Package ‘MSnID’

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Type Package

Title Utilities for Exploration and Assessment of Confidence of LC-MSn Proteomics Identifications

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Description Extracts MS/MS ID data from mzIdentML (leveraging mzID package) or text files. After collating the search results from multiple datasets it assesses their identification quality and optimize filtering criteria to achieve the maximum number of identifications while not exceeding a specified false discovery rate. Also contains a number of utilities to explore the MS/MS results and assess missed and irregular enzymatic cleavages, mass measurement accuracy, etc.

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R topics documented:

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Description

Extracts MS/MS ID data from mzIdentML (leveraging msID package) or text files. After collating the search results from multiple datasets it assesses their identification quality and optimize filtering criteria to achieve the maximal identifications at a user specified false discovery rate. Additional utilities include:

1. post-experimental recalibration of mass measurement accuracy
2. assessment of irregular and missed cleavages given the enzyme cleavage pattern
3. assessment of false discovery rates at peptide-to-spectrum match, unique peptide and protein levels
4. leverages brute-force and sophisticated optimization routines (Nelder-Mead and simulated annealing) for finding the filtering criteria that provide the maximum spectrum, peptide or protein identifications while not exceeding a corresponding preset threshold of false discovery rate
5. converts the results into MSnSet class object as spectral counting data

Details

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Author(s)

Vladislav A. Petyuk (<vladislav.petyuk@pnnl.gov>)
**apply_filter**

**Description**

Filters the MS/MS identifications.

**Usage**

```r
apply_filter(msnidObj, filterObj)
```

**Arguments**

- `msnidObj` An instance of class "MSnID".
- `filterObj` Either an instance of `MSnIDFilter` class or a "character".

---

**apply_filter**  
Filters the MS/MS identifications

**Description**

Filter out peptide-to-spectrum MS/MS identifications.

**Usage**

```r
apply_filter(msnidObj, filterObj)
```

**Arguments**

- `msnidObj` An instance of class "MSnID".
- `filterObj` Either an instance of `MSnIDFilter` class or a "character".
assess_missed_cleavages

Details

filterObj argument evaluated to a "logical" for each entry of the MS/MS results table.

Value

Returns an instance of "MSnID" class with with peptide-to-spectrum matches that pass criteria defined in filterObj argument.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnID evaluate_filter

Examples

data(c_elegans)

## Filtering using string:
msnidObj <- assess_termini(msnidObj, validCleavagePattern="\[KR\]\.[^P]")
table(msnidObj$numIrregCleavages)
# getting rid of any other peptides except fully tryptic
msnidObj <- apply_filter(msnidObj, "numIrregCleavages == 0")
show(msnidObj)

## Filtering using filter object:
# first adding columns that will be used as filters
msnidObj$msmsScore <- -log10(msnidObj$MS-GF:SpecEValue)
msnidObj$mzError <- abs(msnidObj$experimentalMassToCharge -
msnidObj$calculatedMassToCharge)
# setting up filter object
filtObj <- MSnIDFilter(msnidObj)
filtObj$msmsScore <- list(comparison=">", threshold=10.0)
filtObj$mzError <- list(comparison="<", threshold=0.1) # 0.1 Thomson
show(filtObj)
# applying filter and comparing MSnID object before and after
show(msnidObj)
msnidObj <- apply_filter(msnidObj, filtObj)
show(msnidObj)

assess_missed_cleavages

Counts the missing cleavage sites within the peptides sequence

Description

Bottom-up proteomics approaches utilize endoproteases or chemical agents to digest proteins into smaller fragments called peptides. The enzymes recognize short amino acid motifs and cleave along the peptide bonds. Chemical agents such as CNBr also possess amino acid cleavage specificity. In real-world not every cleavage site get cleaved during the sample processing. Therefore settings of
MS/MS search engines quite often explicitly allow up to a certain number missed cleavage sites per peptide sequence.

This function counts the number of missed cleavages in peptide sequence given the endoprotease cleavage motif in the form of regular expression. The default value for missedCleavagePattern is \([KR](?=^[P])\), which corresponds to trypsin.

Usage

```r
assess_missed_cleavages(object, missedCleavagePattern="[KR](?=^[P])")
```

Arguments

- `object`: An instance of class "MSnID".
- `missedCleavagePattern`: Cleavage pattern in the form of regular expression.

Value

Returns an instance of "MSnID" class with additional column "numMissCleavages"

Warning

If the "MSnID" instance does not contain "peptide" column in MS/MS results table then there will be an error. E.g. you can check this by "peptide" %in% names(msnid) where msnid is your "MSnID" instance.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

- `assessTermini`

Examples

```r
data(c_elegans)
# adding column numMissCleavages containing count of missed cleavages
msnidObj <- assess_missed_cleavages(msnidObj, missedCleavagePattern="[KR](?=^[P])")
# check the distribution
table(msnidObj$numMissCleavages)
```
assess_termini Checks if the peptide termini conforms with cleavage specificity

Description

Bottom-up proteomics approaches utilize endoproteases or chemical agents to digest proteins into smaller fragments called peptides. The enzymes recognize short amino acid motifs and cleave along the peptide bonds. Chemical agents such as CNBr also possesses amino acid cleavage specificity.

This function checks if peptide termini are as expected given the enzymatic/chemical cleavage specificity. The default value for validCleavagePattern is [KR]\.[^P], which corresponds to trypsin.

Usage

assess_termini(object, validCleavagePattern="[KR]\.[^P]")

Arguments

object An instance of class "MSnID".
validCleavagePattern Cleavage pattern in the form of regular expression.

Details

N- or C- protein termini are not considered as irregular cleavage sites.

Value

Returns an instance of "MSnID" class with additional column "numIrregCleavages". If both termini conforms with cleavage specificity, then value is 0, if one or two termini are irregular then the values are 1 and 2, correspondingly.

Warning

If the "MSnID" instance does not contain "peptide" column in MS/MS results table then there will be an error. E.g. you can check this by "peptide" %in% names(msnid) where msnid is your "MSnID" instance.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

assess_missed_cleavages
correct_peak_selection

Examples

data(c_elegans)
# adding column numIrregCleavages
# containing count of irregularly cleaved termini
msnidObj <- assess_termini(msnidObj, validCleavagePattern="[KR]\.[^P]")
# check the distribution
table(msnidObj$numIrregCleavages)

correct_peak_selection

Corrects wrong selection of monoisotopic peak

Description

In a typical setting instruments select ions for fragmentation primarily based on ion intensity. For low molecular weight peptides the most intense peak usually corresponds to monoisotopic peak (that is only C12 carbon isotopes). With increase of molecular weight, intensity of monoisotopic peak becomes smaller relatively to heavier peptide isotopes (that is containing one or a few C13 isotopes).

The function subtracts or adds the mass difference between C13 and C12 isotopes (1.0033548378 Da) if that reduces the mass error. Such a mass error arises from the fact that instrument may peak non-monoisotopic peak for fragmentation and thus report the mass that is different by ~ 1 Da.

Usage

correct_peak_selection(object)

Arguments

object

An instance of class "MSnID".

Value

Returns an instance of "MSnID" class with updated experimentalMassToCharge value.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnID recalibrate mass_measurement_error

Examples

data(c_elegans)
# plot original mass error
massErr <- (msnidObj$experimentalMassToCharge -
msnidObj$calculatedMassToCharge) *
msnidObj$chargeState
hist(massErr,xlim=c(-1,+1), breaks=seq(-1.5,+1.5,0.01))
# fixing the problem of picking wrong monoisotopic peak
evaluate_filter

Filter the MS/MS identifications

Description

Filter out peptide-to-spectrum MS/MS identifications.

Usage

evaluate_filter(object, filter, level=c("PSM", "peptide", "accession"))

Arguments

- **object**: An instance of class "MSnID".
- **filter**: Either an instance of MSnIDFilter class or a "character".
- **level**: Level at which the filter will be evaluated. Possible values are "PSM", "peptide" and "accession". Multiple are OK. Default is all of them.

Value

Returns a matrix with column names "fdr" and "n". Column "n" contains the number of features (spectra, peptides or proteins/accessions) passing the filter. Column "fdr" is the false discovery rate (i.e. identification confidence) for the corresponding features. Row names correspond to the provided levels.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnID id_quality

Examples

data(c_elegans)

## Filtering using string:
msnidObj <- assess_termini(msnidObj, validCleavagePattern="[KR]\.[^P]")
table(msnidObj$numIrregCleavages)
evaluate_filter(msnidObj, "numIrregCleavages == 0")

## Filtering using filter object:
# first adding columns that will be used as filters
msnidObj$msmsScore <- -log10(msnidObj$MS-GF:SpecEValue)
msnidObj$mzError <- abs(msnidObj$experimentalMassToCharge -

```r
msnidObj <- correct_peak_selection(msnidObj)
# plot fixed mass error
massErr <- (msnidObj$experimentalMassToCharge -
           msnidObj$calculatedMassToCharge) *
           msnidObj$chargeState
hist(massErr, xlim=c(-1, +1), breaks=seq(-1.5, +1.5, 0.01))
```
id_quality

```r
msnidObj$calculatedMassToCharge)
# setting up filter object
filtObj <- MSnIDFilter(msnidObj)
filtObj$msmsScore <- list(comparison=">", threshold=10.0)
filtObj$mzError <- list(comparison="<", comparison="<", threshold=0.1) # 0.1 Thomson
show(filtObj)
evaluate_filter(msnidObj, filtObj)
```

### Description
Reports quality for a given level of identification (spectra, peptide or protein).

### Usage
```r
id_quality(object, filter=NULL, level=c("PSM", "peptide", "accession"))
```

### Arguments
- `object`: An instance of class "MSnID".
- `filter`: Optional argument. Either an instance of MSnIDFilter class or a "character".
- `level`: Level at which the filter will be evaluated. Possible values are "PSM", "peptide" and "accession". Multiple are OK. Default is all of them.

### Value
Returns a matrix with column names "fdr" and "n". Column "n" contains the number of features (spectra, peptides or proteins/accessions) passing the filter. Column "fdr" is the false discovery rate (i.e. identification confidence) for the corresponding features. Row names correspond to the provided levels.

### Author(s)
Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

### See Also
- `MSnID evaluate_filter`

### Examples
```r
data(c_elegans)
id_quality(msnidObj, level="peptide")
id_quality(msnidObj, filter="MS-GF:PepQValue < 0.01", level="peptide")
```
infer_parsimonious_accessions

Eliminates Redundancy in Peptide-to-Protein Mapping

Description

Infer parsimonious set of accessions (e.g. proteins) that explains all the peptide sequences. The algorithm is a simple loop that looks for the accession explaining most peptides, records the peptide-to-accession mapping for this accession, removes those peptides, and then looks for next best accession. The loop continues until no peptides left. The method does not accept any arguments at this point (except the MSnID object itself).

Usage

infer_parsimonious_accessions(object)

Arguments

object An instance of class "MSnID".

Details

Although the algorithm is rather simple it is THE algorithm used for inferring maximal matching in bipartate graphs and is used in the IDPicker software.

Value

Returns an instance of "MSnID" with minimal set of proteins necessary to explain all the peptide sequences.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnID

Examples

data(c_elegans)

# explicitly adding parameters that will be used for data filtering
msnidObj$msmsScore <- -log10(msnidObj$'MS-GF:SpecEValue')
msnidObj$absParentMassErrorPPM <- abs(mass_measurement_error(msnidObj))

# quick-and-dirty filter. The filter is too strong for the sake of saving time
# at the minimal set of proteins inference step.
msnidObj <- apply_filter(msnidObj, 'msmsScore > 12 & absParentMassErrorPPM < 2')

show(msnidObj)
msnidObj2 <- infer_parsimonious_accessions(msnidObj)
show(msnidObj2)
mass_measurement_error

Computes error of the parent ion mass to charge measurement

Description

Computes error of the parent ion mass to charge measurement from experimentalMassToCharge and calculatedMassToCharge. The returned value is in points per million (ppm).

Usage

mass_measurement_error(object)

Arguments

object An instance of class "MSnID".

Details

It may be more common to compute "mass measurement error". However, the practical difference in "mass measurement error" and "mass to charge measurement error" is negligible. Moreover, the instruments measure mass/charge ratio, not mass per se.

Value

Returns mass to charge measurement error in "ppm" units.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnID recalibrate correct_peak_selection

Examples

data(c_elegans)
ppm <- mass_measurement_error(msnidObj)
hist(ppm, 100)
The "MSnID" Class for Mass Spectrometry Based Proteomics Identification Data

Description

The MSnID is a convenience class for manipulating the MS/MS search results.

Objects from the Class

The way to create objects is to call MSnID constructor function that takes as an input the project working directory workDir and the second argument if the cache from previous analysis should be cleaned cleanCache.

Slots

workDir: Object of class "character". containing working directory for the project. The .Rcache subdirectory stores the cached results from the previous analyses. The mechanism of caching relies on R.cache package.

psms: Object of class data.table that contains all the MS/MS identification results in the form of peptide(or protein)-spectrum-matches.

Methods

read_mzIDs signature(object, mzids):
Reads mzIdentML files into psms data.table slot of object MSnID instance. The functionality leverage mzID package facility. Note, the calls are memoised using R.cache facility. So if the call with the same list of files issues again, the results will be read from cache instead of re-parsing the mzIdentML files. See read_mzIDs

psms(object), psms(object)<-value: Gets and sets MS/MS search results as data.frame. See psms

dim signature(x = "MSnID"):
Returns the dimensions of the table with MS/MS identification data.

peptides signature(object = "MSnID"):
Returns unique peptide list. See peptides

accessions signature(object = "MSnID"):
Returns unique accessions (typically proteins) list. See accessions

proteins signature(object = "MSnID"):
Returns unique proteins list. See proteins

assess_termini Checks the agreement of peptide termini with enzymes cleavage specificity. The return value is theMSnID object with extra variable numIrregCleavages. See assess_termini

assess_missed_cleavages Checks if the peptide sequence contains the sites that were not cleaved by the enzyme. For details see assess_missed_cleavages

mass_measurement_error Returns parent ion mass measurement error in parts per million (ppm) units. Note, it requires experimentalMassToCharge and calculatedMassToCharge variables to be set. See mass_measurement_error

recalibrate Recalibrates, that is removes systematic error from experimentalMassToCharge measurements. See recalibrate
MSnID-class

**correct_peak_selection** Subtracts or adds the mass difference between C13 and C12 isotopes (1.0033548378 Da) if that reduces the mass error. Such a mass error arises from the fact that instrument may peak non-monoisotopic peak for fragmentation and thus report the mass that is different by ~ 1 Da. See `correct_peak_selection`

**apply_filter** signature(msnidObj="MSnID", filterObj="character")

signature(msnidObj="MSnID", filterObj="MSnIDFilter")

The filterObj argument is a "character" or converted to a "character" text string that is evaluated to a "logical" for each entry of the MS/MS results table. Return value is a filtered MSnID object with entries that pass the applied filter. See `apply_filter`

**evaluate_filter** evaluate_filter(object, filter, level = c("PSM","peptide","accession"))

Returns a list with `fdr` and `n` elements. Argument filter is either "character" or "MSnIDFilter" object. Argument level can take one of the values c("PSM","peptide","accession") and controls the level filter is evaluated. See `evaluate_filter`

**id_quality** signature(object="MSnID", ...)

Other optional ... arguments are filter is an "MSnIDFilter" instance and level. The level values are one of "PSM", "peptide", "accession". The method returns FDR for given level depending of type of identifications. See `id_quality`

**as(,"MSnSet")** signature(x = "MSnID"): Coerce object from MSnID to MSnSet.

**names** signature(x="MSnID")

Returns the column names in the MS/MS results table.

object$name, object$name<-value Access and set name column in MS/MS search results table.

object[[i]], object[[i]]<-value Access and set column i (character or numeric index) in MS/MS search results table.

**as(,"MSnSet")** signature(from = "MSnID"): Coerce object from MSnID to MSnSet.

**as(,"data.table")** signature(from = "MSnID"): Coerce object from MSnID to data.table.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnSet, mzID.

Examples

```r
## Not run:
msnidObj <- MSnID(.)
mzids <- system.file("extdata","c_elegans.mzid.gz",package="MSnID")
msnidObj <- read_mzIDs(msnidObj, mzids)
# clean up the cache directory
unlink(".Rcache", recursive=TRUE)

## End(Not run)
```
The "MSnIDFilter" Class for Handling MS/MS Criteria, Relationships and Thresholds for Data Filtration.

Description

The MSnIDFilter is a convenience class for manipulating the MS/MS filter for MS/MS results.

Objects from the Class

The way to create objects is to call MSnIDFilter constructor function that takes as input the MSnID class instance and (optionally) filterList.

Slots

MSnIDobj: An instance of class "MSnID".

filterList: An optional argument. A list with element names corresponding to column names available in MSnID instance. Each element contains sub-elements "comparison" and "threshold". "Comparison" is one of the relationship operators (e.g. ">") see Comparison for details. "Threshold" is the corresponding parameter value the identification has to be more or less (depending on comparison) to pass the filter.

Methods

show signature(object="MSnIDFilter"):
Prints MSnIDFilter object.

object$name, object$name<-value Access and set filterList elements.

names signature(x="MSnIDFilter")
Returns the names of the criteria.

as.numeric signature(x="MSnIDFilter")
Converts filterList into "numeric" vector. Vector names are the list element names. Vector values are threshold values. Comparison operators are lost.

length signature(x="MSnIDFilter")
Returns the number of criteria set in the "MSnIDFilter" object.

update signature(object="MSnIDFilter", ...)
The additional ... argument is numeric vector of the same length as the number of criteria in MSnIDFilter object. The method update the corresponding thresholds to new provided values.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnSet evaluate_filter apply_filter optimize_filter
Examples

data(c_elegans)

## Filtering using filter object:
# first adding columns that will be used as filters
msnidObj$msmsScore <- -log10(msnidObj$MS-GF:SpecEValue) / MS-GF:SpecEValue
msnidObj$mzError <- abs(msnidObj$experimentalMassToCharge - msnidObj$calculatedMassToCharge)
# setting up filter object
filtObj <- MSnIDFilter(msnidObj)
filtObj$msmsScore <- list(comparison=">", threshold=10.0)
filtObj$mzError <- list(comparison="<", threshold=0.1) # 0.1 Thomson
show(filtObj)
# applying filter and comparing MSnID object before and after
show(msnidObj)
msnidObj <- apply_filter(msnidObj, filtObj)
show(msnidObj)

mznidObj

Example mzIdenML File and MSnID Object

Description

MSnID object from c_elegans_A_3_1_21Apr10_Draco_10-03-04_msgfplus.mzid.gz dataset from
PeptideAtlas repository id PASS00308.

Usage

data(c_elegans)

Examples

data(c_elegans)
msnidObj

## Not run:
## How to download the example mzID file from PeptideAtlas:
try(setInternet2(FALSE),silent=TRUE)
ftp.loc <- "ftp://PASS00308:PJ5348t@ftp.peptideatlas.org/MSGFPlus_Results/MZID_Files/c_elegans_A_3_1_21Apr10_10-03-04_msgfplus.mzid.gz"
download.file(ftp.loc, "c_elegans.mzid.gz")
## End(Not run)

## Not run:
## Script for generation of the example data:
msnidObj <- MSnID(".")
mzsids <- system.file("extdata","c_elegans.mzid.gz",package="MSnID")
msnidObj <- read_mzIDs(msnidObj, mzsids)
save(msnidObj, file="c_elegans.RData", compress='xz', compression_level=9)
# MD5 sum for the file is: a7c511a6502a6419127f1e648ed92
digest::digest(msnidObj)
# clean up the cache directory
unlink(".Rcache", recursive=TRUE)
optimize_filter

Filter criteria optimization to maximize the number of identifications given the FDR upper threshold

Description

Adjusts parameters in the "MSnIDFilter" instance to achieve the most number of spectra, peptides or proteins/accessions within pre-set FDR upper limit.

Usage

```r
optimize_filter(filterObj, msnidObj, fdr.max, method, level, n.iter, mc.cores=NULL)
```

Arguments

- `filterObj`: An instance of class "MSnIDFilter".
- `msnidObj`: An instance of class "MSnID".
- `fdr.max`: Upper limit on acceptable false discovery rate (FDR).
- `method`: Optimization method. Possible values are "Grid" or same values as for the method argument of the `optim` function. Tested and recommended arguments (besides "Grid") of `method` are "Nelder-Mead" or "SANN".
- `level`: Determines at what level to perform optimization. Possible values are "PSM", "peptides" or "accession".
- `n.iter`: For method "Grid" is approxomate number of evaluation point. For "Nelder-Mean" and "SANN" methods see `optim`.
- `mc.cores`: Controls the number of enabled cores for parallel processing. Make sense only for "Grid" optimization. Default is `getOption("mc.cores", 2L)`. See `mclapply` for details.

Details

The "Grid" method is brute-force optimization through evaluation of approximately `n.iter` combinations of the parameters set in the "MSnIDFilter" object. The enumeration of the parameter combinations proceeds as follows. The `n.iter` number is getting split given the dimensionality of the problem (that is the number of filter parameters in the "MSnIDFilter" object. For each parameter the evaluation points are equally spaced according to quantiles of the parameter distribution. This way we enumerate the grid that has more evaluation points in relatively more dense areas.

Note, optimization is computationally expensive. Thus, the `optimize_filter` call is memoised using facilities from the `R.cache` package. Once the same call of `optimize_filter` function issued second time the results will be retrieved from cache.

Value

Returns an instance of "MSnIDFilter" that is maximized to provide the most number of identifications while maintaining a pre-set confidence (FDR).
peptides

Non-redundant list of peptides

Description

Returns the non-redundant list of peptides from the MSnID object

Usage

peptides(object)

Arguments

object An instance of class "MSnID".
Value

Non-redundant list of peptides.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

accessions proteins

Examples

data(c_elegans)
head(peptides(msnidObj))

Description

Returns results of MS/MS search (peptide-to-spectrum) matches in the form of data.frame.

Usage

psms(object, ...)
psms(object) <- value

Arguments

object An instance of class "MSnID".
value Value is a data.frame with MS/MS search results
... ignored for now

Value

data.frame

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

MSnID

Examples

data(c_elegans)
msnidDF <- psms(msnidObj)
head(msnidDF)
Description

Reads mzIdentML files into `psms` data.table slot of object `MSnID` instance. The functionality leverage `mzID` package facility. Note, the calls are memoised using `R.cache` facility. So if the call with the same list of files issues again, the results will be read from cache instead of re-parsing the mzIdentML files.

Usage

```r
read_mzIDs(object, mzids, backend)
```

Arguments

- `object` An instance of class "MSnID"
- `mzids` paths to mzIdentML (mzid) files
- `backend` Package that is leveraged for parsing. Either 'mzID' or 'mzR' corresponding to `mzID-package` and `mzR-package` respectively. The 'mzR' parser is much faster, since it is based on C++ code. 'mzID' will be kept in the package for legacy reasons. Note, the default is 'mzID'.

Details

mzIdentML files can be either as is or in gzip compressed form (*.mzid.gz).

Value

Returns an instance of "MSnID" class with `@psms` data.table slot populated with MS/MS identifications.

Author(s)

Vladislav A Petyuk <vladislav.petyuk@pnnl.gov>

See Also

- `flatten mzID`

Examples

```r
## Not run:
msnidObj <- MSnID(.)
mzids <- system.file("extdata","c_elegans.mzid.gz",package="MSnID")
msnidObj <- read_mzIDs(msnidObj, mzids)
# clean up the cache directory
unlink(".Rcache", recursive=TRUE)
## End(Not run)
```
Post-experimental recalibration of observed mass to charge ratios

Description

Mass spectrometry measurements like any other real-world measurements are prone to systematic errors. Typically they are minimized by instrument calibration prior to the analysis. Nonetheless, the calibration may drift over time or be affected by some adverse factors (temperature or space charge fluctuations).

This function estimates and removes the systematic error from the datasets. The side effect is the recalibrated `experimentalMassToCharge` values.

Usage

```r
calibrate(object)
```

Arguments

- **object**: An instance of class "MSnID".

Details

Currently it employs a very simple method of zero-centering the histogram of mass measurement errors. In the future it will contain more sophisticated recalibration routines.

Value

"MSnID" class instance with updated `experimentalMassToCharge`.

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See Also

`MSnID mass_measurement_error correct_peak_selection`

Examples

```r
data(c_elegans)

# first let's fix the error of picking wrong monoisotopic peak
# otherwise the mass error range will be very large
msnidObj <- correct_peak_selection(msnidObj)

# original mass error in ppm
ppm <- mass_measurement_error(msnidObj)
hist(ppm, 200, xlim=c(-20,+20))

# The dataset is well calibrated. So let's introduce
# some mass measurement error.
msnidObj$experimentalMassToCharge <-
   .msnidObj$experimentalMassToCharge * (1+0.00001)
```
# mass error (in ppm) after artificial de-calibration
ppm <- mass_measurement_error(msnidObj)
hist(ppm, 200, xlim=c(-20,+20))

# recalibration
msnidObj <- recalibrate(msnidObj)
ppm <- mass_measurement_error(msnidObj)
hist(ppm, 200, xlim=c(-20,+20))
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