1:13])
## and without ignoring right missings (coded as '*')
sqex1b <- seqdef(ex1[,1:13], right=NA)

## Compare the outcome
seqecreate(sqex1)
seqecreate(sqex1, tevent='state')
seqecreate(sqex1, tevent='state', end.event=attr(sqex1,'void'))
seqecreate(sqex1b, tevent='state')
```

---

seqefsub *Searching for frequent subsequences*

Description

Returns the list of subsequences with minimal support sorted in decreasing order of support. Various time constraints can be set to restrict the search to specific time periods or subsequence durations. The function permits also to get information on specified subsequences.

Usage

```
seqefsub(eseq, str.subseq = NULL, min.support = NULL,
  pmin.support = NULL, constraint = seqeconstraint(), max.k = -1,
  weighted = TRUE, seq, strsubseq, minSupport, pMinSupport, maxK)
```

Arguments

eseq	A list of event sequences
str.subseq	A list of specific subsequences to look for. See details.
min.support	The minimum support (in number of sequences)
pmin.support	The minimum support (in percentage, corresponding count will be rounded)
constraint	A time constraint object as returned by seqeconstraint
max.k	The maximum number of events allowed in a subsequence
weighted	Logical. Should seqefsub use the weights specified in eseq (see seqeweight).
seq	Deprecated. Use eseq instead.
strsubseq	Deprecated. Use str.subseq instead.
minSupport	Deprecated. Use min.support instead.
pMinSupport	Deprecated. Use pmin.support instead.
maxK	Deprecated. Use max.k instead.

Details

There are two usages of this function. The first is for searching subsequences satisfying a support condition. By default, the support is counted per sequence and not per occurrence, i.e. when a sequence contains several occurrences of a same subsequence it is counted only once. Use the count.method argument of seqeconstraint to change that. The minimal required support can be set with pmin.support as a proportion (between 0 and 1) in which case the support will be rounded, or through min.support as a number of sequences. Time constraints can also be imposed with the constraint argument, which must be the outcome of a call to the seqeconstraint function.

The second possibility is for searching sequences that contain specified subsequences. This is done by passing the list of subsequences with the str.subseq argument. The subsequences must contain only events from the alphabet of events of eseq and must be in the same format as that used to display subsequences (see str.seqelist). Each transition (group of events) should be enclosed in parentheses () and separated with commas, and the succession of transitions should be denoted by a '-' indicating a time gap. For instance "(FullTime)-(PartTime, Children)" stands for the subsequence "FullTime" followed by the transition defined by the two simultaneously occurring events "PartTime" and "Children".

To get information such as the number of occurrences of the subsequences returned by seqefsub or the sequences that contain each subsequence use the function seqeapplysub.

Subsets of the returned subseqelist can be accessed with the [] operator (see example). There are print and plot methods for subseqelist.

Value

A subseqelist object with at least the following attributes:

eseq	The list of sequences in which the subsequences were searched (a seqelist event sequence object).
subseq	A list of subsequences (a seqelist event sequence object).
data	A data frame containing details (support, frequency, ...) about the subsequences
constraint	The constraint object used when searching the subsequences.
type	The type of search: 'frequent' or 'user'

Author(s)

Matthias Studer and Reto Bürgin (alternative counting methods) (with Gilbert Ritschard for the help page)

References

Ritschard, G., Bürgin, R., and Studer, M. (2014), "Exploratory Mining of Life Event Histories", In McArdle, J.J. & Ritschard, G. (eds) *Contemporary Issues in Exploratory Data Mining in the Behavioral Sciences*. Series: Quantitative Methodology, pp. 221-253. New York: Routledge.

See Also

See `plot.subseqelist` to plot the result. See `seqecreate` for creating event sequences. See `seqeapplysub` to count the number of occurrences of frequent subsequences in each sequence. See `is.seqelist` about `seqelist`.

Examples

```
data(actcal.tse)
actcal.eseq <- seqecreate(actcal.tse)

## Searching for subsequences appearing at least 20 times
fsubseq <- seqefsub(actcal.eseq, min.support=20)
## The same using a percentage
fsubseq <- seqefsub(actcal.eseq, pmin.support=0.01)
## Getting a string representation of subsequences
## First ten most frequent subsequences
fsubseq[1:10]

## Using time constraints
## Looking for subsequences starting in Summer (between June and September)
fsubseq <- seqefsub(actcal.eseq, min.support=10,
  constraint=seqeconstraint(age.min=6, age.max=9))
fsubseq[1:10]

##Looking for subsequences occurring in Summer (between June and September)
fsubseq <- seqefsub(actcal.eseq, min.support = 10,
  constraint=seqeconstraint(age.min=6, age.max=9, age.max.end=9))
fsubseq[1:10]

##Looking for subsequence enclosed in a 6 month period
## and with a maximum gap of 2 month
fsubseq <- seqefsub(actcal.eseq, min.support=10,
  constraint=seqeconstraint(max.gap=2, window.size=6))
fsubseq[1:10]
```

seqeid *Retrieve unique ids from an event sequence object.*

Description

Retrieve the unique ids from an event sequence object or from a list of event sequence object.

Usage

```
seqeid(eseq, s)
```

Arguments

eseq	An event sequence object (as created with seqecreate) or a list of event sequence objects
s	Deprecated. Use eseq instead.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

Examples

```
data(actcal.tse)
actcal.eseq <- seqecreate(actcal.tse)
sid <- seqeid(actcal.eseq)
length(sid)
head(sid)
```

seqelength *Lengths of event sequences*

Description

The length of an event sequence is its time span, i.e., the total time of observation. This information is useful to perform for instance a survival analysis. The function seqelength retrieves the lengths of the provided sequences, while seqelength <- sets the length of the sequences.

Usage

```
seqelength(eseq, s)
seqelength(eseq, s) <- value
```

Arguments

eseq	An event sequence object (seqelist).
value	A list of sequence lengths.
s	Deprecated. Use eseq instead.

Value

A numeric vector with the lengths of the sequences.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

Examples

```
data(actcal.tse)
actcal.eseq <- seqecreate(actcal.tse)
## Since end.event is not specified, contains no sequence lengths
## We set them manually as 12 for all sequences
sl <- numeric()
sl[1:2000] <- 12
seqelength(actcal.eseq) <- sl
actcal.eseq[1:10]
## Retrieve lengths
slen <- seqelength(actcal.eseq)
summary(slen)
```

---

seqetm *Create a transition-definition matrix*

Description

This function automatically creates a transition-definition matrix from a state sequence object to transform the state sequences into time stamped event sequences (in TSE format).

Usage

```
seqetm(seqdata, method = "transition", use.labels = TRUE, sep = ">",
  bp = "", ep = "end", seq)
```

Arguments

seqdata	State sequence object from which transition events will be determined
method	The method to use. One of "transition", "period" or "state".
use.labels	If TRUE, transition names are built from state labels rather than from the alphabet.
sep	Separator to be used between the from-state and to-state that define the transition ("transition" method).

bp	Prefix for beginning of period event names ("period" method)
ep	Prefix for end of period event names ("period" method)
seq	Deprecated. Use seqdata instead.

Details

Warning!!!: State labels should not contain commas "," which are reserved for separating multiple events of a same transition!

One of three methods can be selected with the method argument:

"transition" generates a single (from-state > to-state) event for each found transition and a distinct start-state event for each different sequence start;

"period" generates a pair of events (end-state-event, start-state-event) for each found transition, a start-state event for the beginning of the sequence and an end-state event for the end of the sequence; names used for end-state and start-state names can be controlled with the bp and ep arguments;

"state" generates only the to-state event of each found transition (useful for analysing state sequences with methods for event sequences);

Value

The transition-definition matrix.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqformat for converting to TSE format, seqecreate for creating an event sequence object, seqdef for creating a state sequence object.

Examples

```
## Creating a state sequence object from columns 13 to 24
## in the 'actcal' example data set
data(actcal)
actcal.seq <- seqdef(actcal,13:24,
        labels=c("FullTime", "PartTime", "LowPartTime", "NoWork"))
## Creating a transition matrix, one event per transition
seqetm(actcal.seq,method = "transition")

## Creating a transition matrix, single to-state events
seqetm(actcal.seq,method = "state")

## Creating a transition matrix, two events per transition
seqetm(actcal.seq,method = "period")

## changing the prefix of period start event.
seqetm(actcal.seq,method = "period", bp="begin")
```

seqeweight *Setting or retrieving weights of an event sequence object.*

Description

Event sequence objects can be weighted. Weights are used by other functions such as seqefsub or seqecmpgroup to compute weighted statistics.

Usage

```
seqeweight(eseq, s)
seqeweight(eseq, s) <- value
```

Arguments

eseq	An event sequence object (seqelist).
value	Numerical vector containing weights
s	Deprecated. Use eseq instead.

Value

seqeweight returns a numerical vector containing the weights associated to each event sequence.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

Examples

```
##Starting with states sequences
##Loading data
data(biofam)
## Creating state sequences
biofam.seq <- seqdef(biofam,10:25,informat='STS')

## Creating event sequences from biofam
biofam.eseq <- seqecreate(biofam.seq, weighted=FALSE)

## Using the weights
seqeweight(biofam.eseq) <- biofam$wp00tbgs

## Now seqefsub accounts for weights unless weighted is set to FALSE
fsubseq <- seqefsub(biofam.eseq, pmin.support=0.01)

## Searching for weighted susbsequences which best
## discriminate the birth cohort
discr <- seqecmpgroup(fsubseq, group=biofam$birthyr>=1940)
plot(discr[1:15])
```

seqfind *Indexes of state sequence(s) x in state sequence object y*

Description

Finds the row indexes of state sequence(s) x in the state sequence object y.

Usage

```
seqfind(x, y)
```

Arguments

x	a state sequence object containing one or more sequences (seqdef).
y	a state sequence object.

Value

row index(es) of sequence(s) x in the set of sequences y.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for the help page)

See Also

.

Examples

```
data(mvad)
mvad.shortlab <- c("EM", "FE", "HE", "JL", "SC", "TR")
mvad.seq <- seqdef(mvad, states=mvad.shortlab, 15:86)

## Finding occurrences of sequence 176 in mvad.seq
seqfind(mvad.seq[176,],mvad.seq)

## Finding occurrences of sequence 1 to 8 in mvad.seq
seqfind(mvad.seq[1:8,],mvad.seq)
```

seqformat *Conversion between sequence formats*

Description

Convert a sequence data set from one format to another.

Usage

```
seqformat(data, var = NULL, from, to, compress = FALSE, nrep = NULL, tevent,
  stsep = NULL, covar = NULL, SPS.in = list(xfix = "()", sdsep = ","),
  SPS.out = list(xfix = "()", sdsep = ","), id = 1, begin = 2, end = 3,
  status = 4, process = TRUE, pdata = NULL, pvar = NULL, limit = 100,
  overwrite = TRUE, fillblanks = NULL, tmin = NULL, tmax = NULL, missing = "*",
  with.missing = TRUE, right="DEL", compressed, nr)
```

Arguments

data	Data frame, matrix, stslist state sequence object, or character string vector. The data to use. (Tibble will be converted with as.data.frame). A data frame or a matrix with sequence data in one or more columns when from = "STS" or from = "SPS". If sequence data are in a single column or in a string vector, they are assumed to be in the compressed form (see stsep). A data frame with sequence data in one or more columns when from = "SPELL". If sequence data has not four columns ordered as individual ID, spell start time, spell end time, and spell state status, use var or id / begin / end / status. A state sequence object when from = "STS" or from is not specified.
var	NULL, List of Integers or Strings. Default: NULL. The indexes or the names of the columns with the sequence data in data. If NULL, all columns are considered.
from	String. The format of the input sequence data. It can be "STS", "SPS", or "SPELL". It is not needed if data is a state sequence object.
to	String. The format of the output data. It can be "STS", "DSS", "SPS", "SRS", "SPELL", or "TSE".
compress	Logical. Default: FALSE. When to = "STS", to = "DSS", or to = "SPS", should the sequences (row vector of states) be concatenated into strings? See seqconc.
nrep	Integer. The number of shifted replications when to = "SRS".
tevent	Matrix. The transition-definition matrix when to = "TSE". It should be of size $d * d$ where d is the number of distinct states appearing in the sequences. The cell (i, j) lists the events associated with a transition from state i to state j. It can be created with seqetm.
stsep	NULL, Character. Default: NULL. The separator between states in the compressed form (strings) when from = "STS" or from = "SPS". If NULL, seqfcheck is called for detecting automatically a separator among "-" and ":". Other separators must be specified explicitly. See seqdecomp.

covar — List of Integers or Strings. The indexes or the names of additional columns in data to include as covariates in the output when to = "SRS". The covariates are replicated across the shifted replicated rows.

SPS.in — List. Default: list(xfix = "()", sdsep = ","). The specifications for the state-duration couples in the input data when from = "SPS". The first specification, xfix, specifies the prefix/suffix character. Use a two-character string if the prefix and the suffix differ. Use xfix = "" when no prefix/suffix are present. The second specification, sdsep, specifies the state/duration separator.

SPS.out — List. Default: list(xfix = "()", sdsep = ","). The specifications for the state-duration couples in the output data when to = "SPS". See SPS.in above.

id — NULL, Integer, String, List of Integers or Strings. Default: 1.

When from = "SPELL", the index or the name of the column containing the individual IDs in data (after var filtering).

When to = "TSE", the index or the name of the column containing the individual IDs in data (after var filtering) or the unique individual IDs. If id is not manually specified, id is set as NULL for backward compatibility with TraMineR 1.8-13 behaviour. If id is manually or automatically set as NULL, the original individual IDs are ignored and replaced by the indexes of the sequences in the input data.

When from = "SPELL" and to = "TSE", the index or the name of the column containing the individual IDs in data (after var filtering). The TSE output will use the original individual IDs.

begin — Integer or String. Default: 2. The index or the name of the column containing the spell start times in data (after var filtering) when from = "SPELL". Start times should be positive integers.

end — Integer or String. Default: 3. The index or the name of the column containing the spell end times in data (after var filtering) when from = "SPELL". End times should be positive integers.

status — Integer or String. Default: 4. The index or the name of the column containing the spell statuses in data (after var filtering) when from = "SPELL".

process — Logical. Default: TRUE. When from = "SPELL", if TRUE, create sequences on a process time axis, if FALSE, create sequences on a calendar time axis.

This process argument as well as the associated pdata and pvar arguments are intended for data containing spell data with calendar begin and end times. When those times are ages, use process = FALSE with pdata=NULL to use those ages as process times. Option process = TRUE does currently not work for age times.

pdata — NULL, "auto", or data frame. Default: NULL. (tibble will be converted with as.data.frame).

If NULL, the start and end times of each spell are supposed to be, if process = TRUE, ages, if process = FALSE, years when from = "SPELL".

If "auto", ages are computed using the start time of the first spell of each individual as her/his birthdate when from = "SPELL" and process = TRUE. For from = "SPELL" and process = FALSE, "auto" is equivalent to NULL.

A data frame containing the ID and the birth time of the individuals when from = "SPELL" or to = "SPELL". Use pvar to specify the column names. The ID is

used to match the birth time of each individual with the sequence data. The birth time should be integer. It is the start time from which the positions on the time axis are computed. It also serves to compute `tmin` and to guess `tmax` when the latter are `NULL`, `from = "SPELL"`, and `process = FALSE`.

`pvar` List of Integers or Strings. The indexes or names of the columns of the data frame `pdata` that contain the ID and the birth time of the individuals in that order.

`limit` Integer. Default: `100`. The maximum age of age sequences when `from = "SPELL"` and `process = TRUE`. Age sequences will be considered to start at 1 and to end at `limit`.

`overwrite` Logical. Default: `TRUE`. When `from = "SPELL"`, if `TRUE`, the most recent episode overwrites the older one when they overlap each other, if `FALSE`, in case of overlap, the most recent episode starts after the end of the previous one.

`fillblanks` Character. The value to fill gaps between episodes when `from = "SPELL"`.

`tmin` `NULL` or Integer. Default: `NULL`. The start time of the axis when `from = "SPELL"` and `process = FALSE`. If `NULL`, the value is the minimum of the spell start times (see `begin`) or the minimum of the birth time of the individuals (see `pdata` when it is a data frame and `process = FALSE`).

`tmax` `NULL` or Integer. Default: `NULL`. The end time of the axis when `from = "SPELL"` and `process = FALSE`. If `NULL`, the value is the maximum of the spell end times (see `end`) or the sum of the maximum of the spell end times and of the maximum of the birth time of the individuals (see `pdata` when it is a data frame and `process = FALSE`).

`missing` String. Default: `"*"`. The code for missing states in `data`. It will be replaced by `NA` in the output data. Ignored when `data` is a state sequence object (see `seqdef`), in which case the attribute `nr` is used as missing value code.

`with.missing` Logical. Default: `TRUE`. When `to = "SPELL"`, should the spells of missing states be included?

`right` One of `"DEL"` or `NA`. Default: `"DEL"`. When `to = "SPELL"` and `with.missing=TRUE`, set `right=NA` to include the end spells of missing states.

`compressed` Deprecated. Use `compress` instead.

`nr` Deprecated. Use `missing` instead.

Details

The `seqformat` function is used to convert data from one format to another. The input data is first converted into the STS format and then converted to the output format. Depending on input and output formats, some information can be lost in the conversion process. The output is a matrix or a data frame, NOT a sequence `stslist` object. To process, print or plot the sequences with TraMineR functions, you will have to first transform the data frame into a `stslist` state sequence object with `seqdef`. See *Gabadinho et al. (2009)* and *Ritschard et al. (2009)* for more details on longitudinal data formats and converting between them.

When data are in `"SPELL"` format (`from = "SPELL"`), the begin and end times are expected to be positions in the sequences. Therefore they should be strictly positive integers. With `process=TRUE`, the outcome sequences will be aligned on ages (process duration since birth), while with `process=FALSE`

they will be aligned on dates (position on the calendar time). If process=TRUE, values in the begin and end columns of data are assumed to be ages when pdata is NULL and integer dates otherwise. If process=FALSE, begin and end values are assumed to be integer dates when pdata is NULL and ages otherwise.

To convert from person-period data use from = "SPELL" and set both begin and end as the column index or name of the time variable. Alternatively, use the reshape command of stats, which is more efficient.

Value

A data frame for SRS, TSE, and SPELL, a matrix otherwise.

When from="SPELL", outcome has an attribute issues with indexes of sequences with issues (truncated sequences, missing start time, spells before birth year, ...)

Author(s)

Alexis Gabadinho, Pierre-Alexandre Fonta, Nicolas S. Müller, Matthias Studer, and Gilbert Ritschard.

References

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. Department of Econometrics and Laboratory of Demography, University of Geneva.

Ritschard, G., A. Gabadinho, M. Studer and N. S. Müller. Converting between various sequence representations. in Ras, Z. & Dardzinska, A. (eds.) *Advances in Data Management*, Springer, 2009, 223, 155-175.

See Also

seqdef,reshape

Examples

```
## ========================================
## Examples with raw STS sequences as input
## ========================================

## Loading a data frame with sequence data in the columns 13 to 24
data(actcal)

## Converting to SPS format
actcal.SPS.A <- seqformat(actcal, 13:24, from = "STS", to = "SPS")
head(actcal.SPS.A)

## Converting to compressed SPS format with no
## prefix/suffix and with "/" as state/duration separator
actcal.SPS.B <- seqformat(actcal, 13:24, from = "STS", to = "SPS",
  compress = TRUE, SPS.out = list(xfix = "", sdsep = "/"))
head(actcal.SPS.B)
```

```
## Converting to compressed DSS format
actcal.DSS <- seqformat(actcal, 13:24, from = "STS", to = "DSS",
  compress = TRUE)
head(actcal.DSS)


## ============================================
## Examples with a state sequence object as input
## ============================================

## Loading a data frame with sequence data in the columns 10 to 25
data(biofam)

## Limiting the number of considered cases to the first 20
biofam <- biofam[1:20, ]

## Creating a state sequence object
biofam.labs <- c("Parent", "Left", "Married", "Left/Married",
  "Child", "Left/Child", "Left/Married/Child", "Divorced")
biofam.short.labs <- c("P", "L", "M", "LM", "C", "LC", "LMC", "D")
biofam.seq <- seqdef(biofam, 10:25, alphabet = 0:7,
  states = biofam.short.labs, labels = biofam.labs)

## Converting to SPELL format
bf.spell <- seqformat(biofam.seq, from = "STS", to = "SPELL",
  pdata = biofam, pvar = c("idhous", "birthyr"))
head(bf.spell)


## ====================================
## Examples with SPELL sequences as input
## ====================================

## Loading two data frames: bfspell20 and bfpdata20
## bfspell20 contains the first 20 biofam sequences in SPELL format
## bfpdata20 contains the IDs and the years at which the
## considered individuals were aged 15
data(bfspell)

## Converting to STS format with alignement on calendar years
bf.sts.y <- seqformat(bfspell20, from = "SPELL", to = "STS",
  id = "id", begin = "begin", end = "end", status = "states",
  process = FALSE)
head(bf.sts.y)

## Converting to STS format with alignement on ages
bf.sts.a <- seqformat(bfspell20, from = "SPELL", to = "STS",
  id = "id", begin = "begin", end = "end", status = "states",
  process = TRUE, pdata = bfpdata20, pvar = c("id", "when15"),
  limit = 16)
names(bf.sts.a) <- paste0("a", 15:30)
head(bf.sts.a)
```

```
## ================================
## Examples for TSE and SPELL output
## in presence of missing values
## ================================

data(ex1) ## STS data with missing values
## creating the state sequence object with by default
## the end missings coded as void ('%')
sqex1 <- seqdef(ex1[,1:13])
as.matrix(sqex1)

## Creating state-event transition matrices
ttrans <- seqetm(sqex1, method='transition')
tstate <- seqetm(sqex1, method='state')

## Converting into time stamped events
seqformat(sqex1, from = "STS", to = "TSE", tevent = ttrans)
seqformat(sqex1, from = "STS", to = "TSE", tevent = tstate)

## Converting into vertical spell data
seqformat(sqex1, from = "STS", to = "SPELL", with.missing=TRUE)
seqformat(sqex1, from = "STS", to = "SPELL", with.missing=TRUE, right=NA)
seqformat(sqex1, from = "STS", to = "SPELL", with.missing=FALSE)
```

`seqfpos` *Search for the first occurrence of a given element in a sequence*

Description

Returns a vector containing the position of the first occurrence of the given element in each of the sequences in the data set.

Usage

```
seqfpos(seqdata, state)
```

Arguments

`seqdata`	a sequence object (see `seqdef` function).
`state`	the state element to search in the sequences

Details

the state to search for has to be passed as a character string, and must be one of the state returned by the `alphabet` function. If the state is not contained in a sequence, NA is returned for this sequence.

Author(s)

Alexis Gabadinho

Examples

```
data(biofam)
biofam.seq <- seqdef(biofam,10:25)

## Searching for the first occurrence of state 1
## in each of the 5 first sequence of the biofam data set.
seqfpos(biofam.seq[1:5,],"1")
```

---

seqfposend *End of first spell in given state*

Description

Returns the position in the sequences of end of first spell in a given state

Usage

```
seqfposend(seqdata, state, with.missing=FALSE, lead=0, from.seq.start=TRUE)
```

Arguments

seqdata	State sequence object of class stslist as produced by seqdef.
state	Element of the alphabet of seqdata.
with.missing	Logical. Should non-void missing values be considered as regular states? See seqdss and seqdur.
lead	Integer. Value to be added to the end position.
from.seq.start	Logical. Should position be computed from the start of the sequence? Default is TRUE. If FALSE, position is computed from the start of the spell.

Value

Vector of integers giving position of end of spell in the sequences.

Author(s)

Gilbert Ritschard

See Also

seqfpos

Examples

```
## End of spell in further education (FE) in first 10 mvad sequences

data(mvad)
m.seq <- seqdef(mvad[1:10,17:86])
seqfposend(m.seq, state="FE")
```

seqgen *Random sequences generation*

Description

Generates random sequences.

Usage

```
seqgen(n, length, alphabet, p)
```

Arguments

n	number of sequences to generate
length	sequences length
alphabet	the alphabet from which the sequences are generated
p	an optional vector of probabilities for the states in the alphabet. Must be of the same length as the alphabet. If not specified, equal probabilities are used.

Details

Each sequence is generated by choosing a set of random numbers (with min=1 and max=length of the alphabet) using the runif function. When the probability distribution is not specified, the uniform probability distribution giving same probability to each state is used to generate the sequences.

Value

a sequence object.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for the help page)

Examples

```
seq <- seqgen(1000,10,1:4,c(0.2,0.1,0.3,0.4))
seqstatd(seqdef(seq))
```

seqhasmiss *Count and identification of sequences with nr and void missings*

Description

The function prints the counts of sequences with included (nr) and ignored (void) missings. It returns invisibly three logical vectors with TRUE for sequences with nr or void missing (has.miss), included missing (has.nr), and ignored missing (has.void) respectively.

Usage

```
seqhasmiss(seqdata)
```

Arguments

seqdata	State sequence object of class stslist.

Value

List of three logical indicator vectors: has.miss, has.nr, and has.void.

Author(s)

Gilbert Ritschard

Examples

```
data(ex1)
s <- seqdef(ex1[,1:12])
res <- seqhasmiss(s)
res$has.nr
```

seqibad *Badness index*

Description

Badness index of each sequence, i.e. the sum of undesirableness of each state weighted by the potential to integrate that state in the sequence.

Usage

```
seqibad(seqdata, pow=1, with.missing=FALSE, ...)
```

Arguments

seqdata	a state sequence object (stslist) as returned by seqdef.
pow	real. Exponent applied to the position in the sequence. Higher value increase the importance of recency (see seqintegration). Default is 1.
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.
...	arguments such as stprec or state.order required by seqprecstart to determine/normalize the state undesirableness degrees.

Details

For each sequence, the badness is the sum of the undesirableness of each state weighted by the potential to integrate the state. As long as pow is strictly greater than zero, the undesirableness of states occurring at the end of the sequence get higher weights than those at the beginning. The index reaches its maximum 1 for a sequence made of a single spell in the worst state and the minimum 0 for a sequence made of a single spell is the most favorable state.

Value

A vector with the badness index for each sequence.

Author(s)

Gilbert Ritschard

References

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqintegr, seqidegrad, seqprecarity

Examples

```
data(ex1)
sx <- seqdef(ex1[,1:13], right="DEL")

seqibad(sx) ## using original alphabet order
seqibad(sx, stprec=c(1,2,3,6)) ## user defined undesirableness values
seqibad(sx, with.missing=TRUE, state.order=c('A','B','C','D'))
```

`seqici` *Complexity index of individual sequences*

Description

Computes the complexity index, a composite measure of sequence complexity. The index uses the number of transitions in the sequence as a measure of the complexity induced by the state ordering and the longitudinal entropy as a measure of the complexity induced by the state distribution in the sequence.

Usage

```
seqici(seqdata, with.missing=FALSE, silent=TRUE)
```

Arguments

`seqdata`	a sequence object as returned by the the `seqdef` function.
`with.missing`	if set to `TRUE`, missing status (gaps in sequences) is handled as an additional state when computing the state distribution and the number of transitions in the sequence.
`silent`	logical: should messages about running operations be displayed?

Details

The *complexity index* $C(s)$ of a sequence s is

$$C(s) = \sqrt{\frac{q(s)}{q_{max}} \frac{h(s)}{h_{max}}}$$

where $q(s)$ is the number of transitions in the sequence, q_{max} the maximum number of transitions, $h(s)$ the within entropy, and h_{max} the theoretical maximum entropy which is $h_{max} = -\log 1/|A|$ with $|A|$ the size of the alphabet.

The index $C(s)$ is the geometric mean of its two normalized components and is, therefore, itself normalized. The minimum value of 0 can only be reached by a sequence made of one distinct state, thus containing 0 transitions and having an entropy of 0. The maximum 1 of $C(s)$ is reached when the two following conditions are fulfilled: i) Each of the state in the alphabet is present in the sequence, and the total durations are uniform, i.e. each state occurs $\ell/|A|$ times, and ii) the number of transitions in the sequence is $\ell - 1$, meaning that the length ℓ_d of the DSS is equal to the length of the sequence ℓ.

Value

a single-column matrix of length equal to the number of sequences in `seqdata` containing the complexity index value of each sequence.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for the help page)

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

Gabadinho, A., Ritschard, G., Studer, M. and Müller, N.S. (2010). "Indice de complexité pour le tri et la comparaison de séquences catégorielles", In *Extraction et gestion des connaissances (EGC 2010), Revue des nouvelles technologies de l'information RNTI*. Vol. E-19, pp. 61-66.

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

`seqindic`, `seqient`, `seqipos`.

For alternative measures of sequence complexity see `seqST`, `seqivolatility`.

Examples

```
## Creating a sequence object from the mvad data set
data(mvad)
mvad.labels <- c("employment", "further education", "higher education",
                 "joblessness", "school", "training")
mvad.scodes <- c("EM","FE","HE","JL","SC","TR")
mvad.seq <- seqdef(mvad, 15:86, states=mvad.scodes, labels=mvad.labels)

##
mvad.ci <- seqici(mvad.seq)
summary(mvad.ci)
hist(mvad.ci)

## Example using with.missing argument
data(ex1)
ex1.seq <- seqdef(ex1, 1:13)
seqici(ex1.seq)
seqici(ex1.seq, with.missing=TRUE)
```

---

seqient *Within sequence entropies*

Description

Computes normalized or non-normalized within sequence entropies

Usage

```
seqient(seqdata, norm=TRUE, base=exp(1), with.missing=FALSE, silent=TRUE)
```

Arguments

seqdata	a sequence object as returned by the the seqdef function.
norm	logical: should the entropy be normalized? TRUE by default. (see details)
base	real positive value: base of the logarithm used in the entropy formula (see details). Default is exp(1), i.e., the natural logarithm is used.
with.missing	logical: if TRUE, the missing state (gap in sequences) is handled as an additional state when computing the state distribution in the sequence.
silent	logical: should messages about running operations be displayed?

Details

The seqient function returns the Shannon entropy of each sequence in seqdata. The entropy of a sequence is computed using the formula

$$h(\pi_1, \ldots, \pi_s) = -\sum_{i=1}^{s} \pi_i \log \pi_i$$

where s is the size of the alphabet and π_i the proportion of occurrences of the ith state in the considered sequence. The base of the log is controlled with the base argument. Ba default the natural logarithm, i.e. the logarithm in base e, is used. The entropy can be interpreted as the 'uncertainty' of predicting the states in a given sequence. If all states in the sequence are the same, the entropy is equal to 0. For example, the maximum entropy for a sequence of length 12 with an alphabet of 4 states is 1.386294 and is attained when each of the four states appears 3 times.

Normalization can be requested with the norm=TRUE option, in which case the returned value is the entropy divided by the entropy of the alphabet. The latter is an upper bound for the entropy of sequences made from this alphabet. It is exactly the maximal entropy when the sequence length is a multiple of the alphabet size. The value of the normalized entropy is independent of the chosen logarithm base.

Value

a single-column matrix with an entropy value for each sequence in seqdata; the column length is equal to the number of sequences.

Author(s)

Alexis Gabadinho

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. *Department of Econometrics and Laboratory of Demography, University of Geneva*.

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqindic, seqici, seqST, and seqstatd for the entropy of the cross-sectional state distributions by positions in the sequence.

Examples

```
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## Summarize and plots an histogram
## of the within sequence entropy
actcal.ient <- seqient(actcal.seq)
summary(actcal.ient)
hist(actcal.ient)

## Examples using with.missing argument
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

seqient(ex1.seq)
seqient(ex1.seq, with.missing=TRUE)
```

---

seqindic *Sequence indicators*

Description

Table of per sequence values of selected indicators.

Usage

```
seqindic(seqdata, indic=c("visited","trans","entr","cplx","turb2n"),
    with.missing=FALSE, ipos.args=list(), prec.args=list(), w=.5)
```

Arguments

seqdata	a state sequence object (class stslist) as returned by seqdef.
indic	vector of character strings. List of selected indicators among "lgth" (sequence length), "nonm" (number of non-missing elements), "dlgth" (number of spells), "visited" (number of visited states), "visitp" (proportion of states visites), "trans" (number of state changes), "transp" (number of state changes as a proportion of maximum possible transitions), "meand" (mean spell duration), "dustd" (duration standard deviation), "meand2" (mean spell duration taking non-visited states into account), "dustd2" (duration standard deviation taking non-visited states into account), "entr" (longitudinal normalized entropy), "nsubs" (number of subsequences of the DSS sequence), "volat" (objective volatility), "cplx" (complexity index), "turb" (turbulence), "turbn" (normalized turbulence), "turb2" (turbulence taking non-visited states into account),

	"turb2n" (normalized turbulence taking non-visited states into account), "ppos" (proportion of positive states), "nvolat" (normative volatility), "vpos" objective volatility of positive-negative state sequences, "integr" (integrative potential), "degrad" (degradation), "bad" (badness), "prec" (precarity index), "insec" (insecurity). Can also be "all", "basic", "diversity", "complexity", "binary", and "ranked", each selecting a subset of the indicators. Setting indic="all" selects all indicators but "ppos", "vpos", "nvolat", "integr", "degrad", "bad", "prec", and "insec" that require an additional argument list.
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.
ipos.args	list: when any of "ppos", "nvolat", "vpos", or "integr" is requested, the arguments passed to seqipos together with seqdata and with.missing. See seqipos
prec.args	list: when any of "degrad", "bad", "prec", or "insec" is requested, the arguments passed to the underlying functions together with seqdata and with.missing. See seqprecarity and seqibad.
w	real in range [0,1]: when volat weight coefficient passed to seqivolatility. Default is .5.

Details

The number of visited states is the number of different elements in the sequence, e.g. 2 for aababba. The recurrence index 'recu' is the average number of visits of visited states, i.e. Dlgth/Visited, the number of spells on the number of visited states.

The sequence length, number of transitions, longitudinal entropy, duration standard deviation, volatility, complexity, turbulence, degradation, badness, precarity, and insecurity are computed respectively with functions seqlength, seqtransn, seqient, seqivardur, seqivolatility, seqici, seqST, seqidegrad, seqibad, seqprecarity, and seqinsecurity. The proportion of positive states, normative volatility, and integrative potential are computed with seqipos. See corresponding help pages for details.

The proportion of positive states ('ppos') and the normative volatility ('nvolat') are the proportions of positive elements in respectively the original sequences and the DSS. They ignore the value of dss in the ipos.args list.

The with.missing argument applies to all indicators but the length. 'lgth' returns the length obtained with with.missing=TRUE, and 'nonm' the length obtained with with.missing=FALSE.

Value

A data frame with the selected indicators. Names are:
Lght: Length of the sequence
NonM: Number of non-missing elements
Dlgth: Number of spells (length of DSS)
Visited: Number of visited states
Visitp: Proportion of states visited
Recu: Recurrence: average number of visits to visited states
Trans: Number of transitions (state changes)
Transp: Number of state changes as a proportion of maximum number of transitions

`Entr`: Longitudinal entropy
`Meand`: Mean spell duration
`Dustd`: Duration standard deviation
`Meand2`: Mean spell duration taking non visited states into account
`Dustd2`: Duration standard deviation taking non visited states into account
`Nsubs`: Number of subsequences of the DSS sequence
`Volat`: Objective volatility
`Cplx`: Complexity
`Turb`: Turbulence
`Turbn`: Normalized turbulence
`Turb2`: Turbulence taking non visited states into account
`Turbn2`: Normalized turbulence taking non visited states into account
`Ppos`: Proportion of positive states
`Nvolat`: Normative volatility (proportion of positive spells)
`Vpos`: Objective volatility of positive-negative state sequences
`Integr`: Integrative capacity (potential)
`Degrad`: Degradation
`Bad`: Badness
`Prec`: Precarity
`Insec`: Insecurity

Author(s)

Gilbert Ritschard

References

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

`seqlength`, `seqtransn`, `seqient`, `seqivardur`, `seqivolatility`, `seqici`, `seqST`, `seqidegrad`, `seqibad`, `seqprecarity`, `seqinsecurity`, `seqipos`.

Examples

```
data(ex1)
sx <- seqdef(ex1[,1:13], right="DEL")
print(sx, format='SPS')
seqindic(sx, indic=c("lgth","nonm","visited","turbn","cplx"))
seqindic(sx, indic=c("lgth","nonm","visited","turbn","cplx"), with.missing=TRUE)
seqindic(sx, indic=c("lgth","dlgth","ppos","integr","prec"), with.missing=TRUE,
          ipos.args=list(pos.states=c("A","B")),
          prec.args=list(state.order=c("A","B","C"), state.equiv=list(c("C","D"))))
seqindic(sx, indic=c("volat","binary"), ipos.args=list(pos.states=c("A","B")))
seqindic(sx, indic=c("basic","integr"), ipos.args=list(pos.states="D"))
```

seqintegr *Integrative potential*

Description

Returns the index of integrative potential (capability) for each sequence, either a table with the index for each state or a vector with the index for the selected state.

Usage

```
seqintegr(seqdata, state=NULL, pow=1, with.missing=FALSE)
```

Arguments

seqdata	a state sequence object (stslist) as returned by seqdef.
state	character string. The state for which to compute the integrative index (see Details). When NULL the index is computed for each state.
pow	real. Exponent applied to the position in the sequence. Higher value increase the importance of recency (see Details). Default is 1.
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.

Details

The index of integrative potential or capability *(Brzinsky-Fay, 2007, 2018)* measures the capacity to integrate the selected state within the sequence, i.e. the tendency to reach the selected state and end up in it. The index is defined as the sum of the position numbers occupied by the selected state in the sequence over the sum of all position numbers. Formally, for a sequence s of length L, and numbering the positions i from 1 to L, the index is

$$integr = \sum_{(i|s_i=state)} i^{pow} / \sum_{i} i^{pow}$$

where $state$ is the selected state. This same index has also been independently developed by *Manzoni and Mooi-Reci (2018)* under the name of quality index.

The recency exponent pow permits to control the focus given on the latest positions in the sequence. The higher pow, the higher the importance of the last positions relative to the first ones.

When with.missing = FALSE, the index is obtained by using the sum of the positions numbers of the non-missing elements as denominator. To compute the index for the missing state, with.missing should be set as TRUE.

For capability to integrate a set of states see seqipos.

Value

when state=NULL, a numeric matrix with a row for each sequence and a column by state. When a state is provides, a single column.

Author(s)

Gilbert Ritschard

References

Brzinsky-Fay, C. (2007) Lost in Transition? Labour Market Entry Sequences of School Leavers in Europe, *European Sociological Review*, 23(4). doi:10.1093/esr/jcm011

Brzinsky-Fay, C. (2018) Unused Resources: Sequence and Trajectory Indicators. International Symposium on Sequence Analysis and Related Methods, Monte Verita, TI, Switzerland, October 10-12, 2018.

Manzoni, A and I. Mooi-Reci (2018) Measuring Sequence Quality, in Ritschard and Studer (eds), *Sequence Analysis and Related Approaches. Innovative Methods and Applications*, Springer, 2018, pp 261-278.

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqipos, seqivolatility, seqindic

Examples

```
data(ex1)
sx <- seqdef(ex1[,1:13], right="DEL")

seqintegr(sx)
seqintegr(sx, with.missing=TRUE)
seqintegr(sx, state="B")
seqintegr(sx, state="B", pow=1.5)
```

`seqipos` *Indicators for binary sequences of positive and negative states.*

Description

Indicators for the underlying binary sequences of positive and negative states. Possible indicators are the proportion of positive states within each sequence, i.e. of positive spells if computed on the sequences of distinct successive states (DSS), objective volatility of the binary sequences, and capacity to integrate a positive state.

Usage

```
seqipos(seqdata, dss=NULL, pos.states=NULL, neg.states=NULL, index="share",
   pow=1, w=.5, with.missing=FALSE)
```

Arguments

seqdata	a state sequence object (stslist) as returned by seqdef.
dss	logical. Should the proportion be computed inside the DSS sequences? Defaults to TRUE when index="share" and to FALSE otherwise.
pos.states	vector of positive states.
neg.states	vector of negative states.
index	character string. One of "share" (proportion of positive states or spells), "volatility" (objective volatility), or "integr" (capability to integrate a positive state). See Details. Default is "share".
pow	real. Recency exponent passed to seqintegr. Only used when index="integr". Default is 1.
w	real in range [0,1]. Relative weight of proportion of visited states in volatility (see seqivolatility). Only used when index="volatility". Default is .5.
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.

Details

The function transforms the provided state sequences into binary sequences of positive and negative states. When dss = TRUE, the counts of positive and negative elements give the number of positive and negative spells. The binary state sequence object is returned as an attribute.

When neg.states=NULL, states not listed on the pos.states argument are considered as negative and conversely when pos.states=NULL. When with.missing=TRUE, the missing state nr will be considered as positive if included in the pos.states list or as negative if in neg.states. When with.missing=FALSE (default) missing states are ignored. However, when missing values appear within a spell, such as in AA*ABB, the spell is split into two consecutive spells in a same state. For the example we would have AAB, i.e. if A is positive and B negative, a proportion of 2/3 of positive spells.

When both pos.states and neg.states are provided, states of the alphabet (including the nr code when with.missing=TRUE) that belong nor to pos.states nor to neg.states are ignored.

For index="share", letting $npos$ be the number of positive states and $nneg$ the number of negative states in the sequence, the function returns the value of $npos/(npos + nneg)$ for each sequence. With dss=TRUE, this is the normative volatility of Brzinsky-Fay (2007,2018).

For index="volatility", the function returns the objective volatility of the binary sequences. See seqivolatility.

For index="integr", the function returns the index of integrative potential for the positive state. See seqintegr.

Value

A numeric vector of
- when index="share", the proportion of positive states (or spells) within each sequence;
- when index="volatility", the objective volatility of the binary sequences;
- when index="integration", the index of integration into a positive state.

The binary sequence as an attribute sbinary.

Author(s)

Gilbert Ritschard

References

Brzinsky-Fay, C. (2007) Lost in Transition? Labour Market Entry Sequences of School Leavers in Europe, *European Sociological Review*, 23(4). doi:10.1093/esr/jcm011

Brzinsky-Fay, C. (2018) Unused Resources: Sequence and Trajectory Indicators. International Symposium on Sequence Analysis and Related Methods, Monte Verita, TI, Switzerland, October 10-12, 2018.

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqindic, seqintegr, seqivolatility

Examples

```
data(ex1)
sx <- seqdef(ex1[,1:13], right="DEL")
nr <- attr(sx,'nr') ## code for missing values

seqipos(sx, pos.states=c("A","B"))
seqipos(sx, pos.states=c("A","B"), with.missing=TRUE)

## ignoring state "D"
seqipos(sx, pos.states=c("A","B"), neg.states=c("C",nr), with.missing=TRUE)

seqipos(sx, pos.states=c("A","B"), dss=FALSE)
seqipos(sx, pos.states=c("A","B",nr), dss=FALSE, with.missing=TRUE)

seqipos(sx, pos.states=c("A","B"), index="volatility")
seqipos(sx, pos.states=c("A","B"), index="integr")

## retrieving the binary sequences
ip <- seqipos(sx, pos.states=c("A","B"))
attr(ip,"sbinary")
ip <- seqipos(sx, pos.states=c("A","B"), with.missing=TRUE)
attr(ip,"sbinary")
```

---

seqistatd *State frequencies in each individual sequence*

Description

Returns the state frequencies (total durations) for each sequence in the sequence object.

Usage

```
seqistatd(seqdata, with.missing=FALSE, prop=FALSE)
```

Arguments

seqdata	a sequence object (see seqdef function).
with.missing	logical: if set as TRUE, total durations are also computed for the missing status (gaps in the sequences). See seqdef on options for handling missing values when creating sequence objects.
prop	logical: if TRUE, proportions of time spent in each state are returned instead of absolute values. This option is specially useful when sequences contain missing states, since the sum of the state durations may not be the same for all sequences.

Author(s)

Alexis Gabadinho

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

Examples

```
data(actcal)
actcal.seq <- seqdef(actcal,13:24)
seqistatd(actcal.seq[1:10,])

## Example using "with.missing" argument
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

seqistatd(ex1.seq)
seqistatd(ex1.seq, with.missing=TRUE)
```

---

seqivardur *Variance of spell durations in individual sequences*

Description

Variance of spell durations of individual state sequences.

Usage

```
seqivardur(seqdata, type=1, with.missing=FALSE)

## S3 method for class 'seqivardur'
print(x, stat='var', ...)
```

Arguments

seqdata	a state sequence object (stslist) as returned by seqdef.
type	either 1 or 2. The default type=1 ignores non visited states. Type 2 takes into account the 0-time spent in non-visited states (see Details).
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.
x	an outcome of seqivardur.
stat	string or vector of strings. Duration statistic to be printed. Either 'mean' (mean duration), 'std' (standard deviation), 'var' (variance), 'vmax' (maximum variance for number of spells), or 'all'. Default is 'var'.
...	further arguments such as digits passed to the next print method.

Details

The returned variance is a population variance, i.e. the sum of squares divided by the number of terms.

When type=1, this is the variance of the observed spells in the sequence. When type=2, in addition to the observed spells one spell of length 0 is considered for each non-visited state. The mean duration is computed the same way.

Value

A numeric vector with the variance of spell duration of each sequence.

The returned object has two attributes:

vmax	the maximum value that the variance of each sequence could reach given its number of spells.
meand	the mean spell duration of each sequence.

Author(s)

Gilbert Ritschard

References

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqdur, seqindic

Examples

```
sq.dat <- c('AAAA','AAAC','ABC','ABAA','AC')
sq <- seqdef(seqdecomp(sq.dat, sep=''), right=NA)

seqivardur(sq, type=1)
seqivardur(sq, type=1, with.missing=TRUE)
vd2 <- seqivardur(sq, type=2)
print(vd2, stat='all')
vd2m <- seqivardur(sq, type=2, with.missing=TRUE)
print(vd2m, stat=c('var','vmax'))
```

---

seqivolatility *Volatility of individual state sequences*

Description

Returns Brzinsky-Fay's objective volatility of each sequence.

Usage

```
seqivolatility(seqdata, w=.5, with.missing=FALSE, adjust=TRUE)
```

Arguments

seqdata	a state sequence object (stslist) as returned by seqdef.
adjust	Logical. Should the indicator be adjusted such that it can reach its bounds 0 and 1. Deafult is TRUE (see Details).
w	Real in the range [0, 1]. Default is 0.5. Weight given to the proportion of states visited (see Details).
with.missing	Logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.

Details

The (objective) volatility is the weighted average between the proportion $pvisited$ of states visited and the frequency $ftrans$ of transitions (state changes). Formally,

$$volatility = w \cdot pvisited + (1 - w) \cdot ftrans$$

The proportion of states visited is computed as $(visited - 1)/(|a| - 1)$ when adjsut=TRUE and as $visited/|a|$ when adjsut=FALSE. Here, $visited$ is the number of states visited and $|a|$ the size of the alphabet.

The frequency of transition is $ftrans = \frac{transn}{max.transn}$ where $transn$ is the number of transitions (state changes) within the sequence, and $max.transn$ the maximum possible transitions in the sequence.

For the normative volatility, see seqipos. For alternative measures of sequence complexity see seqST, seqici, seqindic.

Value

A numeric vector with the volatility of each sequence.

Author(s)

Gilbert Ritschard

References

Brzinsky-Fay, C. Unused Resources: Sequence and Trajectory Indicators. International Symposium on Sequence Analysis and Related Methods, Monte Verita, TI, Switzerland, Oct 10-11, 2018

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqintegr, seqipos, seqindic

Examples

```
data(ex1)
sx <- seqdef(ex1[,1:13], right="DEL")

seqivolatility(sx)
seqivolatility(sx, adjust=FALSE)
seqivolatility(sx, with.missing=TRUE)
seqivolatility(sx, w=.7, with.missing=TRUE)
```

---

seqlegend *Plot a legend for the states in a sequence object*

Description

Plots a legend for the states in a sequence object. Useful if several graphics are plotted together and only one legend is necessary. Unless specified by the user, the *cpal* and *labels* attributes of the sequence object are used for the colors and text appearing in the legend (see seqdef).

Usage

```
seqlegend(seqdata, with.missing = "auto", cpal = NULL, missing.color = NULL,
  ltext = NULL, position = "topleft", cex = 1, boxes=TRUE, fontsize, ...)
```

Arguments

seqdata	a state sequence object (of class stslist) as returned by the seqdef function.
with.missing	logical: if set to "auto" (default), a legend for the missing state is added automatically if one or more of the sequences in seqdata contains a missing state. If TRUE a legend for the missing state is added in any case. Setting to FALSE omits the legend for the missing state.
cpal	alternative color palette to use for the states. If user specified, a vector of colors with number of elements equal to the number of distinct states. By default, the 'cpal' attribute of the 'seqdata' sequence object is used (see seqdef).
missing.color	alternative color for representing missing values inside the sequences. By default, this color is taken from the "missing.color" attribute of the sequence object being plotted.
ltext	optional description of the states to appear in the legend. Must be a vector of character strings with number of elements equal to the number of distinct states. If unspecified, the 'labels' attributes of the 'seqdata' sequence object is used (see seqdef).
position	the position of the legend in the graphic area. For accepted values, see the x argument of legend. Defaults to "topleft".
cex	size of the font for the labels. A value less than 1 decreases the font size, a value greater than 1 increases the font size. Defaults to 1.
boxes	logical: should the colors be displayed in small square boxes? Default is TRUE. If FALSE, colors are shown using small line segments of by default length .4 and width 15. The latter can be changed by means of the lwd and seg.len par arguments.
fontsize	Deprecated. Use cex instead.
...	optional arguments passed to the legend function.

Details

When x, legend, or col arguments are provided, they supersede respectively the position, ltext, and cpal values.

Value

Coordinate values returned by the legend function.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

Examples

```
## Loading the 'actcal' example data set
## and defining a sequence object with
## activity statuses from Jan. to Dec. 2000 (columns 13 to 24)
## of first 100 cases.
```

```
data(actcal)
actcal.seq <- seqdef(actcal[1:100,13:24],
labels=c("> 37 hours", "19-36 hours", "1-18 hours", "no work"))

## Plotting the sequences frequency,
## the states distribution
## and the legend
par(mfrow=c(2,2))
seqIplot(actcal.seq, sortv="from.start", with.legend=FALSE)
seqfplot(actcal.seq, pbarw=TRUE, with.legend=FALSE)
seqdplot(actcal.seq, with.legend=FALSE)
seqlegend(actcal.seq)
```

`seqlength` *Sequence length*

Description

Returns the length of sequences.

Usage

```
seqlength(seqdata, with.missing=TRUE)
```

Arguments

`seqdata`	a sequence object created with the `seqdef` function.
`with.missing`	logical: should non-void missing values be treated as a regular state? Default is `TRUE`. If `FALSE` missing values are considered as void.

Details

The length of a sequence is computed by counting its number of non void elements, i.e. including non-void missing values. The `seqlength` function returns a vector containing the length of each sequence in the provided sequence object.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

See Also

`seqlength.align`

Examples

```
## Loading the 'famform' example data set
data(famform)

## Defining a sequence object with the 'famform' data set
ff.seq <- seqdef(famform)

## Retrieving the length of the sequences
## in the ff.seq sequence object
seqlength(ff.seq)
```

`seqlength.align` *Align sequence length across domains*

Description

Sets lengths of sequences of multiple domains as the shortest lengths across domains.

Usage

```
seqlength.align(seq.list)
```

Arguments

`seq.list`	list of sequence objects (of class `stslist`) created with the `seqdef` function. The sequence objects must all have the same number of sequences.

Details

Sequences in the sequence objects are assumed to be ordered conformably. The length of the i-th sequence in each domain is set as the length of the shortest i-th sequence of the domains. The reduction of length is done by filling end positions with voids.

Author(s)

Gilbert Ritschard

See Also

`seqlength`

Examples

```
## Using the ex1 data set with sequences of different length
data(ex1)
s1 <- seqdef(ex1[,1:13])
seqlength(s1)

## sequence object s2 with a shorter 1st sequence
```

```
s2 <- s1
s2[1,8:13] <- attr(s2,"void")
seqlength(s2)

## aligning sequence lengths
seqlength.align(list(s1,s2))
```

---

seqLLCP *Compute the length of the longest common prefix of two sequences*

Description

Returns the length of the longest common prefix of two sequences. This attribute is described in *Elzinga (2008)*.

Usage

```
seqLLCP(seq1, seq2)
```

Arguments

seq1	a sequence from a sequence object.
seq2	a sequence from a sequence object.

Value

an integer being the length of the longest common prefix of the two sequences.

References

Elzinga, Cees H. (2008). Sequence analysis: Metric representations of categorical time series. *Technical Report*, Department of Social Science Research Methods, Vrije Universiteit, Amsterdam.

See Also

seqdist

Examples

```
data(famform)
famform.seq <- seqdef(famform)

## The LCP's length between sequences 1 and 2
## in the famform sequence object is 2
seqLLCP(famform.seq[1,],famform.seq[2,])
```

seqLLCS *Compute the length of the longest common subsequence of two sequences*

Description

Returns the length of the longest common subsequence of two sequences. This attribute is described in *Elzinga (2008)*.

Usage

```
seqLLCS(seq1, seq2)
```

Arguments

seq1	a sequence from a sequence object
seq2	a sequence from a sequence object

Value

an integer being the length of the longest common subsequence of the two sequences.

References

Elzinga, Cees H. (2008). Sequence analysis: Metric representations of categorical time series. *Technical Report*, Department of Social Science Research Methods, Vrije Universiteit, Amsterdam.

See Also

seqdist

Examples

```
LCS.ex <- c("S-U-S-M-S-U", "U-S-SC-MC", "S-U-M-S-SC-UC-MC")
LCS.ex <- seqdef(LCS.ex)
seqLLCS(LCS.ex[1,],LCS.ex[3,])
```

seqlogp *Logarithm of the probabilities of state sequences*

Description

Logarithm of the probabilities of state sequences. The probability of a sequence is defined as the product of the probabilities of the successive states in the sequence. State probabilities can either be provided or be computed with one of a few basic models.

Usage

```
seqlogp(seqdata, prob="trate", time.varying=TRUE,
        begin="freq", weighted=TRUE, with.missing=FALSE)
```

Arguments

seqdata	A state sequence object as produced by seqdef.
prob	String or numeric array. If a string, either "trate" or "freq" to select a probability model to compute the state probabilities. If a numeric array, a matrix or 3-dimensional array of transition probabilities. See details.
time.varying	Logical. If TRUE, the probabilities (transitions or frequencies) are computed separately for each time t point.
begin	String of numeric vector. Distribution used to determine the probability of the first state. If a vector, the probabilites to use. If a string, either "freq" or global.freq. With freq, the observed distribution at first position is used. If global.freq, the overall distribution is used. Default is "freq".
weighted	Logical. Should we account for the weights when present in seqdata? Default is TRUE.
with.missing	Logical. Should non void missing states be treated as regular values? Default is FALSE.

Details

The sequence likelihood $P(s)$ is defined as the product of the probability with which each of its observed successive state is supposed to occur at its position. Let $s = s_1 s_2 \cdots s_\ell$ be a sequence of length ℓ. Then

$$P(s) = P(s_1, 1) \cdot P(s_2, 2) \cdots P(s_\ell, \ell)$$

with $P(s_t, t)$ the probability to observe state s_t at position t.

There are different ways to determine the state probabilities $P(s_t, t)$. The method is chosen by means of the prob argument.

With prop = "freq", the probability $P(s_t, t)$ is set as the observed relative frequency at position t. In that case, the probability does not depend on the probabilities of transition. By default (time.varying=TRUE), the relative frequencies are computed separately for each position t. With time.varying=FALSE, the relative frequencies are computed over the entire covered period, i.e. the same frequencies are used at each t.

Option `prop = "trate"` assumes that each $P(s_t, t)$, $t > 1$ is set as the transition probability $p(s_t|s_{t-1})$. The state distribution used to determine the probability of the first state s_1 is set by means of the `begin` argument (see below). With the default `time.varying=TRUE`), the transition probabilities are estimated separately at each position, yielding an array of transition matrices. With `time.varying=FALSE`, the transition probabilities are assumed to be constant over the successive positions and are estimated over the entire sequence duration, i.e. from all observed transitions.

Custom transition probabilities can be provided by passing a matrix or a 3-dimensional array as `prob` argument.

The distribution used at the first position is set by means of the `begin` argument. You can either pass the distribution (probabilities of the states in the alphabet including the missing value when `with.missing=TRUE`), or specify `"freq"` for the observed distribution at the first position, or `global.freq` for the overall state distribution.

The likelihood $P(s)$ being generally very small, `seqlogp` returns $-\log P(s)$. The latter quantity is minimal when $P(s)$ is equal to 1.

Value

Vector of the negative logarithm $-\log P(s)$ of the sequence probabilities.

Author(s)

Matthias Studer, Alexis Gabadinho, and Gilbert Ritschard

Examples

```
## Creating the sequence objects using weigths
data(biofam)
biofam.seq <-  seqdef(biofam, 10:25, weights=biofam$wp00tbgs)

## Computing sequence probabilities
biofam.prob <- seqlogp(biofam.seq)
## Comparing the probability of each cohort
cohort <- biofam$birthyr>1940
boxplot(biofam.prob~cohort)
```

---

seqmaintokens *Indexes of most frequent tokens*

Description

Extracts the indexes of the most frequent token, either the k most frequent tokens or the tokens that occur on average more than `mint` times.

Usage

```
seqmaintokens(seqdata, k=8L, mint=NULL, ...)
```

Arguments

seqdata	state sequence stslist object as produced by seqdef.
k	Integer. Number of main states.
mint	Real. Minimal mean number of occurrences per sequence.
...	Additional arguments passed to seqmeant

Details

When mint is NULL, indexes of the k most frequent tokens. Otherwise, indexes of tokens occurring on average more than tmin times are returned as long as their number does not exceed k. If more than k, indexes of the k most frequent are returned.

Value

Vector of indexes of the most frequent tokens repecting order of the alphabet.

Author(s)

Gilbert Ritschard

See Also

seqmeant

Examples

```
data(biofam)
b.lab <- c("Parent",
           "Left",
           "Married",
           "Left+Marr",
           "Child",
           "Left+Child",
           "Left+Marr+Child",
           "Divorced"
)
b.short <- c("P","L","M","L+M","C","L+C","L+M+C","D")
set.seed(5)
cases <- sample(nrow(biofam),100)
b.seq <- seqdef(biofam[cases,10:25], labels=b.lab, states=b.short,
                weights=biofam[cases,"wp00tbgs"])

## Tokens occurring at least once on average
alphabet(b.seq)[seqmaintokens(b.seq, mint=1)]
#[1] "P"     "L"     "L+M"   "L+M+C"

## Three more frequent tokens
main.tokens <- seqmaintokens(b.seq, k=3)
## Labels of main tokens
attr(b.seq,"labels")[main.tokens]
```

```
#[1] "Parent"  "Left"    "Left+Marr+Child"
## Colors of main tokens
cpal(b.seq)[main.tokens]
#[1] "#7FC97F" "#BEAED4" "#BF5B17"
```

---

seqMD *Multidomain sequences*

Description

Build multidomain (MD) sequences of combined individual domain states (expanded alphabet), derive multidomain indel and substitution costs from domain costs by means of an additive trick (CAT), and compute OM pairwise distances using CAT costs.

Usage

```
seqMD(channels,
  method=NULL,
  norm="none",
  indel="auto",
  sm=NULL,
  with.missing=NULL,
  full.matrix=TRUE,
  link="sum",
  cval=2,
  miss.cost=2,
  cweight=NULL,
  what="MDseq",
  ch.sep="+",
  fill.with.miss=TRUE
  )

seqdistmc(channels, what="diss", ch.sep="@@@@TraMineRSep@@@@", ...)
```

Arguments

channels	A list of domain state sequence `stslist` objects defined with the `seqdef` function, each state sequence object corresponding to a domain.
method	String. Default: `NULL`. Dissimilarity measure between sequences. When `what="diss"`, must be one of `"OM"` (Optimal Matching), `"HAM"` (Hamming distance), or `"DHD"` (Dynamic Hamming distance). Otherwise, ignored. Can also be `"LCS"` (Longest common subsequence), but see details.
norm	String. Default: `"none"`. The normalization method to use. See `seqdist`. Ignored if `what` is not `"diss"`.

indel	Double, vector of doubles, or list with an insertion/deletion cost or a vector of state dependent indel costs for each domain. Can also be "auto" (default), in which case the indel cost of each domain is automatically set in accordance with the sm value of the domain. See indel argument of seqdist.
sm	A list with a substitution-cost matrix for each domain or a list of method names for generating the domain substitution costs (see seqcost). Ignored when method="LCS".
with.missing	Logical, vector of logical, or NULL (default). See seqdist and seqcost.
full.matrix	Logical. If TRUE (default), the full distance matrix between MD sequences is returned. If FALSE, an object of class dist is returned.
link	Character string. One of "sum" or "mean". Method to compute the "link" between domains. Default is to sum substitution and indel costs.
cval	Double. Domain substitution cost for "CONSTANT" matrix, see seqcost.
miss.cost	Double. Cost to substitute missing values at domain level, see seqcost.
cweight	A vector of domain weights. Default is 1 (same weight for each domain).
what	Character string. What output should be returned? One of "MDseq", "cost", "diss". The deprecated value what="sm" is treated as what="cost". MDseq returns the multidomain sequences expressed in terms of the expanded alphabet, "cost" the CAT costs, and "diss" the CAT-based multidomain distances.
ch.sep	Character string. Separator used for building state names of the expanded alphabet.
fill.with.miss	Logical. Should shorter domain sequences be filled with missings to match sequence lengths across domains? Applies only to domains that already have missings.
...	arguments passed to seqMD

Details

The seqMD function builds MD sequences by combining the domain states. When what="cost", it derives multidomain indel and substitution costs from the indel and substitution costs of each domain by means of the cost additive trick (CAT) (*Ritschard et al., 2023*, *Pollock, 2007*). When what="diss", it computes multidomain distances using the CAT multidomain costs. The available metrics (see method argument) are optimal matching ("OM"), Hamming distance ("HAM"), and Dynamic Hamming Distance ("DHD"). If method="LCS", distances are obtained with OM using CAT costs derived from domain indel and sm costs of respectively 1 and 2 (i.e. inputted indel and sm are ignored). For other edit distances, extract the combined state sequence object (by setting what="MDseq") and the CAT-multidomain substitution and indel costs (by setting what="cost"). Then use these outcomes as input in a call to seqdist. See seqdist for more information about available distance measures.

Normalization may be useful when dealing with sequences that are not all of the same length. For details on the applied normalization, see seqdist.

Sequences lengths are supposed to match across domains. If fill.with.miss is TRUE and the i-th sequence is shorter in one domain than the longest i-th sequence, it will, when constructing the i-th MD sequence, be filled with missing values to adapt its length to that of the longest sequence. However, this applies only for domain that already have missings, i.e., domains with a corresponding with.missing value set as TRUE.

Value

When `what="MDseq"`, the MD sequences of combined states as a `stslist` sequence object.
When `what="cost"`, the matrix of CAT-substitution costs with three attributes: `indel` the CAT-indel cost(s), `alphabet` the alphabet of the combined state sequences, and `cweight` the channel weights used.
When `what="diss"`, a matrix of pairwise distances between MD sequences.

Author(s)

Gilbert Ritschard and Matthias Studer

References

Ritschard, G., T.F. Liao, and E. Struffolino (2023). Strategies for multidomain sequence analysis in social research. *Sociological Methodology*, 53(2), 288-322. doi:10.1177/00811750231163833.

Pollock, G. (2007) Holistic trajectories: a study of combined employment, housing and family careers by using multiple-sequence analysis. *Journal of the Royal Statistical Society: Series A* **170**, Part 1, 167–183.

See Also

`seqcost`, `seqdef`, `seqdist`, `seqplotMD`.

Examples

```
data(biofam)

## Building one channel per type of event left home, married, and child
cases <- 200
bf <- as.matrix(biofam[1:cases, 10:25])
left <- bf==1 | bf==3 | bf==5 | bf==6
married <- bf == 2 | bf== 3 | bf==6
children <-  bf==4 | bf==5 | bf==6

## Building sequence objects
left.seq <- seqdef(left)
marr.seq <- seqdef(married)
child.seq <- seqdef(children)
channels <- list(LeftHome=left.seq, Marr=marr.seq, Child=child.seq)

## CAT multidomain distances based on channel specific cost methods
MDdist <- seqMD(channels, method="OM",
    sm =list("INDELSLOG", "INDELSLOG", "TRATE"), what="diss")

## Providing channel specific substitution costs
smatrix <- list()
smatrix[[1]] <- seqsubm(left.seq, method="TRATE")
smatrix[[2]] <- seqsubm(marr.seq, method="CONSTANT")
smatrix[[3]] <- seqsubm(child.seq, method="CONSTANT")

## Retrieving the MD sequences
```

```
MDseq <- seqMD(channels)
alphabet(MDseq)

## Retrieving the CAT multidomain substitution costs
## Using double weight for domain "child"
CATcost <- seqMD(channels,
    sm=smatrix, cweight=c(1,1,2), what="cost")

## OMspell distances between MD sequences
MDdist2 <- seqdist(MDseq, method="OMspell",
    sm = CATcost, indel=attr(CATcost,"indel"))
```

`seqmeant` *Mean durations in each state*

Description

Compute the mean total time spent in each state of the alphabet for the set of sequences given as input.

Usage

```
seqmeant(seqdata, weighted=TRUE, with.missing=FALSE, prop=FALSE, serr=FALSE)
```

Arguments

`seqdata`	a sequence object as defined by the `seqdef` function.
`weighted`	logical: if `TRUE`, the weights (weights attribute) attached to the sequence object are used for computing weighted mean total time.
`with.missing`	logical: if set to `TRUE`, cumulated durations are also computed for the missing status (gaps in the sequences). See seqdef on options for handling missing values when creating sequence objects.
`prop`	logical: if `TRUE`, proportions of time spent in each state are returned instead of absolute values. This option is especially useful when sequences contain missing states, since the sum of the state durations may not be the same for all sequences.
`serr`	logical: if `TRUE`, the variance and standard deviation of the total time spent in the states, as well as the standard error of the mean are also computed.

Value

An object of class *stslist.meant*. There are `print` and `plot` methods for such objects.

Author(s)

Alexis Gabadinho

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

See Also

`plot.stslist.meant` for basic plots of *stslist.meant* objects and `seqmtplot` (`seqplot` with `type="mt"`) argument for more sophisticated plots of the mean durations allowing grouping and legend.

Examples

```
## Defining a sequence object with columns 13 to 24
## in the actcal example data set
data(actcal)
actcal.lab <- c("> 37 hours", "19-36 hours", "1-18 hours", "no work")
actcal.seq <- seqdef(actcal,13:24,labels=actcal.lab)

## Computing the mean time in the different states
seqmeant(actcal.seq)

## Mean times with their standard error
seqmeant(actcal.seq, serr=TRUE)
```

---

seqmodst *Sequence of modal states*

Description

Sequence made of the modal state at each position.

Usage

```
seqmodst(seqdata, weighted=TRUE, with.missing=FALSE)
```

Arguments

`seqdata`	a state sequence object as defined by the `seqdef` function.
`weighted`	if `TRUE`, distributions account for the weights assigned to the state sequence object (see `seqdef`). Set as `FALSE` if you want ignore the weights.
`with.missing`	If `FALSE` (default value), returned distributions ignore missing values.

Details

In case of multiple modal states at a given position, the first one is taken. Hence, the result may vary with the alphabet order.

Value

an object of class *stslist.modst*. This is actually a state sequence object (containing a single state sequence) with additional attributes, among which the `Frequencies` attribute containing the transversal frequency of each state in the sequence. There are print and plot methods for such objects. More sophisticated plots can be produced with the `seqplot` function.

Author(s)

Alexis Gabadinho

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

See Also

`plot.stslist.modst` for default plot method, `seqplot` for higher level plots.

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
"Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam, 10:25, labels=biofam.lab)

## Modal state sequence
seqmodst(biofam.seq)

## Examples using weights and with.missing arguments
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

seqmodst(ex1.seq)
seqmodst(ex1.seq, weighted=FALSE)
seqmodst(ex1.seq, weighted=FALSE, with.missing=TRUE)
```

`seqmpos` *Number of matching positions between two sequences.*

Description

Returns the number of common elements, i.e., same states appearing at the same position in the two sequences.

Usage

```
seqmpos(seq1, seq2, with.missing=FALSE)
```

Arguments

seq1	a sequence from a sequence object.
seq2	a sequence from a sequence object.
with.missing	if TRUE, gaps appearing at the same position in both sequences are also considered as common elements

.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for help page)

See Also

seqLLCP, seqLLCS .

Examples

```
data(famform)
famform.seq <- seqdef(famform)

seqmpos(famform.seq[1,],famform.seq[2,])
seqmpos(famform.seq[2,],famform.seq[4,])

## Example with gaps in sequences
a <- c(NA,"A",NA,"B","C")
b <- c(NA,"C",NA,"B","C")

ex1.seq <- seqdef(rbind(a,b))

seqmpos(ex1.seq[1,], ex1.seq[2,])
seqmpos(ex1.seq[1,], ex1.seq[2,], with.missing=TRUE)
```

---

seqnum *Transform into a sequence object with numerical alphabet.*

Description

The function seqnum transforms the provided state sequence object into an equivalent sequence object in which the original alphabet is replaced with an alphabet of numbers ranging from 0 to (nbstates-1).

Usage

```
seqnum(seqdata, with.missing=FALSE)
```

Arguments

seqdata	a state sequence object as defined by the seqdef function.
with.missing	logical: Should missing elements in the sequences be turned into numerical values as well? The code for missing values in the sequences is retrieved from the 'nr' attribute of seqdata.

Details

The first state (for example 'A') is coded with the value 0, the second state (for example 'B') is coded with the value 1, etc... The function returns a sequence object containing the original sequences coded with the new numerical alphabet ranging from 0 to (nbstates-1)

Author(s)

Alexis Gabadinho

See Also

seqdef, alphabet

Examples

```
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## The first 10 sequences in the actcal.seq
## sequence object
actcal.seq[1:10,]
alphabet(actcal.seq)

## The first 10 sequences in the actcal.seq
## sequence object with numerical alphabet
seqnum(actcal.seq[1:10,])

## states A,B,C,D are now coded 0,1,2,3
alphabet(seqnum(actcal.seq))
```

---

seqpcplot *Parallel coordinate plot for sequence data*

Description

A decorated parallel coordinate plot to render the order of the successive elements in sequences. The sequences are displayed as jittered frequency-weighted parallel lines. The plot is also embedded as the type="pc" option of the seqplot function and serves as plot method for eseq and seqelist objects.

Usage

```
seqpcplot(seqdata, group = NULL, weights = NULL, cex = 1, lwd = 1/4,
  cpal = NULL, grid.scale = 1/5, ltype = "unique",
  embedding = "most-frequent", lorder = NULL , lcourse = "upwards",
  filter = NULL, hide.col = "grey80", alphabet = NULL,
  missing = "auto", order.align = "first", main = "auto", xlab = NULL,
  ylab = NULL, xaxis = TRUE, yaxis = TRUE, axes = "all", xtlab = NULL,
  cex.lab = 1, rows = NA, cols = NA, plot = TRUE, seed = NULL,
  weighted = TRUE, with.missing = TRUE,
  title, cex.plot, ...)

seqpcfilter(method = c("minfreq", "cumfreq", "linear"), level = 0.05)
```

Arguments

seqdata	The sequence data. Either an event sequence object of class seqelist (see seqecreate) or a state sequence object of class stslist (see seqdef).
group	a vector (numeric or factor) of group memberships of length equal the number of sequences. When specified, one plot is generated for each different membership value.
weights	a numeric vector of weights of length equal the number of sequences. When NULL, the weights are taken from the seqdata object.
cex	Plotting text and symbols magnification. See par.
lwd	expansion factor for line widths. The expansion is relative to the size of the squared symbols.
cpal	color palette vector for line coloring.
grid.scale	Expansion factor for the translation zones.
ltype	the type of sequence that is drawn. Either "unique" to render unique patterns or "non-embeddable" to render non-embeddable sequences.
embedding	The method for embedding sequences embeddable in multiple non-embeddable sequences. Either "most-frequent" (default) or "uniformly". Relevant only with ltype = "non-embeddable".
lorder	line ordering. Either "background" or "foreground".
lcourse	Method to connect simultaneous elements with the preceding and following ones. Either "upwards" (default) or "downwards".
filter	list of line coloring options. See details.
hide.col	Color for sequences filtered-out by the filter specification.
alphabet	a vector of response levels in the order they should appear on the y-axis. This argument is solely relevant for seqelist objects.
missing	character. Whether and how missing values should be displayed. Available are "auto", "show" and "hide". If "auto", the plot will show missings only if present. "hide" will fade out missings and "show" will always show missings. If with.missing=FALSE, missing is turned into "hide". If with.missing=TRUE and missing="hide", missing is turned into "auto".

order.align	Aligning method. For aligning on order positions use either "first" (default) or "last". Option "first" numbers the positions from the beginning while "last" numbers them from the end. With order.align = "time", the elements in the sequences are aligned on their rounded timestamps.
main	title for the graphic. Default "auto" prints default titles. Set as NULL to suppress the title.
xlab	label for the x-axis
ylab	label for the y-axis
xaxis	logical: Should x-axis be plotted?
yaxis	logical: Should y-axis be plotted?
axes	if set as "all" (default value) x-axes are drawn for each plot in the graphic. If set as "bottom" and group is used, axes are drawn only under the plots at the bottom of the graphic area. If FALSE, no x-axis is drawn.
xtlab	labels for the x-axis ticks.
cex.lab	x and y labels magnification. See par.
rows, cols	integers. Number of rows and columns of the plot panel.
plot	logical. Should the plot be displayed? Set as FALSE to retrieve the seqpcplot object without plotting it.
seed	integer. Start seed value.
weighted	logical. Should weights be accounted for? Default is TRUE.
with.missing	logical. Should we care about possible missings? Default is TRUE. See also the missing argument.
method	character string. Defines the filtering function. Available are "minfreq", "cumfreq" and "linear".
level	numeric scalar between 0 and 1. The frequency threshold for the filtering methods "minfreq" and "cumfreq".
title	Deprecated. Use main instead.
cex.plot	Deprecated. Use cex.lab instead.
...	arguments to be passed to other methods, such as graphical parameters (see par).

Details

For plots by groups specified with the group argument, plotted line widths and point sizes reflect relative frequencies within group.

The filter argument serves to specify filters to gray less interesting patterns. The filtered-out patterns are displayed in the hide.col color. The filter argument expects a list with at least elements type and value. The following types are implemented:

Type "sequence": colors a specific pattern, for example assign
filter = list(type = "sequence", value = "(Leaving Home,Union)-(Child)").

Type "subsequence": colors patterns which include a specific subsequence, for example
filter = list(type = "subsequence", value = "(Child)-(Marriage)") .

Type "value": gradually colors the patterns according to the numeric vector (of length equal to the number of sequences) provided as "value" element in the list. You can give something like filter = list(type = "value", value = c(0.2, 1, ...)) or provide the distances to the medoid as value vector for example.

Type "function": colors the patterns depending on the values returned by a [0,1] valued function of the frequency x of the pattern. Three native functions can be used: "minfreq", "cumfreq" and "linear". Use filter = list(type = "function", value = "minfreq", level = 0.05) to color patterns with a support of at least 5% (within group). Use filter = list(type = "function", value = "cumfreq", level = 0.5) to highlight the 50% most frequent patterns (within group). Or, use filter = list(type="function", value="linear") to use a linear gradient for the color intensity (the most frequent trajectory gets 100% intensity). Other user-specified functions can be provided by giving something like filter = list(type="function", value=function(x, arg1, arg2) {return(x/max(x) * arg1/arg2)}, arg1 = 1, arg2 = 1). This latter function adjusts gradually the color intensity of patterns according to the frequency of the pattern.

The function seqpcfilter is a convenience function for type "function". The three examples above can be imitated by seqpcfilter("minfreq", 0.05), seqpcfilter("cumfreq", 0.5) and seqpcfilter("linear").

If a numeric scalar is assigned to filter, the "minfreq" filter is used.

Value

An object of class "seqpcplot" with various information necessary for constructing the plot, e.g. coordinates. There is a summary method for such objects.

Author(s)

Reto Bürgin (with Gilbert Ritschard for the help page)

References

Bürgin, R. and G. Ritschard (2014), A decorated parallel coordinate plot for categorical longitudinal data, *The American Statistician* 68(2), 98-103.

See Also

seqplot, seqdef, seqecreate

Examples

```
## ================
## plot biofam data
## ================

data(biofam)
lab <- c("Parent","Left","Married","Left+Marr","Child","Left+Child",
         "Left+Marr+Child","Divorced")

## plot state sequences in STS representation
```

```
## ========================================

## creating the weighted state sequence object.
biofam.seq <- seqdef(data = biofam[,10:25], labels = lab,
                     weights = biofam$wp00tbgs)

## select the first 20 weighted sequences (sum of weights = 18)
biofam.seq <- biofam.seq[1:20, ]

par(mar=c(4,8,2,2))
seqpcplot(seqdata = biofam.seq, order.align = "time")

## .. or
seqplot(seqdata = biofam.seq, type = "pc", order.align = "time")

## Distinct successive states (DSS)
## ========================================

seqplot(seqdata = biofam.seq, type = "pc", order.align = "first")

## .. or (equivalently)

biofam.DSS <- seqdss(seqdata = biofam.seq) # prepare format
seqpcplot(seqdata = biofam.DSS)

## plot event sequences
## ====================

biofam.eseq <- seqecreate(biofam.seq, tevent = "state") # prepare data

## plot the time in the x-axis
seqpcplot(seqdata = biofam.eseq, order.align = "time", alphabet = lab)

## ordering of events
seqpcplot(seqdata = biofam.eseq, order.align = "first", alphabet = lab)

## ... or
plot(biofam.eseq, order.align = "first", alphabet = lab)

## additional arguments
## ====================

## non-embeddable sequences
seqpcplot(seqdata = biofam.eseq, ltype = "non-embeddable",
          order.align = "first", alphabet = lab)

## align on last event
par(mar=c(4,8,2,2))
seqpcplot(seqdata = biofam.eseq, order.align = "last", alphabet = lab)

## use group variables
seqpcplot(seqdata = biofam.eseq, group = biofam$sex[1:20],
          order.align = "first", alphabet = lab)
```

```
## color patterns (Parent)-(Married) and (Parent)-(Left+Marr+Child)
par(mfrow = c(1, 1))
seqpcplot(seqdata = biofam.eseq,
          filter = list(type = "sequence",
                        value=c("(Parent)-(Married)",
                                "(Parent)-(Left+Marr+Child)")),
          alphabet = lab, order.align = "first")

## color subsequence pattern (Parent)-(Left)
seqpcplot(seqdata = biofam.eseq,
          filter = list(type = "subsequence",
                        value = "(Parent)-(Left)"),
          alphabet = lab, order.align = "first")

## color sequences over 10% (within group) (function method)
seqpcplot(seqdata = biofam.eseq,
          filter = list(type = "function",
                       value = "minfreq",
                       level = 0.1),
          alphabet = lab, order.align = "first", seed = 1)

## .. same result using the convenience functions
seqpcplot(seqdata = biofam.eseq,
          filter = 0.1,
          alphabet = lab, order.align = "first", seed = 1)

seqpcplot(seqdata = biofam.eseq,
          filter = seqpcfilter("minfreq", 0.1),
          alphabet = lab, order.align = "first", seed = 1)

## highlight the 50% most frequent sequences
seqpcplot(seqdata = biofam.eseq,
          filter = list(type = "function",
                        value = "cumfreq",
                        level = 0.5),
          alphabet = lab, order.align = "first", seed = 2)

## .. same result using the convenience functions
seqpcplot(seqdata = biofam.eseq,
          filter = seqpcfilter("cumfreq", 0.5),
          alphabet = lab, order.align = "first", seed = 2)

## linear gradient
seqpcplot(seqdata = biofam.eseq,
          filter = list(type = "function",
                        value = "linear"),
          alphabet = lab, order.align = "first", seed = 2)

seqpcplot(seqdata = biofam.eseq,
          filter = seqpcfilter("linear"),
          alphabet = lab, order.align = "first", seed = 1)
```

seqplot *Plot state sequence objects*

Description

High level plot functions to render state sequence objects. Can produce many different types of plots and can render sequences by group.

Usage

```
seqplot(seqdata,
  group = NULL,
  type = "i",
  main = "auto",
  cpal = NULL,
  missing.color = NULL,
  ylab = NULL,
  yaxis = "all",
  xaxis = "all",
  xtlab = NULL,
  cex.axis = 1,
  with.legend = "auto",
  ltext = NULL,
  cex.legend = 1,
  use.layout = (!is.null(group) | with.legend != FALSE),
  legend.prop = NA,
  rows = NA,
  cols = NA,
  title, cex.plot, withlegend, axes,
  ...)

seqdplot(seqdata, group = NULL, main = "auto", ...)
seqdHplot(seqdata, group = NULL, main = "auto", ...)
seqfplot(seqdata, group = NULL, main = "auto", ...)
seqiplot(seqdata, group = NULL, main = "auto", ...)
seqIplot(seqdata, group = NULL, main = "auto", ...)
seqHtplot(seqdata, group = NULL, main = "auto", ...)
seqmsplot(seqdata, group = NULL, main = "auto", ...)
seqmtplot(seqdata, group = NULL, main = "auto", ...)
seqrplot(seqdata, group = NULL, main = "auto", ...)
seqrfplot(seqdata, group = NULL, main = "auto", ...)
```

Arguments

seqdata	State sequence object created with the seqdef function.
group	Grouping variable of length equal to the number of sequences. When not NULL, a distinct plot is generated for each level of group.
type	the type of the plot. Available types are "d" for state distribution plots (chronograms), "dH" for chronograms with overlayed entropy line, "f" for sequence frequency plots, "Ht" for transversal entropy plots, "i" for selected sequence index plots, "I" for whole set index plots, "ms" for plotting the sequence of modal states, "mt" for mean times plots, "pc" for parallel coordinate plots, "r" for representative sequence plots, and "rf" for relative frequency plots.
main	Character string. Title of the graphic. Default "auto" prints group levels as default title when group is not NULL and no title otherwise. Set as NULL to suppress titles.
cpal	Color palette of the states. By default, the cpal attribute of the seqdata sequence object is used (see seqdef). If user specified, a vector of colors of length and order corresponding to alphabet(seqdata).
missing.color	Color for representing missing values inside the sequences. By default, this color is taken from the missing.color attribute of seqdata.
ylab	Character string or vector of strings. Optional label of the y-axis. If a vector, y-axis label of each group level. If set as NA, no label is drawn.
yaxis	Logical or one of "all" or "left". If set as TRUE or "all" (default value), sequence index numbers are displayed for "i" and "I", mean time values for "mt", percentages for "d" and "f", and state/event labels for "pc". Ignored for "r". If "left" and group is used, the y-axis is displayed on plots of the left panel only. If FALSE no y-axis is drawn. For type "f", can also be one of "pct" or "left.pct".
xaxis	Logical or one of "all" or "bottom". If set as TRUE or "all" (default value) x-axes are drawn for each plot in the graphic. If set as "bottom" and group is used, axes are drawn under the plots of the bottom panel only. If FALSE, no x-axis is drawn.
xtlab	Vector of length equal to the number of columns of seqdata. Optional x-axis tick labels. If unspecified, column names of the seqdata sequence object are used (see seqdef).
cex.axis	Real value. Axis annotation magnification. When type = "r" and for seqrplot(), it also determines the magnification of the plotted text and symbols. See par.
with.legend	Character string or logical. Defines if and where the legend of the state colors is plotted. The default value "auto" sets the position of the legend automatically. Other possible value is "right". Obsolete value TRUE is equivalent to "auto".
ltext	Vector of character strings of length and order corresponding to alphabet(seqdata). Optional description of the states to appear in the legend. If unspecified, the label attribute of the seqdata sequence object is used (see seqdef).
cex.legend	Real. Legend magnification. See legend.
use.layout	Logical. Should layout be used to arrange plots when using the group option or plotting a legend? When layout is activated, the standard 'par(mfrow=....)'

	for arranging plots does not work. With `with.legend=FALSE` and `group=NULL`, layout is automatically deactivated and '`par(mfrow=...)`' can be used.
`legend.prop`	Real in range [0,1]. Proportion of the graphic area devoted to the legend plot when `use.layout=TRUE` and `with.legend=TRUE`. Default value is set according to the place (bottom or right of the graphic area) where the legend is plotted.
`rows`, `cols`	Integers. Number of rows and columns of the plot panel when `use.layout=TRUE`.
`title`	Deprecated. Use `main` instead.
`cex.plot`	Deprecated. Use `cex.axis` instead.
`withlegend`	Deprecated. Use `with.legend` instead.
`axes`	Deprecated. Use `xaxis` instead.
`...`	arguments to be passed to the function called to produce the appropriate statistics and the associated plot method (see details), or other graphical parameters. For example, the `weighted` argument can be passed to control whether (un)weighted statistics are produced, and `with.missing=TRUE` to take missing values into account when computing cross-sectional or longitudinal state distributions. Can also include arguments of `legend` such as `bty="n"` to suppress the box surrounding the legend.

Details

`seqplot` is the generic function for high level plots of state sequence objects with group splits and automatic display of the color legend. Many different types of plots can be produced by means of the `type` argument. Except for sequence index plots, `seqplot` first calls the specific function producing the required statistics and then the plot method for objects produced by this function (see below). For sequence index plots, the state sequence object itself is plotted by calling the `plot.stslist` method. When splitting by groups and/or displaying the color legend, the `layout` function is used for arranging the plots.

The `seqdplot`, `seqdHplot`, `seqfplot`, `seqiplot`, `seqIplot`, `seqHtplot`, `seqmsplot`, `seqmtplot`, `seqpcplot` and `seqrplot` functions are aliases for calling `seqplot` with `type` argument set respectively to `"d"`, `"dH"`, `"f"`, `"i"`, `"I"`, `"Ht"`, `"ms"`, `"mt"`, `"pc"` or `"r"`.

A *State distribution plot* (`type="d"`) represents the sequence of the cross-sectional state frequencies by position (time point) computed by the `seqstatd` function and rendered with the `plot.stslist.statd` method. Such plots are also known as *chronograms*.

A *Sequence frequency plots* (`type="f"`) displays the most frequent sequences, each one with an horizontal stack bar of its successive states. Sequences are displayed bottom-up in decreasing order of their frequencies (computed by the `seqtab` function). The `plot.stslist.freq` plot method is called for producing the plot.
The `idxs` optional argument may be specified for selecting the sequences to be plotted (default is 1:10, i.e. the 10 most frequent sequences). The width of the bars representing the sequences is by default proportional to their frequencies, but this can be disabled with the `pbarw=FALSE` optional argument. If weights have been specified when creating `seqdata`, weighted frequencies are used unless you set the `weighted=TRUE` option. See examples below, the `seqtab` and `plot.stslist.freq` manual pages for a complete list of optional arguments and *Müller et al., (2008)* for a description of sequence frequency plots.

In *sequence index plots* (`type="i"` or `type="I"`), the requested individual sequences are rendered with horizontal stacked bars depicting the states over successive positions (time). Optional arguments are `idxs` for specifying the indexes of the sequences to be plotted (when `type="i"` defaults to the first ten sequences, i.e `idxs=1:10`). For nicely plotting a (large) whole set of sequences, use `type="I"` which is `type="i"` with `idxs=0` and the additional graphical parameters `border=NA` and `space=0` to suppress bar borders and space between bars. The `sortv` argument can be used to pass a vector of numerical values for sorting the sequences or to specify a sorting method. See `plot.stslist` for a complete list of optional arguments and their description.

The interest of sequence index plots has, for instance, been stressed by *Scherer (2001)* and *Brzinsky-Fay et al. (2006)*. Notice that index plots for thousands of sequences result in very heavy PDF or POSTSCRIPT graphic files. Dramatic file size reduction may be achieved by saving the figures in bitmap format by using for instance the `png` graphic device instead of `postscript` or `pdf`.

The *transversal entropy plot* (`type="Ht"`) displays the evolution over positions of the cross-sectional entropies (*Billari, 2001*). Cross-sectional entropies are computed by calling `seqstatd` function and then plotted with the `plot.stslist.statd` plot method. With `type="dH"`, the entropy line is overlayed on the state distribution plot. Due to argument name conflict, use `col.entr=` to set the color of the overlayed entropy curve (`col` argument of `plot.stslist.statd`).

The *modal state sequence plot* (`type="ms"`) displays the sequence of the modal states with each mode proportional to its frequency at the given position. The `seqmodst` function is called which returns the sequence and the result is plotted by calling the `plot.stslist.modst` plot method.

The *mean time plot* (`type="mt"`) displays the mean time spent in each state of the alphabet as computed by the `seqmeant` function. The `plot.stslist.meant` plot method is used to plot the resulting statistics. Set `serr=TRUE` to display error bars on the mean time plot. Bar labels can be specified by passing the `bar.labels` among the `...` arguments. In that case, `bar.labels` must be either a matrix with group specific labels in columns or a single vector to display the same labels for all groups.

The *representative sequence plot* (`type="r"`) displays a reduced, non redundant set of representative sequences extracted from the provided state sequence object and sorted according to a representativeness criterion. The `seqrep` function is called to extract the representative set which is then plotted by calling the `plot.stslist.rep` method. A distance matrix is required that is passed with the `diss` argument or by calling the `seqdist` function if `diss=NULL`. The `criterion` argument sets the representativeness criterion used to sort the sequences. Refer to the `seqrep` and `plot.stslist.rep` manual pages for a complete list of optional arguments. See *Gabadinho and Ritschard (2013)* for more details on the extraction of representative sets. Also look at the examples below.

Relative frequency plot (`type="rf"`) displays the medoids of equal sized groups *Fasang and Liao (2014)*. The partition into equal sized groups and the identification of the medoids is done by calling `seqrf` and plots are generated by `plot.seqrf`. See these functions for possible options. Option `which.plot = "both"` applies only when `group = NULL`. Whatever the value of `info`, `seqplot` does not display the statistics on the plot. When `sortv="mds"` is set, the first MDS factor of the whole `diss` matrix is computed and used for sorting each group. Set `sortv=NULL` to use the original data order.

For *decorated parallel coordinate plots* (`type="pc"`) see the specific manual page of `seqpcplot`.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

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Scherer S (2001). Early Career Patterns: A Comparison of Great Britain and West Germany. *European Sociological Review*, **17**(2), 119-144.

See Also

plot.stslist.statd, plot.stslist.freq, plot.stslist, plot.stslist.modst, plot.stslist.meant, plot.stslist.rep, seqrep, seqpcplot, seqsplot, seqplotMD.

Examples

```
## =====================================================
## Creating state sequence objects from example data sets
## =====================================================

## biofam data set
data(biofam)
## We use only a sample of 300 cases
set.seed(10)
biofam <- biofam[sample(nrow(biofam),300),]
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
                "Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam, 10:25, labels=biofam.lab)

## actcal data set
data(actcal)
## We use only a sample of 300 cases
set.seed(1)
actcal <- actcal[sample(nrow(actcal),300),]
```

```
actcal.lab <- c("> 37 hours", "19-36 hours", "1-18 hours", "no work")
actcal.seq <- seqdef(actcal,13:24,labels=actcal.lab)

## ex1 using weights
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

## ====================
## Sequence index plots
## ====================

## First ten sequences
seqiplot(biofam.seq)

## All sequences sorted by age in 2000
## grouped by sex
seqIplot(actcal.seq, group=actcal$sex, sortv=actcal$age00)


## ======================
## State distribution plot
## ======================

## biofam grouped by sex
seqplot(biofam.seq, type="d", group=biofam$sex)

## actcal grouped by sex
seqplot(actcal.seq, type="d", group=actcal$sex)

## with overlayed entropy line
seqplot(actcal.seq, type="dH", group=actcal$sex)

## ==================
## Cross-sectional entropy plot
## ==================
seqplot(biofam.seq, type="Ht", group=biofam$sex)

## ========================
## Sequence frequency plots
## ========================

## Plot of the 10 most frequent sequences
seqplot(biofam.seq, type="f")

## Grouped by sex
seqfplot(actcal.seq, group=actcal$sex)

## Unweighted vs weighted frequencies
seqfplot(ex1.seq, weighted=FALSE)
seqfplot(ex1.seq, weighted=TRUE)

## ====================
## Modal states sequence
```

```
## ====================
seqplot(biofam.seq, type="ms")
## same as
seqmsplot(biofam.seq)

## ====================
## Representative plots
## ====================

## Computing a distance matrix
## with OM metric
costs <- seqcost(actcal.seq, method="INDELSLOG")
actcal.om <- seqdist(actcal.seq, method="OM", sm=costs$sm, indel=costs$indel)

## Plot of the representative sets grouped by sex
## using the default density criterion
seqrplot(actcal.seq, group=actcal$sex, diss=actcal.om, coverage=.5)

## Plot of the representative sets grouped by sex
## using the "dist" (centrality) criterion
seqrplot(actcal.seq, group=actcal$sex, criterion="dist", diss=actcal.om, coverage=.33)

## ========================
## Relative frequency plots
## ========================
## Using default sorting by first MDS variable
seqrfplot(actcal.seq, diss=actcal.om, sortv=NULL, group=actcal$sex)


## ===============
## Mean time plot
## ===============

## actcal data set, grouped by sex
seqplot(actcal.seq, type="mt", group=actcal$sex)

## displaying mean times as bar labels
group <- factor(actcal$sex)
blab <- NULL
for (i in 1:length(levels(group))){
  blab <- cbind(blab,seqmeant(actcal.seq[group==levels(group)[i],]))
}
seqmtplot(actcal.seq, group=group,
          bar.labels = round(blab,digits=2), cex.barlab=1.2)
```

---

seqplotMD *Plot multidomain state sequences*

Description

Plot function to render multidomain state sequences by domain and group. The function takes care to make the plots comparable across domains.

Usage

```
seqplotMD(channels,
  group = NULL,
  type = "i",
  main = NULL,
  cpal.dom = NULL,
  missing.color = NULL,
  ylab = NULL,
  yaxis = "all",
  xaxis = "all",
  xtlab = NULL,
  stats = "all",
  cex.axis = 1,
  with.legend = "auto",
  ltext.dom = NULL,
  cex.legend = 1,
  legend.prop = ifelse(dom.byrow,.25,.15),
  dom.byrow = FALSE,
  dom.crit = 0,
  dnames=names(channels),
  ...)
```

Arguments

channels	List of paired domain state sequence objects.
group	Grouping variable of length equal to the number of multidomain sequences. When not NULL, a distinct plot is generated for each level of group.
type	the type of the plot. Available types are "d" for state distribution plots (chronograms), "dH" for chronograms with overlayed entropy line, "f" for sequence frequency plots, "Ht" for transversal entropy plots, "i" for index plots of selected sequences, "I" for index plots of the whole set of sequences, "ms" for plotting the sequence of modal states, "mt" for mean times plots, "pc" for parallel coordinate plots, "r" for representative sequence plots, and "rf" for relative frequency plots.
main	Character string. Title of the graphic. Default is NULL.
cpal.dom	List. List of color palettes for the states of each domain. By default, the cpal attribute of each element of the list channels is used (see seqdef). If user specified, each element of the list should be a vector of colors of length of the alphabet of the corresponding element of channels.
missing.color	Color for representing missing values inside the sequences. By default, this color is taken for each domain from the missing.color attribute of the corresponding element of channels.

ylab	Character string or vector of strings. Optional label of the y-axis. If a vector, y-axis label of each group level. If set as NA, no label is drawn.
yaxis	Logical or one of "all" or "left". If set as TRUE or "all" (default value), sequence indexes are displayed for "i" and "I", mean time values for "mt", percentages for "d" and "f", and state/event labels for "pc". If "left" and group is used, the y-axis is displayed on plots of the left panel only. If FALSE no y-axis is drawn. Ignored when type="r". For type="f", can also be one of "pct" and "left.pct"
xaxis	Logical or one of "all" or "bottom". If set as TRUE or "all" (default value) x-axes are drawn for each plot in the graphic. If set as "bottom" is used, axes are drawn under the plots of the bottom panel only. If FALSE, no x-axis is drawn.
xtlab	Vector of length equal to the maximal length of the sequences. Optional labels of the x-axis tick labels. If unspecified, column names of the elements of channels are used (see seqdef).
stats	Logical or one of "all" or "first". When type="r", if "all" (default), stats of the MD representatives are displayed on all plots and if "first", MD stats are displayed only on the plot of the first domain. Ignored for all non-"r" types.
cex.axis	Real value. Axis annotation magnification. When type = "r" and for seqrplot(), it also determines the magnification of the plotted text and symbols. See par.
with.legend	Character string or logical. Should legends of the state colors be plotted? Default value "auto" sets the position of the legend automatically. Value TRUE is equivalent to "auto".
ltext.dom	List. List of vector of character strings of length and order corresponding to the alphabet of the corresponding elements of channels. Optional description of the states to appear in the legend. If unspecified, the label attribute of the corresponding sequence object in channels is used (see seqdef).
cex.legend	Real. Legend magnification. See legend.
legend.prop	Real in range [0,1]. Proportion of the graphic area devoted to the legends when with.legend=TRUE. Default value used depends of dom.byrow.
dom.byrow	Logical. Should domains be displayed by row?
dom.crit	Integer in range [-2,ndom] where ndom is number of domains. Applies when sortv is provided among the ... arguments and is one of "from.start" or "from.end". Domain on which sorting is done. When 0 (default), sorting is done on multidomain sequences, when -1, sorting is done on first domain then, for ties, successively on the next domains, when -2, sorting is done across domains at each successive position. Does not apply when sortv="mds" for "rf" plots.
dnames	String vector. Names of the domains.
...	arguments to be passed to the function called to produce the appropriate statistics and the associated plot method (see details), or other graphical parameters. For example, the weighted argument can be passed to control whether (un)weighted statistics are produced, and with.missing=TRUE to take missing values into account when computing cross-sectional or longitudinal state distributions. Can also include arguments of legend such as bty="n" to suppress the box surrounding the legend.

Details

The seqplotMD function is intended for multidomain (or multichannel) sequences, i.e. situations where each case is represented by a sequence in each of several domains. The elements (set of state sequences) of the channels list are assumed to be paired. Sequences defined in terms of the expanded alphabet formed by the combination of the domain states are called MD sequences. Although the MD sequences (which can be obtained with seqMD) may be used for some computations, seqplotMD does not plot the MD sequences themselves, but the corresponding domain sequences.

For details on the types of plot, see seqplot.

The function organizes the plot area with either domains in rows, groups in columns, and domain legend on the right of each row, or conversely when dom.byrow=FALSE. Panel titles are defined as "group level: domain", and are preceded by main when a main value is provided.

The function takes the matching constraints into account as follows:

- For index plots ("i", "I"), sequences are displayed in same order for each domain. When a sortv vector is provided among the ... list, this same sort order is applied to all domains. If a sortv method is provided, the sorting is computed on the domain specified by the dom.crit argument. When there is a which.plot argument (for type="rf") in the ... list, it cannot be "both".

- Likewise, for relative frequency plots ("rf") the same order is retained for all domains. The sortv argument is handled as for "i" and "I", except for sortv="mds", in which case the sorting is done using the provided diss matrix.

- For frequency plots ("f"), sequences displayed correspond to the most frequent MD sequences.

- For plots of representative sequences ("r"), the representatives are computed for the provided diss matrix (generally the distances between the MD sequences) and their representation in each domain are displayed. Likewise, for type="rf", the medoids of the equally sized groups are computed using the required diss matrix.

- When type="mt", mean time plot, and there is a bar.labels argument among the ... list, bar.labels should be a list of vector or matrices of bar labels by domain.

No special handling other than the domain-group titles and the organization of the plot panels is applied to other types ("d","dH","Ht","ms","pc").

Author(s)

Gilbert Ritschard

References

Ritschard, G., T.F. Liao, and E. Struffolino (2023). Strategies for multidomain sequence analysis in social research. *Sociological Methodology*, 53(2), 288-322. doi:10.1177/00811750231163833.

See Also

seqplot, plot.stslist, seqstatd, plot.stslist.statd, seqtab, plot.stslist.freq, seqmodst, plot.stslist.modst, seqmeant, plot.stslist.meant, seqrep, plot.stslist.rep, seqrf, plot.seqrf, seqpcplot, seqMD.

Examples

```
data(biofam)

## Building one channel per type of event (left, children or married)
cases <- 200
bf <- as.matrix(biofam[1:cases, 10:25])
children <-  bf==4 | bf==5 | bf==6
married <- bf == 2 | bf== 3 | bf==6
left <- bf==1 | bf==3 | bf==5 | bf==6

## Building sequence objects
require(colorspace)
m.col <- sequential_hcl(2, palette = "PurpOr")
c.col <- sequential_hcl(2, palette = "Mint")
l.col <- sequential_hcl(2, palette = "OrYel")

child.seq <- seqdef(children, weights=biofam[1:cases,"wp00tbgs"], cpal=c.col)
marr.seq <- seqdef(married, weights=biofam[1:cases,"wp00tbgs"], cpal=m.col)
left.seq <- seqdef(left, weights=biofam[1:cases,"wp00tbgs"], cpal=l.col)
seqdom <- list(LeftHome=left.seq,Marr=marr.seq,Child=child.seq)


seqplotMD(seqdom, type="d", group=biofam[1:cases,"sex"], xaxis="bottom")

seqplotMD(seqdom, type="dH", group=biofam[1:cases,"sex"], dom.byrow=TRUE,
    xaxis="bottom", yaxis="left")

seqplotMD(seqdom, type="mt", group=biofam[1:cases,"sex"])

seqplotMD(seqdom, type="I", group=biofam[1:cases,"sex"],
    xaxis="bottom", sortv="from.end")

## sorting on first domain
seqplotMD(seqdom, type="I", group=biofam[1:cases,"sex"],
    xaxis="bottom", sortv="from.start", dom.crit=1)

seqplotMD(seqdom, type="f", group=biofam[1:cases,"sex"],
    xaxis="bottom", yaxis="left")

## distances betweem MD sequences
MDseq <- seqMD(seqdom, what="MDseq", ch.sep="+")
diss <- seqdist(MDseq, method="OM", sm="INDELSLOG")

seqplotMD(seqdom, type="rf", group=biofam[1:cases,"sex"],
    xaxis="bottom", sortv="from.end", dom.crit=0, diss=diss, k=10)

seqplotMD(seqdom, type="r", group=biofam[1:cases,"sex"],
    xaxis="bottom", dom.crit=0, diss=diss)
```

seqpm *Find substring patterns in sequences*

Description

Search for a pattern (substring) into sequences.

Usage

```
seqpm(seqdata, pattern, sep="")
```

Arguments

seqdata	a sequence object as defined by the seqdef function.
pattern	a character string representing the pattern (substring) to search for.
sep	state separator used in the pattern definition.

Details

This function searches a pattern (a character string) into a set of sequences and returns the results as a list with two elements: 'Nbmatch' the number of occurrences of the pattern and 'MatchesIndex' the vector of indexes (row numbers) of the sequences that match the pattern (see examples below).

Value

a list with two elements (see details).

Author(s)

Alexis Gabadinho

Examples

```
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## search for pattern "DAAD"
## (no work-full time work-full time work-no work)
## results are stored in the 'daad' object
daad <- seqpm(actcal.seq,"DAAD")

## Looking at the sequences
## containing the pattern
actcal.seq[daad$MIndex,]

## search for pattern "AD"
## (full time work-no work)
seqpm(actcal.seq,"AD")
```

seqprecarity *Degradation, Precarity, and Insecurity indexes*

Description

The degradation index returned by seqidegrad is a normalized transformation of the difference between the proportion of downward and upward state changes (transitions). The precarity and insecurity indexes are composite measures of complexity, degradation tendency, and undesirableness of the first state in the sequence.

Usage

```
seqidegrad(seqdata, state.order=alphabet(seqdata, with.missing), state.equiv=NULL,
    stprec=NULL, with.missing=FALSE,
    penalized="BOTH", method="RANK", weight.type="ADD",
    pow=1, border.effect=10)

seqprecarity(seqdata, correction=NULL,
    state.order=alphabet(seqdata, with.missing), state.equiv=NULL,
    stprec=NULL, with.missing=FALSE,
    otto=.2, a=1, b=1.2, method = "TRATEDSS",
    ...)

seqinsecurity(seqdata, correction=NULL,
    state.order=alphabet(seqdata, with.missing), state.equiv=NULL,
    stprec=NULL, with.missing=FALSE,
    pow = 1, spow=pow, bound=FALSE, method = "RANK",
    ...)

seqprecorr(...)
```

Arguments

seqdata	a state sequence object (class stslist) as returned by the seqdef function.
correction	Vector of non-negative correction factor values. If NULL (default), the correction factor is set as the degradation value returned by seqidegrad. See details.
state.order	Vector of short state labels defining the order of the states. First the less precarious (most positive) state and then the other states in increasing precariousness order. States of the alphabet that are not included here (and are not equivalent to one of the listed state) define the non-comparable states.
state.equiv	List of state equivalence classes. Each class in the list is given as the vector of the short labels of the states forming the class.
stprec	Vector of state undesirableness degrees. If NULL the values are derived from the state order using seqprecstart. If not NULL, the values in stprec should conform the order of the alphabet. Use negative values to indicate non-comparable states. See details.

with.missing	Logical. Should the missing state be considered as an element of the alphabet?
otto	Scalar in the range [0,1]. Trade-off weight between the precarity degree of the initial state and the corrected complexity. Default is otto=.2
a	Non-negative real value. Exponent weight of the complexity. Default is 1.
b	Non-negative real value. Exponent weight of the correction factor. Default is 1.2.
penalized	One of 'BOTH' (default), 'NEG', 'POS', or 'NO'. What should be penalized or rewarded? 'NEG' only negative transitions, POS only positive transitions (with negative penalization), 'BOTH' penalize negative transitions and reward positive ones, NO no penalization. Can also be logical with TRUE equivalent to 'BOTH' and FALSE equivalent to 'NO'.
method	One of 'FREQ', 'FREQ+', 'TRATE', 'TRATE+', 'TRATEDSS' (default for seqprecarity for backward compatibility), 'TRATEDSS+', 'RANK' (default for seqinsecurity and seqidegrad), 'RANK+', or 'ONE'. Method for determining transition weights. Weights based on transition probabilities: 'FREQ' overall frequency of the transitions, 'TRATE' transition probabilities, and 'TRATEDSS' transition probabilites in the DSS sequences. 'RANK' differences between state undesirableness degrees. 'ONE' no weight. With the + form the returned penalty is adjusted by the mean transition weight in the sequence.
weight.type	One of 'ADD' (default), 'INV', or 'LOGINV'. When method is one of 'FREQ', 'TRATE' or 'TRATEDSS', how weights are derived from the transition probabilities: 'ADD' additive (1-p), 'INV' inverse (1/p), and 'LOGINV' log of inverse. Ignored when any other method is selected.
pow	Real or logical. Recency weight exponent for potential to integrate the next spell. If real, transition weights are adjusted by the potential to integrate the next state using the pow value. pow=TRUE is equivalent to pow=1. (See details.)
spow	Real. Recency weight exponent for potential to integrate the first spell.
bound	Logical. Should the insecurity index be bounded by undesirableness degrees of best and worst states in the sequence?
border.effect	Real. Value (strictly greater than 1) used to adjust estimated transition probabilities to avoid border effect. Default is 10. See details.
...	Arguments passed to seqidegrad when correction=NULL

Details

The seqidegrad function returns for each sequence x the difference $q(x)$ between the proportions of downward and upward transitions (state changes).

The argument penalized allows to chose between three strategies for computing $q(x)$: only penalizing negative weights (in which case $q(x)$ is the proportion of negative transitions), only rewarding (with negative penalties) positive transitions, and applying both positive and negative penalties. The transitions can be weighted and the type of transition weights used is selected with the method argument. For weights based on transition probabilities, the way how theses probabilites are transformed into weights is controlled with weight.type. To avoid a border effect, when any computed transition probability p is close from 1 ($p > 1 - .1/d$), all p's are adjusted as $p - p/d$, where d

is the border.effect parameter. With method="RANK", the weights are set as the differences between the to and from state undesirableness. When pow is not FALSE, the weight of each transition is multiplied by the potential to integrate the next spell using the provided pow value.

The precarity and insecurity indexes of a sequence x are both based on the complexity index (*Gabadinho et al., 2010*) $c(x)$ (See the seqici function) and the undesirableness degree $\pi(x_1)$ of the starting state.

The precarity applies a multiplicative correction to the complexity. It is defined as

$$prec(x) = \lambda\pi(x_1) + (1-\lambda)(1+r(x))^{\beta}c(x)^{\alpha}$$

where $r(x)$ is the correction factor (argument correction) for the sequence. The λ parameter (argument otto) determines the trade-off between the importance of the undesirableness of the starting state and of the corrected complexity index. Parameters α and β (arguments a and b) are exponent weights of respectively the complexity and the correction factor.

The insecurity index applies an additive correction of the complexity:

$$insec(x) = \pi(x_1)integr(x, sp1) + r(x) + c(x)$$

where $integr(x, sp1)$ is the potential to integrate the first spell (proportion of sequence length covered by first spell when spow=0).

When correction = NULL (default), $r(x)$ is set as the degradation index $q(x)$ provided by seqidegrad. The degradation is computed with pow=FALSE for the precarity and using the provided pow value for the insecurity.

When stprec is a vector, negative values indicate non-comparable sates that receive each the mean positive undesirableness value. After this transformation, the vector is normalized such that the minimum is 0 and the maximum 1.

When equivalent classes are provided, the class mean undesirableness degree is assigned to each state of the class (see seqprecstart). For the count of transitions a same state value is assigned to all equivalent states.

Non-comparable states (those not listed on the state.order argument and not equivalent to a listed state) all receive the mean undesirableness value. For the count of transitions, transitions from and to non-comparable states are ignored and replaced by a transition between the states that immediately precede and follow a spell in non-comparable states.

When there are missing states in the sequences, set with.missing = TRUE to treat the missing state as an additional state. In that case the missing state will be considered as non-comparable unless you include the nr attribute of seqdata in state.order or state.equiv. With with.missing = FALSE, transitions to and from the missing state will just be ignored and the undesirableness value of the first valid state will be used as starting undesirableness.

The earlier seqprecorr function is obsolete, use seqidegrad with pow=FALSE and method='TRATEDSS' instead.

Value

For seqprecarity and seqinsecurity, an object of class seqprec with the value of the precarity or insecurity index for each sequence. The returned object has an attribute stprec that contains the

state precarity degree used at the starting position. The associated print method (`print.seqprec`) prints the state precarity values without the additional attribute.

For `seqidegrad` an object of class `seqidegrad` with the degradation index $q(x)$ and as additional attributes: `tr` the used transition weights; `signs` the transitions signs; `state.noncomp` the non-comparable states; and `state.order` the used state order. The associated print method (`print.seqidegrad`) prints the outcome values without the additional attributes.

Author(s)

Gilbert Ritschard

References

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

Ritschard, G., Bussi, M., and O'Reilly, J. (2018), "An index of precarity for measuring early employment insecurity", in G. Ritschard, and M. Studer, *Sequence Analysis and Related Approaches: Innovative Methods and Applications*, Series Life Course Research and Social Policies, Vol. 10, pp 279-295. Cham: Springer, doi:10.1007/9783319954202_16.

Gabadinho, A., Ritschard, G., Studer, M. and Müller, N.S. (2010), "Indice de complexité pour le tri et la comparaison de séquences catégorielles", In Extraction et gestion des connaissances (EGC 2010), *Revue des nouvelles technologies de l'information RNTI*. Vol. E-19, pp. 61-66.

See Also

`seqici`, `seqibad`, `seqprecstart`, `seqindic`.

Examples

```
## Defining a sequence object with columns 13 to 24
## in the 'actcal' example data set
data(actcal)
actcal <- actcal[1:20,] ## Here, only a subset
actcal.seq <- seqdef(actcal[,13:24], alphabet=c('A','B','C','D'))

## insecurity and precarity using the original state order
insec <- seqinsecurity(actcal.seq)
prec <- seqprecarity(actcal.seq)
ici <- seqici(actcal.seq) ## complexity

seqn <- seqformat(actcal.seq, to="SPS", compress=TRUE)
tab <- data.frame(seqn,ici,insec,prec)
names(tab) <- c("seq","ici","insec","prec")
tab

## Assuming A and B as equivalent regarding insecurity
insec2 <- seqinsecurity(actcal.seq, state.equiv=list(c('A','B')))
tab <- cbind(tab,insec2)
names(tab)[ncol(tab)] <- "insec2"
```

```
## and letting C be non-comparable
insec3 <- seqinsecurity(actcal.seq, state.order=c("A","B","D"),
  state.equiv=list(c('A','B')))
tab <- cbind(tab,insec3)
names(tab)[ncol(tab)] <- "insec3"

## bounding insecurity with undesirableness of best and worst state in sequence
insec4 <- seqinsecurity(actcal.seq, state.order=c("A","B","D"),
  state.equiv=list(c('A','B')), bound=TRUE)
tab <- cbind(tab,insec4)
names(tab)[ncol(tab)] <- "insec4"

## degrading index
degr <- seqidegrad(actcal.seq, state.order=c("A","B","D"),
                  state.equiv=list(c('A','B')))
tab <- cbind(tab,degr)
names(tab)[ncol(tab)] <- "degr"
tab

## Precarity with transition weights based on differences in state undesirableness
prec.rank <- seqprecarity(actcal.seq, method='RANK')

################
## Indexes in presence of missing values:
##  missing state treated as an additional state
data(ex1)
## by default right missings are dropped from the sequences
s.ex1 <- seqdef(ex1[,1:13])
state.order=c("A","B","C","D") ## missing left as non-comparable
seqprecarity(s.ex1, state.order=state.order, with.missing=TRUE)
seqinsecurity(s.ex1, state.order=state.order, with.missing=TRUE)

## same result using the correction argument
dgp <- seqidegrad(s.ex1, with.missing=TRUE, state.order=state.order, method='TRATEDSS')
seqprecarity(s.ex1, state.order=state.order, with.missing=TRUE, correction=dgp)

dg <- seqidegrad(s.ex1, with.missing=TRUE, state.order=state.order)
seqinsecurity(s.ex1, state.order=state.order, with.missing=TRUE, correction=dg)

## bounding insecurity with undesirableness of best and worst state in sequence
seqinsecurity(s.ex1, state.order=state.order, with.missing=TRUE, bound=TRUE)
```

`seqprecstart` *State precarity*

Description

Determines the state undesirableness degree from the state ordering or conversely the state undesirableness values from the state ordering. (See details.)

Usage

```
seqprecstart(seqdata,
    state.order=alphabet(seqdata, with.missing), state.equiv=NULL,
    stprec=NULL, with.missing=FALSE)
```

Arguments

seqdata	a state sequence object (class stslist) as returned by the seqdef function.
state.order	Vector of short state labels defining the order of the states. First the most desirable (most positive) state and then the other states in decreasing desirability order. States of the alphabet that are not included here define the non-comparable states.
state.equiv	List of state equivalence classes. The classes in the list are each set as the vector of the short labels of the states forming the class.
stprec	Vector of user defined state undesirableness degrees ordered conformably with the alphabet of seqdata. Use negative values to indicate non-comparable states.
with.missing	Logical. Should the missing state be considered as an element of the alphabet?

Details

When stprec is provided, the order is determined from the stprec values and overwrites state.order.

When stprec=NULL, the initial state undesirableness degrees are set as equivalently spaced values between 0 and 1 assigned to the states in specified order by state.order.

Equivalent states get the mean value of the states in the equivalence class.

Incomparable states (those not on the state.order list and not member of an equivalent class having a state listed in state.order) receive the average of all state undesirableness degrees.

When stprec is user defined, the provided vector is normalized into a vector with minimum 0 and maximum 1 and mean value of states in a class are assigned to all class members.

Only one state per class needs to be on the state order list. If more than one member is on the state order list they should be listed consecutively. Note that currently no check is performed.

When with.missing=TRUE, use the seqdata, "nr" argument to possibly include it in the state.order or state.equiv.

Value

The vector of assigned undesirableness degrees sorted according to the original order of states in the alphabet.

Author(s)

Gilbert Ritschard

References

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

Ritschard, G., Bussi, M., and O'Reilly, J. (2018), "An index of precarity for measuring early employment insecurity", in G. Ritschard, and M. Studer, *Sequence Analysis and Related Approaches: Innovative Methods and Applications*, Series Life Course Research and Social Policies, Vol. 10, pp 279-295. Cham: Springer.

See Also

seqprecarity.

Examples

```
## Defining a sequence object with columns 13 to 24
## in the 'actcal' example data set
data(actcal)
actcal <- actcal[1:200,] ## Here, only a subset
actcal.seq <- seqdef(actcal[,13:24])

## state precarity levels using the original state order
seqprecstart(actcal.seq)

## Assuming A and B as equivalent regarding precarity
seqprecstart(actcal.seq, state.equiv=list(c('A','B')))

## and letting C be non-comparable
seqprecstart(actcal.seq, state.order=c("A","B","D"), state.equiv=list(c('A','B')))
```

---

seqrecode *Recoding state sequence objects and factors*

Description

Utilities for recoding factors or state sequence objects created with seqdef.

Usage

```
seqrecode(seqdata, recodes, otherwise = NULL,
     labels = NULL, cpal = NULL)
recodef(x, recodes, otherwise=NULL, na=NULL)
```

Arguments

seqdata	The state sequence object to be recoded (created with seqdef).
recodes	A list specifying the recoding operations where each element is in the form newcode=oldcode or newcode=c(oldcode1, oldcode2,...). The rules are treated in the same order as they appear, hence subsequent rules may modify the first ones.
otherwise	NULL or Character. Level given to cases uncovered by the recodes list. If NULL, old states remain unchanged.
labels	optional state labels used for the color legend of TraMineR's graphics. If NULL (default), the state names in the alphabet are also used as state labels (see seqdef).
cpal	an optional color palette for representing the newly defined alphabet in graphics. If NULL (default), a color palette is created from the colors in seqdata by assigning to newcode the color of the first old state listed as oldcode and by leaving the colors of the other states unchanged.
x	A factor to be recoded.
na	Character vector. If not NULL, the list of states that should be recoded as NA (missing values).

Value

The recoded factor or state sequence object.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

seqdef to create a state sequence object.

Examples

```
## Recoding a state sequence object with seqrecode
data(actcal)
## Creating a state sequence object
actcal.seq <- seqdef(actcal,13:24, labels=c("> 37 hours", "19-36 hours",
   "1-18 hours", "no work"))
## Regrouping states B and C and setting the whole alphabet to A BC D
actcal.new <-seqrecode(actcal.seq,
    recodes = list("A"="A", "BC"=c("B", "C"), "D"="D"))
## Crosstabulate the first column of the recoded and
## original state sequence objects
table(actcal.new[,1], actcal.seq[,1])

## Same as before but using automatically original
## codes for unspecified states.
actcal.new2 <-seqrecode(actcal.seq,
recodes = list("BC"=c("B", "C")))
```

```
table(actcal.new2[,1], actcal.seq[,1])

## Same as before but using otherwise
actcal.new3 <-seqrecode(actcal.seq, recodes = list("A"="A", "D"="D"),
   otherwise="BC")
table(actcal.new3[,1], actcal.seq[,1])

## Recoding factors
## Recoding the marital status to oppose married to all other case
maritalstatus <- recodef(actcal$civsta00,
recodes=list("Married"="married"), otherwise="Single")
summary(maritalstatus)
table(maritalstatus, actcal$civsta00)

## Recoding the number of kids in the household
## -2 is a missing value
nbkids <- recodef(actcal$nbkid00,
   recodes=list("None"=0, "One"=1, "Two or more"=2:10), na=-2)
table(nbkids, actcal$nbkid00, useNA="always")
```

---

seqrep *Extracting sets of representative sequences*

Description

Returns either an as small as possible set of non redundant representatives covering (having in their neighborhood) a desired percentage of all sequences, or a given number of patterns with highest coverage. Special cases are single representatives such as the medoid or the sequence pattern with densest neighborhood. See `plot.stslist.rep` for the plot method and `seqplot` for other plot options.

Usage

```
seqrep(seqdata, criterion = "density", score = NULL, decreasing = TRUE,
  coverage = 0.25, nrep = NULL, pradius = 0.10, dmax = NULL, diss = NULL,
  weighted = TRUE, trep, tsim, dist.matrix, ...)
```

Arguments

`seqdata`	a state sequence object as defined by the `seqdef` function.
`criterion`	the representativeness criterion for sorting the candidate list. One of `"freq"` (sequence frequency), `"density"` (neighborhood density), `"mscore"` (mean state frequency), `"dist"` (centrality) and `"prob"` (sequence likelihood). See details.
`score`	an optional vector of representativeness scores for sorting the sequences in the candidate list. The length of the vector must be equal to the number of sequences in the sequence object.

decreasing	if a score vector is provided, indicates whether the objects in the candidate list must be sorted in ascending or descending order of this score. Default is TRUE, i.e. descending. The first object in the candidate list is then supposed to be the most representative.
coverage	coverage threshold, i.e., minimum proportion of sequences that should have a representative in their neighborhood (neighborhood radius is defined by pradius).
nrep	number of representative sequences. If NULL (default), the size of the representative set is controlled by coverage.
pradius	neighborhood radius as a percentage of the maximum (theoretical) distance dmax. Defaults to 0.1 (10%). Sequence y is redundant to sequence x when it is in the neighborhood of x, i.e., within a distance pradius*dmax from x.
dmax	maximum theoretical distance. The dmax value is used to derive the neighborhood radius as pradius*dmax. If NULL, the value of dmax is derived from the dissimilarity matrix.
diss	matrix of pairwise dissimilarities between sequences in seqdata. If NULL, the matrix is computed by calling the seqdist function. In that case, optional arguments to be passed to the seqdist function (see ... hereafter) should also be provided.
weighted	logical: Should weights assigned to the state sequence object be accounted for? (See seqdef.) Set as FALSE to ignore the weights.
trep	Deprecated. Use coverage instead.
tsim	Deprecated. Use pradius instead.
dist.matrix	Deprecated. Use diss instead.
...	optional arguments to be passed to the seqdist function, mainly dist.method specifying the metric for computing the distance matrix, norm for normalizing the distances, indel and sm for indel and substitution costs when Optimal Matching metric is chosen. See seqdist manual page for details.

Details

The representative set is obtained by an heuristic. Representatives are selected by successively extracting from the sequences sorted by their representativeness score those which are not redundant with already retained representatives. The selection stops when either the desired coverage or the wanted number of representatives is reached. Sequences are sorted either by the values provided as score argument or by specifying one of the following as criterion argument: "freq" (*sequence frequency*), "density" (*neighborhood density*), "mscore" (*mean state frequency*), "dist" (*centrality*), and "prob" (*sequence likelihood*).

With the *sequence frequency* criterion, the more frequent a sequence the more representative it is supposed to be. Therefore, sequences are sorted in decreasing frequency order.

The *neighborhood density* is the number—density—of sequences in the neighborhood of the sequence. This requires to set the neighborhood radius pradius. Sequences are sorted in decreasing density order.

The *mean state frequency* criterion is the mean value of the transversal frequencies of the successive states. Let $s = s_1 s_2 \cdots s_\ell$ be a sequence of length ℓ and $(f_{s_1}, f_{s_2}, \ldots, f_{s_\ell})$ the frequencies of the

states at (time-)position $(t_1, t_2, \ldots t_\ell)$. The mean state frequency is the sum of the state frequencies divided by the sequence length

$$MSF(s) = \frac{1}{\ell} \sum_{i=1}^{\ell} f_{s_i}$$

The lower and upper boundaries of MSF are 0 and 1. MSF is equal to 1 when all the sequences in the set are identical, i.e. when there is a single sequence pattern. The most representative sequence is the one with the highest score.

The *centrality* criterion is the sum of distances to all other sequences. The smallest the sum, the most representative is the sequence.

The *sequence likelihood* $P(s)$ is defined as the product of the probability with which each of its observed successive state is supposed to occur at its position. Let $s = s_1 s_2 \cdots s_\ell$ be a sequence of length ℓ. Then

$$P(s) = P(s_1, 1) \cdot P(s_2, 2) \cdots P(s_\ell, \ell)$$

with $P(s_t, t)$ the probability to observe state s_t at position t.
The question is how to determinate the state probabilities $P(s_t, t)$. One commonly used method for computing them is to postulate a Markov Chain model, which can be of various order. The implemented criterion considers the probabilities derived from the first order Markov model, that is each $P(s_t, t)$, $t > 1$ is set to the transition rate $p(s_t|s_{t-1})$ estimated across sequences from the observations at positions t and $t - 1$. For $t = 1$, we set $P(s_1, 1)$ to the observed frequency of the state s_1 at position 1.

The likelihood $P(s)$ being generally very small, we use $-\log P(s)$ as sorting criterion. The latter quantity reaches its minimum for $P(s)$ equal to 1, which leads to sort the sequences in ascending order of their score.

Use `criterion="dist"` (centrality) and `nrep=1` to get the medoid, and `criterion="density"` and `nrep=1` to get the densest sequence pattern.

For more details, see *Gabadinho & Ritschard, 2013.*

Value

An object of class `stslist.rep`. This is actually a state sequence object (containing a list of state sequences) with the following additional attributes:

`Scores`	a vector with the representative score of each sequence in the original set given the chosen criterion.
`Distances`	a matrix with the distance of each sequence to its nearest representative.
`Rep.group`	vector with, for each sequence, the representative that represents it.
`idx.rep`	list with indexes of occurrences of each representative in original data.
`Statistics`	a data frame with quality measures for each representative sequence: number na of sequences attributed to the representative, number nb of sequences in the representative's neighborhood, mean distance MD to the representative and a few other indexes.
`Quality`	overall quality measure.

Print, plot and summary methods are available. More elaborated plots are produced by the `seqplot` function using the `type="r"` argument, or the `seqrplot` alias.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

References

Gabadinho A, Ritschard G (2013). "Searching for typical life trajectories applied to child birth histories", In R Lévy, E. Widmer (eds.), *Gendered Life Courses*, pp. 287-312. Vienna: LIT.

Gabadinho A, Ritschard G, Studer M, Müller NS (2011). "Extracting and Rendering Representative Sequences", In A Fred, JLG Dietz, K Liu, J Filipe (eds.), *Knowledge Discovery, Knowledge Engineering and Knowledge Management*, volume 128 of *Communications in Computer and Information Science (CCIS)*, pp. 94-106. Springer-Verlag.

See Also

seqplot, plot.stslist.rep, dissrep, disscenter

Examples

```
## Defining a sequence object with the data in columns 10 to 25
## (family status from age 15 to 30) in the biofam data set
data(biofam)
biofam.lab <- c("Parent", "Left", "Married", "Left+Marr",
"Child", "Left+Child", "Left+Marr+Child", "Divorced")
biofam.seq <- seqdef(biofam[,10:25], labels=biofam.lab)

## Computing the distance matrix
costs <- seqsubm(biofam.seq, method="TRATE")
biofam.om <- seqdist(biofam.seq, method="OM", sm=costs)

## Representative set using the neighborhood density criterion
biofam.rep <- seqrep(biofam.seq, diss=biofam.om, criterion="density")
biofam.rep
summary(biofam.rep)
plot(biofam.rep)

## plot by groups represented by the representatives
seqdplot(biofam.seq, group=attr(biofam.rep,"Rep.group"), border=NA)

## indexes of sequences represented by 1st representative
r1.grp <- which(attr(biofam.rep,"Rep.group")==1)
## indexes of occurrences of the first representative sequence
attr(biofam.rep,"idx.rep")[[1]]
```

---

seqsep *Adds separators to sequences stored as character string*

Description

Adds separators to sequences stored as character string.

Usage

```
seqsep(seqdata, sl=1, sep="-")
```

Arguments

seqdata	a dataframe or matrix containing sequence data, as vectors of states or events.
sl	the length of the states (the number of characters used to represent them). Default is 1.
sep	the character used as separator. Set by default as "-".

See Also

seqdecomp.

Examples

```
seqsep("ABAAAAAAD")
```

---

seqST *Sequences turbulence*

Description

Elzinga's turbulence for each sequence in a sequence data set.

Usage

```
seqST(seqdata, norm=FALSE, silent=TRUE, with.missing=FALSE, type=1)
```

Arguments

seqdata	a state sequence object as returned by the the seqdef function.
norm	logical: should the turbulence index be normalized?
silent	logical: should messages about running operations (extracting dss and durations, computing turbulence) be displayed?
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.
type	either 1 or 2. Type of duration variance. The default type=1 ignores non visited states. Type 2 takes into account the 0-time spent in non-visited states (see seqivardur).

Details

Sequence turbulence is a measure proposed by *Elzinga & Liefbroer (2007)*. It is based on the number $\phi(x)$ of distinct subsequences that can be extracted from the distinct successive state (DSS) sequence and the variance of the consecutive times t_i spent in the distinct states. For a sequence x, the formula is

$$T(x) = \log_2(\phi(x)\,\frac{s^2_{t,max}(x)+1}{s^2_t(x)+1})$$

where $s^2_t(x)$ is the variance of the successive state durations in sequence x and $s^2_{t,max}(x)$ is the maximum value that this variance can take given the number of spells and the total duration of the sequence. For `type=1`, this maximum is computed as

$$s^2_{t,max} = (d-1)(1-\bar{t})^2$$

where $\bar{t}$ is the mean consecutive time spent in the distinct states, i.e. the sequence duration t divided by the number d of distinct states in the sequence. For `type=2`, the variance takes into account the 0-time spent in non-visited states and the maximum is adjusted for the maximum number of non-visited states for the number of spells (see *Ritschard, 2021*).

When `with.missing=TRUE`, the function searches for missing states in the sequences and if found, adds the missing state to the alphabet for the computation of the turbulence. In this case the `seqdss` and `seqdur` functions for extracting the distinct successive state sequences and the associated durations are called with the `{with.missing=TRUE}` argument. Thus, a missing state in a sequence is considered as the occurrence of an additional symbol of the alphabet and two or more consecutive missing states are considered as two or more occurrences of this additional state. E.g. the DSS of `A-A-*-*-*-B-B-C-C-D` is `A-*-B-C-D` and the associated durations are `2-3-2-2-1`.

The normalized value is obtained by subtracting 1 to the index and then dividing by the resulting value for a sequence made by the successive repetition of the alphabet up to the maximal length in `seqdata` (*Ritschard, 2021)*).

Value

a sinlge-column matrix of length equal to the number of sequences in `seqdata` containing the turbulence value of each sequence. Normalized values are returned when `norm=TRUE`.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

References

Elzinga, Cees H. and Liefbroer, Aart C. (2007). De-standardization of Family-Life Trajectories of Young Adults: A Cross-National Comparison Using Sequence Analysis. *European Journal of Population*, 23, 225-250.

Ritschard, G. (2023), "Measuring the nature of individual sequences", *Sociological Methods and Research*, 52(4), 2016-2049. doi:10.1177/00491241211036156.

See Also

seqdss, seqdur, seqsubsn. For alternative measures of sequence complexity see seqivolatility, seqici, seqindic.

Examples

```
## Loading the 'actcal' example data set
data(actcal)
## Here we consider only the first 10 sequences
actcal <- actcal[1:10,]

## Defining a sequence object with data in columns 13 to 24
## (activity status from January to December 2000)
actcal.seq <- seqdef(actcal[,13:24], informat='STS')

## Computing the sequences turbulence
turb <- seqST(actcal.seq)

## Normalized turbulence
turb.norm <- seqST(actcal.seq, norm=TRUE)

## Normalized turbulence taking non-visited states into account.
turb2.norm <- seqST(actcal.seq, norm=TRUE, type=2)
```

---

seqstatd *Sequence of transversal state distributions and their entropies*

Description

Returns the state relative frequencies, the number of valid states and the entropy of the state distribution at each position in the sequence.

Usage

```
seqstatd(seqdata, weighted=TRUE, with.missing=FALSE, norm=TRUE)
```

Arguments

seqdata	a state sequence object as defined by the seqdef function.
weighted	if TRUE, distributions account for the weights assigned to the state sequence object (see seqdef). Set as FALSE if you want ignore the weights.
with.missing	If FALSE (default value), returned distributions ignore missing values.
norm	if TRUE (default value), entropy is normalized, ie divided by the entropy of the alphabet. Set as FALSE if you want the entropy without normalization.

Details

In addition to the state distribution at each position in the sequence, the `seqstatd` function provides also for each time point the number of valid states and the Shannon entropy of the observed cross-sectional state distribution. Letting p_i denote the proportion of cases in state i at the considered position, the entropy is

$$h(p_1, \ldots, p_s) = -\sum_{i=1}^{s} p_i \log(p_i)$$

where s is the size of the alphabet. The log is here the natural (base e) logarithm. The entropy is 0 when all cases are in the same state and is maximal when the same proportion of cases are in each state. The entropy is a measure of the diversity of states observed at the considered position. First studies using sequence of cross-sectional entropies (but with aggregated transversal data) are *Billari (2001)* and *Fussell (2005)*.

Value

A list with three elements: `Frequencies` (relative frequencies), `ValidStates` (number of valid states at each position), and `Entropy` (cross-sectional entropy at each position).

The returned list has attributes `nbseq` (number of sequences), `cpal`, `xtlab`, `xtstep`, `tick.last`, `weighted`, and `norm`.

Author(s)

Alexis Gabadinho and Gilbert Ritschard

References

Ritschard, G. (2021), "Measuring the nature of individual sequences", *Sociological Methods and Research*, doi:10.1177/00491241211036156.

Billari, F. C. (2001). The analysis of early life courses: complex descriptions of the transition to adulthood. *Journal of Population Research* 18 (2), 119-24.

Fussell, E. (2005). Measuring the early adult life course in Mexico: An application of the entropy index. In R. Macmillan (Ed.), *The Structure of the Life Course: Standardized? Individualized? Differentiated?*, Advances in Life Course Research, Vol. 9, pp. 91-122. Amsterdam: Elsevier.

See Also

`plot.stslist.statd` the plot method for objects of class `stslist.statd`,
`seqdplot` for higher level chronograms (state distribution plots)),
`seqHtplot` for transversal entropy line over sequence positions, and
`seqdHplot` for chronograms with overlayed entropy line.

Examples

```
data(biofam)
biofam.seq <- seqdef(biofam,10:25)
sd <- seqstatd(biofam.seq)
## Plotting the state distribution
plot(sd, type="d")
```

```
## Line of cross-sectional entropies
plot(sd, type="Ht")

## ====================
## example with weights
## ====================
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

## Unweighted
seqstatd(ex1.seq, weighted=FALSE)

seqstatd(ex1.seq, weighted=TRUE)
```

`seqstatf` *State frequencies in the whole sequence data set*

Description

Overall frequency of each state of the alphabet in the state sequence object.

Usage

```
seqstatf(seqdata, weighted = TRUE, with.missing=FALSE)
```

Arguments

`seqdata`	a sequence object as defined by the `seqdef` function.
`weighted`	Logical. Should frequencies account for weights when present in the state sequence object (see `seqdef`). Default is `TRUE`.
`with.missing`	Logical. Should non void missing states be treated as regular values? Default is `FALSE`.

Details

The `seqstatf` function computes the (weighted) count and frequency of each state of the alphabet in `seqdata`, i.e., the (weighted) sum of the occurrences of a state in `seqdata`.

Value

A data frame with as many rows as states in the alphabet and two columns, one for the count (Freq) and one for the percentage frequencies (Percent).

Author(s)

Alexis Gabadinho

See Also

seqstatd for the state distribution by time point (position), seqistatd for the state distribution within each sequence.

Examples

```
## Creating a sequence object from the actcal data set
data(actcal)
actcal.lab <- c("> 37 hours", "19-36 hours", "1-18 hours", "no work")
actcal.seq <- seqdef(actcal, 13:24, labels=actcal.lab)

## States frequencies
seqstatf(actcal.seq)

## Example with weights
data(ex1)
ex1.seq <- seqdef(ex1, 1:13, weights=ex1$weights)

## Unweighted
seqstatf(ex1.seq, weighted=FALSE)

## Weighted
seqstatf(ex1.seq, weighted=TRUE)
```

---

seqstatl *List of distinct states or events (alphabet) in a sequence data set.*

Description

Returns a list containing distinct states or events found in a data frame or matrix containing sequence data, the alphabet.

Usage

```
seqstatl(data, var=NULL, format='STS')
```

Arguments

data	a data frame, matrix, or character string vector containing sequence data (tibble will be converted with as.data.frame).
var	the list of columns containing the sequences. Default NULL means all columns. Whether the sequences are in the compressed (character strings) or extended format is automatically detected from the number of columns.
format	the format of the sequence data set. One of "STS", "SPS", "DSS". Default is "STS". The seqstatl function uses the seqformat function to translate between formats when necessary.

Author(s)

Alexis Gabadinho

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

Gabadinho, A., G. Ritschard, M. Studer and N. S. Müller (2009). Mining Sequence Data in R with the TraMineR package: A user's guide. Department of Econometrics and Laboratory of Demography, University of Geneva.

See Also

seqformat

Examples

```
data(actcal)
seqstatl(actcal,13:24)
```

---

seqsubsn *Number of distinct subsequences in a sequence.*

Description

Computes the number of distinct subsequences in a sequence using Elzinga's algorithm.

Usage

```
seqsubsn(seqdata, DSS=TRUE, with.missing=FALSE)
```

Arguments

seqdata	a state sequence object as defined by the seqdef function.
DSS	if TRUE, the sequences of Distinct Successive States (DSS, see seqdss) are first extracted (e.g., the DSS contained in 'D-D-D-D-A-A-A-A-A-A-D' is 'D-A-D'), and the number of distinct subsequences in the DSS is computed. If FALSE, the number of distinct subsequences is computed from sequences as they appear in the input sequence object. Hence the number of distinct subsequences is in most cases much higher with the DSS=FALSE option.
with.missing	logical: should non-void missing values be treated as a regular state? If FALSE (default) missing values are ignored.

Details

The function first searches for missing states in the sequences and if found, adds the missing state to the alphabet for the extraction of the distinct subsequences. A missing state in a sequence is considered as the occurrence of an additional symbol of the alphabet, and two or more consecutive missing states are considered as two or more occurrences of the same state. The `with.missing=TRUE` argument is used for calling the `seqdss` function when `DSS=TRUE`.

Value

Vector with the number of distinct subsequences for each sequence in the input state sequence object.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for the help page)

See Also

`seqdss`.

Examples

```
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## Number of subsequences with DSS=TRUE
seqsubsn(actcal.seq[1:10,])

## Number of subsequences with DSS=FALSE
seqsubsn(actcal.seq[1:10,],DSS=FALSE)
```

---

seqtab *Frequency table of the sequences*

Description

Computes the frequency table of the sequences (count and percent of each sequence).

Usage

```
seqtab(seqdata, idxs = 1:10, weighted = TRUE, format = "SPS", tlim)
```

Arguments

seqdata	a sequence object as defined by the seqdef function.
idxs	returns the table for the sequences at ranks 'idxs' in the list of distinct sequences sorted in decreasing order of their frequencies. Default is 1:10, i.e. the 10 most frequent sequences. Can be any subset, like 5:10 (fifth to tenth most frequent sequences) or c(2,10) (second and tenth most frequent sequences). Set idxs=0 to get the table for the whole set of distinct sequences.
weighted	if TRUE (default), frequencies account for the weights, if any, assigned to the state sequence object (see seqdef). Set to FALSE for ignoring weights.
format	format used for displaying the rownames (the sequences) in the output table. Default is SPS format, which yields shorter and more readable sequence representations. Alternatively, "STS" may be specified.
tlim	Deprecated. Use idxs instead.

Details

The weighted argument has no effect when no weights were assigned to the state sequence object since weights default in that case to 1.

Value

An object of class stslist.freq. This is actually a state sequence object (containing a list of state sequences) with added attributes, among others the freq attribute containing the frequency table. There are print and plot methods for such objects. More sophisticated plots can be produced with the seqplot function.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for the help page)

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

See Also

seqplot, plot.stslist.freq.

Examples

```
## Creating a sequence object from the actcal data set
data(actcal)
actcal.lab <- c("> 37 hours", "19-36 hours", "1-18 hours", "no work")
actcal.seq <- seqdef(actcal, 13:24, labels=actcal.lab)

## 10 most frequent sequences in the data
seqtab(actcal.seq)
```

```
## With idxs=0, we get all distinct sequences in the data set
## sorted in decreasing order of their frequency
stab <- seqtab(actcal.seq, idxs=0)
head(stab)
tail(stab)

## Example with weights
## from biofam data set using weigths
data(ex1)
ex1.seq <-  seqdef(ex1, 1:13, weights=ex1$weights)

## Unweighted frequencies
seqtab(ex1.seq, weighted=FALSE)

## Weighted frequencies
seqtab(ex1.seq, weighted=TRUE)
```

`seqtransn` *Number of transitions in a sequence*

Description

Computes the number of transitions (state changes) in each sequence of a sequence object.

Usage

```
seqtransn(seqdata, with.missing=FALSE, norm=FALSE, pweight=FALSE)
```

Arguments

`seqdata`	a state sequence object as defined by the `seqdef` function.
`with.missing`	logical: should non-void missing values be treated as a regular state? If `FALSE` (default) missing values are ignored.
`norm`	logical. If set as `TRUE`, the number of transitions is divided by its theoretical maximum, length of the sequence minus 1. When the length of the sequence is 1, the normalized value is set as 0.
`pweight`	logical. EXPERIMENTAL! If set as `TRUE`, return count of transitions weighted by their probability to not occur to give higher weights to rare transitions.

Details

A transition in a sequence is a state change between time/position t and $t + 1$. For example, the sequence `"A-A-A-A-B-B-A-D-D-D"` contains 3 transitions. The maximum number of transitions a sequence can contain is $\ell - 1$ where ℓ is the length of the sequence. The number of transitions is obtained by subtracting 1 to the length of the sequence of distinct successive states (DSS).

Value

a one column matrix with the number of transitions in each sequence.

Author(s)

Alexis Gabadinho (with Gilbert Ritschard for the help page)

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

See Also

seqdss.

Examples

```
## Creating a sequence object from columns 13 to 24
## in the 'actcal' example data set
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## Computing the number of transitions
actcal.trans <- seqtransn(actcal.seq)

## Displaying number of transitions in the first 10 sequences
actcal.trans[1:10]

## Example with with.missing argument
data(ex1)
ex1.seq <- seqdef(ex1, 1:13)

seqtransn(ex1.seq)
seqtransn(ex1.seq, with.missing=TRUE)
```

---

seqtrate *Compute transition rates between states*

Description

Returns a matrix with transition rates between states, computed from a set of sequences.

Usage

```
seqtrate(seqdata, sel.states = NULL, time.varying = FALSE, weighted = TRUE,
  lag = 1, with.missing = FALSE, count = FALSE, statl)
```

Arguments

seqdata	a sequence object as defined by the seqdef function.
sel.states	a list of states or events for which the transition rates will be computed. If omitted (default), transition rates are computed between the distinct states in seqdata (obtained with the alphabet function).
time.varying	Logical. If TRUE, return an array containing a distinct matrix for each time unit. The time is the third dimension (subscript).
weighted	Logical. If TRUE, compute transition rates using weights specified in seqdata.
lag	Integer. Time between the two states considered to compute transition rates (one by default).
with.missing	Logical. If FALSE (default value), returned transition rates ignore missing values.
count	Logical. Should counts of transition be returned instead of transition probabilities. Default is FALSE.
statl	Deprecated. Use sel.states instead.

Details

Transition rates are the probabilities of transition from one state to another observed in the sequence data. Substitution costs based on transition rates can be used when computing distances between sequences with the optimal matching method (see seqdist).

Value

a matrix of dimension $ns * ns$, where ns is the number of states in the alphabet of the sequence object.

Author(s)

Matthias Studer, Alexis Gabadinho, and Gilbert Ritschard

References

Gabadinho, A., G. Ritschard, N. S. Müller and M. Studer (2011). Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* **40**(4), 1-37.

See Also

seqdist seqsubm alphabet.

Examples

```
## Loading the 'actcal' example data set
data(actcal)

## Defining a sequence object with data in columns 13 to 24
## (activity status from January to December 2000)
actcal.seq <- seqdef(actcal[,13:24])
```

```
  ## Computing transition rates
  seqtrate(actcal.seq)

  ## Computing transition rates between states "A" and "B" only
  seqtrate(actcal.seq, c("A","B"))

## ====================
## Example with weights
## ====================
data(ex1)
ex1.seq <- seqdef(ex1[,1:13], weights=ex1$weights)

seqtrate(ex1.seq, weighted=FALSE)
seqtrate(ex1.seq, weighted=FALSE, count=TRUE)

## weights are accounted for by default
seqtrate(ex1.seq)
seqtrate(ex1.seq, count=TRUE)
```

`seqtree` *Tree structured analysis of a state sequence object.*

Description

Facility for growing a regression tree for a state sequence object.

Usage

```
seqtree(formula, data = NULL, weighted = TRUE, min.size = 0.05,
  max.depth = 5, R = 1000, pval = 0.01, weight.permutation = "replicate",
  seqdist.args = list(method = "LCS", norm = "auto"), diss = NULL,
  squared = FALSE, first = NULL, minSize, maxdepth, seqdist_arg)
```

Arguments

`formula`	a formula where the left hand side is a state sequence object (see `seqdef`) and the right hand specifies the candidate variables for partitioning the set of sequences.
`weighted`	Logical. If `TRUE`, use the weights of the state sequence object.
`data`	a data frame where variables in the formula will be searched
`min.size`	minimum number of cases in a node, in percentage if less than 1.
`max.depth`	maximum depth of the tree.
`R`	Number of permutations used to assess the significance of the split.
`pval`	Maximum p-value, in percent.

`weight.permutation`
: Weights permutation method: "diss" (attach weights to the dissimilarity matrix), "replicate" (replicate case according to the `weights` arguments), "rounded-replicate" (replicate case according to the rounded `weights` arguments), "random-sampling" (random assignment of covariate profiles to the objects using distributions defined by the weights.)

`seqdist.args`
: list of arguments directly passed to `seqdist`, only used if `diss=NULL`

`diss`
: An optional dissimilarity matrix. If not provided, a dissimilarity matrix is computed using `seqdist` and `seqdist.args`

`squared`
: Logical. If `TRUE`, the dissimilarity matrix is squared

`first`
: Character. An optional variable name to force the first split.

`minSize`
: Deprecated. Use `min.size` instead.

`maxdepth`
: Deprecated. Use `max.depth` instead.

`seqdist_arg`
: Deprecated. Use `seqdist.args` instead.

Details

The function provides a simplified interface for applying `disstree` on state sequence objects.

The `seqtree` objects can be "plotted" with `seqtreedisplay`. A print method is also available which prints the medoid sequence for each terminal node.

Value

A `seqtree` object with same attributes as `disstree` objects.

The leaf membership is in the first column of the fitted attribute. For example, the leaf memberships for a tree `dt` are in `dt$fitted[,1]`.

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

References

Studer, M., G. Ritschard, A. Gabadinho and N. S. Müller (2011). Discrepancy analysis of state sequences, *Sociological Methods and Research*, Vol. 40(3), 471-510, doi:10.1177/0049124111415372.

See Also

`seqtreedisplay`, `disstree`

Examples

```
data(mvad)

## Defining a state sequence object
mvad.seq <- seqdef(mvad[, 17:86])

## Growing a seqtree from Hamming distances:
```

```
##   Warning: The R=10 used here to save computation time is
##   much too small and will generate strongly unstable results.
##   We recommend to set R at least as R=1000.
##   To comply with this small R value, we set pval = 0.1.
seqt <- seqtree(mvad.seq~ male + Grammar + funemp + gcse5eq + fmpr + livboth,
    data=mvad, R=10, pval=0.1, seqdist.arg=list(method="HAM", norm="auto"))
print(seqt)

## Growing a seqtree from an existing distance matrix
mvad.dhd <- seqdist(mvad.seq, method="DHD")
seqt <- seqtree(mvad.seq~ male + Grammar + funemp + gcse5eq + fmpr + livboth,
    data=mvad, R=10, pval=0.1, diss=mvad.dhd)
print(seqt)


### Following commands only work if GraphViz is properly installed
## Not run:
seqtreedisplay(seqt, type="d", border=NA)
seqtreedisplay(seqt, type="I", sortv=cmdscale(mvad.dhd, k=1))

## End(Not run)
```

`seqtreedisplay` *Graphical rendering of a sequence regression tree*

Description

Generate a graphical representation of a regression tree of state sequence data.

Usage

```
seqtreedisplay(tree, filename = NULL, seqdata = tree$info$object,
  only.leaf = FALSE, sortv = NULL, diss = NULL, cex.main = 3,
  with.legend = "auto", cex.legend = cex.main, xaxis = FALSE,
  image.format = "png", with.quality = TRUE, cex.quality = cex.main,
  legend.text = NULL, show.tree = TRUE, show.depth = FALSE,
  imgLeafOnly, dist.matrix, title.cex, withlegend, legend.fontsize,
  imageformat, withquality, quality.fontsize, legendtext, showtree,
  showdepth, axes, ...)

disstreedisplay(tree, filename = NULL, image.data= NULL, image.fun = plot,
  only.leaf = FALSE, cex.main = 3, image.format = "png",
  with.quality = TRUE, cex.quality = cex.main,
  legend.text = NULL, show.tree = TRUE, show.depth = FALSE,
  imagedata, imagefunc, imgLeafOnly, title.cex, imageformat,
  withquality, quality.fontsize, legendtext, showtree, showdepth, ...)
```

Arguments

tree	A seqtree object (as produced by seqtree) for seqtreedisplay. A disstree object (as produced by disstree) for disstreedisplay.
filename	The name of a file where to save the plot (overwritting existing file). If NULL, a temporary file is created.
seqdata	The sequence object containing the state sequences plotted in the nodes.
only.leaf	Logical. If TRUE sequences are plotted only in terminal nodes.
sortv	Argument passed to seqplot
diss	Argument passed to seqplot
cex.main	Node title magnification. See par.
with.legend	Logical. Should the color legend be displayed on the plot?
cex.legend	Legend magnification. See par. If not specified, use the value of cex.main.
xaxis	Logical. Should the x-axis be displayed on the plots? (argument passed to seqplot)
image.format	Image format of the output file (filename)
with.quality	If TRUE, a node displaying fitting measures of the tree is added to the plot.
cex.quality	Fitting measure text magnification. See par. If not specified, use the value of cex.main.
legend.text	Character. Optional text information that should be added.
show.tree	Logical. Should the tree be shown on the screen?
show.depth	Logical. If TRUE, the splits are ordered according to their global pseudo-R2.
image.fun	A function to plot the individuals in a node, see details.
image.data	a data.frame that will be passed to image.fun.
imgLeafOnly	Deprecated. Use only.leaf instead.
dist.matrix	Deprecated. Use diss instead.
title.cex	Deprecated. Use cex.main instead.
withlegend	Deprecated. Use with.legend instead.
legend.fontsize	Deprecated. Use cex.legend instead.
imageformat	Deprecated. Use image.format instead.
withquality	Deprecated. Use with.quality instead.
quality.fontsize	Deprecated. Use cex.quality instead.
legendtext	Deprecated. Use legend.text instead.
showtree	Deprecated. Use show.tree instead.
showdepth	Deprecated. Use show.depth instead.
imagedata	Deprecated. Use image.data instead.
imagefunc	Deprecated. Use image.fun instead.
axes	Deprecated. Use xaxis instead.
...	additional arguments passed to seqplot

Details

This function generates a tree image. For each node, it invokes `seqplot` for the selected lines of `seqdata` as argument. You should at least specify the `type` of the plot to use (`type="d"` for instance, see `seqplot` for more details).

The plot is actually not generated as an R plot, but with GraphViz (www.graphviz.org). Hence, `seqtreedisplay` only works when GraphViz is correctly installed. If the path to GraphViz is not found, pass the path as a `gvpath` argument among the ... list.

Conversion to image formats other than "jpeg" or "png" is done using ImageMagick (www.imagemagick.org). To use this feature, ImageMagick (www.imagemagick.org) should hence also be installed.

Value

None

Author(s)

Matthias Studer (with Gilbert Ritschard for the help page)

See Also

See `seqtree` and `disstree` for examples, and `disstree2dot` for generating "dot" files.

---

stlab *Get or set the state labels of a sequence object*

Description

This function gets or sets the state labels of a sequence object, that is, the long labels used when displaying the state legend in plotting functions.

Usage

```
stlab(seqdata)
stlab(seqdata) <- value
```

Arguments

`seqdata`	a state sequence object as defined by the `seqdef` function.
`value`	a vector of character strings containing the labels, of length equal to the number of states in the alphabet. Each string is attributed to the corresponding state in the alphabet, the order being the one returned by the `alphabet`.

Details

The state legend is plotted either automatically by the plot functions provided for visualizing sequence objects or with the seqlegend function. A long label is associated to each state of the alphabet and displayed in the legend. The state labels are defined when creating the sequence object, either automatically using the values found in the data or by specifying a user defined vector of labels. The stlab function can be used to get or set the state labels of a previously defined sequence object.

Value

For 'stlab' a vector containing the labels.

For 'stlab<-' the updated sequence object.

See Also

seqdef

Examples

```
## Creating a sequence object with the columns 13 to 24
## in the 'actcal' example data set
## The color palette is automatically set
data(actcal)
actcal.seq <- seqdef(actcal,13:24)

## Retrieving the color palette
stlab(actcal.seq)
seqiplot(actcal.seq)

## Changing the state labels
stlab(actcal.seq) <- c("Full time","Part time (19-36 hours)",
    "Part time (1-18 hours)", "No work")
seqiplot(actcal.seq)
```

TraMineR.check.depr.args

Checking and managing deprecated arguments

Description

Checks the presence of deprecated arguments, assigns value of a deprecated argument to the corresponding new argument name, and issues warning messages.

Usage

```
TraMineR.check.depr.args(arg.pairs)
```

Arguments

arg.pairs	List of pairs of old and new argument names (e.g. alist(newname1 = oldname1, newname2 = oldname2))

Details

To be used inside functions. For developers only.

For each specified pair of new and old argument names, the function checks if the old argument name is specified. If so and the new one is not, a warning message is raised and the argument value is assigned to the new argument name. If one of the names declared in check.depr.args() arguments si not an argument of the parent function or if both the new and old argument names are specified an error is raised.

The function does not detect when the new and the old argument names are specified together and the new argument value is its default value. In this case, the value associated with the old argument name is assigned to the new name and a warning message is raised.

The function works whether the argument names are explicitly declared or not in the call to the checked function.

The only requirement for the function to work is that the deprecated arguments should be listed WITHOUT default values in the definition of the checked function.

Value

None.

Author(s)

Pierre-Alexandre Fonta, Gilbert Ritschard

TraMineRInternal *Access to TraMineR internal functions*

Description

Functions allowing other packages to access some TraMineR internal functions. Corresponding functions are respectively TraMineR.setlayout, TraMineR.Legend, DTNInit, seqeage, seqgbar, DTNsplit, and tmrWeightedInertiaDist. For experts only.

Usage

```
TraMineRInternalLayout(...)
TraMineRInternalLegend(...)
TraMineRInternalNodeInit(...)
TraMineRInternalSeqeage(...)
TraMineRInternalSeqgbar(...)
TraMineRInternalSplitInit(...)
TraMineRInternalWeightedInertiaDist(diss, diss.size, is.dist, individuals, sweights, var)
```

Arguments

...	Arguments passed to or from other methods.
diss	See tmrWeightedInertiaDist().
diss.size	See tmrWeightedInertiaDist().
is.dist	See tmrWeightedInertiaDist().
individuals	See tmrWeightedInertiaDist().
sweights	See tmrWeightedInertiaDist().
var	See tmrWeightedInertiaDist().

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