

Package ‘PRISMA’

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Type Package

Title Protocol Inspection and State Machine Analysis

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Suggests tm (>= 0.6)

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Description The PRISMA package is capable of loading and processing huge text corpora processed with the sally toolbox (<http://www.mlsec.org/sally/>). sally acts as a very fast preprocessor which splits the text files into tokens or n-grams. These output files can then be read with the PRISMA package which applies testing-based token selection and has some replicate-aware, highly tuned non-negative matrix factorization and principal component analysis implementation which allows the processing of very big data sets even on desktop machines.

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 PRISMA-package

PRISMA - Protocol Inspection and State Machine Analysis

Description

The PRISMA package is capable of loading and processing huge text corpora processed with the sally toolbox (<http://www.mlsec.org/sally/>). sally acts as a very fast preprocessor which splits the text files into tokens or n-grams. These output files can then be read with the PRISMA package which applies testing-based token selection and has some replicate-aware, highly tuned non-negative matrix factorization and principal component analysis implementation which allows the processing of very big data sets even on desktop machines.

Details

Package: PRISMA
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Author(s)

Tammo Krueger, Nicole Kraemer

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References

Krueger, T., Gascon, H., Kraemer, N., Rieck, K. (2012) Learning Stateful Models for Network Honeypots *5th ACM Workshop on Artificial Intelligence and Security (AISEC 2012)*, accepted

Krueger, T., Kraemer, N., Rieck, K. (2011) ASAP: Automatic Semantics-Aware Analysis of Network Payloads *Privacy and Security Issues in Data Mining and Machine Learning - International ECML/PKDD Workshop. Lecture Notes in Computer Science 6549*, Springer. 50 - 63

Examples

```
data(asap)
plot(asap)
asapDim = estimateDimension(asap)
plot(asapDim)
asapNMF = prismaNMF(asap, asapDim, time=120)
plot(asapNMF, minValue=.2)
```

asap

The ASAP Data Set

Description

Toy data set to show the capabilities of the PRISMA package.

Usage

asap

Format

A prisma object.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

References

Krueger, T., Kraemer, N., Rieck, K. (2011) ASAP: Automatic Semantics-Aware Analysis of Network Payloads *Privacy and Security Issues in Data Mining and Machine Learning - International ECML/PKDD Workshop. Lecture Notes in Computer Science 6549*, Springer. 50 - 63

corpusToPrisma

Convert tm corpus to PRISMA

Description

Converts a tm corpus object to a PRISMA object.

Usage

```
corpusToPrisma(corpus, alpha = 0.05, skipFeatureCorrelation = FALSE)
```

Arguments

corpus a tm corpus
 alpha significance level for the feature tests. If NULL, all features are kept.
 skipFeatureCorrelation should the grouping of features based on correlation analysis be skipped.

Value

prismaData data object representing the tokenized documents as features x samples matrix.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

Examples

```
data(thesis)
thesis
thesis = corpusToPrisma(thesis, NULL, TRUE)
thesis
```

estimateDimension *Estimate Inner Dimension*

Description

Matrix factorization methods compress the original data matrix $A \in R^{f,N}$ with f features and N samples into two parts, namely $A = BC$ with $B \in R^{f,k}$, $C \in R^{k,N}$. The function estimateDimension estimates k based on a noise model estimated from a scrambled version of the original data matrix.

Usage

```
estimateDimension(prismaData, alpha = 0.05, nScrambleSamples = NULL)
```

Arguments

prismaData A prismaData object loaded via loadPrismaData
 alpha Error probability for confidence intervals
 nScrambleSamples The number of scrambled samples that should be used to estimate the noise model. NULL means to use the complete data set.

Value

estDim prismaDimension object that can be printed and plotted.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

References

R. Schmidt. Multiple emitter location and signal parameter estimation. *IEEE Transactions on Antennas and Propagation*, 34(3):276 – 280, 1986.

Examples

```
data(asap)
asapDim = estimateDimension(asap)
plot(asapDim)
```

`getDuplicateData` *Restores Data with Duplicates*

Description

The [loadPrismaData](#) function triggers a feature selection and data combination methods which subsequently remove duplicate entries for efficient representation of the data. The [getDuplicateData](#) rebuilds the data matrix with explicit representation of all duplicate entries.

Usage

```
getDuplicateData(prismaData)
```

Arguments

`prismaData` prisma data loaded via [loadPrismaData](#)

Value

`dataWithDuplicates`
Data matrix containing explicit copies of all duplicates.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

Examples

```
data(asap)
dataWithDuplicates = getDuplicateData(asap)
```

`getMatrixFactorizationLabels`*Convert Coordinates of Matrix Factorization to Labels*

Description

Given a matrix factorization object $A = BC$, this function returns for each document the index of the inner dimension which has the maximal coordinate. Thus, it converts the fuzzy clustering found in the columns of the C matrix into a hard clustering by returning the position with the maximal coordinate value.

Usage

```
getMatrixFactorizationLabels(prismaMF)
```

Arguments

`prismaMF` a matrix factorization object.

Value

`labels` vector containing the label assignment for each document.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

See Also

[prismaNMF](#)

`loadPrismaData`*Load PRISMA Data Files*

Description

Loads files generated by the sally tool (see <http://www.mlsec.org/sally/>) and represents the data as binary token/ngrams x documents matrix. After loading, statistical tests are applied to find features which are not volatile nor constant. Co-occurring features are grouped to further compactify the data. See `system.file("extdata", "sallyPreprocessing.py", package="PRISMA")` for a Python script which generates the corresponding `.fsally` file from a `.sally` file which reduce the loading time via `loadPrismaData` considerably.

Usage

```
loadPrismaData(path, maxLines = -1, fastSally = TRUE,  
               alpha = 0.05, skipFeatureCorrelation=FALSE)
```

Arguments

path	path of the data file without the .sally extension. loadPrisma loads path.sally or path.fsally depending on the fastSally switch.
maxLines	maximal number of lines to read from the data file. -1 means to read all lines.
fastSally	should the fsally file be used, which drastically decreases loading time.
alpha	significance level for the feature tests. If NULL, all features are kept.
skipFeatureCorrelation	should the grouping of features based on correlation analysis be skipped.

Value

prismaData	data object representing the tokenized documents as features x samples matrix.
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Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

References

See <http://www.mlsec.org/sally/> for the sally utility.

Examples

```
# please extract system.file("extdata","asap.tar.gz", package="PRISMA")
# before running this example
asap = loadPrismaData(system.file("extdata","asap", package="PRISMA"))
```

plot.prisma

Generics For PRISMA Objects

Description

Print and plot generic for the PRISMA objects.

Usage

```
## S3 method for class 'prisma'
print(x, ...)
## S3 method for class 'prisma'
plot(x, ...)
```

Arguments

x	PRISMA data loaded via loadPrismaData
...	not used

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

See Also

[estimateDimension](#), [prismaHclust](#), [prismaDuplicatePCA](#), [prismaNMF](#)

Examples

```
data(asap)
print(asap)
plot(asap)
```

plot.prismaDimension *Generics For PRISMA Objects*

Description

Print and plot generic for the PRISMA dimension objects.

Usage

```
## S3 method for class 'prismaDimension'
print(x, ...)
## S3 method for class 'prismaDimension'
plot(x, ...)
```

Arguments

x	PRISMA dimension object generated via estimateDimension
...	not used

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

See Also

[estimateDimension](#), [prismaHclust](#), [prismaDuplicatePCA](#), [prismaNMF](#)

Examples

```
data(asap)
asapDim = estimateDimension(asap)
print(asapDim)
plot(asapDim)
```


Description

Print and plot generic for the PRISMA matrix factorization objects.

Usage

```
## S3 method for class 'prismaMF'  
plot(x, nLines = NULL, baseIndex = NULL, sampleIndex = NULL,  
minValue = NULL, noRowClustering = FALSE, noColClustering = FALSE, type  
= c("base", "coordinates"), ...)
```

Arguments

x	PRISMA matrix factorization object
nLines	number of lines that should be plotted
baseIndex	which bases should be plotted
sampleIndex	which samples should be plotted
minValue	cut-off value, i.e., every value smaller than minValue won't be shown
noRowClustering	don't cluster the rows
noColClustering	don't cluster the columns
type	show the base (type = "base", i.e. the B matrix) or show the coordinate (type = "coordinates", i.e. the C matrix).
...	not used

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

See Also

[estimateDimension](#), [prismaHclust](#), [prismaDuplicatePCA](#), [prismaNMF](#)

Examples

```
data(asap)  
asapDim = estimateDimension(asap)  
asapNMF = prismaNMF(asap, asapDim, time=120)  
plot(asapNMF, minValue=.2)
```

prismaDuplicatePCA *Matrix Factorization Based on Replicate-Aware PCA*

Description

Efficient implementation of a replicate-aware principal component analysis (PCA).

Usage

```
prismaDuplicatePCA(prismaData)
```

Arguments

prismaData PRISMA data for which a PCA should be calculated

Value

prismaPCA Matrix factorization object $A = B C$, in which the factors are calculated by a replicate-aware PCA

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

Examples

```
data(asap)
asapPCA = prismaDuplicatePCA(asap)
```

prismaHclust *Matrix Factorization Based on Hierarchical Clustering*

Description

A matrix factorization $A = BC$ based on the results of hclust is constructed, which holds the mean feature values for each cluster in the matrix B and the indication of the cluster in the matrix C for each data point (i.e. each data point is represented by its assigned cluster center).

Usage

```
prismaHclust(prismaData, ncomp, method = "single")
```

Arguments

prismaData PRISMA data for which a clustering should be calculated.
ncomp the number of components that should be extracted.
method the method used for clustering.

Value

prismaHclust Matrix factorization object containing B and C resulting from the hierarchical clustering of the data.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

See Also

[hclust](#)

Examples

```
data(asap)
asapHclust = prismaHclust(asap)
```

prismaNMF

Matrix Factorization Based on Replicate-Aware NMF

Description

Matrix factorization $A = BC$ with strictly positive matrices B, C which minimize the reconstruction error $\|A - BC\|$. This replicate-aware version of the non-negative matrix factorization (NMF) is based on the alternating least squares approach and exploits the replicate information to speed up the calculation.

Usage

```
prismaNMF(prismaData, ncomp, time = 60, pca.init = TRUE, doNorm = TRUE, oldResult = NULL)
```

Arguments

prismaData	PRISMA data for which a NMF should be calculated.
ncomp	either an integer or prismaDimension object specifying the inner dimension of the matrix factorization.
time	seconds after which the calculation should end.
pca.init	should the B matrix be initialized by a PCA.
doNorm	should the B matrix be normalized (i.e. all columns have the Euclidean length of 1).
oldResult	re-use results of a previous run, i.e. B and C are pre-initialized with the values of this previous matrix factorization object.

Value

prismaNMF Matrix factorization object containing the B and C matrix.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

References

Krueger, T., Gascon, H., Kraemer, N., Rieck, K. (2012) Learning Stateful Models for Network Honeypots *5th ACM Workshop on Artificial Intelligence and Security (AISEC 2012)*, accepted

R. Albright, J. Cox, D. Duling, A. Langville, and C. Meyer. (2006) Algorithms, initializations, and convergence for the nonnegative matrix factorization. *Technical Report 81706, North Carolina State University*

Examples

```
data(asap)
print(asap)
plot(asap)
asapDim = estimateDimension(asap)
print(asapDim)
plot(asapDim)
# let it run for 60 second
asapNMF = prismaNMF(asap, asapDim, time=60)
plot(asapNMF, minValue=0.2)
# ...and for another 60 seconds re-using the results from the previous run
asapNMF = prismaNMF(asap, asapDim, time=60, oldResult=asapNMF)
plot(asapNMF, minValue=0.2)
labels = getMatrixFactorizationLabels(asapNMF)
```

thesis

The Thesis Data Set

Description

The 15 sections of a thesis (see references) as a tm-corpus.

Usage

thesis

Format

A tm-corpus.

Author(s)

Tammo Krueger <tammokrueger@googlemail.com>

References

Tammo Krueger. *Probabilistic Methods for Network Security. From Analysis to Response*. PhD thesis, TU Berlin, 2013. <http://opus.kobv.de/tuberlin/volltexte/2013/3881/>

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