Package ‘CAMERA’

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Title Collection of annotation related methods for mass spectrometry data

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Imports methods, xcms, RBGL, graph, graphics, grDevices, stats, utils, Hmisc, igraph

Suggests faahKO, RUnit, BiocGenerics

Enhances Rmpi, snow

Description Annotation of peaklists generated by xcms, rule based annotation of isotopes and adducts, isotope validation, EIC correlation based tagging of unknown adducts and fragments

License GPL (>= 2)

ByteCompile TRUE

URL http://msbi.ipb-halle.de/msbi/CAMERA/

BugReports https://github.com/sneumann/CAMERA/issues/new

biocViews MassSpectrometry, Metabolomics

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annotate-methods

Description

Wrapper script for automatic annotation of isotope peaks, adducts and fragments for a (grouped) `xcmsSet` xs. The function returns an `xsAnnotate` object.

Usage

```r
annotate(object, sample=NA, nSlaves=1, sigma=6, perfwhm=0.6, cor_eic_th=0.75, graphMethod="hcs", pval=0.05, calcCiS=TRUE, calcIso=FALSE, calcCaS=FALSE, maxcharge=3, maxiso=4, minfrac=0.5, ppm=5, mzabs=0.015, quick=FALSE, psg_list=NULL, rules=NULL, polarity="positive", multiplier=3, max_peaks=100, intval="into")
```
Arguments

- **object**: `xcmsSet` with peak group assignments
- **sample**: `xsAnnotate`: Sample selection for grouped `xcmsSet`, see `xsAnnotate-class`
- **nSlaves**: `xsAnnotate`: Use parallel CAMERA mode, require Rmpi
- **sigma**: `groupFWHM`: multiplier of the standard deviation
- **perfwhm**: `groupFWHM`: percentage of FWHM width
- **cor_eic_th**: `groupCorr`: correlation threshold (0..1)
- **graphMethod**: `groupCorr`: Method selection for grouping peaks after correlation analysis into pseudospectra
- **pval**: `groupCorr`: significant correlation threshold
- **calcCiS**: `groupCorr`: Use correlation inside samples for peak grouping
- **calcIso**: `groupCorr`: Use isotopic relationship for peak grouping
- **calcCaS**: `groupCorr`: Use correlation across samples for peak grouping
- **maxcharge**: `findIsotopes`: max. ion charge
- **maxiso**: `findIsotopes`: max. number of expected isotopes
- **minfrac**: `findIsotopes`: The percentage number of samples, which must satisfy the C12/C13 rule for isotope annotation
- **ppm**: General ppm error
- **mzabs**: General absolut error in m/z
- **quick**: Use only `groupFWHM` and `findIsotopes`
- **psg_list**: Calculation will only be done for the selected groups
- **rules**: `findAdducts`: User defined ruleset
- **polarity**: `findAdducts`: Which polarity mode was used for measuring of the ms sample
- **multiplier**: `findAdducts`: If no ruleset is provided, calculate ruleset with max. number \(nM+x\) clusterions
- **max_peaks**: How much peaks will be calculated in every thread using the parallel mode
- **intval**: General used intensity value (into, maxo, intb)

Details

Batch script for annotation of an (grouped) `xcmsSet` `xs`. Generates an `xsAnnotate` object by calling all involved functions for the annotation step. Function list: 1: `groupFWHM()`, 2: `findIsotopes()`, 3: `groupCorr()`, 4: `findAdducts()`. Return the `xsAnnotate` object, which inherits all annotations. For more information about the parameters see the specific function manpages.

Value

`annotate` returns an `xsAnnotate` object. For more information about the `xsAnnotate` object see `xsAnnotate-class`.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>
annotateDiffreport

Examples

library(CAMERA)
file <- system.file("mzdata/MM14.mzdata", package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
xsa <- annotate(xs)

annotateDiffreport	Automatic deconvolution/annotation of LC/ESI-MS data

Description

Wrapper function for the xcms diffreport and the annotate function. Returns a diffreport within the annotation results.

Usage

annotateDiffreport(object, sample=NA, nSlaves=1, sigma=6, perfwhm=0.6,
cor_eic_th=0.75, cor_exp_th = 0.75, graphMethod="hcs", pval=0.05, calcCiS=TRUE,
calcIso=FALSE, calcCaS=FALSE, maxcharge=3, maxiso=4, minfrac=0.5,
ppm=5, mzabs=0.015, quick=FALSE, psg_list=NULL, rules=NULL,
polarity="positive", multiplier=3, max_peaks=100, intval="into",
pval_th = NULL, fc_th = NULL, sortpval=TRUE, ...)

Arguments

object	xcmsSet with peak group assignments
sample	xsAnnotate: Sample selection for grouped xcmsSet, see xsAnnotate-class
nSlaves	xsAnnotate: Use parallel CAMERA mode, require Rmpi
sigma
groupFWHM: multiplier of the standard deviation
perfwhm
groupFWHM: percentage of FWHM width
cor_eic_th
groupCorr: Correlation threshold for EIC correlation (0..1)
cor_exp_th
groupCorr: Threshold for intensity correlations across samples (0..1)
graphMethod
groupCorr: Method selection for grouping peaks after correlation analysis into pseudospectra
pval
groupCorr: significant correlation threshold
calcCiS
groupCorr: Use correlation inside samples for peak grouping
calcIso
groupCorr: Use isotopic relationship for peak grouping
calcCaS
groupCorr: Use correlation across samples for peak grouping
maxcharge
findIsotopes: max. ion charge
maxiso
findIsotopes: max. number of expected isotopes
minfrac
findIsotopes: The percentage number of samples, which must satisfy the C12/C13 rule for isotope annotation
ppm	General ppm error
mzabs	General absolut error in m/z
quick	Use only groupFWHM and findIsotopes
**psg_list**  
Calculation will only be done for the selected groups

**rules**  
findAdducts: User defined ruleset

**polarity**  
findAdducts: Which polarity mode was used for measuring of the ms sample

**_multiplier**  
findAdducts: If no ruleset is provided, calculate ruleset with max. number n of [nM+x] cluster ions

**max_peaks**  
How much peaks will be calculated in every thread using the parallel mode

**intval**  
General used intensity value (into, maxo, intb)

**pval_th**  
pval threshold. Creates a new psg_list. A pseudospectra is selected if it contains peaks, with pval < pval_th

**fc_th**  
Same as pval. Select those groups with contains peaks with fold-change > fc_th. Pval_th and fc_th can be combined

**sortpval**  
Sort diffreport after pvalues

...  
Diffreport parameters see **diffreport**

**Details**

Batch script wrapper for combining the annotation and the diffreport for a (grouped) xcmsSet xs. Function list: 1: diffreport(), 2: groupFWHM(), 3: findIsotopes(), 4: groupCorr(), 5: findAdducts()  
For a speedup calculation users can create a quick run, with quick = TRUE to preselect pseudospectra of interest. The indices of those pseudospectra are set with psg_list in a second run. On the other hand, an automatic selection with pval_th and/or fc_th can be performed. Returns the normal xcms diffreport table, with the additional CAMERA slots

**Value**

annotateDiffreport returns an diffreport, see **diffreport**, within additional columns containing the annotation results.

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

**Examples**

```r
#Multiple sample
library(CAMERA)
library(faahKO)
xs.grp <- group(faahko)
xs.fill <- fillPeaks(xs.grp)

# fast preselection
# diffreport <- annotateDiffreport(xs.fill,quick=TRUE)
# index <- c(1,18,35,45,56) # Make only for those grps a adduct annotation
# diffreport2 <- annotateDiffreport(xs.fill,psg_list=index,metlin = TRUE)

#automatic selection for groups with peaks p-val < 0.05 and fold-change > 3
# diffreport <- annotateDiffreport(xs.fill,pval_th=0.05,fc=3)
```
Description

Calculate the correlation across samples. Filtering correlation with specific parameters and returns a correlation matrix.

Usage

```
calcCaS(object, corval=0.75, pval=0.05, intval="into")
```

Arguments

- `object`: The `xsAnnotate` object
- `corval`: Correlation threshold for positive hits
- `pval`: P-Value threshold for significance level of correlation
- `intval`: Selection of the intensity values that should be used in the correlation analysis. Can be `into`, `maxo` or `intb`.

Details

Calculate pearson correlation between the peak intensities over all samples. Afterwards use `cor.test` for returning only significant correlation. Returns only those correlation, which are above both threshold. Set `corval` and `pval` to 0 to get the unfiltered correlation matrix. If the object is pregrouped with `groupFWHM`, then the correlation is only calculated between peaks within a pseudospectrum. Otherwise between all peaks.

Value

A matrix with 4 columns:

- `x`: peak index according to `peaktable`
- `y`: peak index according to `peaktable`
- `cor`: correlation value between peak `x` and peak `y`
- `ps`: pseudospektrum index for both peaks

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

See Also

- `calcCiS`
- `groupCorr`
- `xsAnnotate-class`
calcCiS-methods

Examples

```r
library(CAMERA)
#Multiple sample
library(faahKO)
x.s.grp <- group(faahKO)
#create xsAnnotate object
xsa <- xsAnnotate(x.s.grp)
#generate pseudospectra
xsa.group <- groupFWHM(xsa)
#calculate correlation
correlationMatrix <- calcCaS(xsa.group)
```

calcCiS-methods  Calculate peak distance matrix after EIC correlation

Description

Processing an xsAnnotate object and correlates peak EIC curves from one pseudospectrum, using
a precalculated EIC matrix (getAllPeakEICs). It return a weighted edge list as distance matrix
between peaks according to the correlation analysis. The edge value is the pearson correlation
coefficient. The list can be used as input for calcPC.

Usage

```
calcCiS(object, EIC=EIC, corval=0.75, pval=0.05, psg_list=NULL)
```

Arguments

- **object**: The xsAnnotate object
- **EIC**: EIC Matrix
- **corval**: Correlation threshold for the EIC correlation
- **pval**: pvalue for testing correlation of significance
- **psg_list**: Vector of pseudospectra indices. The correlation analysis will be only done for
  those groups

Details

The algorithm correlates the EIC of a every peak with all others, to find the peaks that belong to
one substance. LC/MS data should grouped with groupFWHM first. This step reduce the runtime
a lot and increased the number of correct classifications. Only correlation with a higher value than
the correlation threshold and significant p-values will be returned.

Value

A matrix with 4 columns:

- **x**: peak index
- **y**: peak index
- **cor**: correlation value
- **ps**: pseudospectrum index, which contains x and y
Author(s)
Carsten Kuhl <ckuhl@ipb-halle.de>

See Also
calcCaS groupCorr getAllPeakEICs xsAnnotate-class

calcIsotopes-methods

Calculate isotope distance matrix from xsAnnotate object

Description
Processing an xsAnnotate object with annotated isotopes (findIsotopes). It return a weighted edge list as distance matrix between peaks according to the isotope annotation. The edge value for recognized isotopes is 1 for all cases. The list can be used as input for calcPC.

Arguments
object xsAnnotate object

Value
A matrix with 4 columns:

<table>
<thead>
<tr>
<th>x</th>
<th>peak index</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>peak index</td>
</tr>
<tr>
<td>cor</td>
<td>edge value, always 1</td>
</tr>
<tr>
<td>ps</td>
<td>pseudospectrum index, which contains x and y</td>
</tr>
</tbody>
</table>

Methods
object = "xsAnnotate" calcIsotopes(object)

Author(s)
Carsten Kuhl, <ckuhl@ipb-halle.de>

See Also
calcPC xsAnnotate-class
calcPC-methods

Peakclustering into pseudospectra according to a distance matrix

Description

A number of clustering methods exist in CAMERA. calcPC is the generic method.

Usage

calcPC(object, method, ...)

Arguments

object xsAnnotate-class object
method Method to use for clustering. See details.
... Optional arguments to be passed along

Details

This algorithms cluster peaks from a xsAnnotate object into pseudospectra according to a provided distance matrix. Therefore all peaks are transformend into a graph, with peaks as nodes and the value from the distance matrix as edges. Afterwards a graph separation algorithm is applied, which searches in the graph for clusters. See the manpages of the specific clustering algorithms for more information.

If the xsAnnotate is pregrouped, for example groupFWHM, only the already existing groups will be further processed.

The different algorithms that can be used by specifying them with the method argument. For example to use the highly connected subgraphs approach by E. Hartuv, R. Shamir, (1999), one would use: calcPC(object, method="hcs"). This is also the default, see calcPC.hcs.

Further arguments given by ... are passed through to the function implementing the method, which are most likely ajc. The parameter ajc is the peak distance matrix.

getOption("BioC")$CAMERA$findPeaks.methods returns a character vector of nicknames for the algorithms available.

The function returns a xsAnnotate object with grouping information, as list of peak indices. They are stored as object@pspectra.

See Also

calcPC.lpc calcPC.hcs xsAnnotate-class
calcPC.hcs

Peakclustering into pseudospectra with the highly connected subgraphs approach

Description

Cluster peaks from an xsAnnotate object into pseudospectra

Arguments

object xsAnnotate object
aqc Weighted symbolic edge list as four column matrix ("x","y","cor","ps"). Columns x,y are peak indices, cor the edge value and ps the pseudospectrum index, where both peaks occur.
psg_list additional vector ps pseudospectra indices, which are used in the clustering. If set to NULL all pseudospectra will be processed.

Details

In some cases, is the peak grouping after retentiontime with groupFWHM not enough to separate co-elution compounds. Therefore groupCorr use additional correlation analysis to achieve a separation. calcPC is part of this approach, which takes the calculated weighted edge list and performs the graph clustering. It returns an xsAnnotate object with further separated pseudospectra.

Methods

object = "xsAnnotate" calcPC.hcs(object, aqc=NULL, psg_list=NULL)

Author(s)

Carsten Kuhl, <ckuhl@ipb-halle.de>

See Also
calcPC groupCorr highlyConnSG xsAnnotate-class

calcPC.lpc

Peakclustering into pseudospectra with the label-propagation-community algorithm

Description

Cluster peaks from an xsAnnotate object into pseudospectra
Arguments

object  xsAnnotate object
ajc  Weighted symbolic edge list as four column matrix ("x","y","cor","ps"). Columns x,y are peak indices, cor the edge value and ps the pseudospectrum index, where both peaks occur.
psg_list  additional vector ps pseudospectra indices, which are used in the clustering. If set to NULL all pseudospectra will be processed.

Details

In some cases, is the peak grouping after retentiontime with groupFWHM not enough to separate co-elution compounds. Therefore groupCorr use additional correlation analysis to achieve a separation. calcPC is part of this approach, which takes the calculated weighted edge list and performs the graph clustering. It returns an xsAnnotate object with further separated pseudospectra.

Methods

   object = "xsAnnotate"        calcPC.lpc(object, ajc=NULL, psg_list=NULL)

Author(s)

Carsten Kuhl, <ckuhl@ipb-halle.de>

See Also

calcPC groupCorr xsAnnotate-class label.propagation.community

Description

The spawned slaves processes, which are created within the parallel mode, are closed explicit.

Usage

cleanParallel(object)

Arguments

object  xsAnnotate object

Details

The function needs a xsAnnotate object after groupCorr or groupFWHM. The resulting object is a artificial xcmsSet, where the peaks with the specific neutral loss are stored in xcmsSet@peaks.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>
combinexsAnnos

Examples

```r
## Not run: library(CAMERA)
file <- system.file("mm14.mzdata", package = "CAMERA")
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(x, polarity="positive", nSlaves=2)
an <- groupFWHM(an)
an <- findAdducts(an)
cleanParallel(an)
## End(Not run)
```

combinexsAnnos Check CAMERA ion species annotation due to matching with opposite ion mode

Description

This function check annotations of ion species with the help of a sample from opposite ion mode. As first step it searches for pseudospectra from the positive and the negative sample within a retention time window. For every result the m/z differences between both samples are matched against specific rules, which are combinations from pos. and neg. ion species. As example M+H and M-H with a m/z difference of 2.014552. If two ions matches such a difference, the ion annotations are changed (previous annotation is wrong), confirmed or added. Returns the peaklist from one ion mode with recalculated annotations.

Usage

```r
combinexsAnnos(xsa.pos, xsa.neg, pos=TRUE, tol=2, ruleset=NULL)
```

Arguments

- `xsa.pos` xsAnnotate object with positive ion mode
- `xsa.neg` xsAnnotate object with negative ion mode
- `pos` If TRUE the peaklist from the positive mode is returned, if FALSE the negative
- `tol` Retention time window in seconds
- `ruleset` Matrix of matching rules, see example

Details

Both xsAnnotate object should be full processed (grouping and annotation). Without previous annotation the resulting peaklist only includes annotation with matches peaks from both mode according to the rule(s). With ruleset=NULL the function only looks for M+H/M-H pairs. The ruleset is a two column matrix with includes rule indices from the rule table of both xsAnnotate objects. ruleset <- cbind(1,1) would create the M+H/M-H rule, since the first rule of xsa.pos@ruleset and xsa.neg@ruleset is M+H respectively M-H. Only rules with identical charge can be combined!

Value

Returns a (normal) CAMERA peaklist with a additional column neg. Mode or pos. Mode, where matching peaks from the opposite mode are noted.
compoundLibraries

Author(s)
Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

```r
## Not run:
# Searches for M+H/M-H combinations within a retention time window of 2 seconds
peaklist.pos <- combinexsAnnos(xsa.pos, xsa.neg, tol=2)
## End(Not run)
```

compoundLibraries

The supported compound databases

Description
Returns a set of supported compound databases

Usage
```r
compoundLibraries()
```

Value
Vector of supported compound databases

Author(s)
Hendrik Treutler

Examples
```r
compoundLibraries()
```

compoundQuantiles

compoundQuantiles constructor

Description
constructor of class compoundQuantiles

Usage
```r
compoundQuantiles(compoundLibrary = "kegg", massWindowSize = 50)
```

Arguments
- `compoundLibrary` the database; see `compoundLibraries()` for a list of supported databases
- `massWindowSize` the mass window size for grouping compounds; see `massWindowSizes(compoundLibrary = "kegg")` for a list of supported databases for e.g. the database kegg
compoundQuantiles-class

Value

the compoundQuantiles object

Author(s)

Hendrik Treutler

Examples

cpObj <- compoundQuantiles()

compoundQuantiles-class

Class compoundQuantiles encapsulates compound statistics from different databases.

Description

The user is able to get the expected number of atoms of element e (C, N, ...) for a compound of mass m for a q-quantile. I.e. getAtomCount(object = compoundQuantiles(), element = e, mass = m, quantile = q) returns the number of atoms of element e in a compound of mass m in the lowest-(q*100) (sorted ascending by the possible number of atoms of element e for compounds of such mass).

The user is able to get the expected proportion between the intensities of two isotope peaks for a compound of mass m for a q-quantile. I.e. getIsotopeProportion(object = compoundQuantiles(), isotope1 = i1, isotope2 = i2, mass = m, quantile = q) returns the isotope proportion i1 / i2 for a compound of mass m in the lowest-(q*100) (sorted ascending by the possible isotope proportions for compounds of such mass).

Objects from the Class

Objects can be created with the compoundQuantiles constructor.

Slots

compoundLibrary: The compound library to rely on (kegg, chebi, ...)
massWindowSize: The mass window size of the compound statistics (25, 100, ...)
minCompoundMass: Minimum compound mass for which there are statistics
maxCompoundMass: Maximum compound mass for which there are statistics
numberOfMassWindows: Number of mass windows
numberOfIsotopes: Number of isotopes for which there are isotope ratio quantiles
isotopeSet: The set of isotopes for which there are isotope ratio quantiles
elementSet: The set of elements for which there are element count statistics
quantileSet: The set of quantiles for which there are isotope ratio statistics
eleCounters_e_q_mw: Three dimensional array containing the element count statistics (element, quantile, mass window index)
proportions_i_q_mw: Three dimensional array containing the isotope ratio quantiles relative to the monoisotopic peak (isotope index, quantile, mass window index)
Method

**getAtomCount** signature(object = "xsAnnotate"): returns the number of atoms of the specified element for the given quantile and mass window index

**getIsotopeProportion,compoundQuantiles-method** signature(object = "xsAnnotate"): returns the isotope ratio of the specified isotope for the given quantile and mass window index relative to the monoisotopic peak

Note

No notes yet.

Author(s)

Hendrik Treutler, <hendrik.treutler@ipb-halle.de>

See Also

compoundQuantiles getAtomCount getIsotopeProportion

---

**findAdducts-methods** Calculate Adducts and Annotate LC/ESI-MS Spectra

Description

Annotate adducts (and fragments) for a xsAnnotate object. Returns a xsAnnotate object with annotated pseudospectra.

Usage

```r
findAdducts(object, ppm=5, mzabs=0.015, multiplier=3, polarity=NULL, rules=NULL, max_peaks=100, psg_list=NULL)
```

Arguments

- **object** the xsAnnotate object
- **ppm** ppm error for the search
- **mzabs** allowed variance for the search
- **multiplier** highest number(n) of allowed clusterion [nM+ion]
- **polarity** Which polarity mode was used for measuring of the ms sample
- **rules** personal ruleset or with NULL standard ruleset will be calculated
- **max_peaks** If run in parralel mode, this number defines how much peaks will be calculated in every thread
- **psg_list** Vector of pseudospectra indices. The correlation analysis will be only done for those groups
Details

Adducts (and fragments) are annotated for a xsAnnotate object. For every pseudospectra group, generated by groupFWHM and groupCorr, all possible Adducts are calculated and mapped to the peaks. If at least two adducts match, a possible molecule mass for the group can be calculated. After the annotation every mass hypothesis is checked against the charge of the calculated isotopes. It is recommended to call findIsotopes() before the annotation step.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

```r
library(CAMERA)
file <- system.file("mzdata/MM14.mzdata", package = "CAMERA")
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(x)
an <- groupFWHM(an)
an <- findIsotopes(an)  # optional but recommended.
#an <- groupCorr(an)  # optional but very recommended step
an <- findAdducts(an,polarity="positive")
peaklist <- getPeaklist(an)  # get the annotated peak list
```

findIsotopes

Deconvolute/Annotate LC/ESI-MS data

Description

Annotate isotope peaks for a xsAnnotate object. Returns a xsAnnotate object with annotated isotopes.

Usage

```r
findIsotopes(object, maxcharge=3, maxiso=4, ppm=5, mzabs=0.01, intval=c("maxo","into","intb"),
minfrac=0.5, isotopeMatrix = NULL, filter = TRUE)
```

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>the xsAnnotate object</td>
</tr>
<tr>
<td>maxcharge</td>
<td>max. number of the isotope charge</td>
</tr>
<tr>
<td>maxiso</td>
<td>max. number of the isotope peaks</td>
</tr>
<tr>
<td>ppm</td>
<td>ppm error for the search</td>
</tr>
<tr>
<td>mzabs</td>
<td>allowed variance for the search</td>
</tr>
<tr>
<td>intval</td>
<td>choose intensity values for C12/C13 check. Allowed values are into, maxo, intb</td>
</tr>
<tr>
<td>minfrac</td>
<td>in case of multiple samples, percentaged value of samples, which have to contain the correct C12/C13 ratio and are not NA</td>
</tr>
<tr>
<td>isotopeMatrix</td>
<td>four column m/z-diff and ratio Matrix, for matching isotopic peaks.</td>
</tr>
<tr>
<td>filter</td>
<td>Should C12/C13 filter be applied</td>
</tr>
</tbody>
</table>
findIsotopesWithValidation

Details

Isotope peaks are annotated for a xsAnnotate object according to given rules (maxcharge, maxiso). The algorithm benefits from an earlier grouping of the data, with groupFWHM. Generates a list of all possible isotopes, which is stored in object@isotopes. Those isotope information will be used in the groupCorr function. The intensity of the C13 isotope peak is checked against the C12 of proper ratio. In the case of multiple sample, all samples will be tested. Minfrac describe the minimal percentaged of samples, which must passed the test. If peaks are NA, then this sample is skipped and the ratio is (found correct C12/C13 ratio) / (samples containing C12 and C13 peak).

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

library(CAMERA)
file <- system.file("/quotesingle.Varmzdata/MM14.mzdata", package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
an <- findIsotopes(an)

findIsotopesWithValidation

Deconvolute/Annotate LC/ESI-MS data

Description

Annotate validated isotope clusters for a xsAnnotate object. Returns a xsAnnotate object with annotated isotopes. Validation of isotope clusters is based on statistics of the KEGG database implemented in S4 class object compoundQuantiles.

Usage

findIsotopesWithValidation(object, maxcharge=3, ppm=5, mzabs=0.01, intval=c("maxo","into","intb"), validateIsotopePatterns = TRUE, database="kegg")

Arguments

object the xsAnnotate object
maxcharge max. number of the isotope charge
ppm ppm error for the search
mzabs allowed variance for the search
intval choose intensity values for C12/C13 check. Allowed values are into, maxo, intb
validateIsotopePatterns logical, if TRUE putative isotope clusters are validated based on KEGG database statistics.
database the database which is the basis for isotope cluster validation. One of compoundLibraries().
findKendrickMasses

Details

Isotope peaks are annotated for a xsAnnotate object according to given rules (maxcharge, maxiso). The algorithm benefits from a earlier grouping of the data, with groupFWHM. Generates a list of all possible isotopes, which is stored in object@isotopes. Those isotope information will be used in the groupCorr function. The ratios between isotope peaks are checked against the mass–specific 99% confidence interval based on statistics of the KEGG database.

Author(s)

Hendrik Treutler <hendrik.treutler@ipb-halle.de>

References

Hendrik Treutler and Steffen Neumann. "Prediction, detection, and validation of isotope clusters in mass spectrometry data". Submitted to Metabolites 2016, Special Issue "Bioinformatics and Data Analysis".

See Also

findIsotopes

Examples

library(CAMERA)
file <- system.file("mzdata/MM14.mzdata", package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
an <- findIsotopesWithValidation(an)

findKendrickMasses Find specific mass defects using Kendrick mass scales

Description

Todo

Usage

findKendrickMasses(object, masses=c(14, 14.01565),
maxHomologue=4, error=0.002, time=60, intval="maxo",
plot=FALSE)

Arguments

object xsAnnotate object
masses nominal mass and exact mass
error allowed mass difference in Da for matching Kendrick mass defect
maxHomologue max number of homologue
time allowed retention time difference between homologues
intval intensity value (allowed values: maxo, into or intb)
plot plot hits
findNeutralLoss

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

library(CAMERA)
library(faahko)
xs <- group(faahko)

#With specific selected sample
xsa <- xsAnnotate(xs)
#Screen for substance with CH2 differences
findKendrickMasses(xsa, masses=c(14, 14.01565), plot=TRUE)

findNeutralLoss

Find pseudospectra that contains a specific neutral loss

Description

The method searches in every pseudospectra for a distance between two ions matching a provided mass difference. It returns a xcmsSet object containing the matching peaks.

Usage

findNeutralLoss(object, mzdiff=NULL, mzabs=0, mzppm=10)

Arguments

<table>
<thead>
<tr>
<th>argument</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>xsAnnotate object</td>
</tr>
<tr>
<td>mzdiff</td>
<td>neutral loss in Dalton</td>
</tr>
<tr>
<td>mzabs</td>
<td>absolut allowed mass difference</td>
</tr>
<tr>
<td>mzppm</td>
<td>relative allowed mass difference</td>
</tr>
</tbody>
</table>

Details

The function needs a xsAnnotate object after groupCorr or groupFWHM. The resulting object is a artificial xcmsSet, where the peaks with the specific neutral loss are stored in xcmsSet@peaks.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
#Searches for Peaks with water loss
xs.pseudo <- findNeutralLoss(an,mzdif=18.01,mzabs=0.01)
xp.pseudo@peaks #show Hits
findNeutralLossSpecs  
*Find pseudospectra that contains a specific neutral loss*

**Description**

The method searches in every pseudospectra for a distance between two ions matching a provided mass difference. It returns a boolean vector with the length equals to the number of pseudospectra, where a hit is marked with TRUE.

**Usage**

```r
findNeutralLossSpecs(object, mzdiff=NULL, mzabs=0, mzppm=10)
```

**Arguments**

- `object`  
xSAnnotate object
- `mzdiff`  
neutral loss in Dalton
- `mzabs`  
absolut allowed mass difference
- `mzppm`  
relative allowed mass difference

**Details**

The function needs a xSAnnotate object after groupCorr or groupFWHM.

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

**Examples**

```r
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xSAnnotate(x)
an <- groupFWHM(an)
#Searches for Pseudospectra with water loss
hits <- findNeutralLossSpecs(an, mzdiff=18.01, mzabs=0.01)
```

---

getAllPeakEICs  
*Generate EIC information from raw data*

**Description**

Generate EIC data out of the raw data, according to the peak peakier information.

**Usage**

```r
g getAllPeakEICs(object, index)
```
### $\text{getAllPeakEICs}$

**Arguments**

- **object**: The `xsAnnotate` object
- **index**: Sample index vector, with the same length as the number of peaks. Encoding from with sample the peak should be extracted. If all peaks should be generated from the same sample set index = rep(sample index, peak count)

**Details**

The function extract from the raw data the EIC curves. Therefore all .netcdf, .mzdata etc. files must be accessible. It returns a list with two item.

**Value**

A list with items:

- **EIC**: EIC Matrix with rows = number of peaks and columns = maxscans. It contains mostly NA values and only in that part, where a peak had been found, the intensity information.
- **scantimes**: Scantimes of each sample

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

**See Also**

- `xsAnnotate-class`

**Examples**

```r
library(CAMERA)
#Multiple sample
library(faahKO)
x.s.grp <- group(faahko)

#create xsAnnotate object
xsa <- xsAnnotate(x.s.grp)
#generate pseudospectra
xsa.group <- groupFWHM(xsa)

#calculate correlation
tmp <- getAllPeakEICs(xsa.group,index=rep(1,nrow(xsa.group@groupInfo)))
#extract EIC matrix
EIC.matrix <- tmp$EIC;
```
getAtomCount, compoundQuantiles-method

*The number of atoms of the given element*

**Description**

Returns the number of atoms the specified element in a compound of the specified mass for the specified quantile level.

**Usage**

```r
## S4 method for signature 'compoundQuantiles'
getAtomCount(object, element, mass, quantile)
```

**Arguments**

- `object`: A compoundQuantiles object
- `element`: The element of interest specified by element symbol
- `mass`: The mass of the compound specified in atomic units (= dalton)
- `quantile`: The quantile level for the number of atoms

**Value**

The number of atoms

**Author(s)**

Hendrik Treutler

**Examples**

```r
cpObj <- compoundQuantiles()

compoundMass <- 503
quantileLow <- 0.05
quantileHigh <- 0.95
element <- "C"

countLow <- getAtomCount(object = cpObj, element = element, mass = compoundMass, quantile = quantileLow)
countHigh <- getAtomCount(object = cpObj, element = element, mass = compoundMass, quantile = quantileHigh)

print(paste("The ", (quantileHigh - quantileLow) * 100, ", % confidence interval for the number of atoms of element ", element, " in a compound with mass ", compoundMass, " is [", countLow, ", ", countHigh, "]", sep = ""))
```


getIsotopeCluster Retrieve the annotated isotopes

Description
Extract all annotated isotope cluster. Returns a list with one element per cluster. A element contains the charge of the molecule and a peakmatrix with mz and intensity value.

Usage
getIsotopeCluster(object, number=NULL, value="maxo", sampleIndex=NULL)

Arguments

- object: xsAnnotate object
- number: Set to NULL extract all isotope cluster or to specific chosen ones
- value: Which intensity values should be extracted. Allowed values are: maxo, into, intb
- sampleIndex: Selection vector with indexes to select from which sample(s) the intensity values should be retrieved. If set to NULL the sample is selected, which has been chosen for the pseudospectra in the grouping step

Details
This method extract the isotope annotation from a xsAnnotate object. The order of the resulting list is the same as the one in the peaklist, see getPeaklist.

Author(s)
Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

# single sample
library(CAMERA)
file <- system.file("mzdata/MM14.mzdata", package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHMM(an)
an <- findIsotopes(an)
isolist <- getIsotopeCluster(an)
isolist[[10]] # get IsotopeCluster 10

# multiple sample
library(faahKO)
xs <- group(faahko)
x <- fillPeaks(xs)
an <- xsAnnotate(xs)
an <- groupFWHMM(an)
an <- findIsotopes(an)
isolist <- getIsotopeCluster(an)
getIsotopeProportion, compoundQuantiles-method

Description

Returns the proportion of the intensities of isotope1 versus isotope2 for a compound of the given mass for the given quantile level

Usage

## S4 method for signature 'compoundQuantiles'
getIsotopeProportion(object, isotope1, isotope2, mass, quantile)

Arguments

- **object**: A compoundQuantiles object
- **isotope1**: The divident isotope ranging from 0 (the monoisotopic peak) to 5
- **isotope2**: The divisor isotope ranging from 0 (the monoisotopic peak) to 5
- **mass**: The mass of the compound specified in atomic units (=dalton)
- **quantile**: The quantile level for the isotope proportion

Value

The isotope proportion

Author(s)

Hendrik Treutler

Examples

```r
cpObj <- compoundQuantiles(compoundLibrary = "kegg")

compoundMass <- 503
isotope1 <- 0
isotope2 <- 1
quantileLow <- 0.05
```
getPeaklist

quantileHigh <- 0.95

propLow <- getIsotopeProportion(object = cpObj, isotope1 = isotope1, isotope2 = isotope2, mass = compoundMass, quantile = quantileLow)
propHigh <- getIsotopeProportion(object = cpObj, isotope1 = isotope1, isotope2 = isotope2, mass = compoundMass, quantile = quantileHigh)
print(paste("The ", (quantileHigh - quantileLow) * 100, "% confidence interval for the proportion of isotopes "))

getPeaklist Generate the annotated peaklist

Description

Extract all information from an xsAnnotate object. Returns a peaklist with annotated peaks.

Usage

getPeaklist(object, intval="into")

Arguments

object xsAnnotate object
intval Choose intensity values. Allowed values are into, maxo, intb, intf, maxf, area, depending on the feature detection algorithm used.

Details

This function extract the peaktable from an xsAnnotate object, containing three additional columns (isotopes, adducts, pseudospectrum) with represents the annotation results. For a grouped xcmsSet it returns the grouped peaktable.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
an <- findIsotopes(an)
an <- findAdducts(an,polarity="positive")
peaklist <- getPeaklist(an)
getpspectra

Retrieve a peaklist of one or more pseudospectra

**Description**
Extract group(s) from a xsAnnotate object. Returns a peaklist as matrix with annotated peaks.

**Usage**

```r
getpspectra(object, grp)
```

**Arguments**

- `object`: xsAnnotate object
- `grp`: index of pseudo-spectra-group

**Details**
xsAnnotate groups LC/MS Peaklist after there EIC correlation and FWHM. These function extract one or more of these so called "pseudo spectra groups" with include the peaklist with there annotations. The annotation depends on a before called findAdducts() (and findIsotopes()). Important: The indices for the isotopes, are those from the whole peaklist. See getPeaklist().

**Author(s)**
Carsten Kuhl <ckuhl@ipb-halle.de>

**Examples**

```r
library(CAMERA)
file <- system.file("mzdata/MM14.mzdata", package = "CAMERA")
x <- xcmsSet(c(file), method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
#For one group
peaklist <- getpspectra(an, 1)
#For two groups
peaklist <- getpspectra(an, c(1,2))
```

getReducedPeaklist

Generate reduced peaklist from the annotatad peaklist

**Description**
Extract information from an xsAnnotate object. Returns a reduced peaklist with annotated peaks. For any putative compound in the pcgroup, all found adducts are pooled into one putative compound per group. Thus, the reduced peaklist only contains one annotated adduct per pcgroup.

**Usage**

```r
getReducedPeaklist(object, method = "median", intval = "into", default.adduct.info = "first", mzrt.range = FALSE, npeaks.sum = FALSE, cleanup = FALSE)
```
getReducedPeaklist

Arguments

object xsAnnotate object.
method Choose reduction method. Allowed values are "sum", "median", "maxint", "pca".
intval Choose intensity values. Allowed values are "into", "maxo", "intb".
default.adduct.info Choose method to select adduct information. Allowed values are "first", "maxint", "maxpeaks"
mzrt.range If TRUE, max and min values of mz and rt values of all adducts within a pc-group are saved (not recommended).
npeaks.sum If TRUE, the sum of all peaks of all adducts within a pcgroup is saved (not recommended).
cleanup If TRUE, NA values and negative abundances are being set to zero and constant features (rows) are being removed.

Details

This function extracts a reduced peaktable from an xsAnnotate object. Normally, all adducts are grouped for any putative compounds and saved within the peaklist (see method getPeaklist). However, for statistical computation it is sometimes better to only work with putative compounds rather than with all of their adducts. Thus, this function pools all adducts for any putative compound into one putative compound per pcgroup. There are several methods to choose from how this is being done. Selection methods: "sum": The intensities of adducts are summed for each sample. "median" (default): The median intensities of adducts is calculated for each sample. "maxint": Only the adduct with the highest intensities throughout the samples is returned. "pca": A Principal Component Analysis is being performed for the adducts for the samples and the PC1 values are taken as intensity information. Select mz / rt methods: "first" (default): The mz & rt information of the first adduct are taken. "maxint": The mz & rt information of the adduct that has highest intensities are taken. "maxpeaks": The mz & rt information of the adduct that has the most peaks are taken. In addition, when mzrt.range is TRUE, the min and max values of all mz and rt found in a group are stored within mzmin, mzmax and rtmin and rrtmax (not recommended). In addition, when npeaks.sum is TRUE, all peaks within a pcgroup are summed (not recommended).

Author(s)

Kristian Peters <kpeters@ipb-halle.de>

Examples

library(CAMERA)
file <- system.file("mzdata/MM14.mzdata", package = "CAMERA")
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(x)
an <- groupFWHM(an)
an <- findIsotopes(an)
an <- findAdducts(an,polarity="positive")
peaklist.reduced <- getReducedPeaklist(an)
groupCorr  

EIC correlation grouping of LC/ESI-MS data

Description

Peak grouping after correlation information into pseudospectrum groups for an xsAnnotate object. Return an xsAnnotate object with grouping information.

Usage

groupCorr(object, cor_eic_th=0.75, pval=0.05, graphMethod="hcs", calcIso = FALSE, calcCiS = TRUE, calcCaS = FALSE, psg_list=NULL, xraw=NULL, cor_exp_th=0.75, intval="into", ...)

Arguments

object The xsAnnotate object
cor_eic_th Correlation threshold for EIC correlation
pval p-value threshold for testing correlation of significance
graphMethod Clustering method for resulting correlation graph. See calcPC for more details.
calcIso Include isotope detection information for graph clustering
calcCiS Calculate correlation inside samples
calcCaS Calculate correlation across samples
psg_list Vector of pseudospectra indices. The correlation analysis will be only done for those groups
xraw Optional xcmsRaw object, which should be used for raw data extraction
cor_exp_th Threshold for intensity correlations across samples
intval Selection of the intensity values (such as "into") that should be used in the correlation analysis. See getPeaklist for all allowed values.
... Additional parameter

Details

The algorithm calculates different informations for group peaks into so called pseudospectra. This pseudospectra contains peaks, with have a high correlation between each other. So far three different kind of information are available. Correlation of intensities across samples (need more than 3 samples), EIC correlation between peaks inside a sample and additional the information about recognized isotope cluster can be included. After calculation of all these informations, they are combined as edge value into a graph object. A following graph clustering algorithm separate the peaks (nodes in the graph) into the pseudospectra.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

See Also

calcCiS calcCaS calcPC xsAnnotate-class
Examples

library(CAMERA)
file <- system.file("/quotesingle.Varmzdata/MM14.mzdata", package = "CAMERA");
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5, 10));
an <- xsAnnotate(x);
an.group <- groupFWHM(an);
an.iso <- findIsotopes(an.group); #optional step for using isotope information
an.grp.corr <- groupCorr(an.iso, calcIso=TRUE);

#For csv output
# write.csv(file="peaklist_with_isotopes.csv",getPeaklist(an))

#Multiple sample
library(faahKO)
x <- group(faahko)

#With selected sample
xsa <- xsAnnotate(x.grp, sample=1)
xsa.group <- groupFWHM(xsa)
xsa.iso <- findIsotopes(xsa.group) #optional step
xsa.grp.corr <- groupCorr(xsa.iso, calcIso=TRUE)

#With automatic selection
xsa.auto <- xsAnnotate(x.grp)
xsa.grp <- groupFWHM(xsa.auto)
xsa.iso <- findIsotopes(xsa.grp) #optional step
index <- c(1,4) #Only group one and four will be calculate
#We use also correlation across sample
xsa.grp.corr <- groupCorr(xsa.iso, psg_list=index, calcIso=TRUE, calcCaS=TRUE)
#Note: Group 1 and 4 have no subgroups

---

**groupDen**

*Density-Grouping of LC/ESI-MS data*

**Description**

Group peaks of a xsAnnotate object according to peak distributions in chromatographic time into pseudospectra-groups. Works analogous as the group.density method of xcms. Returns xsAnnotate object with pseudospectra informations.

**Usage**

```
groupDen(object, bw = 5, ...)
```

**Arguments**

- **object**: the xsAnnotate object
- **bw**: bandwidth (standard deviation or half width at half maximum) of gaussian smoothing kernel to apply to the peak density chromatogram
- **...**: Further Arguments, NYI
The grouping strongly depends on the bw parameter. For an UPLC a good starting point is smaller or around 1.

Returns a grouped xsAnnotate object.

Carsten Kuhl <ckuhl@ipb-halle.de>

library(CAMERA)
#Single sample
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
xsa <- xsAnnotate(x)
xsa.grp <- groupDen(xsa, bw=0.5)

#Multiple sample
library(faahKO)
x <- group(faahko)

#With specific selected sample
xsa <- xsAnnotate(x, sample=1)
xsa.grp <- groupDen(xsa)

#With automatic selection
xsa.auto <- xsAnnotate(x)
xsa.grp.auto <- groupDen(xsa.auto)

Group peaks of a xsAnnotate object according to there retention time into pseudospectra-groups. Uses the peak FWHMs as grouping borders. Returns xsAnnotate object with pseudospectra informations.

Usage

\texttt{groupFWHM(object, sigma = 6, perfwhm = 0.6, intval = "maxo")}

Arguments

\begin{itemize}
  \item \textbf{object} \hspace{5mm} the \texttt{xsAnnotate} object
  \item \textbf{sigma} \hspace{5mm} the multiplier of the standard deviation
  \item \textbf{perfwhm} \hspace{5mm} percentage of the width of the FWHM
  \item \textbf{intval} \hspace{5mm} intensity values for ordering. Allowed values are \texttt{into}, \texttt{maxo}, \texttt{intb}
massWindowSizes

Details

Every peak who eluate at the same time-point as a selected peak, will be part of the group. Same
time-point is defined about the $Rt_{med}/FWHM * perfwhm$. For a single sample xcmsSet the
selection of peaks starts at the most abundant and goes down to the smaller ones. With a multiple
sample set the automatic selection uses the most abundant peak as an representative for every feature
group, according to the xcms grouping. With the xsAnnotate sample parameter a sample selection
can be defined to use only specific samples. See xsAnnotate-class for further information. The
FWHM (full width at half maximum) of a peak is estimated as $FWHM = SD * 2.35$. For the
calculation of the SD, the peak is assumed as normal distributed.

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

library(CAMERA)
#Single sample
file <- system.file("/quotesingle.Varmzdata/MM14.mzdata", package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)

#Multiple sample
library(faahKO)
xs <- group(faahKO)

#With specific selected sample
xs.anno <- xsAnnotate(xs, sample=1)
xs.group <- groupFWHM(xs.anno)

#With automatic selection
xs.anno.auto <- xsAnnotate(xs)
xs.group.auto <- groupFWHM(xs.anno.auto)

massWindowSizes

The supported mass window sizes

Description

Returns the set of supported mass window sizes for the given compound database

Usage

massWindowSizes(libraryName = "kegg")

Arguments

libraryName  The compound database

Value

Vector of supported mass window sizes
mm14  

**Examples**

```r
massWindowSizes()
```

---

**mm14**  

*Extract of marker mixture 14 LC/MS data*

---

**Description**

xcmsSet object containing quantitated LC/MS peaks from a marker mixture. The data is a centroided subset from 117-650 m/z and 271-302 seconds with 134 peaks. Positive ionization mode data in mzData file format.

**Usage**

data(mm14)

**Format**

The format is:

```r
Formal class 'xcmsSet' [package "xcms"] with 8 slots
@ peaks : num [1:83, 1:11] 117 117 118 119 136 ...
.. ..- attr(*, "dimnames")=List of 2
.. ...$ : NULL
.. ...$ : chr [1:11] "mz" "mzmin" "mzmax" "rt"
..@ groups : logi[0 , 0 ]
..@ groupidx : list()
..@ phenoData: 'data.frame': 1 obs. of 1 variable:
.. ...$ class: Factor w/ 1 level "mzdata": 1
..@ rt :List of 2
.. ...$ raw :List of 1
.. ...$ : num [1:112] 270 271 271 271 272 ...
.. ...$ corrected:List of 1
.. ...$ : num [1:112] 270 271 271 271 272 ...
..@ filepaths: chr "mzdata/MM14.mzdata"
..@ profinfo :List of 2
.. ...$ method: chr "bin"
.. ...$ step : num 0.1
..@ polarity : chr(0)
```

**Details**

The corresponding raw mzData files are located in the mzData subdirectory of this package.

**Author(s)**

Hendrik Treutler

Carsten Kuhl <ckuhl@ipb-halle.de>
plotEICs-methods

Source

References
Data originally reported in "Highly sensitive feature detection for high resolution LC/MS" BMC Bioinformatics; 2008; 9:504.

---

plotEICs-methods  Plot extracted ion chromatograms from (multiple) Pseudospectra

Description
Batch plot a list of extracted ion chromatograms to the current graphics device.

Arguments
- **object**: the xsAnnotate object
- **xraw**: xcmsRaw object underlying the the xsAnnotate
- **maxlabel**: How many m/z labels to print
- **sleep**: seconds to pause between plotting EICs
- **...**: other graphical parameters

Value
None.

Methods
```r
object = "xsAnnotate" plotEICs(object, xraw, pspec=1:length(object@pspectra), maxlabel=)
```

Author(s)
Steffen Neumann, <sneumann@ipb-halle.de>

See Also
xsAnnotate-class, png, pdf, postscript,
**plotPsSpectrum-methods**

*Plot a Pseudospectrum*

---

**Description**
Plot a pseudospectrum, with the most intense peaks labelled, to the current graphics device.

**Usage**

```r
plotPsSpectrum(object, pspec=1:length(object@pspectra), log=FALSE, value="into", maxlabel=0, title=NULL, mzrange=numeric(), sleep=0, cexMulti = 1,...)
```

**Arguments**

- `object`: the `xsAnnotate` object
- `pspec`: ID of the pseudospectrum to print
- `log`: Boolean, whether the log(intensity) should be shown
- `value`: Which of a peak’s intensities should be used
- `maxlabel`: How many m/z labels to print
- `title`: Main title of the Plot
- `mzrange`: Which m/z range should plotted
- `sleep`: Time (in seconds) to wait between successive Spectra, if multiple `pspec` are requested.
- `cexMulti`: Cex multiplier for peak labels
- `...`: Additional parameter for function `plot`

**Value**
None.

**Methods**

```r
signature(object = "xsAnnotate") object deriviving from class "xsAnnotate"
```

**Author(s)**
Steffen Neumann, <sneumann@ipb-halle.de>

**See Also**

`xsAnnotate-class`, `png`, `pdf`, `postscript`. 
**Description**

The package `xcms` contains several methods for calculating a distance between two sets of peaks. The CAMERA method `psDist` is the generic wrapper to use these methods for processing two pseudospectra from two different `xsAnnotate` objects.

**Arguments**

- `object1`: a `xsAnnotate` object with pseudospectra
- `object2`: a `xsAnnotate` object with pseudospectra
- `PSpec1`: index of pseudospectrum in `object1`
- `PSpec2`: index of pseudospectrum in `object2`
- `method`: method to use for distance calculation. See details.
- `...`: `mzabs`, `mzppm` and parameters for the distance function.

**Details**

Different algorithms can be used by specifying them with the `method` argument. For example to use the "meanMZmatch" approach one would use: `specDist(object1, object2, pspectrum1, pspectrum2, method="meanMZmatch")`. This is also the default.

Further arguments given by `...` are passed through to the function implementing the `method`.

A character vector of nicknames for all the algorithms which are available is returned by `getOption("BioC")$xcms$specDist.methods`. If the nickname of a method is called "meanMZmatch", the help page for that specific method can be accessed with `?specDist.meanMZmatch`.

**Value**

- `mzabs`: maximum absolute deviation for two matching peaks
- `mzppm`: relative deviations in ppm for two matching peaks
- `symmetric`: use symmetric pairwise m/z-matches only, or each match

**Methods**

`object1 = "xsAnnotate"` specDist(object1, object2, pspectrum1, pspectrum2, method,...)

**Author(s)**

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pspec2metfrag

Export the putative fragments as MetFrag query files

Description

MetFrag is an in-silico metabolite identification system, which aims to putatively identify compounds from fragmentation MS data, especially from tandem-MS, but also in-source fragments might give additional hints on top of the accurate mass of the precursor alone.

Usage

```r
pspec2metfrag(object, pspecidx=NULL, filedir=NULL)
pspec2metfusion(object, pspecidx=NULL, filedir=NULL)
```

Arguments

- **object**: an xsAnnotate object
- **pspecidx**: Index of pspectra to export, if NULL then all are exported.
- **filedir**: Directory for placement of batch query files

Details

For each spectrum in pspecidx (or all in the xsAnnotate object), for each \([M]\) mass hypothesis, remove all non-fragment peaks (isotopes, clusters, adducts) and pass them to MetFrag and MetFusion batch query files.

Value

Returns a list

Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

Examples

```r
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA");
x <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5, 10));
an <- xsAnnotate(x);
an <- groupFWHM(an);
an <- findIsotopes(an); #optional step
an <- findAdducts(an, polarity="positive")

pspec2metfrag(an, pspecidx=c(1))
```
**ruleSet**

---

### Class ruleSet

#### Description

The class ruleSet is used to read lists of ions, adducts and neutral losses, and compile the dynamic ruleSet from those. This makes it possible to modify the default rules for certain analytical settings.

#### Slots

- **ionlistfile**: File of known charged ions, an example is found in CAMERA/lists/ions.csv.
- **neutrallossfile**: File of known neutral losses, an example is found in CAMERA/lists/neutralloss.csv.
- **neutraladditionfile**: File of known adducts, an example is found in CAMERA/lists/lists/neutraladdition.csv.
- **ionlist**: Known charged ions.
- **neutralloss**: Known neutral losses.
- **neutraladdition**: Known adducts.
- **maxcharge**:.
- **mol**:.
- **nion**:.
- **nnloss**:.
- **nnadd**:.
- **nh**:.
- **polarity**: Polarity of the ruleSet.
- **rules**: data.frame of resulting mass differences, this is the dynamic ruleSet.
- **lib.loc**: Path to local R library

#### Extends

Class "Versioned", directly.

#### Methods

Methods implemented for ruleSet

- **setDefaultLists** signature(object = "ruleSet")**: Set filenames for the lists shipped with CAMERA.
- **readLists** signature(object = "ruleSet")**: Read and parse the lists from the files.
- **setDefaultParams** signature(object = "ruleSet")**: Set the default parameters for rule generation.
- **setParams** signature(object = "ruleSet")**: Set the parameters for rule generation.
- **generateRules** signature(object = "ruleSet")**: Create the rules in ruleSet@rules.

#### Author(s)

Steffen Neumann and Carsten Kuhl
Examples

```r
r <- new("ruleSet");
r2 <- setDefaultLists(r);
r3 <- readLists(r2);
r4 <- setDefaultParams(r3);
r5 <- generateRules(r4)
dim(r5@rules)
```

---

**xsAnnotate**  
**xsAnnotate constructor for an provided xcmsSet object**

### Description

This function deals with the construction of an xsAnnotate object. It extracts the peaktable from a provided xcmsSet, which is used for all further analysis. The xcmsSet can be a single sample or multiple sample experiment. Since some functions need the raw data a selection algorithm must be chosen in the case of a multiple sample. CAMERA includes two different strategies: A defined selection of samples (sample = indices of samples) or the default automatic solution (sample = NA). The automatic solution chooses the best sample for specific groups called pseudospectrum, see groupFWHM and groupCorr. It returns a xsAnnotate object, see xsAnnotate-class.

### Usage

```r
xsAnnotate(xs = NULL, sample=NA, nSlaves = 1, polarity = NULL)
```

### Arguments

- **xs**  
  a xcmsSet object

- **sample**  
  Indices of the group xcmsSet sample, that are used for the EIC correlation step. For automatic selection don’t set a value. For use all samples simply define sample = c(1:n), with n = number of samples.

- **nSlaves**  
  For parallel mode set nSlaves higher than 1, but not higher than the number of cpu cores.

- **polarity**  
  Set polarity mode: "positive" or "negative"

### Value

A xsAnnotate object.

### Author(s)

Carsten Kuhl, <ckuhl@ipb-halle.de>

### See Also

xsAnnotate-class
Examples

```r
library(faahKO)
x <- group(faahko)
xsa <- xsAnnotate(xs, sample=c(1:12))
```

# With automatic selection
```r
gxsa.autoselect <- xsAnnotate(xs)
```

GlAnnotate-class

Class xsAnnotate, a class for annotated peak data

Description

This class transforms a `xcmsSet` object with peaks from multiple LC/MS or GC/MS samples into a set of annotation results. It contains searching algorithms for isotopes and adducts, peak grouping algorithms to find connected peak, which originate from the same molecule.

Objects from the Class

Objects can be created with the `xsAnnotate` constructor which include the peaktable from a provided `xcmsSet`. Objects can also be created by calls of the form `new("xsAnnotate", ...)`. 

Slots

- `annoGrp`: Assignment of mass hypotheses to correlation groups
- `annoID`: The assignment of peaks to the mass difference rule used
- `derivativeIons`: List with annotation result for every peak
- `formula`: Matrix containing putative sum formula (intended for future use)
- `isoID`: Matrix containing IDs and additional of all annotated isotope peaks
- `groupInfo`: (grouped) Peaktable with “into” values
- `isotopes`: List with annotated isotopid results for every peak
- `polarity`: A single string with the polarity mode of the peaks
- `pspectra`: List contains all pseudospectra with there peak IDs
- `psSamples`: List containing information with sample was sample was selecteted as representative (automatic selection)
- `ruleset`: A dataframe describing the mass difference rules used for the annotation
- `runParallel`: Flag if CAMERA runs in serial or parallel mode
- `sample`: Number of the used xcmsSet sample (beforehand sample selection)
- `xcmsSet`: The embedded xcmsSet

Methods

- `groupFWHM`: signature(object = "xsAnnotate"): group the peak data after the FWHM of the retention time
- `groupCorr`: signature(object = "xsAnnotate"): group the peak data after the correlation of the EICs
- `findIsotopes`: signature(object = "xsAnnotate"): search for possible isotopes in the spectra
- `findAdducts`: signature(object = "xsAnnotate"): search for possible adducts in the spectra
- `plotEICs`: signature(object = "xsAnnotate"): plot EICs of pseudospectra
Note

No notes yet.

Author(s)

Carsten Kuhl, <ckuhl@ipb-halle.de>

See Also

xsAnnotate
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