Package 'MetaNLP'

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Type Package

Title Natural Language Processing for Meta Analysis

Version 0.1.4

Description Given a CSV file with titles and abstracts, the package creates a document-term matrix that is lemmatized and stemmed and can directly be used to train machine learning methods for automatic title-abstract screening in the preparation of a meta analysis.

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Imports glmnet, tm, textstem, methods, lexicon, utils

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BugReports https://github.com/imbi-heidelberg/MetaNLP/issues

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Contents

`delete_stop_words` *Delete stop words*

Description

Usually, stop words do not offer useful information in the classification whether a paper should be included or excluded from a meta-analysis. Thus, such words should not be part of the document-term matrix. This function allows the user to automatically delete stop words.

Usage

```
delete_stop_words(object, ...)

## S4 method for signature 'MetaNLP'
delete_stop_words(object, ...)
```

Arguments

`object`	A MetaNLP object, whose data frame is to be modified.
`...`	Language of the stop words. Defaults to "english".

Details

This function allows to delete stop words from different languages. Supported languages are `english`, `french`, `german`, `russian` and `spanish`. Language names are case sensitive.

Value

An object of class `MetaNLP`.

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
obj <- delete_stop_words(obj, "english")
```

`delete_words` *Delete list of words*

Description

There can be words that do not offer additional information in the classification whether a paper should be included or excluded from a meta-analysis. Thus, such words should not be part of the document-term matrix. This function allows the user to remove these columns of the word count matrix by specifying a vector of words to delete.

Usage

```
delete_words(object, delete_list)

## S4 method for signature 'MetaNLP,character'
delete_words(object, delete_list)
```

Arguments

`object`	A MetaNLP object, whose data frame is to be modified
`delete_list`	A character vector containing the words to be deleted

Details

The words in `delete_list` can be given like they appear in the text. They are lemmatized and stemmed by `delete_words` to match the columns of the document-term matrix.

Value

An object of class `MetaNLP`

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
del_words <- c("beautiful", "considering", "found")
obj <- delete_words(obj, del_words)
```

MetaNLP *Natural Language Processing for Meta Analysis*

Description

The **MetaNLP** package provides methods to quickly transform a CSV-file with titles and abstracts to an R data frame that can be used for automatic title-abstract screening using machine learning.

A `MetaNLP` object is the base class of the package **MetaNLP**. It is initialized by passing the path to a CSV file and constructs a data frame whose column names are the words that occur in the titles and abstracts and whose cells contain the word frequencies for each paper.

Usage

```
MetaNLP(
  file,
  bounds = c(2, Inf),
  word_length = c(3, Inf),
  language = "english",
  weighting = "frequency",
  ...
)
```

Arguments

`file`	Either the path to the CSV file or a data frame containing the abstracts
`bounds`	An integer vector of length 2. The first value specifies the minimum number of appearances of a word to become a column of the word count matrix, the second value specifies the maximum number. Defaults to `c(2, Inf)`. Note that the bounds are with respect to the potentially weighted entries of the matrix.
`word_length`	An integer vector of length 2. The first value specifies the minimum number of characters of a word to become a column of the word count matrix, the second value specifies the maximum number. Defaults to `c(3, Inf)`.
`language`	The language for lemmatization and stemming. Supported languages are `english`, `french`, `german`, `russian` and `spanish`. For non-english languages make sure that the csv which is processed has the correct encoding.
`weighting`	A weighting function for the entries of the document-term matrix. Default is "frequency", other options are "binary" and "tf-idf".
`...`	Additional arguments passed on to `read.csv2`, e.g. when "," should be used as a separator or when the encoding should be changed. See read.table.

Details

An object of class `MetaNLP` contains a slot data_frame where the document-term matrix is stored as a data frame. The CSV file must have a column `ID` to identify each paper, a column `title` with the belonging titles of the papers and a column `abstract` which contains the abstracts. If the CSV

stores training data, a column `decision` should exist, indicating whether an abstract is included in the meta analysis. This column does not need to exist, because there is no decision for test data yet. Allowed values in this column are either "yes" and "no" or "include" and "exclude" or "maybe". The value "maybe" is handled as a "yes"/"include".

Value

An object of class `MetaNLP`

Note

To ensure correct processing of the data when there are special characters (e.g. "é" or "ü"), make sure that the csv-file is correctly encoded as `UTF-8`. The stemming algorithm makes use of the C libstemmer library generated by Snowball. When german texts are stemmed, umlauts are replaced by their non-umlaut equivalent, so "ä" becomes "a" etc.

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See Also

Useful links:

- https://github.com/imbi-heidelberg/MetaNLP
- Report bugs at https://github.com/imbi-heidelberg/MetaNLP/issues

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
```

`plot,MetaNLP,missing-method`

Create bar plot from MetaNLP-object

Description

This method creates a bar plot from a MetaNLP object, displaying the most frequent word stems.

Usage

```
## S4 method for signature 'MetaNLP,missing'
plot(
  x,
  y = NULL,
  n = 10,
  decision = c("total", "include", "exclude"),
  stop_words = FALSE,
  ...
)
```

Arguments

`x`	A MetaNLP object to plot
`y`	not used
`n`	Number of bars
`decision`	Stratify bar plot by decision. Default is no stratification.
`stop_words`	Boolean to decide whether stop words shall be included in the summary. `stop_words = TRUE` means, that stop words are included.
`...`	Additional parameters for `delete_stop_words` (e.g. language of the stop words).

Value

nothing

Note

Note that "most frequent" here refers to the entries of the document-term matrix. If "binary" or "tf-idf" weighting was chosen, the displayed values are in terms of the weighted entries.

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
plt <- plot(obj)
```

read_test_data *Read and adapt test data*

Description

This function takes a MetaNLP object (the training data) and the test data. The function creates the document-term matrix from the test data and matches the columns of the given training MetaNLP object with the columns of the test document-term matrix. This means that columns, which do appear in the test document-term matrix but not in the training document-term matrix are removed; columns that appear in the training document-term matrix but not in the test document-term matrix are added as a column consisting of zeros.

Usage

```
read_test_data(object, ...)

## S4 method for signature 'MetaNLP'
read_test_data(object, file, ...)
```

Arguments

object	The MetaNLP object created from the training data.
...	Further arguments to MetaNLP.
file	Either the path to the test data csv, the data frame containing the papers or a MetaNLP object

Value

An object of class MetaNLP

Examples

```
path_train <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
path_test <- system.file("extdata", "test_data_changed.csv", package = "MetaNLP", mustWork = TRUE)
obj_train <- MetaNLP(path_train)
obj_test <- MetaNLP(path_test)
to_test_obj <- read_test_data(obj_train, obj_test)
```

replace_special_characters

Replace special characters in column names

Description

When using non-english languages, the column names of the document-term matrix can contain special characters. These might lead to encoding problems, when this matrix is used to train a machine learning model. This functions automatically replaces all special characters by the nearest equivalent character, e.g. "é" would be replaced by "e".

Usage

```
replace_special_characters(object)

## S4 method for signature 'MetaNLP'
replace_special_characters(object)
```

Arguments

object	An object of class MetaNLP.

Value

An object of class MetaNLP, where the column names do not have special characters anymore.

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path, language = "french")
obj <- replace_special_characters(obj)
```

select_features

Select features via elasticnet regularization

Description

As the document-term matrix quickly grows with an increasing number of abstracts, it can easily reach several thousand columns. Thus, it can be important to extract the columns that carry most of the information in the decision making process. This function uses a generalized linear model combined with elasticnet regularization to extract these features. In contrast to a usual regression model or a L2 penalty (ridge regression), elasticnet (and LASSO) sets some regression parameters to 0. Thus, the selected features are exactly the features with a non-zero entry.

Usage

```
select_features(object, ...)

## S4 method for signature 'MetaNLP'
select_features(object, alpha = 0.8, lambda = "avg", seed = NULL, ...)
```

Arguments

object	An object of class MetaNLP
...	Additional arguments for cv.glmnet. An important option might be type.measure to specify which loss is used when the cross validation is executed.
alpha	The elastic net mixing parameter, with $0 \leq \alpha \leq 1$. alpha = 1 then equals the lasso penalty, alpha = 0 is the ridge penalty.
lambda	The weight parameter of the penalty. The possible values are "avg", "min", "1se" or a numeric value which directly determines λ. When choosing "avg", "min" or "1se", cross validation is executed to determine λ. Note that cross validation uses random folds, so the results are not necessarily replicable. "avg" calls select_features 10 times, computes the λ which minimizes the loss for each iteration and then uses the median of these values as the final value, for which the objective function is minimized. "min" and "1se" carry out the cross validation just once and λ is either the value, for which the cross-validated error is minimized (option "min") or the value, that gives the most regularized model such that the cross-validated error is within one standar error of the minimum (option "1se").
seed	A numeric value which is used as a local seed for this function. Default is seed = NULL, so no seed is set. Setting a seed leads to replicable results of the cross validation, such that each call of select_features selects the same columns. If a seed is set, the option lambda = "avg" yields the same results as lambda = "min".

Details

The computational aspects are executed by the glmnet package. At first, a model is fitted via glmnet. The elastic net parameter α can be specified by the user. The parameter λ, which determines the weight of the penalty, can either be chosen via cross validation (using cv.glmnet or by giving a numeric value.

Value

An object of class MetaNLP, where the columns were selected via elastic net.

Note

By using a fix value for lambda, the number of features which should be selected can easily be adjusted by the parameter alpha. The smaller one chooses alpha, the more columns will still be present in the resulting data frame, the higher one chooses alpha, the less columns will be chosen.

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
obj2 <- select_features(obj, alpha = 0.7, lambda = "min")
```

`summary,MetaNLP-method`

Summary of MetaNLP-objects

Description

Returns a quick overview over the n most frequent word stems structured into included and excluded papers.

Usage

```
## S4 method for signature 'MetaNLP'
summary(object, n = 5, stop_words = FALSE, ...)
```

Arguments

`object`	An object of class MetaNLP.
`n`	Number of most frequent words to be displayed.
`stop_words`	Boolean to decide whether stop words shall be included in the summary. `stop_words = TRUE` means, that stop words are included.
`...`	Additional parameters for `delete_stop_words` (e.g. language of the stop words).

Value

A list of most frequent words.

Note

Note that "most frequent" here refers to the entries of the document-term matrix. This function simply computes the sum of each column and if a different weighting function was chosen, the displayed values are in terms of the weighted entries.

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
summary(obj, n = 8)
```

wordcloud *Create word cloud from MetaNLP-object*

Description

This method creates a word cloud from a MetaNLP object. The word size indicates the frequency of the words.

Usage

```
wordcloud(object, ...)

## S4 method for signature 'MetaNLP'
wordcloud(
  object,
  max.words = 70,
  colors = c("snow4", "darkgoldenrod1", "turquoise4", "tomato"),
  decision = c("total", "include", "exclude"),
  stop_words = FALSE,
  ...
)
```

Arguments

object	A MetaNLP object to plot
...	Additional parameters for wordcloud
max.words	Maximum number of words in the word cloud
colors	Character vector with the colors in
decision	Stratify word cloud by decision. Default is no stratification.
stop_words	Boolean to decide whether stop words shall be included in

Value

nothing

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
plt <- plot(obj)
```

write_csv *Save the document-term matrix*

Description

This function can be used to save the document-term matrix of a MetaNLP object as a csv-file.

Usage

```
write_csv(object, ...)

## S4 method for signature 'MetaNLP'
write_csv(object, path, type = c("train", "test"), ...)
```

Arguments

object	An object of class MetaNLP.
...	Additional arguments for write.table, e.g. encoding as UTF-8.
path	Path where to save the csv.
type	Specifies if the document-term matrix should be saved as "train_wcm.csv" or "test_wcm.csv". If the user wants to use another file name, the whole path including the file name should be given as the path argument

Details

If a path to a specific folder is given (but the path name does not end with ".csv"), the file is saved in this folder as "train_wcm.csv" or "test_wcm.csv". By providing a path ending with ".csv", the user can override the default naming convention and the file is saved according to this path.

Value

nothing

Examples

```
path <- system.file("extdata", "test_data.csv", package = "MetaNLP", mustWork = TRUE)
obj <- MetaNLP(path)
obj2 <- delete_stop_words(obj)
write_path <- tempdir()
write_csv(obj2, path = write_path)
file.remove(file.path(write_path, "train_wcm.csv"))
```

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