

Package ‘mspms’

December 24, 2024

Type Package

Title Tools for the analysis of MSP-MS data

Version 0.99.7

Description This package provides functions for the analysis of data generated by the multiplex substrate profiling by mass spectrometry for proteases (MSP-MS) method. Data exported from upstream proteomics software is accepted as input and subsequently processed for analysis. Tools for statistical analysis, visualization, and interpretation of the data are provided.

License MIT + file LICENSE

Encoding UTF-8

RoxygenNote 7.3.2

Depends R (>= 4.4.0)

biocViews Proteomics, MassSpectrometry, Preprocessing

LazyData true

Imports QFeatures, SummarizedExperiment, magrittr, rlang, dplyr, purrr, stats, tidyr, stringr, ggplot2, ggseqlogo, heatmaply, readr, rstatix, tibble, ggpubr

Suggests knitr, testthat (>= 3.0.0), downloadthis, DT, rmarkdown, BiocStyle, imputeLCMD

Config/testthat/edition 3

URL <https://github.com/baynec2/mspms>

BugReports <https://github.com/baynec2/mspms/issues>

VignetteBuilder knitr

git_url <https://git.bioconductor.org/packages/mspms>

git_branch devel

git_last_commit 9653326

git_last_commit_date 2024-12-02

Repository Bioconductor 3.21

Date/Publication 2024-12-23

Author Charlie Bayne [aut, cre] (ORCID:
<<https://orcid.org/0000-0003-1870-5298>>)

Maintainer Charlie Bayne <baynec2@gmail.com>

Contents

mspms-package	3
add_cleavages	4
all_possible_8mers_from_228_library	4
calculate_all_cleavages	5
calc_AA_count_of_motif	5
calc_AA_fc	6
calc_AA_motif_zscore	6
calc_AA_percent_difference	7
calc_AA_prop_of_motif	8
calc_per_samples_library_nd	8
calc_sig_zscores	9
check_file_is_valid_fragpipe	9
check_file_is_valid_pd	10
check_file_is_valid_peaks	10
check_peptide_library	11
colData	11
consolidate_cleavages	12
count_cleavages_per_pos	12
cterm_cleavage	13
generate_report	14
icelogo_col_scheme	15
load_colData	15
log2fc_t_test	16
log2fc_t_test_data	16
mspms_log2fc	17
mspms_tidy	17
mspms_tidy_data	18
mspms_t_tests	18
nterm_cleavage	19
peaks_prepared_data	20
peptide_library	20
plot_all_icelogos	21
plot_cleavages_per_pos	22
plot_heatmap	22
plot_icelogo	23
plot_nd_peptides	24
plot_pca	25
plot_qc_check	26
plot_time_course	27
plot_volcano	28

<i>mspm-package</i>	3
prepared_to_qf	28
prepare_fc	29
prepare_for_PCA	30
prepare_fragpipe	30
prepare_icelogo_data	31
prepare_pd	32
prepare_peaks	33
prepare_qc_check_data	34
prepare_sig_p_dif	34
processed_qf	35
process_qf	36
remaining_cd_names	36
rlog2	37
%>%	37
Index	38

<i>mspm-package</i>	<i>mspm: Tools for the analysis of MSP-MS data</i>
---------------------	--

Description

This package provides functions for the analysis of data generated by the multiplex substrate profiling by mass spectrometry for proteases (MSP-MS) method. Data exported from upstream proteomics software is accepted as input and subsequently processed for analysis. Tools for statistical analysis, visualization, and interpretation of the data are provided.

Author(s)

Maintainer: Charlie Bayne <baynec2@gmail.com> ([ORCID](#))

See Also

Useful links:

- <https://github.com/baynec2/mspms>
- Report bugs at <https://github.com/baynec2/mspms/issues>

<code>add_cleavages</code>	<i>add_cleavages</i>
----------------------------	----------------------

Description

Adds cleavage information to a tibble by wrapping the `n_term_cleavage` and `c_term_cleavage` functions into a consolidated function.

Usage

```
add_cleavages(joined_with_library, n_residues = 4)
```

Arguments

<code>joined_with_library</code>	a tibble containing columns named "peptide", "library_match_sequence", and "library_real_sequence".
<code>n_residues</code>	the number of residues to the left and right of the cleavage site to include in the output.

Value

a tibble with cleavage information added.

<code>all_possible_8mers_from_228_library</code>	<i>all_possible_8mers_from_228_library</i> All possible 8mers from the standard (as of 26April2024) 228 MSP-MS peptide library (This is equivalent to the result of <code>mspms::calculate_all_cleavages(mspms::peptide_library\$real_cleavage_seq,n=4)</code> vector of the 14 AA peptides used in the library.
--	--

Description

`all_possible_8mers_from_228_library` All possible 8mers from the standard (as of 26April2024) 228 MSP-MS peptide library (This is equivalent to the result of `mspms::calculate_all_cleavages(mspms::peptide_library$real_cleavage_seq,n=4)` vector of the 14 AA peptides used in the library.

Usage

```
all_possible_8mers_from_228_library
```

Format

```
## 'all_possible_8mers_from_228_library' A vector with 2964 entries
```

Source

<standard peptide library used with MSP-MS method in the O'Donoghue lab as of 26April2024>

calculate_all_cleavages

calculate_all_cleavages calculate all possible cleavages for a defined peptide library containing peptides of the same length.

Description

calculate_all_cleavages calculate all possible cleavages for a defined peptide library containing peptides of the same length.

Usage

```
calculate_all_cleavages(peptide_library_seqs, n_AA_after_cleavage = 4)
```

Arguments

peptide_library_seqs

The sequences of each peptide in the peptide library. They should all be the same length.

n_AA_after_cleavage

The number of AA after (and before) the cleavage site to consider.

Value

a vector of all the possible cleavages for the peptide library sequences

Examples

```
calculate_all_cleavages(mspms::peptide_library$library_real_sequence,  
  n_AA_after_cleavage = 4  
)
```

calc_AA_count_of_motif

calc_AA_count_of_motif

Description

Calculate the counts of amino acids at each position of a motif for all the sequences in a vector.

Usage

```
calc_AA_count_of_motif(cleavage_motif)
```

Arguments

`cleavage_motif` a vector of cleavage motifs

Value

a matrix of counts

<code>calc_AA_fc</code>	<i>calc_AA_fc</i>
-------------------------	-------------------

Description

Calculate the fold change of each amino acid by position.

Usage

```
calc_AA_fc(experimental_prop_matrix, background_prop_matrix, sig_zscores)
```

Arguments

`experimental_prop_matrix`

a matrix of the experimental proportions (from your vector of cleavage sequences) at each position.

`background_prop_matrix`

a matrix of the background proportions of AAs at each position

`sig_zscores`

a tibble of the significant zscores.

Value

a matrix

<code>calc_AA_motif_zscore</code>	<i>calc_AA_motif_zscore</i>
-----------------------------------	-----------------------------

Description

Calculate the Z score for the amino acids at each position

Usage

```
calc_AA_motif_zscore(
  background_count_matrix,
  background_prop_matrix,
  experimental_count_matrix,
  experimental_prop_matrix
)
```

Arguments

- background_count_matrix
the count matrix from the background sequences
- background_prop_matrix
the proportion matrix from the background sequences
- experimental_count_matrix
the count matrix from the experimental sequences
- experimental_prop_matrix
the proportion matrix from the experimental sequences

Value

a data frame of Zscores for each amino acid at each position.

`calc_AA_percent_difference`
calc_AA_percent_difference

Description

Calculate the percent difference between a matrix of background proportions and a matrix of experimentally observed proportions.

Usage

`calc_AA_percent_difference(background_prop_matrix, experimental_prop_matrix)`

Arguments

- background_prop_matrix
a proportion matrix of amino acids per position from background cleavage sequences
- experimental_prop_matrix
a proportion matrix of amino acids per position from experimental cleavage sequences

Value

a data frame of percent differences

calc_AA_prop_of_motif *calc_AA_prop_of_motif*

Description

Calculate the proportion of amino acids at each position in a vector of motifs.

Usage

```
calc_AA_prop_of_motif(count_matrix)
```

Arguments

count_matrix this is a matrix of the counts of cleavage motifs

Value

a matrix with proportions of counts.

calc_per_samples_library_nd

calc_per_samples_library_nd Calculate the percentage of samples each library_id peptide was not detected in.

Description

calc_per_samples_library_nd Calculate the percentage of samples each library_id peptide was not detected in.

Usage

```
calc_per_samples_library_nd(  
  processed_qf,  
  peptide_library_ids = mspms::peptide_library$library_id  
)
```

Arguments

processed_qf a QFeatures object with a SummarizedExperiment named "peptides". Intended to be prepared by one of the pre-processing prepare_x_data functions of the mspms R package.

peptide_library_ids
 a character vector containing the names of the library_ids

Value

a tibble containing percentage of samples each library id was detected in, both as full length, and as cleavage products.

calc_sig_zscores	<i>calc_sig_zscores Determine which Zscores are significant at the given alpha for a matrix of scores</i>
------------------	---

Description

calc_sig_zscores Determine which Zscores are significant at the given alpha for a matrix of scores

Usage

```
calc_sig_zscores(zscores, pval = 0.05)
```

Arguments

zscores = a data frame of zscores
pval = p value threshold for significance. Default is 0.05

Value

a tibble of significant zscores

check_file_is_valid_fragpipe	<i>check_file_is_valid_fragpipe Check to make sure the input data looks like the expected FragPipe file.</i>
------------------------------	--

Description

check_file_is_valid_fragpipe Check to make sure the input data looks like the expected FragPipe file.

Usage

```
check_file_is_valid_fragpipe(fragpipe_data)
```

Arguments

fragpipe_data combined_peptide.tsv file generated by FragPipe read into R.

Value

a stop command with a informative message if file looks unexpected. otherwise, nothing.

check_file_is_valid_pd

check_file_is_valid_pd Check to make sure the input data looks like the expected ProteomeDiscoverer file.

Description

check_file_is_valid_pd Check to make sure the input data looks like the expected ProteomeDiscoverer file.

Usage

```
check_file_is_valid_pd(pd_data)
```

Arguments

pd_data PeptideGroups.txt file generated by ProteomeDiscover and read into R.

Value

a stop command with a informative message if file looks unexpected. otherwise, nothing.

check_file_is_valid_peaks

check_file_is_valid_peaks Check to make sure the input data looks like the expected PEAKS file.

Description

check_file_is_valid_peaks Check to make sure the input data looks like the expected PEAKS file.

Usage

```
check_file_is_valid_peaks(peaks_data)
```

Arguments

peaks_data protein-peptides-lfq.csv file generated by PEAKS read into R.

Value

a stop command with a informative message if file looks unexpected. otherwise, nothing.

check_peptide_library *check_peptide_library*

Description

check_peptide_library

Usage

check_peptide_library(peptide_library)

Arguments

peptide_library

Value

an informative error if the column names of the peptide library are unexpected. Otherwise nothing.

colData *colData A tibble containing the colData associated with an experiment to proc*

Description

colData A tibble containing the colData associated with an experiment to proc

Usage

colData

Format

'colData' A tibble: 42 × 4

Source

colData corresponding to cathepsin A-D MSP-MS experiment

consolidate_cleavages *consolidate_cleavages*

Description

Consolidate the n term and c term cleavage data. The nterm and cterm cleavage information are consolidated into a single column and rows

Usage

```
consolidate_cleavages(cleavage_added_data)
```

Arguments

cleavage_added_data
a tibble where cleavage information has been added by add_cleavages()

Value

a tibble with the cleavage information combined into a single column and rows with no cleavage information or double information removed.

count_cleavages_per_pos
count_cleavages_per_pos

Description

Count the number of cleavages per position

Usage

```
count_cleavages_per_pos(data, peptide_library = mspms::peptide_library)
```

Arguments

data a tibble containing columns named peptide,cleavage_pos,condition, and time. Other column names can be included.

Value

a ggplot2 object

cTerm_cleavage	<i>cTerm_cleavage</i>
----------------	-----------------------

Description

Finding the cleavage sequences on the C terminus of a given peptide in reference to the peptide library it was derived from

Usage

```
cTerm_cleavage(  
  peptide_sequence,  
  library_match_sequence,  
  library_real_sequence,  
  n_residues = 4  
)
```

Arguments

peptide_sequence the peptide sequence represented in single letter code. "_" denotes cleavage site.

library_match_sequence the sequence the peptide matches to with the proteomics search software used. Note, this may not be the true sequence of the peptide depending on how the library was constructed. For example, in the standard MSP-MS 228 member library, methionine has been replaced with norleucine (n). This was done because norleucine looks like methionine to a protease, but it cannot be oxidized. Norleucine's (n) mass is the same as leucine (L), so it is recognized by the proteomics software as L.

library_real_sequence the sequence the peptide truly is. In the standard MSP-MS 228 member library, some of the amino acids recognize as leucine (L) are truly Norleucine (n).

n_residues the number of residues to the left and right of the cleavage event to return

Value

a tibble with the peptide sequence, cleavage sequences (converted from the matching to real sequence), with n number of amino acids to the left and right of the c term cleavage, and the position of the c-term cleavage in the library sequence

generate_report	<i>generate_report</i>
-----------------	------------------------

Description

wrapper function to generate an automatic .html report of a basic mspms analysis.

Usage

```
generate_report(  
  prepared_data,  
  peptide_library = mspms::peptide_library,  
  n_residues = 4,  
  outdir = getwd(),  
  output_file = paste0(Sys.Date(), "_mspms_report.html")  
)
```

Arguments

prepared_data	a QFeatures object containing a SummarizedExperiment named "peptides".
peptide_library	peptide library used with experiment. Contains columns "library_id", "library_match_sequence", and "library_real_sequence".
n_residues	the number of amino acid residues before and after the cleavage site to generate a cleavage seq for.
outdir	the output directory you would like to render the report to.
output_file	the file name to export.

Value

a knitted .html report of the mspms analysis.

Examples

```
generate_report(mspms::peaks_prepared_data)
```

icelogo_col_scheme	<i>icelogo_col_scheme</i> Defining a color scheme for our iceLogos
--------------------	--

Description

icelogo_col_scheme Defining a color scheme for our iceLogos

Usage

```
icelogo_col_scheme()
```

Value

a ggseqlogo color scheme function

load_colData	<i>load_colData</i>
--------------	---------------------

Description

load a .csv file containing sample colData.

Usage

```
load_colData(colData_filepath)
```

Arguments

colData_filepath
filepath to .csv file containing colData.

Value

a tibble

log2fc_t_test	<i>log2fc_t_test</i>
---------------	----------------------

Description

Calculates the log2 fold change and t-test statistics given a user specified reference variable and value.

Usage

```
log2fc_t_test(processed_qf, reference_variable = "time", reference_value = 0)
```

Arguments

processed_qf mspms data in a QFeatures object.
reference_variable
 the colData variable to use as reference
reference_value
 the value of the colData variable to use as reference

Value

a tibble containing log2fc and t test statistics

Examples

```
log2fc_and_t_test <- log2fc_t_test(mspms::processed_qf)
```

log2fc_t_test_data	<i>log2fc_t_test_data</i> A tibble containing the results of t-tests and log2fc compared to time 0 14,497 × 19
--------------------	--

Description

log2fc_t_test_data A tibble containing the results of t-tests and log2fc compared to time 0 14,497 × 19

Usage

```
log2fc_t_test_data
```

Format

```
## 'peaks_prepared_data' A tibble: 14,497 × 19
```


Source

<mspms processed data originally from PEAKS files found in "tests/testdata/protein-peptides-id.csv" and "tests/testdata/protein-peptides-lfq.csv">

mspms_log2fc	<i>mspms_log2fc</i>
--------------	---------------------

Description

calculates the log2fc for each time point within each condition relative to a specified value for a specified reference variable.

Usage

```
mspms_log2fc(processed_qf, reference_variable = "time", reference_value = 0)
```

Arguments

processed_qf a QFeatures object with a SummarizedExperiment named "peptides_norm".
reference_variable the variable to used as a reference (denominator of log2 fold change).
reference_value the value of the reference variable to use as the reference

Value

a tibble with the t test statistics for each peptide within each group with the supplied value at the supplied variable as reference.

mspms_tidy	<i>mspms_tidy</i> Convert a SummarizedExperiment object within a QFeatures object into a tidy tibble.
------------	---

Description

mspms_tidy Convert a SummarizedExperiment object within a QFeatures object into a tidy tibble.

Usage

```
mspms_tidy(processed_qf, se_name = "peptides_norm")
```

Arguments

processed_qf a QFeature object containing rowData and colData.
se_name the name of the SummarizedExperiment you would like to extract

Value

a tibble containing all the rowData, colData, and assay data for the specified SummarizedExperiment.

Examples

```
mspms_data <- mspms_tidy(mspms::processed_qf)
```

mspms_tidy_data	<i>mspms_tidy_data</i> A tibble containing tidy data derived from QFeatures object
-----------------	--

Description

mspms_tidy_data A tibble containing tidy data derived from QFeatures object

Usage

```
mspms_tidy_data
```

Format

```
## 'mspms_tidy_data' A tibble:
```

Source

```
processed_qf
```

mspms_t_tests	<i>mspms_t_tests</i>
---------------	----------------------

Description

performs t-tests for each peptide within each group for the user specified. FDR adjustment is performed.

Usage

```
mspms_t_tests(processed_qf, reference_variable = "time", reference_value = "0")
```

Arguments

processed_qf a QFeatures object with a SummarizedExperiment named "peptides_norm".
reference_variable the variable to used as a reference.
reference_value the value of the reference variable to use as the reference

Value

a tibble with the t test statistics for each peptide within each group with the supplied value at the supplied variable as reference.

nterm_cleavage	<i>nterm_cleavage</i>
----------------	-----------------------

Description

Finding the cleavage sequences on the N terminus of a given peptide in reference to the peptide library it was derived from.

Usage

```
nterm_cleavage(
  peptide_sequence,
  library_match_sequence,
  library_real_sequence,
  n_residues = 4
)
```

Arguments

`peptide_sequence` the peptide sequence represented in single letter code. "_" denotes cleavage site.

`library_match_sequence` the sequence the peptide matches to with the proteomics search software used. Note, this may not be the true sequence of the peptide depending on how the library was constructed. For example, in the standard MSP-MS 228 member library, methionine has been replaced with norleucine (n). This was done because norleucine looks like methionine to a protease, but it cannot be oxidized. Norleucine's (n) mass is the same as leucine (L), so it is recognized by the proteomics software as L.

`library_real_sequence` the sequence the peptide truly is. In the standard MSP_MS 228 member library, some of the amino acids recognize as leucine (L) are truly Norleucine (n).

`n_residues` the number of residues to the left and right of the cleavage event to return.

Value

a tibble with the peptide sequence, cleavage sequences n specified number of AA on the left and right of the n term cleavage, and the position of the n term cleavage in the library sequence.

peaks_prepared_data *peaks_prepared_data* A *QFeatures* object prepared from PEAKS data of cathepsin data/.

Description

peaks_prepared_data A *QFeatures* object prepared from PEAKS data of cathepsin data/.

Usage

peaks_prepared_data

Format

'peaks_prepared_data' An instance of class *QFeatures* containing 1 assays: [1] peptides: SummarizedExperiment with 2071 rows and 42 columns

peptides Peptide Sequence Detected ...

Source

<mspms processed data originally from PEAKS files found in "tests/testdata/protein-peptides-id.csv" and "tests/testdata/protein-peptides-lfq.csv">

peptide_library *peptide_library*

Description

This is the 228 peptide library used by the O'Donoghue lab as of 26April2024.

Usage

peptide_library

Format

'peptide_library' A data frame with 228 rows and 3 columns:

library_reference_id reference id of the detected peptide as put in upstream software

library_match_sequence the sequence match to the peptide library, methionine is replaced with norleucine, which should function the same as methionine for proteases but has the same mass as L

library_real_sequence Ls corresponding to norleucine are replaced back with n (for norleucine)

...

Source

<O'Donoghue lab as of 26April2024 >

plot_all_icelogos *plot_all_icelogos*

Description

Easily plot a iceLogo corresponding to peptides of interest across each condition of an experiment.

Usage

```
plot_all_icelogos(  
  sig_cleavage_data,  
  type = "percent_difference",  
  pval = 0.05,  
  background_universe = mspms::all_possible_8mers_from_228_library  
)
```

Arguments

sig_cleavage_data	a tibble of data of interest containing a column labeled peptide, cleavage_seq, and condition
type	this is the type of iceLogo you would like to generate, can be either "percent_difference" or "fold_change".
pval	this is the pvalue threshold (\leq) to consider significant when determining the significance of the sig_cleavages relative to the background at each position of the iceLogo.
background_universe	this is a list cleavages you would like to compare to as background of the iceLogo

Value

a ggplot object that shows the motif of the cleavage sequences

Examples

```
# Determining cleavages of interest  
sig_cleavage_data <- mspms::log2fc_t_test_data %>%  
  dplyr::filter(p.adj <= 0.05, log2fc > 3)  
# Plotting a iceLogo for each condition.  
plot_all_icelogos(sig_cleavage_data)
```

plot_cleavages_per_pos
plot_cleavages_per_pos

Description

plot the number of cleavages at each

Usage

```
plot_cleavages_per_pos(sig_cleavage_data, ncol = NULL)
```

Arguments

`sig_cleavage_data` a tibble of data of interest containing a column labeled peptide, cleavage_seq, condition, and cleavage_pos.

`ncol` the number of columns to plot.

Value

a ggplot2 object

Examples

```
# Defining the significant peptides
sig_cleavage_data <- log2fc_t_test_data %>%
  dplyr::filter(p.adj <= 0.05, log2fc > 3)
# Plotting
p1 <- mspms::plot_cleavages_per_pos(sig_cleavage_data)
p1
```

plot_heatmap *plot_heatmap*

Description

This produces a heatmaply interactive heatmap of the QFeatures object with color bars representing the condition and time for each sample in each row.

Usage

```
plot_heatmap(  
  mspms_tidy_data,  
  value_colname = "peptides_norm",  
  scale = "column",  
  plot_method = "plotly",  
  show_dendrogram = c(TRUE, TRUE)  
)
```

Arguments

mspms_tidy_data	tidy mspms data (prepared from QFeatures object by mspms_tidy())
value_colname	the name of the column containing values.
scale	how would you like the data scaled? default is none, but can also be "row", "column", or "none"
plot_method	what plot method would you like to use, can use plotly or ggplot2.
show_dendrogram	Logical vector of length two, controlling whether the row and/or column dendrograms are displayed. If a logical scalar is provided, it is repeated to become a logical vector of length two.

Details

Each column has a colored bar representing whether the peptide is a cleavage product or a full length member of the peptide library.

Value

a heatmaply interactive heatmap

Examples

```
plot_heatmap(mspms::mspms_tidy_data)
```

plot_icelogo

plot_icelogo

Description

This function plots the cleavage motifs that were enriched relative to background as implemented in the iceLogo method. <https://iomics.ugent.be/icelogoserver/resources/manual.pdf>

Usage

```
plot_icelogo(
  cleavage_seqs,
  background_universe = mspms::all_possible_8mers_from_228_library,
  pval = 0.05,
  type = "percent_difference"
)
```

Arguments

`cleavage_seqs` these are the cleavage sequences of interest

`background_universe`
this is a list of cleavage sequences to use as the background in building the iceLogo.

`pval` this is the pvalue threshold (\leq) to consider significant when determining the significance of the sig_cleavages relative to the background at each position of the iceLogo.

`type` this is the type of visualization you would like to perform, accepted values are either "percent_difference" or "fold_change".

Value

a ggplot2 object

Examples

```
# Determining significant cleavages for catA
catA_sig_cleavages <- mspms::log2fc_t_test_data %>%
  dplyr::filter(p.adj <= 0.05, log2fc > 3) %>%
  dplyr::filter(condition == "CatA") %>%
  dplyr::pull(cleavage_seq) %>%
  unique()

# Plotting icelogo
plot_icelogo(catA_sig_cleavages,
  background_universe = all_possible_8mers_from_228_library
)
```

plot_nd_peptides

plot_nd_peptides

Description

plot the percentage of samples each peptide from library was undetected in (if the percentage is > 0).

Usage

```
plot_nd_peptides(
  processed_qf,
  peptide_library_ids = mspms::peptide_library$library_id
)
```

Arguments

`processed_qf` a QFeatures object containing a SummarizedExperiment named "peptides"
`peptide_library_ids` a vector of all peptide library ids in the experiment.

Value

a ggplot2 object

Examples

```
plot_nd_peptides(mspms::processed_qf)
```

plot_pca

plot_pca

Description

Easily create a PCA plot from a QFeatures object containing mspms data. Ellipses are drawn around the points at a 95 Shape and colors are user specified.

Usage

```
plot_pca(
  mspms_tidy_data,
  value_colname = "peptides_norm",
  color = "time",
  shape = "condition"
)
```

Arguments

`mspms_tidy_data` tidy mspms data (prepared from QFeatures object by `mspms_tidy`)
`value_colname` the name of the column containing values.
`color` the name of the variable you would like to color by.
`shape` the name of the variable that you would like to determine shape by.

Value

a ggplot2 object

Examples

```
plot_pca(mspms::mspms_tidy_data)
```

plot_qc_check	<i>plot_qc_check plot the the percentage of the peptide library undetected in each sample per each sample group.</i>
---------------	--

Description

plot_qc_check plot the the percentage of the peptide library undetected in each sample per each sample group.

Usage

```
plot_qc_check(  
  processed_qf,  
  peptide_library = mspms::peptide_library$library_id,  
  full_length_threshold = NULL,  
  cleavage_product_threshold = NULL,  
  ncol = 2  
)
```

Arguments

processed_qf	QFeatures object containing a SummarizedExperiment named "peptides"
peptide_library	a vector of all peptide library ids in the experiment.
full_length_threshold	percent to use as threshold visualized as a vertical blue dashed line
cleavage_product_threshold	percent to use as a threshold visualized as a red dashed line
ncol	n columns.

Value

a ggplot2 object.

Examples

```
plot_qc_check(mspms::processed_qf)
```

plot_time_course	<i>plot_time_course</i>
------------------	-------------------------

Description

Easily plot a time course of all peptides in a QFeatures object by peptide.

Usage

```
plot_time_course(  
  mspms_tidy_data,  
  value_colname = "peptides_norm",  
  summarize_by_mean = FALSE  
)
```

Arguments

`mspms_tidy_data` tidy mspms data (prepared from QFeatures object by `mspms_tidy()`)

`value_colname` the name of the column containing values.

`summarize_by_mean` whether to summarise by mean (TRUE- show error bars +- 1 standard deviation) or not (FALSE)

Value

a ggplot2 object

Examples

```
# Determining peptide of interest  
max_log2fc_pep <- mspms::log2fc_t_test_data %>%  
  dplyr::filter(p.adj <= 0.05, log2fc > 3) %>%  
  dplyr::filter(log2fc == max(log2fc)) %>%  
  dplyr::pull(peptide)  
  
# Defining QFeatures filter  
filtered <- mspms::mspms_tidy_data %>%  
  dplyr::filter(peptide == max_log2fc_pep) %>%  
  plot_time_course()
```

plot_volcano	<i>plot_volcano</i>
--------------	---------------------

Description

create a volcano plot to generate log2fc and adjusted p values for experimental conditions

Usage

```
plot_volcano(  
  log2fc_t_test_data,  
  log2fc_threshold = 3,  
  padj_threshold = 0.05,  
  facets = "grid",  
  ncol = 1  
)
```

Arguments

`log2fc_t_test_data` a tibble containing the log2fc and adjusted p values

`log2fc_threshold` the log2fc threshold that you want displayed on plot

`padj_threshold` the padj threshold that you want displayed on plot

`facets` how facets should be displayed. Accepted values are grid and wrap

`ncol` ncol to include if facets = "wrap"

Value

a ggplot2 object

Examples

```
p1 <- mspms::plot_volcano(mspms::log2fc_t_test_data, log2fc_threshold = 3)  
p1
```

prepared_to_qf	<i>convert prepared data to a QFeatures object</i>
----------------	--

Description

convert prepared data to a QFeatures object

Usage

```
prepared_to_qf(
  prepared_data,
  colData,
  peptide_library = mspms::peptide_library,
  n_residues = 4
)
```

Arguments

prepared_data data prepared within one of the prepare functions
 colData sample metadata
 peptide_library the peptide library used.
 n_residues the number of residues reported in the cleavage site

Value

a QFeatures object

prepare_fc	<i>prepare_fc</i>
------------	-------------------

Description

Prepare fold changes of amino acids by position for Icelogo visualization.

Usage

```
prepare_fc(fold_change, sig_zscores)
```

Arguments

fold_change a matrix of the fold changes of the AA by position.
 sig_zscores a tibble of the significant zscores.

Value

a matrix of the fold changes of the significant AAs at each position.

```
prepare_for_PCA      prepare_for_PCA()
```

Description

prepare QFeatures object for PCA analysis

Usage

```
prepare_for_PCA(mspms_tidy_data, value_colname = "peptides_norm")
```

Arguments

`mspms_tidy_data` tidy mspms data (prepared from QFeatures object by `mspms_tidy()`)

`value_colname` the name of the column containing values.

Value

a tibble

```
prepare_fragpipe      prepare_fragpipe
```

Description

Prepare a label free quantification file exported from Fragpipe for subsequent mspms analysis.

Usage

```
prepare_fragpipe(  
  combined_peptide_filepath,  
  colData_filepath,  
  peptide_library = mspms::peptide_library,  
  n_residues = 4  
)
```

Arguments

`combined_peptide_filepath` file path the combined_peptide.tsv file generated by FragPipe.

`colData_filepath` file path to .csv file containing colData. Must have columns named "quant-Cols", "group", "condition", and "time".

peptide_library peptide library used with experiment. Contains columns "library_id", "library_match_sequence", and "library_real_sequence".

n_residues the number of amino acid residues before and after the cleavage site to generate a cleavage seq for.

Value

a QFeatures object containing a summarizedExperiment named "peptides"

Examples

```
fragpipe_combined_peptide <- system.file("extdata/fragpipe_combined_peptide.tsv", package = "mspms")
colData_filepath <- system.file("extdata/colData.csv", package = "mspms")
# Prepare the data
fragpipe_prepared_data <- mspms::prepare_fragpipe(fragpipe_combined_peptide, colData_filepath)
```

```
prepare_icelogo_data  prepare_icelogo_data
```

Description

Prepare the final matrix containing iceLogo data for plotting.

Usage

```
prepare_icelogo_data(
  cleavage_seqs,
  background_universe = mspms::all_possible_8mers_from_228_library,
  pval = 0.05,
  type = "percent_difference"
)
```

Arguments

cleavage_seqs the cleavage sequences that are observed in the experiment

background_universe a vector of the cleavage sequences to use as the background.

pval the p-value threshold to consider

type the type of iceLogo calculation to perform. Accepted values are "percent_difference" or "fold_change".

Value

a matrix of enriched amino acids per position

prepare_pd	<i>prepare_pd Prepare a label free quantification file exported from Proteome Discoverer for subsequent mspms analysis.</i>
------------	---

Description

prepare_pd Prepare a label free quantification file exported from Proteome Discoverer for subsequent mspms analysis.

Usage

```
prepare_pd(
  peptide_groups_filepath,
  colData_filepath,
  peptide_library = mspms::peptide_library,
  n_residues = 4
)
```

Arguments

peptide_groups_filepath	filepath to PeptideGroups.txt file exported from proteome discoverer.
colData_filepath	file path to .csv file containing colData. Must have columns named "quant-Cols", "group", "condition", and "time".
peptide_library	peptide library used with experiment. Contains columns "library_id", "library_match_sequence", and "library_real_sequence".
n_residues	the number of amino acid residues before and after the cleavage site to generate a cleavage seq for.

Value

a QFeatures object containing a summarizedExperiment named "peptides"

Examples

```
peptide_groups_filepath <- system.file(
  "extdata/proteome_discoverer_PeptideGroups.txt",
  package = "mspms"
)
colData_filepath <- system.file("extdata/colData.csv", package = "mspms")
```

prepare_peaks	<i>prepare_peaks</i> Prepare a label free quantification file exported from PEAKS for subsequent mspms analysis.
---------------	--

Description

prepare_peaks Prepare a label free quantification file exported from PEAKS for subsequent mspms analysis.

Usage

```
prepare_peaks(
  lfq_filepath,
  colData_filepath,
  quality_threshold = 0.3,
  peptide_library = mspms::peptide_library,
  n_residues = 4
)
```

Arguments

`lfq_filepath` this is the file path to a .csv file exported from PEAKS

`colData_filepath` file path to .csv file containing colData. Must have columns named "quant-Cols", "group", "condition", and "time".

`quality_threshold` only consider peptides with quality scores > than this threshold.

`peptide_library` peptide library used in the experiment.

`n_residues` the number of amino acid residues before and after the cleavage site to generate a cleavage seq for.

Value

a QFeatures object containing a summarizedExperiment named "peptides"

Examples

```
lfq_filepath <- system.file("extdata/peaks_protein-peptides-lfq.csv", package = "mspms")
colData_filepath <- system.file("extdata/colData.csv", package = "mspms")
# Prepare the data
peaks_prepared_data <- mspms::prepare_peaks(lfq_filepath, colData_filepath)
```

`prepare_qc_check_data` *prepare_qc_check* Run simple quality control checks on the data. This checks to see how many peptides belonging to the library were identified in the data in each sample. Computes full length, and cleavage products independantly.

Description

`prepare_qc_check` Run simple quality control checks on the data. This checks to see how many peptides belonging to the library were identified in the data in each sample. Computes full length, and cleavage products independantly.

Usage

```
prepare_qc_check_data(
  processed_qf,
  peptide_library_ids = mspms::peptide_library$library_id
)
```

Arguments

`processed_qf` a QFeatures object with a SummarizedExperiment named "peptides". Intended to be prepared by one of the pre-processing `prepare_x_data` functions of the `mspms` R package.

`peptide_library_ids` a character vector containing the names of the `library_ids`

Value

a tibble containing percentage of `library_ids` detected per sample, both as full length, and as cleavage products.

`prepare_sig_p_dif` *prepare_sig_p_dif*

Description

Prepare significant percent difference data frame for `iceLogo`

Usage

```
prepare_sig_p_dif(percent_difference, sig_zscores)
```

Arguments

percent_difference a data frame containing the percent differences

sig_zscores a matrix of significant amino acids at each position based on z-scores

Value

a tibble

processed_qf	<i>processed_qf</i> A <i>QFeatures</i> object prepared from PEAKS data of Cathepsin data that has been processed (imputation/normalization)
--------------	---

Description

processed_qf A *QFeatures* object prepared from PEAKS data of Cathepsin data that has been processed (imputation/normalization)

Usage

```
processed_qf
```

Format

```
## 'peaks_prepared_data' An instance of class QFeatures containing 5 assays: [1] peptides: SummarizedExperiment with 2071 rows and 42 columns [2] peptides_log: SummarizedExperiment with 2071 rows and 42 columns [3] peptides_log_norm: SummarizedExperiment with 2071 rows and 42 columns [4] peptides_log_impute_norm: SummarizedExperiment with 2071 rows and 42 columns [5] peptides_norm: SummarizedExperiment with 2071 rows and 42 columns
```

peptides Peptide Sequence Detected ...

Source

```
<mspms processed data originally from PEAKS files found in "tests/testdata/protein-peptides-id.csv" and "tests/testdata/protein-peptides-lfq.csv">
```

process_qf	<i>process_qf</i>
------------	-------------------

Description

process_qf

Usage

```
process_qf(prepared_qf)
```

Arguments

prepared_qf	this is a QFeatures object containing a SummarizedExperiment named "peptides"
-------------	---

Value

a QFeatures object containing a SummarizedExperiments named "peptides", "peptides_log", "peptides_log_norm", "peptides_log_impute_norm", and "peptides_norm"

Examples

```
processed_qf <- process_qf(mspms::peaks_prepared_data)
```

remaining_cd_names	<i>remaining_cd_names</i>
--------------------	---------------------------

Description

determine what the remaining colData names are when removing the reference variable.

Usage

```
remaining_cd_names(processed_qf, reference_variable)
```

Arguments

processed_qf	a QFeatures object
reference_variable	name of reference variable

Value

a vector of the remaining names in the colData

rlog2	<i>rlog2 Reverse log2 transformation</i>
-------	--

Description

rlog2 Reverse log2 transformation

Usage

```
rlog2(x)
```

Arguments

x	a numeric value
---	-----------------

Value

a reverse log2 transformed value

<code>%>%</code>	<i>Pipe operator</i>
---------------------	----------------------

Description

See `magrittr::%>%` for details.

Usage

```
lhs %>% rhs
```

Arguments

lhs	A value or the magrittr placeholder.
rhs	A function call using the magrittr semantics.

Value

The result of calling `'rhs(lhs)'`.

Index

* datasets

- all_possible_8mers_from_228_library, 4
- colData, 11
- log2fc_t_test_data, 16
- mspms_tidy_data, 18
- peaks_prepared_data, 20
- peptide_library, 20
- processed_qf, 35

* internal

- %>%, 37
- add_cleavages, 4
- calc_AA_count_of_motif, 5
- calc_AA_fc, 6
- calc_AA_motif_zscore, 6
- calc_AA_percent_difference, 7
- calc_AA_prop_of_motif, 8
- calc_per_samples_library_nd, 8
- calc_sig_zscores, 9
- check_file_is_valid_peaks, 10
- check_peptide_library, 11
- consolidate_cleavages, 12
- count_cleavages_per_pos, 12
- cterm_cleavage, 13
- icelogo_col_scheme, 15
- load_colData, 15
- mspms-package, 3
- mspms_log2fc, 17
- mspms_t_tests, 18
- nterm_cleavage, 19
- prepare_fc, 29
- prepare_for_PCA, 30
- prepare_icelogo_data, 31
- prepare_qc_check_data, 34
- prepare_sig_p_dif, 34
- prepared_to_qf, 28
- remaining_cd_names, 36
- rlog2, 37
- %>%, 37, 37

- add_cleavages, 4
- all_possible_8mers_from_228_library, 4
- calc_AA_count_of_motif, 5
- calc_AA_fc, 6
- calc_AA_motif_zscore, 6
- calc_AA_percent_difference, 7
- calc_AA_prop_of_motif, 8
- calc_per_samples_library_nd, 8
- calc_sig_zscores, 9
- calculate_all_cleavages, 5
- check_file_is_valid_fragpipe, 9
- check_file_is_valid_pd, 10
- check_file_is_valid_peaks, 10
- check_peptide_library, 11
- colData, 11
- consolidate_cleavages, 12
- count_cleavages_per_pos, 12
- cterm_cleavage, 13
- generate_report, 14
- icelogo_col_scheme, 15
- load_colData, 15
- log2fc_t_test, 16
- log2fc_t_test_data, 16
- mspms (mspms-package), 3
- mspms-package, 3
- mspms_log2fc, 17
- mspms_t_tests, 18
- mspms_tidy, 17
- mspms_tidy_data, 18
- nterm_cleavage, 19
- peaks_prepared_data, 20
- peptide_library, 20
- plot_all_icelogos, 21
- plot_cleavages_per_pos, 22

plot_heatmap, [22](#)
plot_icelogo, [23](#)
plot_nd_peptides, [24](#)
plot_pca, [25](#)
plot_qc_check, [26](#)
plot_time_course, [27](#)
plot_volcano, [28](#)
prepare_fc, [29](#)
prepare_for_PCA, [30](#)
prepare_fragpipe, [30](#)
prepare_icelogo_data, [31](#)
prepare_pd, [32](#)
prepare_peaks, [33](#)
prepare_qc_check_data, [34](#)
prepare_sig_p_dif, [34](#)
prepared_to_qf, [28](#)
process_qf, [36](#)
processed_qf, [35](#)

remaining_cd_names, [36](#)
rlog2, [37](#)