Package 'MSstatsTMT'

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Title Protein Significance Analysis in shotgun mass spectrometry-based proteomic experiments with tandem mass tag (TMT) labeling

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Description The package provides statistical tools for detecting differentially abundant proteins in shotgun mass spectrometry-based proteomic experiments with tandem mass tag (TMT) labeling. It provides multiple functionalities, including aata visualization, protein quantification and normalization, and statistical modeling and inference. Furthermore, it is inter-operable with other data processing tools, such as Proteome Discoverer, MaxQuant, OpenMS and SpectroMine.

License Artistic-2.0

Depends R (>= 4.1)

Imports limma, lme4, lmerTest, methods, data.table, stats, utils, ggplot2, grDevices, graphics, MSstats, MSstatsConvert, checkmate

Suggests BiocStyle, knitr, rmarkdown, testthat

VignetteBuilder knitr

biocViews ImmunoOncology, MassSpectrometry, Proteomics, Software

Encoding UTF-8

LazyData true

URL http://msstats.org/msstatstmt/

BugReports https://groups.google.com/forum/#!forum/msstats

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R topics documented:

`annotation.mine` *Example of annotation file for raw.mine, which is the output of SpectroMine.*

Description

Annotation of example data, raw.mine, in this package. It should be prepared by users. The variables are as follows:

Usage

```
annotation.mine
```

Format

A data frame with 72 rows and 7 variables.

Details

- Run : MS run ID. It should be the same as R.FileName info in raw.mine
- Channel : Labeling information (TMT6_126, ..., TMT6_131). The channels should be consistent with the channel columns in raw.mine.
- Condition : Condition (ex. Healthy, Cancer, Time0). If the channal doesn't have sample, please add 'Empty' under Condition.
- Mixture : Mixture of samples labeled with different TMT reagents, which can be analyzed in a single mass spectrometry experiment.
- TechRepMixture : Technical replicate of one mixture. One mixture may have multiple technical replicates. For example, if 'TechRepMixture' = 1, 2 are the two technical replicates of one mixture, then they should match with same 'Mixture' value.
- Fraction : Fraction ID. One technical replicate of one mixture may be fractionated into multiple fractions to increase the analytical depth. Then one technical replicate of one mixture should correspond to multuple fractions. For example, if 'Fraction' = 1, 2, 3 are three fractions of the first technical replicate of one TMT mixture of biological subjects, then they should have same 'TechRepMixture' and 'Mixture' value.
- BioReplicate : Unique ID for biological subject. If the channal doesn't have sample, please add 'Empty' under BioReplicate

Examples

```
head(annotation.mine)
```

---

annotation.mq *Example of annotation file for evidence, which is the output of MaxQuant.*

Description

Annotation of example data, evidence, in this package. It should be prepared by users. The variables are as follows:

Usage

```
annotation.mq
```

Format

A data frame with 150 rows and 7 variables.

Details

- Run : MS run ID. It should be the same as Raw.file info in raw.mq
- Channel : Labeling information (channel.0, ..., channel.9). The channel index should be consistent with the channel columns in raw.mq.
- Condition : Condition (ex. Healthy, Cancer, Time0)
- Mixture : Mixture of samples labeled with different TMT reagents, which can be analyzed in a single mass spectrometry experiment. If the channal doesn't have sample, please add 'Empty' under Condition.
- TechRepMixture : Technical replicate of one mixture. One mixture may have multiple technical replicates. For example, if 'TechRepMixture' = 1, 2 are the two technical replicates of one mixture, then they should match with same 'Mixture' value.
- Fraction : Fraction ID. One technical replicate of one mixture may be fractionated into multiple fractions to increase the analytical depth. Then one technical replicate of one mixture should correspond to multuple fractions. For example, if 'Fraction' = 1, 2, 3 are three fractions of the first technical replicate of one TMT mixture of biological subjects, then they should have same 'TechRepMixture' and 'Mixture' value.
- BioReplicate : Unique ID for biological subject. If the channal doesn't have sample, please add 'Empty' under BioReplicate.

Examples

```
head(annotation.mq)
```

`annotation.pd` *Example of annotation file for raw.pd, which is the PSM output of Proteome Discoverer*

Description

Annotation of example data, raw.pd, in this package. It should be prepared by users. The variables are as follows:

Usage

```
annotation.pd
```

Format

A data frame with 150 rows and 7 variables.

Details

- Run : MS run ID. It should be the same as Spectrum.File info in raw.pd.
- Channel : Labeling information (126, ... 131). It should be consistent with the channel columns in raw.pd.
- Condition : Condition (ex. Healthy, Cancer, Time0)
- Mixture : Mixture of samples labeled with different TMT reagents, which can be analyzed in a single mass spectrometry experiment. If the channal doesn't have sample, please add 'Empty' under Condition.
- TechRepMixture : Technical replicate of one mixture. One mixture may have multiple technical replicates. For example, if 'TechRepMixture' = 1, 2 are the two technical replicates of one mixture, then they should match with same 'Mixture' value.
- Fraction : Fraction ID. One technical replicate of one mixture may be fractionated into multiple fractions to increase the analytical depth. Then one technical replicate of one mixture should correspond to multuple fractions. For example, if 'Fraction' = 1, 2, 3 are three fractions of the first technical replicate of one TMT mixture of biological subjects, then they should have same 'TechRepMixture' and 'Mixture' value.
- BioReplicate : Unique ID for biological subject. If the channal doesn't have sample, please add 'Empty' under BioReplicate.

Examples

```
head(annotation.pd)
```

`dataProcessPlotsTMT` *Visualization for explanatory data analysis - TMT experiment*

Description

To illustrate the quantitative data and quality control of MS runs, dataProcessPlotsTMT takes the quantitative data and summarized data from function 'proteinSummarization' as input and generate two types of figures in pdf files as output : (1) profile plot (specify "ProfilePlot" in option type), to identify the potential sources of variation for each protein; (2) quality control plot (specify "QCPlot" in option type), to evaluate the systematic bias between MS runs and channels.

Usage

```
dataProcessPlotsTMT(
  data,
  type,
  ylimUp = FALSE,
  ylimDown = FALSE,
  x.axis.size = 10,
  y.axis.size = 10,
  text.size = 4,
```

```
  text.angle = 90,
  legend.size = 7,
  dot.size.profile = 2,
  ncol.guide = 5,
  width = 10,
  height = 10,
  which.Protein = "all",
  originalPlot = TRUE,
  summaryPlot = TRUE,
  address = ""
)
```

Arguments

data	the output of proteinSummarization function. It is a list with data frames 'FeatureLevelData' and 'ProteinLevelData'
type	choice of visualization. "ProfilePlot" represents profile plot of log intensities across MS runs. "QCPlot" represents box plots of log intensities across channels and MS runs.
ylimUp	upper limit for y-axis in the log scale. FALSE(Default) for Profile Plot and QC Plot uses the upper limit as rounded off maximum of log2(intensities) after normalization + 3..
ylimDown	lower limit for y-axis in the log scale. FALSE(Default) for Profile Plot and QC Plot uses 0..
x.axis.size	size of x-axis labeling for "Run" and "channel in Profile Plot and QC Plot.
y.axis.size	size of y-axis labels. Default is 10.
text.size	size of labels represented each condition at the top of Profile plot and QC plot. Default is 4.
text.angle	angle of labels represented each condition at the top of Profile plot and QC plot. Default is 0.
legend.size	size of legend above Profile plot. Default is 7.
dot.size.profile	size of dots in Profile plot. Default is 2.
ncol.guide	number of columns for legends at the top of plot. Default is 5.
width	width of the saved pdf file. Default is 10.
height	height of the saved pdf file. Default is 10.
which.Protein	Protein list to draw plots. List can be names of Proteins or order numbers of Proteins. Default is "all", which generates all plots for each protein. For QC plot, "allonly" will generate one QC plot with all proteins.
originalPlot	TRUE(default) draws original profile plots, without normalization.
summaryPlot	TRUE(default) draws profile plots with protein summarization for each channel and MS run.

address — the name of folder that will store the results. Default folder is the current working directory. The other assigned folder has to be existed under the current working directory. An output pdf file is automatically created with the default name of "ProfilePlot.pdf" or "QCplot.pdf". The command address can help to specify where to store the file as well as how to modify the beginning of the file name. If address=FALSE, plot will be not saved as pdf file but showed in window.

Value

plot or pdf

Examples

```
data(input.pd)
quant.msstats = proteinSummarization(input.pd,
                                     method="msstats",
                                     global_norm=TRUE,
                                     reference_norm=TRUE)

## Profile plot
dataProcessPlotsTMT(data=quant.msstats,
                    type='ProfilePlot',
                    width = 21,
                    height = 7)

## NottoRun: QC plot
# dataProcessPlotsTMT(data=quant.msstats,
                     # type='QCPlot',
                     # width = 21,
                     # height = 7)
```

---

evidence *Example of output from MaxQuant for TMT-10plex experiments.*

Description

Example of evidence.txt from MaxQuant. It is the input for MaxQtoMSstatsTMTFormat function, with proteinGroups.txt and annotation file. Annotation file should be made by users. It includes peak intensities for 10 proteins among 15 MS runs with TMT10. The important variables are as follows:

Usage

```
evidence
```

Format

A data frame with 1075 rows and 105 variables.

Details

- Proteins
- Protein.group.IDs
- Modified.sequence
- Charge
- Raw.file
- Score
- Potential.contaminant
- Reverse
- Channels : Reporter.intensity.corrected.0, ..., Reporter.intensity.corrected.9

Examples

```
head(evidence)
```

`groupComparisonTMT` *Finding differentially abundant proteins across conditions in TMT experiment*

Description

Tests for significant changes in protein abundance across conditions based on a family of linear mixed-effects models in TMT experiment. Experimental design of case-control study (patients are not repeatedly measured) is automatically determined based on proper statistical model.

Usage

```
groupComparisonTMT(
  data,
  contrast.matrix = "pairwise",
  moderated = FALSE,
  adj.method = "BH",
  remove_norm_channel = TRUE,
  remove_empty_channel = TRUE,
  save_fitted_models = FALSE,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL
)
```

Arguments

data	the output of proteinSummarization function. It is a list with data frames 'FeatureLevelData' and 'ProteinLevelData'
contrast.matrix	Comparison between conditions of interests. 1) default is "pairwise", which compare all possible pairs between two conditions. 2) Otherwise, users can specify the comparisons of interest. Based on the levels of conditions, specify 1 or -1 to the conditions of interests and 0 otherwise. The levels of conditions are sorted alphabetically.
moderated	TRUE will moderate t statistic; FALSE (default) uses ordinary t statistic.
adj.method	adjusted method for multiple comparison. "BH" is default.
remove_norm_channel	TRUE(default) removes "Norm" channels from protein level data.
remove_empty_channel	TRUE(default) removes "Empty" channels from protein level data.
save_fitted_models	logical, if TRUE, fitted models will be added to
use_log_file	logical. If TRUE, information about data processing will be saved to a file.
append	logical. If TRUE, information about data processing will be added to an existing log file.
verbose	logical. If TRUE, information about data processing wil be printed to the console.
log_file_path	character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.

Value

a list that consists of the following elements: (1) ComparisonResult: statistical testing results; (2) FittedModel: the fitted linear models

Examples

```
data(input.pd)
# use protein.summarization() to get protein abundance data
quant.pd.msstats = proteinSummarization(input.pd,
                                        method="msstats",
                                        global_norm=TRUE,
                                        reference_norm=TRUE)

test.pairwise = groupComparisonTMT(quant.pd.msstats, moderated = TRUE)
head(test.pairwise$ComparisonResult)

# Only compare condition 0.125 and 1
levels(quant.pd.msstats$ProteinLevelData$Condition)

# Compare condition 1 and 0.125
```

```
comparison=matrix(c(-1,0,0,1),nrow=1)

# Set the nafmes of each row
row.names(comparison)="1-0.125"

# Set the column names
colnames(comparison)= c("0.125", "0.5", "0.667", "1")
test.contrast = groupComparisonTMT(data = quant.pd.msstats,
contrast.matrix = comparison,
moderated = TRUE)
head(test.contrast$ComparisonResult)
```

`input.pd` *Example of output from PDtoMSstatsTMTFormat function*

Description

It is made from `raw.pd` and `annotation.pd`, which is the output of PDtoMSstatsTMTFormat function. It should include the required columns as below.

Usage

```
input.pd
```

Format

A data frame with 20110 rows and 11 variables.

Details

- ProteinName : Protein ID
- PeptideSequence : peptide sequence
- Charge : peptide charge
- PSM : peptide ion and spectra match
- Channel : Labeling information (126, ... 131)
- Condition : Condition (ex. Healthy, Cancer, Time0)
- BioReplicate : Unique ID for biological subject.
- Run : MS run ID
- Mixture : Unique ID for TMT mixture.
- TechRepMixture : Unique ID for technical replicate of one TMT mixture.
- Intensity: Protein Abundance

Examples

```
head(input.pd)
```

MaxQtoMSstatsTMTFormat *Generate MSstatsTMT required input format from MaxQuant output*

Description

Generate MSstatsTMT required input format from MaxQuant output

Usage

```
MaxQtoMSstatsTMTFormat(
  evidence,
  proteinGroups,
  annotation,
  which.proteinid = "Proteins",
  rmProt_Only.identified.by.site = FALSE,
  useUniquePeptide = TRUE,
  rmPSM_withfewMea_withinRun = TRUE,
  rmProtein_with1Feature = FALSE,
  summaryforMultipleRows = sum,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL,
  ...
)
```

Arguments

evidence	name of 'evidence.txt' data, which includes feature-level data.
proteinGroups	name of 'proteinGroups.txt' data.
annotation	data frame which contains column Run, Fraction, TechRepMixture, Mixture, Channel, BioReplicate, Condition. Refer to the example 'annotation.mq' for the meaning of each column.
which.proteinid	Use 'Proteins' (default) column for protein name. 'Leading.proteins' or 'Leading.razor.proteins' or 'Gene.names' can be used instead to get the protein ID with single protein. However, those can potentially have the shared peptides.
rmProt_Only.identified.by.site	TRUE will remove proteins with '+' in 'Only.identified.by.site' column from proteinGroups.txt, which was identified only by a modification site. FALSE is the default.
useUniquePeptide	TRUE(default) removes peptides that are assigned for more than one proteins. We assume to use unique peptide for each protein.

`rmPSM_withfewMea_withinRun`
: TRUE (default) will remove the features that have 1 or 2 measurements within each Run.

`rmProtein_with1Feature`
: TRUE will remove the proteins which have only 1 peptide and charge. Defaut is FALSE.

`summaryforMultipleRows`
: sum(default) or max - when there are multiple measurements for certain feature in certain run, select the feature with the largest summation or maximal value.

`use_log_file`
: logical. If TRUE, information about data processing will be saved to a file.

`append`
: logical. If TRUE, information about data processing will be added to an existing log file.

`verbose`
: logical. If TRUE, information about data processing wil be printed to the console.

`log_file_path`
: character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.

`...`
: additional parameters to 'data.table::fread'.

Value

data.frame of class "MSstatsTMT"

Examples

```
head(evidence)
head(proteinGroups)
head(annotation.mq)
input.mq <- MaxQtoMSstatsTMTFormat(evidence, proteinGroups, annotation.mq)
head(input.mq)
```

`MSstatsTMT` *MSstatsTMT: A package for protein significance analysis in shotgun mass spectrometry-based proteomic experiments with tandem mass tag (TMT) labeling*

Description

A set of tools for detecting differentially abundant peptides and proteins in shotgun mass spectrometry-based proteomic experiments with tandem mass tag (TMT) labeling.

functions

- PDtoMSstatsTMTFormat : generates MSstatsTMT required input format for Proteome discoverer output.
- MaxQtoMSstatsTMTFormat : generates MSstatsTMT required input format for MaxQuant output.
- SpectroMinetoMSstatsTMTFormat : generates MSstatsTMT required input format for SpectroMine output.
- OpenMStoMSstatsTMTFormat : generates MSstatsTMT required input format for OpenMS output.
- proteinSummarization : summarizes PSM level quantification to protein level quantification.
- dataProcessPlotsTMT : visualizes for explanatory data analysis.
- groupComparisonTMT : tests for significant changes in protein abundance across conditions.

OpenMStoMSstatsTMTFormat

Generate MSstatsTMT required input format for OpenMS output

Description

Generate MSstatsTMT required input format for OpenMS output

Usage

```
OpenMStoMSstatsTMTFormat(
  input,
  useUniquePeptide = TRUE,
  rmPSM_withfewMea_withinRun = TRUE,
  rmProtein_with1Feature = FALSE,
  summaryforMultiplePSMs = sum,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL,
  ...
)
```

Arguments

input	MSstatsTMT report from OpenMS
useUniquePeptide	TRUE(default) removes peptides that are assigned for more than one proteins. We assume to use unique peptide for each protein.

rmPSM_withfewMea_withinRun
: TRUE (default) will remove the features that have 1 or 2 measurements within each Run.

rmProtein_with1Feature
: TRUE will remove the proteins which have only 1 peptide and charge. Defaut is FALSE.

summaryforMultiplePSMs
: sum(default) or max - when there are multiple measurements for certain feature in certain run, select the feature with the largest summation or maximal value.

use_log_file
: logical. If TRUE, information about data processing will be saved to a file.

append
: logical. If TRUE, information about data processing will be added to an existing log file.

verbose
: logical. If TRUE, information about data processing wil be printed to the console.

log_file_path
: character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.

...
: additional parameters to 'data.table::fread'.

Value

'data.frame' of class 'MSstatsTMT'.

Examples

```
head(raw.om)
input.om <- OpenMStoMSstatsTMTFormat(raw.om)
head(input.om)
```

PDtoMSstatsTMTFormat *Convert Proteome Discoverer output to MSstatsTMT format.*

Description

Convert Proteome Discoverer output to MSstatsTMT format.

Usage

```
PDtoMSstatsTMTFormat(
  input,
  annotation,
  which.proteinid = "Protein.Accessions",
  useNumProteinsColumn = TRUE,
  useUniquePeptide = TRUE,
  rmPSM_withfewMea_withinRun = TRUE,
```

```
  rmProtein_with1Feature = FALSE,
  summaryforMultipleRows = sum,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL,
  ...
)
```

Arguments

input	PD report or a path to it.
annotation	annotation with Run, Fraction, TechRepMixture, Mixture, Channel, BioReplicate, Condition columns or a path to file. Refer to the example 'annotation' for the meaning of each column.
which.proteinid	Use 'Protein.Accessions'(default) column for protein name. 'Master.Protein.Accessions' can be used instead to get the protein name with single protein.
useNumProteinsColumn	logical, TURE(default) remove shared peptides by information of # Proteins column in PSM sheet.
useUniquePeptide	logical, if TRUE (default) removes peptides that are assigned for more than one proteins. We assume to use unique peptide for each protein.
rmPSM_withfewMea_withinRun	TRUE (default) will remove the features that have 1 or 2 measurements within each Run.
rmProtein_with1Feature	TRUE will remove the proteins which have only 1 peptide and charge. Defaut is FALSE.
summaryforMultipleRows	sum (default) or max - when there are multiple measurements for certain feature in certain run, select the feature with the largest summation or maximal value.
use_log_file	logical. If TRUE, information about data processing will be saved to a file.
append	logical. If TRUE, information about data processing will be added to an existing log file.
verbose	logical. If TRUE, information about data processing wil be printed to the console.
log_file_path	character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.
...	additional parameters to 'data.table::fread'.

Value

'data.frame' of class 'MSstatsTMT'

Examples

```
head(raw.pd)
head(annotation.pd)
input.pd <- PDtoMSstatsTMTFormat(raw.pd, annotation.pd)
head(input.pd)
```

PhilosophertoMSstatsTMTFormat

Convert Philosopher (Fragpipe) output to MSstatsTMT format.

Description

Convert Philosopher (Fragpipe) output to MSstatsTMT format.

Usage

```
PhilosophertoMSstatsTMTFormat(
  input = NULL,
  path = NULL,
  folder = TRUE,
  annotation,
  protein_id_col = "ProteinAccessions",
  peptide_id_col = "PeptideSequence",
  Purity_cutoff = 0.6,
  PeptideProphet_prob_cutoff = 0.7,
  useUniquePeptide = TRUE,
  rmPSM_withfewMea_withinRun = TRUE,
  rmPeptide_OxidationM = TRUE,
  rmProtein_with1Feature = FALSE,
  summaryforMultipleRows = sum,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL,
  ...
)
```

Arguments

input	list of tables exported by Philosopher. Fragpipe produces a csv file for each TMT mixture.
path	a path to the folder with all the Philosopher msstats csv files. Fragpipe produces a msstats.csv file for each TMT mixture.
folder	logical, if TRUE, path parameter will be treated as folder path and all msstats*.csv files will be imported. If FALSE, path parameter will be treated as a vector of fixed file paths.

`annotation` annotation with Run, Fraction, TechRepMixture, Mixture, Channel, BioReplicate, Condition columns or a path to file. Refer to the example 'annotation' for the meaning of each column. Channel column should be consistent with the channel columns (Ignore the prefix "Channel ") in msstats.csv file. Run column should be consistent with the Spectrum.File columns in msstats.csv file.

`protein_id_col` Use 'Protein.Accessions'(default) column for protein name. 'Master.Protein.Accessions' can be used instead to get the protein ID with single protein.

`peptide_id_col` Use 'Peptide.Sequence'(default) column for peptide sequence. 'Modified.Peptide.Sequence' can be used instead to get the modified peptide sequence.

`Purity_cutoff` Cutoff for purity. Default is 0.6

`PeptideProphet_prob_cutoff`
Cutoff for the peptide identification probability. Default is 0.7. The probability is confidence score determined by PeptideProphet and higher values indicate greater confidence.

`useUniquePeptide`
logical, if TRUE (default) removes peptides that are assigned for more than one proteins. We assume to use unique peptide for each protein.

`rmPSM_withfewMea_withinRun`
TRUE (default) will remove the features that have 1 or 2 measurements within each Run.

`rmPeptide_OxidationM`
TRUE (default) will remove the peptides including oxidation (M) sequence.

`rmProtein_with1Feature`
TRUE will remove the proteins which have only 1 peptide and charge. Defaut is FALSE.

`summaryforMultipleRows`
sum (default) or max - when there are multiple measurements for certain feature in certain run, select the feature with the largest summation or maximal value.

`use_log_file` logical. If TRUE, information about data processing will be saved to a file.

`append` logical. If TRUE, information about data processing will be added to an existing log file.

`verbose` logical. If TRUE, information about data processing wil be printed to the console.

`log_file_path` character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.

`...` additional parameters to 'data.table::fread'.

Value

'data.frame' of class 'MSstatsTMT'

proteinGroups — *Example of proteinGroups file from MaxQuant for TMT-10plex experiments.*

Description

Example of proteinGroup.txt file from MaxQuant, which is identified protein group information file. It is the input for MaxQtoMSstatsTMTFormat function, with evidence.txt and annotation file. It includes identified protein groups for 10 proteins among 15 MS runs with TMT10. The important variables are as follows:

Usage

```
proteinGroups
```

Format

A data frame with 1075 rows and 105 variables.

Details

- id
- Protein.IDs
- Only.identified.by.site
- Potential.contaminant
- Reverse

Examples

```
head(proteinGroups)
```

proteinSummarization — *Summarizing peptide level quantification to protein level quantification*

Description

We assume missing values are censored and then impute the missing values. Protein-level summarization from peptide level quantification are performed. After all, global median normalization on peptide level data and normalization between MS runs using reference channels will be implemented.

Usage

```
proteinSummarization(
  data,
  method = "msstats",
  global_norm = TRUE,
  reference_norm = TRUE,
  remove_norm_channel = TRUE,
  remove_empty_channel = TRUE,
  MBimpute = TRUE,
  maxQuantileforCensored = NULL,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL,
  msstats_log_path = NULL
)
```

Arguments

data	Name of the output of PDtoMSstatsTMTFormat function or peptide-level quantified data from other tools. It should have columns ProteinName, PeptideSequence, Charge, PSM, Mixture, TechRepMixture, Run, Channel, Condition, BioReplicate, Intensity
method	Four different summarization methods to protein-level can be performed : "msstats"(default), "MedianPolish", "Median", "LogSum".
global_norm	Global median normalization on peptide level data (equalizing the medians across all the channels and MS runs). Default is TRUE. It will be performed before protein-level summarization.
reference_norm	Reference channel based normalization between MS runs on protein level data. TRUE(default) needs at least one reference channel in each MS run, annotated by 'Norm' in Condtion column. It will be performed after protein-level summarization. FALSE will not perform this normalization step. If data only has one run, then reference_norm=FALSE.
remove_norm_channel	TRUE(default) removes 'Norm' channels from protein level data.
remove_empty_channel	TRUE(default) removes 'Empty' channels from protein level data.
MBimpute	only for method="msstats". TRUE (default) imputes missing values by Accelated failure model. FALSE uses minimum value to impute the missing value for each peptide precursor ion.
maxQuantileforCensored	We assume missing values are censored. maxQuantileforCensored is Maximum quantile for deciding censored missing value, for instance, 0.999. Default is Null.
use_log_file	logical. If TRUE, information about data processing will be saved to a file.

append	logical. If TRUE, information about data processing will be added to an existing log file.
verbose	logical. If TRUE, information about data processing wil be printed to the console.
log_file_path	character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.
msstats_log_path	path to a MSstats log file

Value

list that consists of two data.frames with feature-level (FeatureLevelData) and protein-level data (ProteinLevelData)

Examples

```
data(input.pd)
quant.pd.msstats <- proteinSummarization(input.pd,
                                         method = "msstats",
                                         global_norm = TRUE,
                                         reference_norm = TRUE)
head(quant.pd.msstats$ProteinLevelData)
```

---

raw.mine *Example of output from SpectroMine for TMT-6plex experiments.*

Description

Example of SpectroMine PSM sheet. It is the output of SpectroMine and the input for SpectroMinetoMSstatsTMTFormat function, with annotation file. Annotation file should be made by users. It includes peak intensities for 10 proteins among 12 MS runs with TMT-6plex. The important variables are as follows:

Usage

```
raw.mine
```

Format

A data frame with 170 rows and 28 variables.

Details

- PG.ProteinAccessions
- P.MoleculeID
- PP.Charge
- R.FileName
- PG.QValue
- PSM.Qvalue
- Channels : PSM.TMT6_126..Raw., ..., PSM.TMT6_131..Raw.

Examples

```
head(raw.mine)
```

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raw.om *Example of MSstatsTMT report from OpenMS for TMT-10plex experiments.*

Description

Example of MSstatsTMT PSM sheet from MaxQuant. It is the input for OpenMStoMSstatsTMT-Format function. It includes peak intensities for 10 proteins among 27 MS runs from three TMT10 mixtures. The important variables are as follows:

Usage

```
raw.om
```

Format

A data frame with 860 rows and 13 variables.

Details

- RetentionTime
- ProteinName
- PeptideSequence
- Charge
- Channel
- Condition
- BioReplicate
- Run
- Mixture

- TechRepMixture
- Fraction
- Intensity
- Reference

Examples

```
head(raw.om)
```

`raw.pd` *Example of output from Proteome Discoverer 2.2 for TMT-10plex experiments.*

Description

Example of Proteome discover PSM sheet. It is the input for PDtoMSstatsTMTFormat function, with annotation file. Annotation file should be made by users. It includes peak intensities for 10 proteins among 15 MS runs with TMT-10plex. The variables are as follows:

Usage

```
raw.pd
```

Format

A data frame with 2858 rows and 50 variables.

Details

- Master.Protein.Accessions
- Protein.Accessions
- Annotated.Sequence
- Charge
- Ions.Score
- Spectrum.File
- Quan.Info
- Channels : 126, ..., 131

Examples

```
head(raw.pd)
```

SpectroMinetoMSstatsTMTFormat *Import data from SpectroMine*

Description

Import data from SpectroMine

Usage

```
SpectroMinetoMSstatsTMTFormat(
  input,
  annotation,
  filter_with_Qvalue = TRUE,
  qvalue_cutoff = 0.01,
  useUniquePeptide = TRUE,
  rmPSM_withfewMea_withinRun = TRUE,
  rmProtein_with1Feature = FALSE,
  summaryforMultipleRows = sum,
  use_log_file = TRUE,
  append = FALSE,
  verbose = TRUE,
  log_file_path = NULL,
  ...
)
```

Arguments

input	data name of SpectroMine PSM output. Read PSM sheet.
annotation	data frame which contains column Run, Fraction, TechRepMixture, Mixture, Channel, BioReplicate, Condition. Refer to the example 'annotation.mine' for the meaning of each column.
filter_with_Qvalue	TRUE(default) will filter out the intensities that have greater than qvalue_cutoff in EG.Qvalue column. Those intensities will be replaced with NA and will be considered as censored missing values for imputation purpose.
qvalue_cutoff	Cutoff for EG.Qvalue. default is 0.01.
useUniquePeptide	TRUE(default) removes peptides that are assigned for more than one proteins. We assume to use unique peptide for each protein.
rmPSM_withfewMea_withinRun	TRUE (default) will remove the features that have 1 or 2 measurements within each Run.
rmProtein_with1Feature	TRUE will remove the proteins which have only 1 peptide and charge. Defaut is FALSE.

summaryforMultipleRows
: sum(default) or max - when there are multiple measurements for certain feature in certain run, select the feature with the largest summation or maximal value.

use_log_file
: logical. If TRUE, information about data processing will be saved to a file.

append
: logical. If TRUE, information about data processing will be added to an existing log file.

verbose
: logical. If TRUE, information about data processing wil be printed to the console.

log_file_path
: character. Path to a file to which information about data processing will be saved. If not provided, such a file will be created automatically. If 'append = TRUE', has to be a valid path to a file.

...
: additional parameters to 'data.table::fread'.

Value

'data.frame' of class 'MSstatsTMT'

Examples

```
head(raw.mine)
head(annotation.mine)
input.mine <- SpectroMinetoMSstatsTMTFormat(raw.mine, annotation.mine)
head(input.mine)
```

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