Package ‘arules’

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Abbreviate function for item labels in transactions, itemMatrix and associations

Methods to abbreviate long item labels in transactions, associations (rules and itemsets) and transaction ID lists. Note that abbreviate is not a generic and this arules defines a generic with the R’s abbreviate as the default.

Usage

```
abbreviate(...)  
## S3 method for class 'transactions'
abbreviate(data, minlength = 4, ..., method = "both.sides")  
## S3 method for rules'
abbreviate(data, minlength = 4, ..., method = "both.sides")  
## S3 method for 'itemsets'
abbreviate(data, minlength = 4, ..., method = "both.sides")  
## S3 method for 'itemMatrix'
abbreviate(data, minlength = 4, ..., method = "both.sides")  
## S3 method for 'tidLists'
abbreviate(data, minlength = 4, ..., method = "both.sides")
```

Arguments

data an object of class "transactions", "itemMatrix", "itemsets", "rules" or "tidLists".
minlength number of characters allowed in abbreviation
method apply to level and value (both.sides)
... further arguments passed on to the default abbreviation function.
Author(s)
Sudheer Chelluboina and Michael Hahsler based on code by Martin Vodenicharov.

See Also
abbreviate in base.

Examples
data(Adult)
inspect(head(Adult, 1))
Adult_abbr <- abbreviate(Adult, 15)
inspect(head(Adult_abbr, 1))

addComplement (Add Complement-items to Transactions)

Description
Provides the generic function `addComplement` and the S4 methods for transactions. This function adds for given items complement items. That is it adds an artificial item to each transactions which does not contain the original item.

Usage
`addComplement(x, labels, complementLabels=NULL)`

Arguments
- `x` an object of class `transactions`.
- `labels` character strings; item labels for which complements should be created.
- `complementLabels` character strings; labels for the artificial complement-items. If omitted then the original label is prepended by "!" to form the complement-item label.

Value
Returns an object of class `transactions` with complement-items added.

Author(s)
Michael Hahsler

See Also
transactions-class, merge
Examples

```r
data("Groceries")

## add a complement-items for "whole milk" and "other vegetables"
g2 <- addComplement(Groceries, c("whole milk", "other vegetables"))
inspect(head(g2, 3))

## use a custom label for the complement-item
g2 <- addComplement(g2, "coffee", "NO coffee")
inspect(head(g2, 3))
```

---

Adult Data Set

Description

The AdultUCI data set contains the questionnaire data of the “Adult” database (originally called the “Census Income” Database) formatted as a data.frame. The Adult data set contains the data already prepared and coerced to transactions for use with arules.

Usage

```r
data("Adult")
data("AdultUCI")
```

Format

The AdultUCI data set contains a data frame with 48842 observations on the following 15 variables.

- **age**  a numeric vector.
- **education**  an ordered factor with levels Preschool < 1st-4th < 5th-6th < 7th-8th < 9th < 10th < 11th < 12th < HS-grad < Prof-school < Assoc-acdm < Assoc-voc < Some-college < Bachelors < Masters < Doctorate.
- **education-num**  a numeric vector.
- **marital-status**  a factor with levels Divorced, Married-AF-spouse, Married-civ-spouse, Married-spouse-absent, Never-married, Separated, and Widowed.
- **relationship**  a factor with levels Husband, Not-in-family, Other-relative, Own-child, Unmarried, and Wife.
- **race**  a factor with levels Amer-Indian-Eskimo, Asian-Pac-Islander, Black, Other, and White.
- **sex**  a factor with levels Female and Male.
capital-gain  a numeric vector.
capital-loss  a numeric vector.
fnlwgt  a numeric vector.
hours-per-week  a numeric vector.
native-country  a factor with levels Cambodia, Canada, China, Columbia, Cuba, Dominican-Republic, Ecuador, El-Salvador, England, France, Germany, Greece, Guatemala, Haiti, Holand-Netherlands, Honduras, Hong, Hungary, India, Iran, Ireland, Italy, Jamaica, Japan, Laos, Mexico, Nicaragua, Outlying-US(Guam-USVI-etc), Peru, Philippines, Poland, Portugal, Puerto-Rico, Scotland, South, Taiwan, Thailand, Trinidad&Tobago, United-States, Vietnam, and Yugoslavia.

income  an ordered factor with levels small < large.

Details

The “Adult” database was extracted from the census bureau database found at http://www.census.gov/ in 1994 by Ronny Kohavi and Barry Becker, Data Mining and Visualization, Silicon Graphics. It was originally used to predict whether income exceeds USD 50K/yr based on census data. We added the attribute income with levels small and large (>50K).

We prepared the data set for association mining as shown in the section Examples. We removed the continuous attribute fnlwgt (final weight). We also eliminated education-num because it is just a numeric representation of the attribute education. The other 4 continuous attributes we mapped to ordinal attributes as follows:

age  cut into levels Young (0-25), Middle-aged (26-45), Senior (46-65) and Old (66+).
hours-per-week  cut into levels Part-time (0-25), Full-time (25-40), Over-time (40-60) and Too-much (60+).
capital-gain and capital-loss  each cut into levels None (0), Low (0 < median of the values greater zero < max) and High (>=max).

Author(s)

Michael Hahsler

Source

http://www.ics.uci.edu/~mlearn/MLRepository.html

References


affinity

Computing Affinity Between Items

Description

Provides the generic function `affinity` and the S4 methods to compute and return a similarity matrix with the affinities between items for a set of transactions.

Usage

```
affinity(x)
```

Arguments

- `x` a matrix or an object of class `itemMatrix` or `transactions`. 

Examples

```r
data("AdultUCI")
dim(AdultUCI)
AdultUCI[1:2,]

## remove attributes
AdultUCI["fnlwgt"] <- NULL
AdultUCI["education-num"] <- NULL

## map metric attributes
AdultUCI["age"] <- ordered(cut(AdultUCI["age"], c(15,25,45,65,100)),
labels = c("Young", "Middle-aged", "Senior", "Old"))

AdultUCI["hours-per-week"] <- ordered(cut(AdultUCI["hours-per-week"],
c(0,25,40,60,168)),
labels = c("Part-time", "Full-time", "Over-time", "Workaholic"))

AdultUCI["capital-gain"] <- ordered(cut(AdultUCI["capital-gain"],
c(-Inf,0,median(AdultUCI["capital-gain"])[AdultUCI["capital-gain"]>0]),
Inf)), labels = c("None", "Low", "High"))

AdultUCI["capital-loss"] <- ordered(cut(AdultUCI["capital-loss"],
c(-Inf,0, median(AdultUCI["capital-loss"])[AdultUCI["capital-loss"]>0]),
Inf)), labels = c("None", "Low", "High"))

## create transactions
Adult <- as(AdultUCI, "transactions")
Adult
```
Affinity between the two items $i$ and $j$ is defined by Aggarwal et al. (2002) as

$$A(i,j) = \frac{\text{sup}(\{i,j\})}{\text{sup}(\{i\}) + \text{sup}(\{j\}) - \text{sup}(\{i,j\})},$$

where $\text{sup}(.)$ is the support measure. This means that affinity is the Jaccard similarity between items.

Value
returns an object of class `ar_similarity` which represents the affinities between items in $x$.

Author(s)
Michael Hahsler

References

See Also
dissimilarity, ar_similarity-class, itemMatrix-class

Examples
data("Adult")

## choose a sample, calculate affinities
s <- sample(Adult, 500)
s
a <- affinity(s)
summary(as.vector(a))

---

**APappearance-class**

Class “APappearance” — Specifying the ‘appearance’ Argument of `apriori()`

Description
Specifies the restrictions on the associations mined by `apriori`. These restrictions can implement certain aspects of rule templates described by Klemettinen (1994).

Note that appearance is not supported by the implementation of `eclat`.
Objects from the Class

If appearance restrictions are used, an appearance object will be created automatically within the `apriori` function using the information in the named list of the function’s appearance argument. In this case, the item labels used in the list will be automatically matched against the items in the used transaction database. The list can contain the following elements:

- **lhs**, **rhs**, **both**, **items**, **none**: character vectors giving the labels of the items which can appear in the specified place (rhs, lhs or both for rules and items for itemsets). The special place none specifies, that the items mentioned there cannot appear in the rule/itemset.
- **default**: one of "both", "1hs", "rhs", "none" (the default is "both"). Specified the default appearance for all items not explicitly mentioned in the other elements of the list.

Objects can also be created by calls of the form `new("APappearance", ...)`. In this case, item IDs (column numbers of the transactions incidence matrix) have to be used instead of labels.

Slots

- **set**: an integer scalar indicating how many items are specified for each of lhs, rhs, items, both and none
- **items**: an integer vector of item IDs (column numbers)
- **labels**: a character vector of item labels
- **default**: a character scalar indicating the value for default appearance

Author(s)

Michael Hahsler and Bettina Gruen

References


See Also

- `apriori`

Examples

```r
data("Adult")

## find only frequent itemsets which do not contain small or large income
is <- apriori(Adult, parameter = list(support= 0.1, target="frequent"),
  appearance = list(none = c("income=small", "income=large"),
    default="both"))
itemFrequency(items(is))[["income=small"]]
```
apriori

Mining Associations with Apriori

Description

Mine frequent itemsets, association rules or association hyperedges using the Apriori algorithm. The Apriori algorithm employs level-wise search for frequent itemsets. The implementation of Apriori used includes some improvements (e.g., a prefix tree and item sorting).

Usage

apriori(data, parameter = NULL, appearance = NULL, control = NULL)

Arguments

data object of class transactions or any data structure which can be coerced into transactions (e.g., a binary matrix or data.frame).

parameter object of class APparameter or named list. The default behavior is to mine rules with support 0.1, confidence 0.8, and maxlen 10.

appearance object of class APappearance or named list. With this argument item appearance can be restricted. By default all items can appear unrestricted.

control object of class APcontrol or named list. Controls the performance of the mining algorithm (item sorting, etc.)

Details

Calls the C implementation of the Apriori algorithm by Christian Borgelt for mining frequent itemsets, rules or hyperedges.

Note: Apriori only creates rules with one item in the RHS (Consequent)!
Note: The default value in `APparameter` for `minlen` is 1. This means that rules with only one item (i.e., an empty antecedent/LHS) like

\[
\emptyset \Rightarrow \{\text{beer}\}
\]

will be created. These rules mean that no matter what other items are involved the item in the RHS will appear with the probability given by the rule’s confidence (which equals the support). If you want to avoid these rules then use the argument `parameter=list(minlen=2).

**Value**

Returns an object of class `rules` or `itemsets`.

**Author(s)**

Michael Hahsler and Bettina Gruen

**References**


APRIORI Implementation: [www.borgelt.net/apriori.html](http://www.borgelt.net/apriori.html)

**See Also**

`APparameter-class`, `APcontrol-class`, `APappearance-class`, `transactions-class`, `itemsets-class`, `rules-class`

**Examples**

```r
data("Adult")
## Mine association rules.
rules <- apriori(Adult,
    parameter = list(supp = 0.5, conf = 0.9, target = "rules"))
summary(rules)
```
AScontrol-classes

Description

The AScontrol class holds the algorithmic parameters for the used mining algorithms. APcontrol and ECcontrol directly extend AScontrol with additional slots for parameters only suitable for the algorithms Apriori (APcontrol) and Eclat (ECcontrol).

Objects from the Class

A suitable default control object will be automatically created by the apriori or the eclat function. By specifying a named list (names equal to slots) as control argument for the apriori or the eclat function, default values can be replaced by the values in the list. Objects can also be created by calls of the form new("APcontrol", ...) or new("ECcontrol", ...).

Slots

Common slots defined in AScontrol:

sort: an integer scalar indicating how to sort items with respect to their frequency: (default: 2)
   1: ascending
   -1: descending
   0: do not sort
   2: ascending
   -2: descending with respect to transaction size sum

verbose: a logical indicating whether to report progress

Additional slots for Apriori in APcontrol:

filter: a numeric scalar indicating how to filter unused items from transactions (default: 0.1)
   = 0: do not filter items with respect to usage in sets
   < 0: fraction of removed items for filtering
   > 0: take execution times ratio into account

tree: a logical indicating whether to organize transactions as a prefix tree (default: TRUE)

heap: a logical indicating whether to use heapsort instead of quicksort to sort the transactions (default: TRUE)

memopt: a logical indicating whether to minimize memory usage instead of maximize speed (default: FALSE)

load: a logical indicating whether to load transactions into memory (default: TRUE)

Additional slots for Eclat in ECcontrol:

sparse: a numeric value for the threshold for sparse representation (default: 7)
**Methods**

```r
coerce signature(from = "NULL", to = "APcontrol")
coerce signature(from = "list", to = "APcontrol")
coerce signature(from = "NULL", to = "ECcontrol")
coerce signature(from = "list", to = "ECcontrol")
```

**Author(s)**

Michael Hahsler and Bettina Gruen

**References**


**See Also**

apriori, eclat

---

**Description**

The ASparameter class holds the mining parameters (e.g., minimum support) for the used mining algorithms. APparameter and ECparameter directly extend ASparameter with additional slots for parameters only suitable for the Apriori (APparameter) or the Eclat algorithms (ECparameter).

**Objects from the Class**

A suitable default parameter object will be automatically created by the apriori or the eclat function. By specifying a named list (names equal to slots) as parameter argument for the apriori or the eclat function, default values can be replaced by the values in the list. Objects can be created by calls of the form `new("APparameter", ...)` or `new("ECparameter", ...)`.

**Slots**

Common slots defined in ASparameter:

- `support`: a numeric value for the minimal support of an item set (default: 0.1)
- `minlen`: an integer value for the minimal number of items per item set (default: 1)
- `maxlen`: an integer value for the maximal number of items per item set (default: 10)
- `target`: a character string indicating the type of association mined. One of
  - "frequent itemsets"
ASparameter-classes

- "maximally frequent itemsets"
- "closed frequent itemsets"
- "rules" (only available for Apriori)
- "hyperedgesets" (only available for Apriori; see references for the definition of association hyperedgesets)

ext: a logical indicating whether to produce extended information on quality measures (e.g., lhs.support) (default: FALSE)

Additional slots for Apriori in APparameter:

confidence: a numeric value for the minimal confidence of rules/association hyperedges (default: 0.8)

smax: a numeric value for the maximal support of itemsets/rules/hyperedgesets (default: 1)

arem: a character string indicating the used additional rule evaluation measure (default: "none")

given by one of

"none": no additional evaluation measure
"diff": absolute confidence difference
"quot": difference of confidence quotient to 1
"aimp": absolute difference of improvement to 1
"info": information difference to prior
"chi2": normalized $\chi^2$ measure

aval: a logical indicating whether to return the additional rule evaluation measure selected with arem.

minval: a numeric value for the minimal value of additional evaluation measure selected with arem (default: 0.1)

originalSupport: a logical indicating whether to use for minimum support the original definition of the support of a rule (lhs and rhs) instead of lhs support. Make sure to use ext = TRUE if originalSupport is set to FALSE (default: TRUE)

Additional slots for Eclat in ECparameter:

tidLists: a logical indicating whether to return also a list of supporting transactions (transaction IDs) (default: FALSE)

Methods

coerce signature(from = "NULL", to = "APparameter")
coerce signature(from = "list", to = "APparameter")
coerce signature(from = "NULL", to = "ECparameter")
coerce signature(from = "list", to = "ECparameter")
show signature(object = "ASparameter")

Author(s)

Michael Hahsler and Bettina Gruen
associations-class

References


See Also

apriori, eclat

associations-class Class “associations” - A Set of Associations

Description

The associations class is a virtual class which is extended to represent mining result (e.g., sets of itemsets or rules). The class provides accessors for the quality slot and a method for sorting the associations.

Objects from the Class

A virtual class: No objects may be created from it.

Slots

quality: a data.frame for quality measures (e.g., interest measures as support or confidence). Each quality measure is a named vector with the same length as the number of elements in the set of associations and each vector element belongs to the association with the same index.

info: a list which is used to store algorithm specific mining information. Typically it contains at least the elements "data" (name of the transaction data set), "ntransactions" (length of the data set), "support" (the minimum support used for mining).

Methods

info<- signature(x = "associations"); replaces the info list.
info signature(x = "associations"); returns the info list.
items signature(x = "associations"); dummy method. This method has to be implemented by all subclasses of associations and return the items which make up each association as an object of class itemMatrix.
labels signature(object = "associations"); dummy method. This method has to be implemented by all subclasses of associations and return a vector of length(object) of labels for the elements in the association.
length signature(x = "associations"); dummy method. This method has to be implemented by all subclasses of associations and return the number of elements in the association.
quality<- signature(x = "associations"); replaces the quality data.frame. The lengths of the vectors in the data.frame have to equal the number of associations in the set.
quality signature(x = "associations"); returns the quality data.frame.
show signature(object = "associations")
Subclasses

itemsets-class, rules-class

Author(s)

Michael Hahsler

See Also

sort, write, length, is.subset, is.superset, sets, unique, itemMatrix-class

Description

Provides the S4 methods to combine several objects based on itemMatrix into a single object.
Note, use union rather than c to combine several mined itemsets (or rules) into a single set.

Usage

```r
## S4 method for signature 'itemMatrix'
c(x, ..., recursive = FALSE)

## S4 method for signature 'transactions'
c(x, ..., recursive = FALSE)

## S4 method for signature 'rules'
c(x, ..., recursive = FALSE)

## S4 method for signature 'itemsets'
c(x, ..., recursive = FALSE)
```

Arguments

- `x`: first object.
- `...`: further objects of the same class as `x` to be combined.
- `recursive`: a logical. If `recursive=TRUE`, the function recursively descends through lists combining all their elements into a vector.

Value

An object of the same class as `x`. 
coverage

Author(s)

Michael Hahsler

See Also

itemMatrix-class, transactions-class, rules-class, itemsets-class

Examples

data("Adult")

## combine transactions
a1 <- Adult[1:10]
a2 <- Adult[101:110]

aComb <- c(a1, a2)
summary(aComb)

## combine rules (can contain the same rule multiple times)
r1 <- apriori(Adult[1:1000])
r2 <- apriori(Adult[1001:2000])
rComb <- c(r1, r2)
rComb

## union of rules (a set with only unique rules: same as unique(rComb))
rUnion <- union(r1,r2)
rUnion

---

coverage

*Calculate coverage for rules*

Description

Provides the generic function and the needed S4 method to calculate the coverage (support of the left-hand-side) of rules.

Usage

coverage(x, transactions = NULL, reuse = TRUE)

Arguments

- **x**: the set of rules.
- **transactions**: the data set used to generate 'x'. Only needed if the quality slot of 'x' does not contain support and confidence.
- **reuse**: reuse support and confidence stored in 'x' or recompute from transactions?
Details

Coverage is calculated from the rules quality measures (support and confidence) stored in the quality slot or, if these values are not present, as the support of the LHS.

Value

A numeric vector of the same length as x containing the coverage values for the sets in x.

Author(s)

Michael Hahsler

See Also

rules-class

Examples

data("Income")

## find and some rules (we only use 5 rules here) and calculate coverage
rules <- apriori(Income)[1:5]
quality(rules) <- cbind(quality(rules), coverage = coverage(rules))

inspect(rules)

crossTable(x, measure = c("count", "support", "probability", "lift", "chiSquared"), sort = FALSE)

Arguments

x object to be cross-tabulated (transactions or itemMatrix).
measure measure to return. Default is co-occurrence counts.
sort sort the items by support.
... additional arguments.
discretize

Value

A symmetric matrix of n time n, where n is the number of items times in x. The matrix contains the co-occurrence counts between pairs of items.

Author(s)

Michael Hahsler

See Also

transactions-class, itemMatrix-class.

Examples

data("Groceries")

c <- crossTable(Groceries, sort=TRUE)
c[c(1:5, 1:5)]

sp <- crossTable(Groceries, measure="support", sort=TRUE)
sp[c(1:5, 1:5)]

lift <- crossTable(Groceries, measure="lift", sort=TRUE)
lift[c(1:5, 1:5)]

chi2 <- crossTable(Groceries, measure="chisquared", sort=TRUE)
chi2[c(1:5, 1:5)]

---

**discretize**  
*Convert a Continuous Variable into a Categorical Variable*

Description

This function implements several basic unsupervised methods to convert continuous variables into a categorical variables (factor) suitable for association rule mining.

Usage

```r
discretize(x, method="interval", categories = 3, labels = NULL, ordered=FALSE, onlycuts=FALSE, ...)
```

Arguments

- **x**: a numeric vector (continuous variable).
- **method**: discretization method. Available are: "interval" (equal interval width), "frequency" (equal frequency), "cluster" (k-means clustering) and "fixed" (categories specifies interval boundaries).
categories  number of categories or a vector with boundaries (all values outside the boundaries will be set to NA).
labels   character vector; names for categories.
ordered   logical; return a factor with ordered levels?
onlycuts  logical; return only computed interval boundaries?
...      for method "cluster" further arguments are passed on to kmeans.

Value

A factor representing the categorized continuous variable or, if onlycuts=TRUE, a vector with the interval boundaries.

Author(s)

Michael Hahsler

Examples

data(iris)
x <- iris[,4]
hist(x, breaks=20, main="Data")
def.par <- par(no.readonly = TRUE) # save default
layout(mat=rbind(1:2:3:4))

### convert continuous variables into categories (there are 3 types of flowers)
### default is equal interval width
table(discretize(x, categories=3))
hist(x, breaks=20, main="Equal Interval length")
abline(v=discretize(x, categories=3, onlycuts=TRUE),
col="red")

### equal frequency
table(discretize(x, "frequency", categories=3))
hist(x, breaks=20, main="Equal Frequency")
abline(v=discretize(x, method="frequency", categories=3, onlycuts=TRUE),
col="red")

### k-means clustering
table(discretize(x, "cluster", categories=3))
hist(x, breaks=20, main="K-Means")
abline(v=discretize(x, method="cluster", categories=3, onlycuts=TRUE),
col="red")

### user-specified
table(discretize(x, "fixed", categories = c(-Inf,.8,Inf)))
table(discretize(x, "fixed", categories = c(-Inf,.8,Inf),
      labels=c("small", "large")))
hist(x, breaks=20, main="Fixed")
dissimilarity

abline(v=discretize(x, method="fixed", categories = c(-Inf,.8,Inf), onlycuts=TRUE), col="red")

par(def.par)  # reset to default

### prepare the iris data set for association rule mining
for(i in 1:4) iris[,i] <- discretize(iris[,i], "frequency", categories=3)

trans <- as(iris, "transactions")
inspect(head(trans, 1))

as(head(trans, 3),"matrix")

---

dissimilarity  Dissimilarity Computation

Description

Provides the generic function dissimilarity and the S4 methods to compute and returns distances for binary data in a matrix, transactions or associations.

Usage

dissimilarity(x, y = NULL, method = NULL, args = NULL, ...)
# S4 method for signature 'itemMatrix'
dissimilarity(x, y = NULL, method = NULL, args = NULL, which = "transactions")
# S4 method for signature 'associations'
dissimilarity(x, y = NULL, method = NULL, args = NULL, which = "transactions")
# S4 method for signature 'matrix'
dissimilarity(x, y = NULL, method = NULL, args = NULL)

Arguments

- **x**: the set of elements (e.g., matrix, itemMatrix, transactions, itemsets, rules).
- **y**: NULL or a second set to calculate cross dissimilarities.
- **method**: the distance measure to be used. Implemented measures are (defaults to "jaccard"):
  - "affinity": measure based on the affinity, a similarity measure between items. It is defined as the average affinity between the items in two transactions (see Aggarwal et al. (2002)). If x is not the full transaction set args needs to contain either precalculated affinities as element "affinities" or the transaction set as "transactions".
  - "cosine": the cosine distance.
  - "dice": the Dice's coefficient defined by Dice (1945). Similar to Jaccard but gives double the weight to agreeing items.
  - "euclidean": the euclidean distance.
"jaccard": the number of items which occur in both elements divided by the total number of items in the elements (Sneath, 1957). This measure is often also called: binary, asymmetric binary, etc.

"matching": the Matching coefficient defined by Sokal and Michener (1958). This coefficient gives the same weight to presents and absence of items.

"pearson": $1 - r$ if $r > 1$ and $1$ otherwise. $r$ is Pearson's correlation coefficient.

"phi": same as pearson. Pearson’s correlation coefficient reduces to the phi coefficient for the 2x2 contingency tables used here.

For associations the following additional measures are available:

"toivonen": Method described in Toivonen et al. (1995). For rules this measure is only defined between rules with the same consequent. The distance between two rules is defined as the number of transactions which is covered by only one of the two rules. The transactions used to mine the associations has to be passed on via args as element "transactions".

"gupta": Method described in Gupta et al. (1999). The distance between two rules is defined as $1$ minus the proportion of transactions which are covered by both rules in the transactions covered by each rule individually. The transactions used to mine the associations has to be passed on via args as element "transactions".

args a list of additional arguments for the methods.

which a character string indicating if the dissimilarity should be calculated between transactions (default) or items (use "items").

... further arguments.

Value

returns an object of class dist.

Author(s)

Michael Hahsler

References


See Also

affinity, dist-class, itemMatrix-class, associations-class.

Examples

```r
## cluster items in Groceries with support > 5%
data("Groceries")

s <- Groceries[, itemFrequency(Groceries)>0.05]
d_jaccard <- dissimilarity(s, which = "items")
plot(hclust(d_jaccard, method = "ward"))

## cluster transactions for a sample of Adult
data("Adult")
s <- sample(Adult, 500)

## calculate Jaccard distances and do hclust
d_jaccard <- dissimilarity(s)
hc <- hclust(d_jaccard)
plot(hc)

## get 20 clusters and look at the difference of the item frequencies (bars)
## for the top 20 items in cluster 1 compared to the data (line)
assign <- cutree(hc, 20)
itemFrequencyPlot(s[assign==1], population=s, topN=20)

## calculate affinity-based distances and do hclust
d_affinity <- dissimilarity(s, method = "affinity")
hc <- hclust(d_affinity)
plot(hc)

## cluster rules
rules <- apriori(Adult, parameter=list(support=0.3))
rules <- subset(rules, subset = lift > 2)

## use affinity
## we need to supply the item affinities from the dataset (sample)
d_affinity <- dissimilarity(rules, method = "affinity",
    args = list(affinity = affinity(s)))
plot(hclust(d_affinity))
```
Find Duplicated Elements

Description

Provides the generic function `duplicated` and the S4 methods for `itemMatrix` and `associations`. `duplicated` finds duplicated elements in an `itemMatrix`. It returns a logical vector indicating which elements are duplicates.

Note that `duplicated` can also be used to find transactions with identical items and identical rules and itemsets stored in `rules` and `itemsets`.

Usage

```r
duplicated(x, incomparables = FALSE, ...)
```

Arguments

- `x`: an object of class `itemMatrix` or `associations`.
- `...`: further arguments (currently unused).
- `incomparables`: argument currently unused.

Value

A logical vector indicating duplicated elements.

Author(s)

Michael Hahsler

See Also

`unique`, `rules-class`, `itemsets-class`, `itemMatrix-class`

Examples

```r
data("Adult")
r1 <- apriori(Adult[1:1000], parameter = list(support = 0.5))
r2 <- apriori(Adult[1001:2000], parameter = list(support = 0.5))

# Note this creates a collection of rules from two sets of rules
r_comb <- c(r1, r2)
duplicated(r_comb)
```
eclat

Mining Associations with Eclat

Description

Mine frequent itemsets with the Eclat algorithm. This algorithm uses simple intersection operations for equivalence class clustering along with bottom-up lattice traversal.

Usage

eclat(data, parameter = NULL, control = NULL)

Arguments

data: object of class transactions or any data structure which can be coerced into transactions (e.g., binary matrix, data.frame).
parameter: object of class ECparameter or named list (default values are: support 0.1 and maxlen 5)
control: object of class ECcontrol or named list for algorithmic controls.

Details

Calls the C implementation of the Eclat algorithm by Christian Borgelt for mining frequent itemsets. Note for control parameter tidlists=TRUE: Since storing transaction ID lists is very memory intensive, creating transaction ID lists only works for minimum support values which create a relatively small number of itemsets. See also supportingTransactions().

Value

Returns an object of class itemsets.

Author(s)

Michael Hahsler and Bettina Gruen

References


ECLAT Implementation: http://www.borgelt.net/eclat.html

See Also

ECparameter-class, ECcontrol-class, transactions-class, itemsets-class, apriori, supportingTransactions
Examples

```r
data("Adult")
## Mine itemsets with minimum support of 0.1.
itemsets <- eclat(Adult,
    parameter = list(supp = 0.1, maxlen = 15))
```
hierarchy

Format

Object of class transactions.

Author(s)

Michael Hahsler

Source

The data set is provided for arules by Michael Hahsler, Kurt Hornik and Thomas Reutterer.

References


| hierarchy | Aggregate Items Into Hierarchical Item Groups |

Description

Provides the generic functions and the S4 methods for aggregating items in rules and itemsets into hierarchical groups.

Often an item hierarchy is available for datasets used for association rule mining. For example in a supermarket dataset items like "bread" and "beagle" might belong to the item group (category) "baked goods". The aggregate methods replaces items in transactions, itemsets or rules by item groups as specified by the user.

Usage

```r
## S4 method for signature 'itemMatrix'
aggregate(x, by)
## S4 method for signature 'itemsets'
aggregate(x, by)
## S4 method for signature 'rules'
aggregate(x, by)
```

Arguments

- `x` : an transactions, itemsets or rules object.
- `by` : name of a field available in itemInfo or a vector of character strings (factor) of the same length as items in `x` by which should be aggregated. Items receiving the same label in `by` will be aggregated into a single, higher-level item.
Details

Transactions can store item hierarchies as additional columns in the itemInfo data.frame ("labels" is reserved for the item labels). These item hierarchies can be used for aggregation.

If rules are aggregated and the aggregation would lead to the same aggregated item in the lhs and in the rhs then the item is removed from the lhs. Rules or itemsets which are not unique after the aggregation are also removed.

Value

This method returns an object of the same class as x encoded with a number of items equal to the number of unique values in by. Note that for associations (itemsets and rules) the number of associations in the returned set will most likely be reduced since several associations might map to the same aggregated association and aggregate returns a unique set. If several associations map to a single aggregated association then the quality measures of one of the original associations is randomly chosen.

Author(s)

Michael Hahsler

Examples

data("Groceries")
Groceries

## Groceries contains a hierarchy stored in itemInfo
head(itemInfo(Groceries))

## aggregate by level2
Groceries_level2 <- aggregate(Groceries, by = "level2")
Groceries_level2
head(itemInfo(Groceries_level2))
inspect(head(Groceries_level2))

## create lables manually (organize items by the first letter)
mylevels <- toupper(substr(itemLabels(Groceries), 1, 1))
head(mylevels)

Groceries_alpha <- aggregate(Groceries, by = mylevels)
Groceries_alpha
inspect(head(Groceries_alpha))

## aggregate rules (note: you could also directly mine rules from aggregated ## transactions)
rules <- apriori(Groceries, parameter=list(supp=0.005, conf=0.5))
rules
inspect(rules[1])
rules_level2 <- aggregate(rules, by = "level2")
inspect(rules_level2[1])
## Computing Transaction Weights With HITS

### Description

Compute the hub weights of a collection of transactions using the HITS (hubs and authorities) algorithm.

### Usage

```r
hits(data, iter = 16L, tol = NULL,
     type = c("normed", "relative", "absolute"), verbose = FALSE)
```

### Arguments

- **data**: an object of or coercible to class `transactions`.
- **iter**: an integer value specifying the maximum number of iterations to use.
- **tol**: convergence tolerance (default `FLT_EPSILON`).
- **type**: a string value specifying the norming of the hub weights. For "normed" scale the weights to unit length (L2 norm), and for "relative" to unit sum.
- **verbose**: a logical specifying if progress and runtime information should be displayed.

### Details

Model a collection of transactions as a bipartite graph of hubs (transactions) and authorities (items) with unit arcs and free node weights. That is, a transaction weight is the sum of the (normalized) weights of the items and vice versa. The weights are estimated by iterating the model to a steady-state using a builtin convergence tolerance of `FLT_EPSILON` for (the change in) the norm of the vector of authorities.

### Value

A numeric vector with transaction weights for data.

### Author(s)

Christian Buchta

### References

See Also

Class `transactions`, function `weclat`

Examples

data(SunBai)

## calculate transaction weights
w <- hits(SunBai)

## add transaction weight to the dataset
transactionInfo(SunBai)["weight"] <- w

## calculate regular item frequencies
itemFrequency(SunBai, weighted = FALSE)

## calculate weighted item frequencies
itemFrequency(SunBai, weighted = TRUE)

---

**Visual Inspection of Binary Incidence Matrices**

**Description**

Provides the S4 methods `image` to generate level plots to visually inspect binary incidence matrices, i.e., objects based on `itemMatrix` (e.g., transactions, tidLists, items in itemsets or rhs/lhs in rules). These plots can be used to identify problems in a data set (e.g., recording problems with some transactions containing all items).

**Usage**

## S4 method for signature 'itemMatrix'
image(x,
    xlab = "Items (Columns)",
    ylab = "Elements (Rows)", ...)

## S4 method for signature 'transactions'
image(x,
    xlab = "Items (Columns)",
    ylab = "Transactions (Rows)", ...)

## S4 method for signature 'tidLists'
image(x,
    xlab="Transactions (Columns)",
    ylab="Items/itemsets (Rows)", ...)
The Income data set originates from an example in the book ‘The Elements of Statistical Learning’ (see Section source). The data set is an extract from this survey. It consists of 8993 instances (obtained from the original data set with 9409 instances, by removing those observations with the annual income missing) with 14 demographic attributes. The data set is a good mixture of categorical and continuous variables with a lot of missing data. This is characteristic of data mining applications. The Income data set contains the data already prepared and coerced to transactions.

Usage

```r
data("Income")
data("IncomeESL")
```
Format

IncomeESL is a data frame with 8993 observations on the following 14 variables.

- **income**: an ordered factor with levels [0, 10) < [10, 15) < [15, 20) < [20, 25) < [25, 30) < [30, 40) < [40, 50) < [50, 75) < 75+
- **sex**: a factor with levels male female
- **marital status**: a factor with levels married cohabitation divorced widowed single
- **age**: an ordered factor with levels 14-17 < 18-24 < 25-34 < 35-44 < 45-54 < 55-64 < 65+
- **education**: an ordered factor with levels grade < 9 < grades 9-11 < high school graduate < college (1-3 years) < college graduate < graduate study
- **occupation**: a factor with levels professional/managerial sales laborer clerical/service homemaker student military retired unemployed
- **years in bay area**: an ordered factor with levels 1 < 1-3 < 4-6 < 7-10 < > 10
- **dual incomes**: a factor with levels not married yes no
- **number in household**: an ordered factor with levels 1 < 2 < 3 < 4 < 5 < 6 < 7 < 8 < 9+
- **number of children**: an ordered factor with levels 0 < 1 < 2 < 3 < 4 < 5 < 6 < 7 < 8 < 9+
- **householder status**: a factor with levels own rent live with parents/family
- **type of home**: a factor with levels house condominium apartment mobile Home other
- **ethnic classification**: a factor with levels american indian asian black east indian hispanic pacific islander white other
- **language in home**: a factor with levels english spanish other

Details

To create *Income* (the transactions object), the original data frame in IncomeESL is prepared in a similar way as described in ‘The Elements of Statistical Learning.’ We removed cases with missing values and cut each ordinal variable (age, education, income, years in bay area, number in household, and number of children) at its median into two values (see Section examples).

Author(s)

Michael Hahsler

Source


Examples

data("IncomeESL")
IncomeESL[1:3, ]

## remove incomplete cases
IncomeESL <- IncomeESL[complete.cases(IncomeESL), ]

## preparing the data set
IncomeESL["income"] <- factor((as.numeric(IncomeESL["income"])) > 6) + 1,
levels = 1:2, labels = c("$0-$40,000", "$40,000+"))

IncomeESL["age"] <- factor((as.numeric(IncomeESL["age"])) > 3) + 1,
levels = 1:2, labels = c("14-34", "35+"))

IncomeESL["education"] <- factor((as.numeric(IncomeESL["education"])) > 4) + 1,
levels = 1:2, labels = c("no college graduate", "college graduate")

IncomeESL["years in bay area"] <- factor(  
(as.numeric(IncomeESL["years in bay area"])) > 4) + 1,
levels = 1:2, labels = c("1-9", "10+"))

IncomeESL["number in household"] <- factor(  
(as.numeric(IncomeESL["number in household"])) > 3) + 1,
levels = 1:2, labels = c("1", "2+"))

IncomeESL["number of children"] <- factor(  
(as.numeric(IncomeESL["number of children"])) > 1) + 0,
levels = 0:1, labels = c("0", "1+")

## creating transactions
Income <- as(IncomeESL, "transactions")
Income

inspect Display Associations and Transactions in Readable Form

Description

Provides the generic function inspect and S4 methods to display associations and transactions plus additional information formatted for online inspection.

Usage

inspect(x, ...)
interestMeasure

Arguments

x a set of associations or transactions or an itemMatrix.

... additional arguments can be used to customize the output: setStart, setEnd, itemSep and ruleSep. Items are printed only one per line in case the output lines get very long. This can also be directly controlled using linebreak.

Author(s)

Michael Hahsler and Kurt Hornik

See Also

itemMatrix-class, itemsets-class, rules-class, transactions-class

Examples

data("Adult")
rules <- apriori(Adult)
inspect(rules[1000])

inspect(rules[1000], ruleSep = "---->", itemSep = " + ", setStart = "", setEnd = "",
linebreak = FALSE)

interestMeasure Calculating various additional interest measures

Description

Provides the generic function interestMeasure and the needed S4 method to calculate various additional interest measures for existing sets of itemsets or rules.

Usage

interestMeasure(x, measure, transactions = NULL, reuse = TRUE, ...)

Arguments

x a set of itemsets or rules.

measure name or vector of names of the desired interest measures (see details for available measures). If measure is missing then all available measures are calculated.

transactions the transaction data set used to mine the associations or a set of different transactions to calculate interest measures from (Note: you need to set reuse=FALSE in the later case).

reuse logical indicating if information in quality slot should be reuse for calculating the measures. This speeds up the process significantly since only very little (or no) transaction counting is necessary if support, confidence and lift are already available. Use reuse=FALSE to force counting (might be very slow but is necessary if you use a different set of transactions than was used for mining).
further arguments for the measure calculation.

Details

For itemsets $X$ the following measures are implemented:

"allConfidence" (Omiencinski, 2003) Is defined on itemsets as the minimum confidence of all possible rule generated from the itemset.
Range: $[0, 1]$

"crossSupportRatio", cross-support ratio (Xiong et al., 2003) Defined on itemsets as the ratio of the support of the least frequent item to the support of the most frequent item, i.e., $\frac{\min(supp(x \in X))}{\max(supp(x \in X))}$. Cross-support patterns have a ratio smaller than a set threshold. Normally many found patterns are cross-support patterns which contain frequent as well as rare items. Such patterns often tend to be spurious.
Range: $[0, 1]$

"lift" Probability (support) of the itemset over the product of the probabilities of all items in the itemset, i.e., $\frac{\text{supp}(X)}{\prod_{x \in X} \text{supp}(x)}$. This is a measure of dependence similar to lift for rules.
Range: $[0, \infty)$ (1 indicated independence)

"support", supp (Agrawal et al., 1996) Support is an estimate of $P(X)$ a measure of generality of the itemset.
Range: $[0, 1]$

For rules $X \Rightarrow Y$ the following measures are implemented. In the following we use the notation $\text{supp}(X \Rightarrow Y) = \text{supp}(X \cup Y)$ to indicate the support of the union of the itemsets $X$ and $Y$, i.e., the proportion of the transactions that contain both itemsets. We also use $\overline{X}$ as the complement itemset to $X$ with $\text{supp}(\overline{X}) = 1 - \text{supp}(X)$, i.e., the proportion of transactions that do not contain $X$.

"addedValue", added Value, AV, Pavillon index, centered confidence (Tan et al., 2002) Defined as $\text{conf}(X \Rightarrow Y) - \text{supp}(Y)$
Range: $[-.5, 1]$

"chiSquared", $\chi^2$ (Liu et al., 1999) The chi-squared statistic to test for independence between the lhs and rhs of the rule. The critical value of the chi-squared distribution with 1 degree of freedom (2x2 contingency table) at $\alpha = 0.05$ is 3.84; higher chi-squared values indicate that the lhs and the rhs are not independent.
Note that the contingency table is likely to have cells with low expected values and that thus Fisher's Exact Test might be more appropriate (see below).
Called with $\text{significance=TRUE}$, the p-value of the test for independence is returned instead of the chi-squared statistic.
Range: $[0, \infty]$

"certainty", certainty factor, CF, Loevinger (Berzal et al., 2002) The certainty factor is a measure of variation of the probability that $Y$ is in a transaction when only considering transactions with $X$. An increasing CF means a decrease of the probability that $Y$ is not in a transaction that $X$ is in. Negative CFs have a similar interpretation.
Range: $[-1, 1]$ (0 indicates independence)
"interestMeasure" Collective strength (S).
Range: \([0, \infty]\)

"confidence", conf (Agrawal et al., 1996) Rule confidence is an estimate of \(P(Y \mid X)\) calculated as \(\frac{\text{supp}(X \Rightarrow Y)}{\text{supp}(X)}\). Confidence is a measure of validity.
Range: \([0, 1]\)

"conviction" (Brin et al. 1997) Defined as \(\frac{\text{supp}(X) \text{supp}(Y)}{\sqrt{\text{supp}(X \cup Y)}}\).
Range: \([, 0.5, \infty]\) (1 indicates unrelated items)

"cosine" (Tan et al., 2004) Defined as \(\frac{\text{supp}(X \cup Y) \text{supp}(X \cap Y)}{\sqrt{\text{supp}(X) \text{supp}(Y)}}\).
Range: \([0, 1]\)

"coverage", cover, LHS-support Support of the left-hand-side of the rule, i.e., \(\text{supp}(X)\). A measure of how often the rule can be applied.
Range: \([0, 1]\)

"confirmedConfidence", descriptive confirmed confidence (Kodratoff, 1999) Confidence confirmed by its negative as \(\text{conf}(X \Rightarrow Y) - \text{conf}(X \Rightarrow \overline{Y})\).
Range: \([-1, 1]\)

"casualConfidence", casual confidence (Kodratoff, 1999) Confidence reinforced by negatives given by \(\frac{1}{2}(\text{conf}(X \Rightarrow Y) + \text{conf}(Y \Rightarrow X))\).
Range: \([0, 1]\)

"casualSupport", casual support (Kodratoff, 1999) Support improved by negatives given by \(\text{supp}(X \cup Y) - \text{supp}(X \cup \overline{Y})\).
Range: \([-1, 1]\)

"counterexample", example and counterexample rate \(\frac{\text{supp}(X \cup Y) - \text{supp}(X \cup \overline{Y})}{\text{supp}(X \cup Y)}\).
Range: \([0, 1]\)

"descriptiveConfirm", descriptive-confirm (Kodratoff, 1999) Defined by \(\text{supp}(X \cup Y) - \text{supp}(X \cup \overline{Y})\).
Range: \([0, 1]\)

"doc", difference of confidence (Hofmann and Wilhelm, 2001) Defined as \(\text{conf}(X \Rightarrow Y) - \text{conf}(\overline{X} \Rightarrow Y)\).
Range: \([-1, 1]\)

"fishersExactTest", Fisher’s exact test (Hahsler and Hornik, 2007) Statistical significance test used in the analysis of contingency tables where sample sizes are small. Returns the p-value. Note that it is equal to hyper-confidence with significance=TRUE.
Range: \([0, 1]\) (p-value scale)

"gini", Gini index (Tan et al., 2004) Measures quadratic entropy.
Range: \([0, 1]\) (0 for independence)

"hyperLift" (Hahsler and Hornik, 2007) Adaptation of the lift measure which is more robust for low counts. It is based on the idea that under independence the count \(c_{XY}\) of the transactions which contain all items in a rule \(X \Rightarrow Y\) follows a hypergeometric distribution (represented by the random variable \(C_{XY}\)) with the parameters given by the counts \(c_X\) and \(c_Y\).
Hyper-lift is defined as:
\[
\text{hyperlift}(X \Rightarrow Y) = \frac{c_{XY}}{\text{Q}(C_{XY})},
\]
where \( Q_\delta[C_{XY}] \) is the quantile of the hypergeometric distribution given by \( \delta \). The quantile can be given as parameter \( d \) (default: \( d=0.99 \)).

Range: \([0, \infty) \) (1 indicates independence)

"hyperConfidence" (Hahsler and Hornik, 2007) Confidence level for observation of too high/low counts for rules \( X \Rightarrow Y \) using the hypergeometric model. Since the counts are drawn from a hypergeometric distribution (represented by the random variable \( C_{XY} \)) with known parameters given by the counts \( c_X \) and \( c_Y \), we can calculate a confidence interval for the observed counts \( c_{XY} \) stemming from the distribution. Hyper-confidence reports the confidence level (significance level if \( \text{significance=TRUE} \) is used) for

complements - \( 1 - P[C_{XY} >= c_{XY} | c_X, c_Y] \)

substitutes - \( 1 - P[C_{XY} < c_{XY} | c_X, c_Y] \).

A confidence level of, e.g., > 0.95 indicates that there is only a 5% chance that the count for the rule was generated randomly.

Per default complementary effects are mined, substitutes can be found by using the parameter \( \text{complements = FALSE} \).

Range: \([0, 1] \)

"imbalance", imbalance ratio, IR (Wu, Chen and Han, 2010) IR is defined as

\[
\left| \frac{\text{supp}(X) - \text{supp}(Y)}{\text{supp}(X) + \text{supp}(Y) - \text{supp}(X \Rightarrow Y)} \right|
\]

gauges the degree of imbalance between two events that the lhs and the rhs are contained in a transaction. The ratio is close to 0 if the conditional probabilities are similar (i.e., very balanced) and close to 1 if they are very different.

Range: \([0, 1] \) (0 indicates a balanced rule)

"implicationIndex", implication index (Gras, 1996) Defined as

\[
\frac{\sqrt{\text{supp}(X \cup Y) - \text{supp}(X) \text{supp}(Y)}}{\sqrt{\text{supp}(X) \text{supp}(Y)}}
\]

Represents a variation of the Lerman similarity.

Range: \([0, 1] \) (0 means independence)

"improvement" (Bayardo et al., 2000) The improvement of a rule is the minimum difference between its confidence and the confidence of any proper sub-rule with the same consequent.

Range: \([0, 1] \)

"jaccard", Jaccard coefficient (Tan and Kumar, 2000) Defined as

\[
\frac{\text{supp}(X \cup Y)}{\text{supp}(X) + \text{supp}(Y) - \text{supp}(X \cup Y)}
\]

Range: \([-1, 1] \) (0 for independence)


Range: \([0, 1] \) (0 for independence)

"kappa" (Tan and Kumar, 2000) Defined as

\[
\frac{\text{supp}(X \cup Y) + \text{supp}(X \cup \overline{Y}) - \text{supp}(X) \text{supp}(Y) - \text{supp}(X \cup \overline{Y})}{1 - \text{supp}(X) \text{supp}(Y) - \text{supp}(X) \text{supp}(\overline{Y})}
\]

Range: \([-1, 1] \) (0 means independence)

"klosgen", Klosgen (Tan and Kumar, 2000) Defined as

\[
\sqrt{\text{conf}(X \Rightarrow Y)} - \text{supp}(Y)
\]

Range: \([-1, 1] \) (0 for independence)

"kulczynski" (Wu, Chen and Han, 2007; Kulczynski, 1927) Calculate the null-invariant Kulczynski measure with a preference for skewed patterns.

Range: \([0, 1] \)

"lambda", Goodman-Kruskal \( \lambda \), predictive association (Tan and Kumar, 2000) Range: \([0, 1] \)


Range: \([0, 1] \)
"leastContradiction", least contradiction (Aze and Kodratoff, 2004) Defined as $\frac{\text{supp}(X \cup Y) - \text{supp}(X)\text{supp}(Y)}{\text{supp}(Y)}$. Range: $[-1, 1]$

"lerman", Lerman similarity (Lerman, 1981) Defined as $\sqrt{\frac{\text{supp}(X \cup Y) - \text{supp}(X)\text{supp}(Y)}{\text{supp}(X)\text{supp}(Y)}}$. Range: $[0, 1]$

"leverage", PS (Piatetsky-Shapiro 1991) PS is defined as $\text{supp}(X \Rightarrow Y) - \text{supp}(X)\text{supp}(Y)$. It measures the difference of X and Y appearing together in the data set and what would be expected if X and Y were statistically dependent. It can be interpreted as the gap to independence. Range: $[-1, 1]$ (0 indicates independence)

"lift", interest factor (Brin et al. 1997) Lift quantifies dependence between X and Y by $\frac{\text{supp}(X \cup Y)}{\text{supp}(X)\text{supp}(Y)}$. Range: $[0, \infty]$ (1 means independence)

"mutualInformation", uncertainty, M (Tan et al., 2002) Measures the information gain for Y provided by X. Range: $[0, 1]$ (0 for independence)

"oddsRatio", odds ratio $\alpha$ (Tan et al., 2004) The odds of finding X in transactions which contain Y divided by the odds of finding X in transactions which do not contain Y. Range: $[0, \infty]$ (1 indicates that Y is not associated to X)

"phi", correlation coefficient $\phi$ (Tan et al. 2004) Equivalent to Pearson’s Product Moment Correlation Coefficient $\rho$. Range: $[-1, 1]$ (0 when X and Y are independent)

"ralambrodrainy", Ralambrodrainy Measure (Ralambrodrainy, 1991) Range: $[0, 1]$

"RLD", relative linkage disequilibrium (Kenett and Salini, 2008) RLD evaluates the deviation of the support of the whole rule from the support expected under independence given the supports of the LHS and the RHS. The code was contributed by Silvia Salini. Range: $[0, 1]$

"sebag", Sebag measure (Sebag and Schoenauer, 1988) Defined as $\frac{\text{supp}(X \cup Y)}{\text{supp}(X)\text{supp}(Y)}$. Range: $[0, 1]$

"support", $\text{supp}$ (Agrawal et al., 1996) Support is an estimate of $P(X \cup Y)$ and measures the generality of the rule. Range: $[0, 1]$

"varyingLiaison", varying rates liaison (Bernard and Charron, 1996) Defined as $1. Is equivalent to lift(X \Rightarrow Y) - 1$. Range: $[-1, 1]$ (0 for independence)

"yuleQ", Yule’s Q (Tan and Kumar, 2000) Defined as $\frac{2\alpha - 1}{\alpha + 1}$ where $\alpha$ is the odds ratio. Range: $[-1, 1]$

"yuleY", Yule’s Y (Tan and Kumar, 2000) Defined as $\frac{\sqrt{\alpha - 1}}{\sqrt{\alpha + 1}}$ where $\alpha$ is the odds ratio. Range: $[-1, 1]$
interestMeasure

Value

If only one measure is used, the function returns a numeric vector containing the values of the interest measure for each association in the set of associations \( x \).

If more than one measures are specified, the result is a data.frame containing the different measures for each association.

NA is returned for rules/itemsets for which a certain measure is not defined.

Author(s)

Michael Hahsler

References


Tan, Pang-Ning and Vipin Kumar (2000). Interestingness Measures for Association Patterns: A Perspective. TR 00-036, Department of Computer Science and Engineering University of Minnesota.


See Also

itemsets-class, rules-class

Examples

data("Income")
rules <- apriori(Income)

## calculate a single measure and add it to the quality slot
quality(rules) <- cbind(quality(rules),
   hyperConfidence = interestMeasure(rules, measure = "hyperConfidence",
   transactions = Income))

inspect(head(sort(rules, by = "hyperConfidence")))

## calculate several measures
m <- interestMeasure(rules, c("confidence", "oddsRatio", "leverage"),
   transactions = Income)
inspect(head(rules))
head(m)

## calculate all available measures for the first 5 rules and show them as a
## is.closed

### Find Closed Itemsets

**Description**

Provides the generic function and the S4 method `is.closed` for finding closed itemsets. The closure of an itemset is its largest proper superset which has the same support (is contained in exactly the same transactions). An itemset is closed, if it is its own closure (Pasquier et al. 1999).

**Usage**

`is.closed(x)`

**Arguments**

- `x`: a set of itemsets.

**Value**

A logical vector with the same length as `x` indicating for each element in `x` if it is a closed itemset.

**Author(s)**

Michael Hahsler

**References**


**See Also**

`itemsets-class`
is.maximal

Find Maximal Itemsets

Description

Provides the generic function and the S4 method is.maximal for finding maximal itemsets. An itemset is maximal in a set if no proper superset of the itemset is contained in the set (Zaki et al., 1997).

Usage

is.maximal(x,...)

## S4 method for signature 'itemMatrix'

is.maximal(x)

Arguments

x
the set of itemsets or an itemMatrix object.

...further arguments.

Value

a logical vector with the same length as x indicating for each element in x if it is a maximal itemset.

Author(s)

Michael Hahsler

References


See Also

is.superset, itemMatrix-class, itemsets-class
is.superset  Find Super and Subsets

Description

Provides the generic functions and the S4 methods is.superset and is.superset for finding super or subsets in associations and itemMatrix objects.

Usage

is.superset(x, y = NULL, proper = FALSE, sparse = FALSE, ...)  

Arguments

- x, y: associations or itemMatrix objects. If y = NULL, the super or subset structure within set x is calculated.
- proper: a logical indicating if all or just proper super or subsets.
- sparse: a logical indicating if a sparse (ngCMat) rather than a dense logical matrix should be returned. This preserves a significant amount of memory for large sets of x and y.
- ...: currently unused.

Details

looks for each element in x which elements in y are supersets or subsets. Note that the method can be very slow and memory intensive if x and/or y contain many elements.

Value

returns a logical matrix or a sparse ngCMat (for parse=TRUE) with length(x) rows and length(y) columns. Each logical row vector represents which elements in y are supersets (subsets) of the corresponding element in x. If either x or y have length zero, NULL is returned instead of a matrix.

Author(s)

Michael Hahsler

See Also

associations-class, itemMatrix-class
Examples

data("Adult")
set <- eclat(Adult, parameter = list(supp = 0.8))

### find the supersets of each itemset in set
is.superset(set, set)
is.superset(set, set, sparse = TRUE)

Description

Provides the generic functions and the S4 methods for converting item labels into column IDs used in the binary matrix representation and vice versa.

decode converts from the numeric (column IDs) representation to readable item labels. decode is used by list.

encode converts from readable item labels to an itemMatrix using a given coding. With this method it is possible to create several compatible itemMatrix objects (i.e., use the same binary representation for items) from data.

recode recodes an itemMatrix object so its coding is compatible with another object or the matrix follows a certain order of items.

Usage

decode(x, ...)
## S4 method for signature 'list'
decode(x, itemLabels)
## S4 method for signature 'numeric'
decode(x, itemLabels)

encode(x, ...)
## S4 method for signature 'list'
encode(x, itemLabels, itemMatrix = TRUE)
## S4 method for signature 'character'
encode(x, itemLabels, itemMatrix = TRUE)
## S4 method for signature 'numeric'
encode(x, itemLabels, itemMatrix = TRUE)

recode(x, ...)
## S4 method for signature 'itemMatrix'
recode(x, itemLabels = NULL, match = NULL)
Arguments

x a vector or a list of vectors of character strings (for encode) or of numeric (for decode), or an object of class itemMatrix (for recode).

itemLabels a vector of character strings used for coding where the position of an item label in the vector gives the item's column ID. The used itemLabels vector can be obtained from itemMatrix, transactions and associations by the method itemLabels.

itemMatrix return an object of class itemMatrix otherwise an object of the same class as x is returned.

match an itemMatrix object whose item coding x should match.

... further arguments.

Value

recode always returns an object of class itemMatrix.

For encode with itemMatrix = TRUE an object of class itemMatrix is returned. Otherwise the result is of the same type as x, e.g., a list or a vector.

Author(s)

Michael Hahsler

See Also

LIST, associations-class, itemMatrix-class

Examples

data("Adult")

## Example 1: Manual decoding
## get code
iLabels <- itemLabels(Adult)
head(iLabels)

## get undecoded list and decode in a second step
list <- LIST(Adult[1:5], decode = FALSE)
list

decode(list, itemLabels = iLabels)

## Example 2: Manually create an itemMatrix
data <- list(
  c("income=small", "age=Young"),
  c("income=large", "age=Middle-aged")
)
iM <- encode(data, iLabels)
iM
inspect(iM)

## use the itemMatrix to create transactions
as(iM, "transactions")

## Example 3: use recode
## select first 100 transactions and all education-related items
sub <- Adult[1:100, itemInfo(Adult)$variables == "education"]
itemLabels(sub)
image(sub)

## recode to match Adult again
sub.recoded <- recode(sub, match = Adult)
image(sub.recoded)

---

### itemFrequency

#### Getting Frequency/Support for Single Items

**Description**

Provides the generic function `itemFrequency` and S4 methods to get the frequency/support for all single items in an objects based on `itemMatrix`. For example, it is used to get the single item support from an object of class `transactions` without mining.

**Usage**

```r
itemFrequency(x, ...)  
```

## S4 method for signature 'itemMatrix'

```r
itemFrequency(x, type, weighted = FALSE)
```

**Arguments**

- **x**: an object.
- **...**: further arguments are passed on.
- **type**: a character string specifying if "relative" frequency/support or "absolute" frequency/support (item counts) is returned. (default: "relative").
- **weighted**: should support be weighted by transactions weights stored as column "weight" in transactionInfo?

**Value**

`itemFrequency` returns a named numeric vector. Each element is the frequency/support of the corresponding item in object x. The items appear in the vector in the same order as in the binary matrix in x.
Author(s)

Michael Hahsler

See Also

itemFrequencyPlot, itemMatrix-class, transactions-class

Examples

data("Adult")
itemFrequency(Adult, type = "relative")

Description

Provides the generic function itemFrequencyPlot and the S4 method to create an item frequency bar plot for inspecting the item frequency distribution for objects based on itemMatrix (e.g., transactions, or items in itemsets and rules).

Usage

itemFrequencyPlot(x, ...)
## S4 method for signature 'itemMatrix'
itemFrequencyPlot(x, type = c("relative", "absolute"),
weighted = FALSE, support = NULL, topN = NULL,
population = NULL, popCol = "black", popLwd = 1,
lift = FALSE, horiz = FALSE,
names = TRUE, cex.names = graphics::par("cex.axis"),
xlab = NULL, ylab = NULL, mai = NULL, ...)

Arguments

x
  the object to be plotted.
...
  further arguments are passed on (see barplot from possible arguments).

   type
  a character string indicating whether item frequencies should be displayed relative of absolute.

weighted
  should support be weighted by transactions weights stored as column "weight" in transactionInfo?

support
  a numeric value. Only display items which have a support of at least support. If no population is given, support is calculated from x otherwise from the population. Support is interpreted relative or absolute according to the setting of type.

topN
  a integer value. Only plot the topN items with the highest item frequency or lift (if lift = TRUE). The items are plotted ordered by descending support.
itemFrequencyPlot

- **population**: object of same class as x; if x is a segment of a population, the population mean frequency for each item can be shown as a line in the plot.

- **popCol**: plotting color for population.

- **popLwd**: line width for population.

- **lift**: a logical indicating whether to plot the lift ratio between instead of frequencies. The lift ratio is given how many times an item is more frequent in x than in population.

- **horiz**: a logical. If horiz = FALSE (default), the bars are drawn vertically. If TRUE, the bars are drawn horizontally.

- **names**: a logical indicating if the names (bar labels) should be displayed?

- **cex.names**: a numeric value for the expansion factor for axis names (bar labels).

- **xlab**: a character string with the label for the x axis (use an empty string to force no label).

- **ylab**: a character string with the label for the y axis (see xlab).

- **mai**: a numerical vector giving the plots margin sizes in inches (see ‘? par’).

**Value**

A numeric vector with the midpoints of the drawn bars; useful for adding to the graph.

**Author(s)**

Michael Hahsler

**See Also**

- [itemFrequency](#)
- [itemMatrix-class](#)

**Examples**

```r
data(Adult)

## the following example compares the item frequencies
## of people with a large income (boxes) with the average in the data set
Adult.largeIncome <- Adult[Adult %in%
  "income=large"]

## simple plot
itemFrequencyPlot(Adult.largeIncome)

## plot with the averages of the population plotted as a line
## (for first 72 variables/items)
itemFrequencyPlot(Adult.largeIncome[, 1:72],
  population = Adult[, 1:72])

## plot lift ratio (frequency in x / frequency in population)
## for items with a support of 20% in the population
itemFrequencyPlot(Adult.largeIncome,
  lift = TRUE)
```
itemMatrix-class

Description

The itemMatrix class is the basic building block for transactions, itemsets and rules in package arules. The class contains a sparse Matrix representation of items (a set of itemsets or transactions) and the corresponding item labels.

Objects from the Class

Objects can be created by calls of the form new("itemMatrix", ...). However, most of the time objects will be created by coercion from a matrix, list or data.frame.

Slots

data: Object of class ngCMatrix (from package Matrix) which stores item occurrences in sparse representation. Note that the ngCMatrix is column-oriented and itemMatrix is row-oriented with each row representing an element (an itemset, a transaction, etc.). As a result, the ngCMatrix in this slot is always a transposed version of the binary incidence matrix in itemMatrix.

itemInfo: a data.frame which contains named vectors of the length equal to the number of elements in the set. If the slot is not empty (contains no item labels), the first element in the data.frame must have the name "labels" and contain a character vector with the item labels used for representing an item. In addition to the item labels, the data.frame can contain arbitrary named vectors (of the same length) to represent, e.g., variable names and values which were used to create the binary items or hierarchical category information associated with each item label.

itemsetInfo: a data.frame which may contain additional information for the rows (mostly representing itemsets) in the matrix.

Methods

coerce signature(from = "matrix", to = "itemMatrix"); expects from to be a binary matrix only containing 0s and 1s.

coerce signature(from = "itemMatrix", to = "matrix"); coerces to a dense 0-1 matrix of storage.mode "integer" instead of "double" to save memory.

coerce signature(from = "list", to = "itemMatrix"); from is a list of vectors. Each vector contains one set/transaction/....

coerce signature(from = "itemMatrix", to = "list"); see also the methods for LIST.

coerce signature(from = "itemMatrix", to = "ngCMatrix"); access the sparse matrix representation. Note, the ngCMatrix contains a transposed from of the itemMatrix.
itemMatrix-class

coerce signature(from = "ngCMatrix", to = "itemMatrix"): Note, the ngCMatrix has to be transposed with items as rows!

c signature(object = "itemMatrix"): combine.

dim signature(x = "itemMatrix"): returns the dimensions of the itemMatrix.

dimnames, rownames, colnames signature(x = "itemMatrix"): returns row (itemsetID) and column (item) names.

labels signature(x = "transactions"): returns the labels for the itemsets in each transaction (see itemMatrix).

dimnames signature(x = "itemMatrix"): returns dimnames.

dimnames<- signature(x = "itemMatrix", value = "list"): replace dimnames.

%in% signature(x = "itemMatrix", table = "character"): matches the strings in table against the item labels in x and returns a logical vector indicating if a row (itemset) in x contains any of the items specified in table. Note that there is a %in% method with signature(x = "itemMatrix", table). This method is described in together with match.

%ain% signature(x = "itemMatrix", table = "character"): matches the strings in table against the item labels in x and returns a logical vector indicating if a row (itemset) in x contains all of the items specified in table.

%pin% signature(x = "itemMatrix", table = "character"): matches the strings in table against the item labels in x (using partial matching) and returns a logical vector indicating if a row (itemset) in x contains any of the items specified in table.

itemLabels signature(object = "itemMatrix"): returns the item labels used for encoding as a character vector.

itemLabels<- signature(object = "itemMatrix"): replaces the item labels used for encoding.

itemInfo signature(object = "itemMatrix"): returns the whole item/column information data.frame including labels.

itemInfo<- signature(object = "itemMatrix"): replaces the item/column info by a data.frame.

itemsetInfo signature(object = "itemMatrix"): returns the item set/row information data.frame.

itemsetInfo<- signature(object = "itemMatrix"): replaces the item set/row info by a data.frame.

labels signature(x = "transactions"): returns labels for the itemsets. The following arguments can be used to customize the representation of the labels: itemSep, setStart and setEnd.

nitems signature(x = "itemMatrix"): returns the number of items (number in columns) in the itemMatrix.

show signature(object = "itemMatrix")

summary signature(object = "itemMatrix")

Author(s)

Michael Hahsler

See Also

LIST, c, duplicated, inspect, is.subset, is.superset, itemFrequency, itemFrequencyPlot, match, length, sets, subset, unique, [-methods, image, ngCMatrix-class (from Matrix), transactions-class, itemsets-class, rules-class
Examples

set.seed(1234)

## Generate random data and coerce data to itemMatrix.
m <- matrix(runif(100000) > 0.8, ncol = 20)
dimnames(m) <- list(NULL, paste("item", c(1:20), sep=""))
i <- as(m, "itemMatrix")

## Get the number of elements (rows) in the itemMatrix.
length(i)

## Get first 5 elements (rows) of the itemMatrix as list.
as(i[1:5], "list")

## Get first 5 elements (rows) of the itemMatrix as matrix.
as(i[1:5], "matrix")

## Get first 5 elements (rows) of the itemMatrix as sparse ngCMatrix.
## Warning: for efficiency reasons, the ngCMatrix you get is transposed!
as(i[1:5], "ngCMatrix")

## Get labels for the first 5 itemsets (first default and then with
## custom formatting)
labels(i[1:5])
labels(i[1:5], itemSep = " + ", setStart = ",", setEnd = ")

## Create itemsets from itemMatrix
is <- new("itemsets", items = i[1:3])
inspect(is)

## Create rules (rhs and lhs cannot share items so I use
## itemSetdiff here). Also assign (random) support.
rules <- new("rules", lhs=itemSetdiff(i[4:6], i[1:3]), rhs=i[1:3],
quality = data.frame(support = runif(3)))
inspect(rules)

Description

Provides the generic functions and the S4 methods for itemwise set operations on items in an itemMatrix. The regular set operations regard each itemset in an itemMatrix as an element. Itemwise operations regard each item as an element and operate on the items of pairs if corresponding itemsets (first itemset in x with first itemset in y, second with second, etc.).

Usage

itemUnion(x, y)
itemSetdiff(x, y)
itemIntersect(x, y)

Arguments

x, y two itemMatrix objects with the same number of rows (itemsets).

Value

An object of class itemMatrix is returned.

Author(s)

Michael Hahsler

See Also

itemMatrix-class

Examples

data("Adult")

fsets <- eclat(Adult, parameter = list(supp = 0.5))
inspect(fsets[1:4])
inspect(itemUnion(items(fsets[1:2]), items(fsets[3:4])))
inspect(itemSetdiff(items(fsets[1:2]), items(fsets[3:4])))
inspect(itemIntersect(items(fsets[1:2]), items(fsets[3:4])))

itemsets-class Class “itemsets” — A Set of Itemsets

Description

The itemsets class represents a set of itemsets and the associated quality measures.
Note that the class can also represent a multiset of itemsets with duplicated elements. Duplicated elements can be removed with unique.

Objects from the Class

Objects are the result of calling the functions apriori (e.g., with target="frequent itemsets" in the parameter list) or eclat. Objects can also be created by calls of the form new("itemsets", ...).

Slots

items: object of class itemMatrix containing the items in the set of itemsets
quality: a data.frame containing the quality measures for the itemsets
tidLists: object of class tidLists containing the IDs of the transactions which support each itemset. The slot contains NULL if no transactions ID list is available (transactions ID lists are only available for eclat).
Extends

Class associations, directly.

Methods

coerce signature(from = "itemsets", to = "data.frame"); represent the itemsets in readable form

items signature(x = "itemsets"): returns the itemMatrix representing the set of itemsets

items<- signature(x = "itemsets"): replaces the itemMatrix representing the set of itemsets

itemInfo signature(object = "itemsets"): returns the whole item information data frame including item labels

labels signature(object = "itemsets"); returns labels for the itemsets as a character vector. The labels have the following format: "item1, item2,..., itemn"

itemLabels signature(object = "itemsets"); returns the item labels used to encode the itemsets as a character vector. The index for each label is the column index of the item in the binary matrix.

summary signature(object = "itemsets")

tidLists signature(object = "itemsets"): returns the transaction ID list

Author(s)

Michael Hahsler

See Also

[-methods, apriori, c, duplicated, eclat, inspect, is.maximal, length, match, sets, size, subset, associations-class, tidLists-class

Examples

data("Adult")

## Mine frequent itemsets with Eclat.
fsets <- eclat(Adult, parameter = list(supp = 0.5))

## Display the 5 itemsets with the highest support.
fsets.top5 <- sort(fsets)[1:5]
inspect(fsets.top5)

## Get the itemsets as a list
as(items(fsets.top5), "list")

## Get the itemsets as a binary matrix
as(items(fsets.top5), "matrix")

## Get the itemsets as a sparse matrix, a ngCMatrix from package Matrix.
## Warning: for efficiency reasons, the ngCMatrix you get is transposed
as(items(fsets.top5), "ngCMatrix")
Getting the Number of Elements

Description

S4 methods for `length` which return the number of elements of objects defined in the package `arules`.

Usage

```r
## S4 method for signature 'rules'
length(x)

## S4 method for signature 'itemsets'
length(x)

## S4 method for signature 'tidLists'
length(x)

## S4 method for signature 'itemMatrix'
length(x)
```

Arguments

- `x` an object of class `transactions, rules, itemsets, tidLists, or itemMatrix`.

Details

For `itemMatrix` and `transactions` the length is defined as the number of rows (transactions) in the binary incidence matrix.

For sets of associations (rules, itemsets and associations in general) the length is defined as the number of elements in the set (i.e., the number of rules or itemsets).

For `tidLists` the length is the number of lists (one per item or itemset) in the object.

Value

An integer scalar giving the “length” of `x`.

Author(s)

Michael Hahsler
List Representation for Objects Based on “itemMatrix”

Description

Provides the generic function LIST and the S4 methods to create a list representation from objects based on *itemMatrix* (e.g., *transactions*, *tidLists*, or *itemsets*). These methods can be used for the coercion to a list.

Usage

```r
LIST(from, ...)  
```

## S4 method for signature 'itemMatrix'

```r
LIST(from, decode = TRUE)
```

## S4 method for signature 'transactions'

```r
LIST(from, decode = TRUE)
```

## S4 method for signature 'tidLists'

```r
LIST(from, decode = TRUE)
```

Arguments

- `from`: the object to be converted into a list.
- `...`: further arguments.
- `decode`: a logical controlling whether the items/transactions are decoded from the column numbers internally used by *itemMatrix* to the names stored in the object from. The default behavior is to decode.

Details

Using LIST with `decode = TRUE` is equivalent to the standard coercion `as(x, "list")`. LIST returns the object from as a list of vectors. Each vector represents one row of the *itemMatrix* (e.g., items in a transaction or itemset).

Value

- a list primitive.

Author(s)

- Michael Hahsler

See Also

- `decode`, `coerce`, `itemMatrix`, `list-method`, `itemMatrix-class`
Examples

data(Adult)

LIST(Adult[1:5])
LIST(Adult[1:5], decode = FALSE)

match    | Value Matching

Description

Provides the generic function `match` and the S4 methods for associations and transactions. `match` returns a vector of the positions of (first) matches of its first argument in its second.

`%in%` is a more intuitive interface as a binary operator, which returns a logical vector indicating if there is a match or not for its left operand.

Usage

```r
match(x, table, nomatch = NA_integer_, incomparables = NULL)
```

```r
x %in% table
```

Arguments

- `x`          an object of class `itemMatrix`, `transactions` or `associations`.
- `table`      a set of associations or transactions to be matched against.
- `nomatch`    the value to be returned in the case when no match is found.
- `incomparables` not implemented.

Value

- `match`: An integer vector of the same length as `x` giving the position in `table` of the first match if there is a match, otherwise `nomatch`.
- `%in%`: A logical vector, indicating if a match was located for each element of `x`.

Author(s)

Michael Hahsler

See Also

`rules-class`, `itemsets-class`, `itemMatrix-class`
merge

Examples

data("Adult")

## get unique transactions, count frequency of unique transactions
## and plot frequency of unique transactions
vals <- unique(Adult)
cnts <- tabulate(match(Adult, vals))
plot(sort(cnts, decreasing=TRUE))

## find all transactions which are equal to transaction 10 in Adult
which(Adult %in% Adult[10])

## for transactions we can also match directly with itemLabels.
## Find in the first 10 transactions the ones which
## contain age=Middle-aged (see help page for class itemMatrix)
Adult[1:10]

merge

Merging (adding) items

Description

Provides the generic function `merge` and the S4 methods for `itemMatrix` and `transactions`. The methods are used to add new items to existing data.

Usage

`merge(x, y, ...)`

Arguments

- `x`: an object of class `itemMatrix` or `transactions`.
- `y`: an object of the same class as `x` (or something which can be coerced to that class).
- `...`: further arguments; unused.

Value

Returns a new object of the same class as `x` with the items in `y` added.

Author(s)

Michael Hahsler

See Also

transactions-class, itemMatrix-class, addComplement
Examples

```r
data("Groceries")

## create a random item as a matrix
randomItem <- sample(c(TRUE, FALSE), size=length(Groceries), replace=TRUE)
randomItem <- as.matrix(randomItem)
colnames(randomItem) <- "random item"
head(randomItem, 3)

## add the random item to Groceries
g2 <- merge(Groceries, randomItem)
nitems(Groceries)
nitems(g2)
inspect(head(g2, 3))
```

---

**Mushroom Data Set**

**Description**

The Mushroom data set includes descriptions of hypothetical samples corresponding to 23 species of gilled mushrooms in the Agaricus and Lepiota Family. It contains information about 8124 mushrooms (transactions). 4208 (51.8%) are edible and 3916 (48.2%) are poisonous. The data contains 22 nominal features plus the class attribute (edible or not). These features were translated into 114 items.

**Usage**

```r
data(Mushroom)
```

**Format**

Object of class `transactions`.

**Author(s)**

Michael Hahsler

**Source**

The data set was obtained from the UCI Machine Learning Repository at [http://archive.ics.uci.edu/ml/datasets/Mushroom](http://archive.ics.uci.edu/ml/datasets/Mushroom).

**References**

predict Model Predictions

Description

Provides the S4 method predict for itemMatrix (e.g., transactions). Predicts the membership (nearest neighbor) of new data to clusters represented by medoids or labeled examples.

Usage

```r
## S4 method for signature 'itemMatrix'
predict(object, newdata, labels = NULL, blocksize = 200,...)
```

Arguments

- `object`: medoids (no labels needed) or examples (labels needed).
- `newdata`: objects to predict labels for.
- `labels`: an integer vector containing the labels for the examples in `object`.
- `blocksize`: a numeric scalar indicating how much memory predict can use for big x and/or y (approx. in MB). This is only a crude approximation for 32-bit machines (64-bit architectures need double the blocksize in memory) and using the default Jaccard method for dissimilarity calculation. In general, reducing `blocksize` will decrease the memory usage but will increase the run-time.
- `...`: further arguments passed on to dissimilarity. E.g., method.

Value

An integer vector of the same length as `newdata` containing the predicted labels for each element.

Author(s)

Michael Hahsler

See Also

dissimilarity, itemMatrix-class

Examples

data("Adult")

```r
## sample
small <- sample(Adult, 500)
large <- sample(Adult, 5000)

## cluster a small sample
d_jaccard <- dissimilarity(small)
```
hc <- hclust(d_jaccard)
l <- cutree(hc, k=4)

## predict labels for a larger sample
labels <- predict(small, large, l)

## plot the profile of the 1. cluster
itemFrequencyPlot(large[labels==1, itemFrequency(large) > 0.1])

---

### proximity-classes

**Classes “dist”, “ar\_cross\_dissimilarity” and “ar\_similarities” — Proximity Matrices**

---

**Description**

Simple classes to represent proximity matrices. For compatibility with clustering functions in R, we represent dissimilarities as the S3 class `dist`. For cross-dissimilarities and similarities, we provide the S4 classes `ar_cross_dissimilarities` and `ar_similarities`.

**Objects from the Class**

- `dist` objects are the result of calling the method `dissimilarity` with one argument or any R function returning a S3 `dist` object.
- `ar_cross_dissimilarity` objects are the result of calling the method `dissimilarity` with two arguments, by calls of the form `new("similarity", ...)`, or by coercion from matrix.
- `ar_similarity` objects are the result of calling the method `affinity`, by calls of the form `new("similarity", ...)`, or by coercion from matrix.

**Slots**

The S4 classes have a method slot which contains the type of measure used for calculation.

**Author(s)**

Michael Hahsler

**See Also**

- `dist` (in package stats), `dissimilarity`, `affinity`.
random.transactions

Simulate a Random Transaction Data Set

Description

Simulates a random transactions object using different methods.

Usage

random.transactions(nItems, nTrans, method = "independent", ..., 
verbose = FALSE)

Arguments

nItems  an integer. Number of items.
nTrans  an integer. Number of transactions.
method  name of the simulation method used (default: all items occur independently).
...      further arguments used for the specific simulation method (see details).
verbose  report progress.

Details

The function generates a nitems times ntrans transaction database.
Currently two simulation methods are implemented:

**method "independent"** (see Hahsler et al., 2006) All items are treated as independent. The transaction size is determined by rpois(lambda - 1) + 1, where lambda can be specified (defaults to 3). Note that one subtracted from lambda and added to the size to avoid empty transactions. The items in the transactions are randomly chosen using the numeric probability vector iprob of length nitems (default: 0.01 for each item).

**method "agrawal"** (see Agrawal and Srikant, 1994) This method creates transactions with correlated items uses the following additional parameters:

- lTrans  average length of transactions.
-nPats  number of patterns (potential maximal frequent itemsets) used.
-IPats  average length of patterns.
-corr   correlation between consecutive patterns.
cmean  mean of the corruption level (normal distr.).
cvar   variance of the corruption level.

The simulation is a two-stage process. First, a set of nPats patterns (potential maximal frequent itemsets) is generated. The length of the patterns is Poisson distributed with mean lPats and consecutive patterns share some items controlled by the correlation parameter corr. For later use, for each pattern a pattern weight is generated by drawing from an exponential distribution with a mean of 1 and a corruption level is chosen from a normal distribution with mean cmean and variance cvar.
The patterns are created using the following function:

```r
random.patterns(nItems, nPats = 2000, method = "agrawal", lPats = 4, corr = 0.5, cmean = 0.5, cva = 0.5, null = TRUE, verbose = FALSE)
```

The function returns the patterns as an itemsets objects which can be supplied to `random.transactions` as the argument patterns. If no argument patterns is supplied, the default values given above are used.

In the second step, the transactions are generated using the patterns. The length the transactions follows a Poisson distribution with mean \( lPats \). For each transaction, patterns are randomly chosen using the pattern weights till the transaction length is reached. For each chosen pattern, the associated corruption level is used to drop some items before adding the pattern to the transaction.

**Value**

Returns an object of class `transactions`.

**Author(s)**

Michael Hahsler

**References**


**See Also**

`transactions-class`.

**Examples**

```r
## generate random 1000 transactions for 200 items with
## a success probability decreasing from 0.2 to 0.0001
## using the method described in Hahsler et al. (2006).
trans <- random.transactions(nItems = 200, nTrans = 1000,
                          lambda = 5, iprob = seq(0.2, 0.0001, length=200))

## size distribution
summary(size(trans))

## display random data set
image(trans)

## use the method by Agrawal and Srikant (1994) to simulate transactions
## which contains correlated items. This should create data similar to
## T10I4D100K (just only 1000 transactions)
```r
patterns <- random.patterns(nItems = 1000)
summary(patterns)

trans2 <- random.transactions(nItems = 1000, nTrans = 1000,
method = "agrawal", patterns = patterns)
image(trans2)

## plot data with items ordered by item frequency
image(trans2[, order(itemFrequency(trans2), decreasing=TRUE)])
```

---

**read.PMML**

**Read and Write PMML**

**Description**

This function reads and writes PMML representations (version 4.1) of associations (itemsets and rules).

**Usage**

```r
write.PMML(x, file)
read.PMML(file)
```

**Arguments**

- `x`     a rules or itemsets object.
- `file`  name of the PMML file (for read.PMML also a XML root node can be supplied).

**Details**

Write delegates to package pmml.

**Author(s)**

Michael Hahsler

**References**

PMML home page: http://www.dmg.org

**See Also**

pmml.
Examples

data("Groceries")

rules <- apriori(Groceries, parameter=list(support=0.001))
rules <- head(sort(rules, by="lift"))
rules

### save rules as PMML
write.PMML(rules, file = "rules.xml")

### read rules back
rules2 <- read.PMML("rules.xml")
rules2

### compare rules
inspect(rules[1])
inspect(rules2[1])

### clean up
unlink("rules.xml")

---

read.transactions  Read Transaction Data

Description

Reads a transaction data file from disk and creates a transactions object.

Usage

read.transactions(file, format = c("basket", "single"), sep = ",",
cols = NULL, rm.duplicates = FALSE,
quote = "\"",skip = 0,
encoding = "unknown")

Arguments

file  the file name.
format a character string indicating the format of the data set. One of "basket" or "single", can be abbreviated.
sep     a character string specifying how fields are separated in the data file. The default ("") splits at whitespaces.
cols  For the ‘single’ format, cols is a numeric or character vector of length two giving the numbers or names of the columns (fields) with the transaction and item ids, respectively. If character, the first line of file is assumed to be a header with column names. For the ‘basket’ format, cols can be a numeric scalar giving the number of the column (field) with the transaction ids. If cols = NULL, the data do not contain transaction ids.
**Details**

For ‘basket’ format, each line in the transaction data file represents a transaction where the items (item labels) are separated by the characters specified by `sep`. For ‘single’ format, each line corresponds to a single item, containing at least ids for the transaction and the item.

**Value**

Returns an object of class `transactions`.

**Author(s)**

Michael Hahsler and Kurt Hornik

**See Also**

transactions-class

**Examples**

```r
## create a demo file using basket format for the example
data <- paste(
  "# this is some test data",
  "item1, item2",
  "item1",
  "item2, item3",
  sep="\n")
cat(data)
write(data, file = "demo_basket")

## read demo data (skip comment line)
tr <- read.transactions("demo_basket", format = "basket", sep="","", skip = 1)
inspect(tr)

## create a demo file using single format for the example
## column 1 contains the transaction ID and column 2 contains one item
data <- paste(
  "trans1 item1",
  "trans2 item1",
  "trans2 item2",
  sep="\n")
cat(data)
write(data, file = "demo_single")
```
## ruleInduction

### Description

Provides the generic function and the needed S4 method to induce all rules which can be generated by the given itemsets from a transactions data set.

### Usage

```r
ruleInduction(x, ...)  
## S4 method for signature 'itemsets'
ruleInduction(x, transactions, confidence = 0.8,  
              control = NULL)
```

### Arguments

- `x`  the set of itemsets from which rules will be induced.
- `...` further arguments.
- `transactions`  the transaction data set used to mine the itemsets. Can be omitted if `x` contains a lattice (complete set) of frequent itemsets together with their support counts.
- `confidence`  a numeric value giving the minimum confidence for the rules.
- `control`  a named list with elements `method` indicating the method ("apriori" or "ptree"), and the logical arguments `reduce` and `verbose` to indicate if unused items are removed and if the output should be verbose. Currently, "ptree" is the default method.

### Details

If in `control method = "apriori"` is used, a very simple rule induction method is used. All rules are mined from the transactions data set using Apriori with the minimal support found in itemsets. And in a second step all rules which do not stem from one of the itemsets are removed. This procedure will be in many cases very slow (e.g., for itemsets with many elements or very low support).

If in `control method = "ptree"` is used, the transactions are counted into a prefix tree and then the rules are selectively generated using the counts in the tree. This is usually faster than the above approach.
If in control `reduce = TRUE` is used, unused items are removed from the data before creating rules. This might be slower for large transaction data sets. However, for `method = "ptree"` this is highly recommended as the items are further reordered to reduce the counting time.

If argument `transactions` is missing it is assumed that `x` contains a lattice (complete set) of frequent itemsets together with their support counts. Then rules can be induced directly without support counting. This approach is very fast.

For `transactions`, a set different to the data used for creating the original itemsets can be used, however, the new set has to conform in terms of items and their order.

**Value**

An object of class `rules`.

**Author(s)**

Christian Buchta and Michael Hahsler

**References**


**See Also**

`itemsets-class, rules-class transactions-class`

**Examples**

data("Adult")

```r
## find all closed frequent itemsets
closed <- apriori(Adult, parameter = list(target = "closed", support = 0.4))
closed

## rule induction
rules <- ruleInduction(closed, Adult, control = list(verbose = TRUE))
summary(rules)

## inspect the resulting rules
inspect(head(sort(rules, by = "lift")))

## use lattice of frequent itemsets
ec <- eclat(Adult, parameter = list(support = 0.4))
rec <- ruleInduction(ec)
rec
inspect(head(rec))
```
Class “rules” — A Set of Rules

Description

The rules class represents a set of rules.

Note that the class can also represent a multiset of rules with duplicated elements. Duplicated elements can be removed with unique.

Objects from the Class

Objects are the result of calling the function apriori. Objects can also be created by calls of the form new(“rules”, ...).

Slots

lhs: Object of class itemMatrix; the left-hand-sides of the rules (antecedents)

rhs: Object of class itemMatrix; the right-hand-sides of the rules (consequents)

quality: a data.frame

Extends

Class associations, directly.

Methods

coerce signature(from = "rules", to = "data.frame"): represents the set of rules as a data.frame

itemInfo signature(object = "rules"); returns the whole item information data frame including item labels

itemLabels signature(object = "rules"); returns the item labels used to encode the rules

items signature(x = "rules"); returns for each rule the union of the items in the lhs and rhs (i.e., the itemsets which generated the rule) as an itemMatrix

generatingItemsets signature(x = "rules"); returns a collection of the itemsets which generated the rules (one itemset for each rule). Note that the collection can be a multiset and contain duplicated elements. Use unique to remove duplicates and obtain a proper set.

labels signature(object = "rules"); returns labels for the rules ("lhs => rhs") as a character vector. The representation can be customized using the additional parameter ruleSep and parameters for label defined in itemMatrix

itemLabels signature(object = "rules"); returns the item labels as a character vector. The index for each label is the column index of the item in the binary matrix.

lhs signature(x = "rules"); returns the itemMatrix representing the left-hand-side of the rules (antecedents)
lhs <- signature(x = "rules"); replaces the itemMatrix representing the left-hand-side of the rules (antecedents)

rhs signature(x = "rules"); returns the itemMatrix representing the right-hand-side of the rules (consequents)

rhs<- signature(x = "rules"); replaces the itemMatrix representing the right-hand-side of the rules (consequents)

summary signature(object = "rules")

Author(s)

Michael Hahsler

See Also

[-methods, apriori, c, duplicated, inspect, length, match, sets, size, subset, associations-class, itemMatrix-class,

Examples

data("Adult")

## Mine rules.
rules <- apriori(Adult, parameter = list(support = 0.4))

## Select a subset of rules using partial matching on the items
## in the right-hand-side and a quality measure
rules.sub <- subset(rules, subset = rhs \%in\% "sex" & lift > 1.3)

## Display rules.
inspect(sort(rules.sub)[1:3])

## Get labels for rules
labels(rules.sub[1:3])
labels(rules.sub[1:3], itemSep = " + ", setStart = "", setEnd="",
ruleSep = " \rightarrow ")

Description

Provides the generic function sample and the S4 method to take a sample of the specified size from the elements of x using either with or without replacement. sample can be used to sample from a set of transactions or associations.
Usage

sample(x, size, replace = FALSE, prob = NULL, ...)

Arguments

x object to be sampled from (a set of associations or transactions).
size sample size.
replace a logical. Sample with replacement?
prob a numeric vector of probability weights.
... further arguments.

Value

An object of the same class as x.

Author(s)

Michael Hahsler

See Also

associations-class, transactions-class, itemMatrix-class.

Examples

data("Adult")

## sample with replacement
s <- sample(Adult, 500, replace = TRUE)
s

---

Description

Provides the generic functions and the S4 methods for the set operations union, intersect, setequal, setdiff and is.element on sets of associations (e.g., rules, itemsets) and itemMatrix.

Usage

union(x, y)
intersect(x, y)
setequal(x, y)
setdiff(x, y)
is.element(el, set)
Arguments

x, y, el, set   sets of associations or itemMatrix objects.

Details

All S4 methods for set operations are defined for the class name "ANY" in the signature, so they should work for all S4 classes for which the following methods are available: match, length and unique.

Value

union, intersect, setequal and setdiff return an object of the same class as x and y.

is.element returns a logic vector of length el indicating for each element if it is included in set.

Author(s)

Michael Hahsler

See Also

associations-class, itemMatrix-class

Examples

data("Adult")

## mine some rules
r <- apriori(Adult)

## take 2 subsets
r1 <- r[1:10]
r2 <- r[6:15]

union(r1,r2)
intersect(r1,r2)
setequal(r1,r2)

size                         Getting the Size of Each Element

Description

Provides the generic function size and S4 methods to get the size of each element from objects based on itemMatrix. For example, it is used to get a vector of transaction sizes (i.e., the number of present items (ones) per element (row) of the binary incidence matrix) from an object of class transactions.
Usage

size(x, ...)

Arguments

x

an object.

... further (unused) arguments.

Value

size returns a numeric vector of length length(x). Each element is the size of the corresponding element (row in the matrix) in object x. For rules, size returns the sum of the number of elements in the LHS and the RHS.

Author(s)

Michael Hahsler

See Also

itemMatrix-class, transactions-class

Examples

data("Adult")
summary(size(Adult))

---

sort Sorting Associations

Description

Provides the method sort to sort elements in class associations (e.g., itemsets or rules) according to the value of measures stored in the association’s slot quality (e.g., support).

Usage

## S4 method for signature 'associations'
sort(x, decreasing = TRUE, na.last = NA,
       by = "support", order = FALSE, ...)

---
Arguments

- `x`: an object to be sorted.
- `decreasing`: a logical. Should the sort be increasing or decreasing? (default is decreasing)
- `na.last`: for controlling the treatment of NAs. If TRUE, missing values in the data are put last; if FALSE, they are put first; if NA, they are removed.
- `by`: a character string specifying the quality measure stored in `x` to be used to sort `x`. If a vector of character strings is specified then the additional strings are used to sort `x` in case of ties.
- `order`: should an order vector be returned instead of the sorted associations?
- `...`: Further arguments are ignored.

Value

An object of the same class as `x`.

Author(s)

Michael Hahsler

See Also

- `associations-class`

Examples

```r
data("Adult")

## Mine rules with APRIORI
rules <- apriori(Adult, parameter = list(supp = 0.6))

## Print the 5 rules sorted by confidence and then support as a data.frame.
as(head(sort(rules, by = c("confidence", "support")), n=5), "data.frame")

## Order of rules by decreasing support
sort(rules, by = "confidence", order = TRUE)
```

Description

Provides the generic function `subset` and S4 methods to subset associations or transactions (item-Matrix) which meet certain conditions (e.g., contains certain items or satisfies a minimum lift).
Usage

subset(x, ...)

## S4 method for signature 'itemMatrix'
subset(x, subset, ...)

## S4 method for signature 'itemsets'
subset(x, subset, ...)

## S4 method for signature 'rules'
subset(x, subset, ...)

## S4 method for signature 'itemMatrix'
subset(x, subset, ...)

Arguments

x          object to be subsetted.
s subset    logical expression indicating elements to keep.
...         further arguments to be passed to or from other methods.

Details

dsubset works on the rows/itemsets/rules of \( x \). The expression given in subset will be evaluated using \( x \), so the items (lhs/rhs/items) and the columns in the quality data.frame can be directly referred to by their names.

Important operators to select itemsets containing items specified by their labels are \%in\% (select itemsets matching any given item), \%ain\% (select only itemsets matching all given item) and \%pin\% (\%in\% with partial matching).

Value

An object of the same class as \( x \) containing only the elements which satisfy the conditions.

Author(s)

Michael Hahsler

See Also

itemMatrix-class, itemsets-class, rules-class, transactions-class

Examples

data("Adult")
rules <- apriori(Adult)

## select all rules with item "marital-status=Never-married" in
## the right-hand-side and lift > 2
```r
rules.sub <- subset(rules, subset = rhs %in% "marital-status=Never-married" & lift > 2)

## use partial matching for all items corresponding to the variable
## "marital-status"
rules.sub <- subset(rules, subset = rhs %in% "marital-status=")

## select only rules with items "age=Young" and "workclass=Private" in
## the left-hand-side
rules.sub <- subset(rules, subset = lhs %in%
c("age=Young", "workclass=Private"))
```

---

**The SunBai Data Set**

**Description**

A small example database for weighted association rule mining provided as an object of class `transactions`.

**Usage**

```r
data(SunBai)
```

**Details**

The data set contains the example database described in the paper by K. Sun and F. Bai for illustration of the concepts of weighted association rule mining. Weight stored in `transactionInfo` denotes the transaction weights obtained using the HITS algorithm.

**Source**


**See Also**

Class `transactions`, method `transactionInfo`, function `hits`.

**Examples**

```r
data(SunBai)
summary(SunBai)
inspect(SunBai)

transactionInfo(SunBai)
```
Support Counting for Itemsets

Description

Provides the generic function and the needed S4 method to count support for given itemsets (and other types of associations) in a given transaction database.

Usage

```r
support(x, transactions, ...) # S4 method for signature 'itemMatrix'
support(x, transactions,
        type = c("relative", "absolute"), weighted = FALSE, control = NULL)
```

## S4 method for signature 'associations'
support(x, transactions,
        type = c("relative", "absolute"), weighted = FALSE, control = NULL)

Arguments

- **x**: the set of itemsets for which support should be counted.
- **transactions**: the transaction data set used for mining.
- **type**: a character string specifying if "relative" support or "absolute" support (counts) are returned for the itemsets in `x` (default: "relative")
- **weighted**: should support be weighted by transactions weights stored as column "weight" in `transactionInfo`?
- **control**: a named list with elements `method` indicating the method ("tidlists" or "ptree"), and the logical arguments `reduce` and `verbose` to indicate if unused items are removed and if the output should be verbose.

Details

Normally, itemset support is counted during mining the database with a set minimum support. However, if only the support information for a single or a few itemsets is needed, one might not want to mine the database for all frequent itemsets.

If in `control` method = "ptree" is used, the counters for the itemsets are organized in a prefix tree. The transactions are sequentially processed and the corresponding counters in the prefix tree are incremented (see Hahsler et al, 2008). This method is used by default since it is typically significantly faster than tid list intersection.

If in `control` method = "tidlists" is used, support is counted using transaction ID list intersection which is used by several fast mining algorithms (e.g., by Eclat). However, Support is determined for each itemset individually which is slow for a large number of long itemsets in dense data.

If in `control` `reduce` = `TRUE` is used, unused items are removed from the data before creating rules. This might be slower for large transaction data sets.
Value

A numeric vector of the same length as x containing the support values for the sets in x.

Author(s)

Michael Hahsler and Christian Buchta

References


See Also

itemMatrix-class, associations-class, transactions-class

Examples

data("Income")

## find and some frequent itemsets
itemsets <- eclat(Income)[1:5]

## inspect the support returned by eclat
inspect(itemsets)

## count support in the database
support(items(itemsets), Income)

supportingTransactions

**Supporting Transactions**

Description

Find transactions which support each of a set of associations and return this information as a transaction ID list.

Usage

supportingTransactions(x, transactions, ...)

Arguments

x a set of associations (itemsets, rules, etc.)
transactions an object of class transactions used to mine the associations in x.
... currently unused.
Details

The supporting transactions are all transactions of which the itemset representing the association is a subset of.

Value

An object of class tidylist containing one transaction ID list per association in x.

Author(s)

Michael Hahsler

See Also

tidylist-class

Examples

```r
data <- list(
c("a","b","c"),
c("a","b"),
c("a","b","d"),
c("b","e"),
c("b","c","e"),
c("a","d","e"),
c("a","c"),
c("a","b","d"),
c("c","e"),
c("a","b","d","e")
)
data <- as(data, "transactions")

## mine itemsets
f <- eclat(data, parameter = list(support = .2, minlen=3))
inspect(f)

## find supporting Transactions
st <- supportingTransactions(f, data)
st

as(st, "list")
```

```
Description

Transaction ID lists contains a set of lists. Each list is associated with an item/itemset and stores the IDs of the transactions which support the item/itemset. tidlists uses the class \texttt{ngCMatrix} to efficiently store the transaction ID lists as a sparse matrix. Each column in the matrix represents one transaction ID list.

tidLists can be used for different purposes. For some operations (e.g., support counting) it is efficient to coerce a \texttt{transactions} database into tidLists where each list contains the transaction IDs for an item (and the support is given by the length of the list).

The implementation of the Eclat mining algorithm (which uses transaction ID list intersection) can also produce transaction ID lists for the found itemsets as part of the returned \texttt{itemsets} object. These lists can then be used for further computation.

Objects from the Class

Objects are created by Eclat if the \texttt{eclat} function is called with \texttt{tidLists = TRUE} in the \texttt{EC}parameter object, and returned as part of the mined \texttt{itemsets}. Objects can also be created by coercion from an object of class \texttt{transactions} or by calls of the form \texttt{new("tidLists", ...)}.

Slots

data: object of class \texttt{ngCMatrix}.

itemInfo: a data.frame to store item/itemset labels (see \texttt{itemMatrix} class).

transactionInfo: a data.frame with vectors of the same length as the number of transactions. Each vector can hold additional information e.g., store transaction IDs or user IDs for each transaction.

Methods

c\texttt{oerce} signature(from = "tidLists", to = "ngCMatrix"); access the sparse matrix representation. In the ngCMatrix each column represents the transaction IDs for one item/itemset.

c\texttt{oerce} signature(from = "tidLists", to = "list")

c\texttt{oerce} signature(from = "list", to = "tidLists")

c\texttt{oerce} signature(from = "tidLists", to = "matrix")

c\texttt{oerce} signature(from = "tidLists", to = "itemMatrix")

c\texttt{oerce} signature(from = "tidLists", to = "transactions")

c\texttt{oerce} signature(from = "itemMatrix", to = "tidLists"): this also coerces from \texttt{transactions}.

c\texttt{oerce} signature(from = "transactions", to = "tidLists")

c\texttt{signature}(x = "tidLists"): combine.

dim signature(x = "tidLists"); returns the dimensions of the sparse Matrix representing the tidLists.

dimnames, rownames, colnames signature(x = "transactions"); returns row (items/itemsets) and column (transactionIDs if available) names.

labels signature(x = "transactions"); returns the labels for the itemsets in each transaction (see \texttt{itemMatrix}).
inspect inspect the transaction ID lists.
itemInfo returns the slot itemInfo.
itemLabels signature(object = "tidLists"): returns the item labels as a character vector.
lables signature(x = "transactions"): returns the labels (transaction IDs).
show signature(object = "tidLists")
summary signature(object = "tidLists")
transactionInfo signature(x = "transactions"): returns the slot transactionInfo.

Author(s)
Michael Hahsler

See Also
[-methods, LIST, eclat, image, length, size, ngCMatrix(in Matrix), itemMatrix-class, itemsets-class, transactions-class

Examples

## Create transaction data set.
data <- list(
  c("a","b","c"),
  c("a","b"),
  c("a","b","d"),
  c("b","e"),
  c("b","c","e"),
  c("a","d","e"),
  c("a","c"),
  c("a","b","d"),
  c("c","e"),
  c("a","b","d","e")
)
data <- as(data, "transactions")
data

## convert transactions to transaction ID lists
tl <- as(data, "tidLists")
tl

inspect(tl)
dim(tl)
dimnames(tl)

## inspect visually
image(tl)

## mine itemsets with transaction ID lists
f <- eclat(data, parameter = list(support = 0, tidLists = TRUE))
tl2 <- tidLists(f)
inspect(tl2)
Class "transactions" — Binary Incidence Matrix for Transactions

**Description**

The `transactions` class represents transaction data used for mining itemsets or rules. It is a direct extension of class `itemMatrix` to store a binary incidence matrix, item labels, and optionally transaction IDs and user IDs.

**Details**

Transactions can be created by coercion from lists containing transactions, but also from matrix and data.frames. However, you will need to prepare your data first. Association rule mining can only use items and does not work with continuous variables.

For example, an item describing a person (i.e., the considered object called a transaction) could be `tall`. The fact that the person is tall would be encoded in the transaction containing the item `tall`. This is typically encoded in a transaction-by-items matrix by a TRUE value. This is why `as.transaction` can deal with logical columns, because it assumes the column stands for an item. The function also can convert columns with nominal values (i.e., factors) into a series of binary items (one for each level). So if you have nominal variables then you need to make sure they are factors (and not characters or numbers) using something like

```r
data[, "a_nominal_var"] <- factor(data[, "a_nominal_var"]).
```

Continuous variables need to be discretized first. An item resulting from discretization might be `age>18` and the column contains only TRUE or FALSE. Alternatively it can be a factor with levels `age<=18`, `50=>age>18` and `age>50`. These will be automatically converted into 3 items, one for each level. Have a look at the function `discretize` for automatic discretization.

Complete examples for how to prepare data can be found in the man pages for `Income` and `Adult`.

**Objects from the Class**

Objects are created by coercion from objects of other classes (see Examples section) or by calls of the form `new("transactions", ...)`.

**Slots**

- `transactionInfo`: a data.frame with vectors of the same length as the number of transactions. Each vector can hold additional information, e.g., store transaction IDs or user IDs for each transaction.
- `data`: object of class `ngCMatrix` to store the binary incidence matrix (see `itemMatrix` class)
- `itemInfo`: a data.frame to store item labels (see `itemMatrix` class)

**Extends**

Class `itemMatrix`, directly.
Methods

coerce signature(from = "matrix", to = "transactions"); produces a transactions data set from a binary incidence matrix. The row names are used as item labels and the column names are stores as transaction IDs.

coerce signature(from = "transactions", to = "matrix"); coerces the transactions data set into a binary incidence matrix.

coerce signature(from = "list", to = "transactions"); produces a transactions data set from a list. The names of the items in the list are used as item labels and the item IDs and the incidence matrix is produced automatically.

coerce signature(from = "transactions", to = "list"); coerces the transactions data set into a list of transactions. Each transaction is a vector of character strings (names of the contained items).

coerce signature(from = "data.frame", to = "transactions"); recodes the data frame containing only categorical variables (factors) or logicals all into a binary transaction data set. For binary variables only TRUE values are converted into items and the item label is the variable name. For factors, a dummy item for each level is automatically generated. Item labels are generated by concatenating variable names and levels with "=". The original variable names and levels are stored in the itemInfo data frame as the components variables and levels. Note that NAs are ignored (i.e., do not generate an item).

coerce signature(from = "transactions", to = "data.frame"); represents the set of transactions in a printable form as a data.frame. Note that this does not reverse coercion from data.frame to transactions.

coerce signature(from = "ngCMatrix", to = "transactions"); Note that the ngCMatrix needs to have the items as rows!

dimnames, rownames, colnames signature(x = "transactions"); returns row (transactionID) and column (item) names.

labels signature(x = "transactions"); returns the labels for the itemsets in each transaction (see itemMatrix).

transactionInfo<- signature(x = "transactions"); replaces the transactionInfo data frame

transactionInfo signature(x = "transactions"); returns transactionInfo

show signature(object = "transactions")

summary signature(object = "transactions")

Author(s)

Michael Hahsler

See Also

[methods, discretize, LIST, write, c, image, inspect, read.transactions, random.transactions, sets, itemMatrix-class]
Examples

```r
## example 1: creating transactions form a list
a_list <- list(
  c("a","b","c"),
  c("a","b"),
  c("a","b","d"),
  c("c","e"),
  c("a","b","d","e")
)

## set transaction names
names(a_list) <- paste("Tr",c(1:5), sep="")
a_list

## coerce into transactions
trans1 <- as(a_list, "transactions")

## analyze transactions
summary(trans1)
image(trans1)

## example 2: creating transactions from a matrix
a_matrix <- matrix(c(
  1,1,1,0,0,
  1,1,0,0,0,
  1,1,0,1,0,
  0,0,1,0,1,
  1,1,0,1,1), ncol = 5)

## set dim names
dimnames(a_matrix) <- list(c("a","b","c","d","e"),
paste("Tr",c(1:5), sep=""))
a_matrix

## coerce
trans2 <- as(a_matrix, "transactions")
trans2
inspect(trans2)

## example 3: creating transactions from data.frame
a_df <- data.frame(
  age  = as.factor(c(6, 8, NA, 9, 16)),
  grade = as.factor(c("A", "C", "F", NA, "C")),
  pass  = c(TRUE, TRUE, FALSE, TRUE, TRUE))

## note: factors are translated differently to logicals and NAs are ignored
a_df

## coerce
trans3 <- as(a_df, "transactions")
inspect(trans3)
```
as(trans3, "data.frame")

## example 4: creating transactions from a data.frame with
## transaction IDs and items
a_df3 <- data.frame(
  TID = c(1,1,2,2,2,3),
  item=c("a","b","a","b","c", "b")
)
a_df3
trans4 <- as(split(a_df3[,"item"], a_df3[,"TID"]), "transactions")
trans4
inspect(trans4)

_________________________

unique Remove Duplicated Elements from a Collection

_________________________

Description

Provides the generic function unique and the S4 methods for itemMatrix. unique uses duplicated to return an itemMatrix with the duplicate elements removed.

Note that unique can also be used on collections of associations.

Usage

unique(x, incomparables = FALSE, ...)

Arguments

x an object of class itemMatrix or associations.

... further arguments (currently unused).

incomparables currently unused.

Value

An object of the same class as x with duplicated elements removed.

Author(s)

Michael Hahsler

See Also

duplicated, associations-class, itemMatrix-class
### Examples

```r
data("Adult")

r1 <- apriori(Adult[1:1000], parameter = list(support = 0.5))
r2 <- apriori(Adult[1001:2000], parameter = list(support = 0.5))

## Note that this produces a collection of rules from two sets
r_comb <- c(r1, r2)
r_comb <- unique(r_comb)
r_comb
```

---

**weclat**  
*Mining Associations from Weighted Transaction Data with Eclat*

**Description**

Find frequent itemsets with the Eclat algorithm. This implementation uses optimized tidlist joins and transaction weights.

**Usage**

```r
weclat(data, parameter = NULL, control = NULL)
```

**Arguments**

- `data`  
  an object that can be coerced into an object of class `transactions`.

- `parameter`  
  an object of class `asParameter` (default values: support = 0.1, minlen = 1L, and maxlen = 5L) or a named list with corresponding components.

- `control`  
  an object of class `asControl` (default values: verbose = TRUE) or a named list with corresponding components.

**Details**

The weighted support of an itemset is the sum of the weights of the transactions that contain the itemset. An itemset is frequent if its weighted support is equal or greater than the threshold specified by `support` (assuming that the weights sum to one).

**Value**

Returns an object of class `itemsets`. Note that weighted support is returned in quality as column support.

**Note**

The C code can be interrupted by CTRL-C. This is convenient but comes at the price that the code cannot clean up its internal memory. This is a known problem of the R API and the workaround is to defer the cleanup to the next function call.
Author(s)

Christian Buchta

See Also

Class transactions, function ruleInduction, eclat

Examples

data(SunBai)
s <- weclat(SunBai, parameter = list(support = 0.3),
control = list(verbosce = TRUE))
inspect(sort(s))

r <- ruleInduction(s, confidence = .9)
inspect(r)

write(x, file = "", ...)  # S4 method for signature 'transactions'
write(x, file="", format = c("basket", "single"),
sep=" ", quote=TRUE, ...)
write(x, file="", sep=" ", quote=TRUE, ...)

Arguments

x the transactions or associations (rules, itemsets, etc.) object.
file either a character string naming a file or a connection open for writing. "" indicates output to the console.
format format to write transactions.
sep the field separator string. Values within each row of x are separated by this string. Use quote=TRUE and sep=" ", " for saving data as in csv format.
Methods for "[": Extraction or Subsetting in Package 'arules'

Description

Methods for "[", i.e., extraction or subsetting in package arules. Subsetting can be done by integers containing column/row numbers, vectors of logicals or strings containing parts of item labels.
Methods

[ signature(x = "itemMatrix", i = "ANY", j = "ANY", drop = "ANY"); extracts parts of an itemMatrix. The first argument selects rows (e.g., transactions or rules) and the second argument selects columns (items). Either argument can be omitted to select all rows or columns.

[ signature(x = "itemsets", i = "ANY", j = "ANY", drop = "ANY"); extracts a subset of itemsets and the associated quality measures. j has to be missing.

[ signature(x = "rules", i = "ANY", j = "ANY", drop = "ANY"); extracts a subset of rules and the associated quality measures. j has to be missing.

[ signature(x = "transactions", i = "ANY", j = "ANY", drop = "ANY"); extracts a subset of transactions/items from a transactions object (a binary incidence matrix). i and j can be numeric where i selects transactions and j selects items.

[ signature(x = "tidLists", i = "ANY", j = "ANY", drop = "ANY"); extracts parts (transaction ID vectors) from tidLists. i selects the items or itemsets and j selects transactions in the lists.

Author(s)

Michael Hahsler

See Also

itemMatrix-class, itemsets-class, rules-class, transactions-class, tidLists-class

Examples

data(Adult)
Adult

## select first 10 transactions
Adult[1:10]

## select first 10 items for first 100 transactions
Adult[1:100, 1:10]

## select the first 100 transactions for the items containing
## "income" or "age=Young" in their labels
Adult[1:100, c("income=small", "income=large", "age=Young")]


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