Package ‘metagenomeSeq’

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Title  Statistical analysis for sparse high-throughput sequencing
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Description  metagenomeSeq is designed to determine features (be it Operational Taxonomic Unit (OTU), species, etc.) that are differentially abundant between two or more groups of multiple samples. metagenomeSeq is designed to address the effects of both normalization and under-sampling of microbial communities on disease association detection and the testing of feature correlations.
License  Artistic-2.0
Depends  R(>= 3.0), Biobase, limma, glmnet, methods, RColorBrewer
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Imports  parallel, matrixStats, foreach, Matrix, gplots, graphics, grDevices, stats, utils, Wrench
VignetteBuilder  knitr
URL  https://github.com/nosson/metagenomeSeq/
BugReports  https://github.com/nosson/metagenomeSeq/issues
biocViews  ImmunoOncology, Classification, Clustering, GeneticVariability, DifferentialExpression, Microbiome, Metagenomics, Normalization, Visualization, MultipleComparison, Sequencing, Software
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metagenomeSeq-package  Statistical analysis for sparse high-throughput sequencing

Description

metagenomeSeq is designed to determine features (be it Operational Taxonomic Unit (OTU), species, etc.) that are differentially abundant between two or more groups of multiple samples. metagenomeSeq is designed to address the effects of both normalization and under-sampling of microbial communities on disease association detection and the testing of feature correlations.

A user's guide is available, and can be opened by typing `vignette("metagenomeSeq")`

The metagenomeSeq package implements novel normalization and statistical methodology in the following papers.

Author(s)

Paulson, JN <jpaulson@umiacs.umd.edu>; Pop, M; Corrada Bravo, H

References


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aggregateBySample  Aggregates a MRexperiment object or counts matrix to by a factor.

Description

Using the phenoData information in the MRexperiment, calling aggregateBySample on a MRexperiment and a particular phenoData column (i.e. 'diet') will aggregate counts using the aggfun function (default rowMeans). Possible aggfun alternatives include rowMeans and rowMedians.

Usage

```r
aggregateBySample(obj, fct, aggfun = rowMeans, out = "MRexperiment")
aggSamp(obj, fct, aggfun = rowMeans, out = "MRexperiment")
```

Arguments

- `obj`: A MRexperiment object or count matrix.
- `fct`: phenoData column name from the MRexperiment object or if count matrix object a vector of labels.
- `aggfun`: Aggregation function.
- `out`: Either 'MRexperiment' or 'matrix'
aggregateByTaxonomy

Value
An aggregated count matrix or MRexperiment object where the new pData is a vector of 'fct' levels.

Examples

data(mouseData)
aggregateBySample(mouseData[1:100,],fct="diet",aggfun=rowSums)
# not run
# aggregateBySample(mouseData,fct="diet",aggfun=matrixStats::rowMedians)
# aggSamp(mouseData,fct='diet',aggfun=rowMaxs)

aggregateByTaxonomy  Aggregates a MRexperiment object or counts matrix to a particular level.

Description
Using the featureData information in the MRexperiment, calling aggregateByTaxonomy on a MRexperiment and a particular featureData column (i.e. 'genus') will aggregate counts to the desired level using the aggfun function (default colSums). Possible aggfun alternatives include colMeans and colMedians.

Usage
aggregateByTaxonomy(  
  obj,  
  lvl,  
  alternate = FALSE,  
  norm = FALSE,  
  log = FALSE,  
  aggfun = colSums,  
  sl = 1000,  
  featureOrder = NULL,  
  returnFullHierarchy = TRUE,  
  out = "MRexperiment"
)

aggTax(  
  obj,  
  lvl,  
  alternate = FALSE,  
  norm = FALSE,  
  log = FALSE,  
  aggfun = colSums,  
  sl = 1000,  
  featureOrder = NULL,
returnFullHierarchy = TRUE, out = "MRexperiment"
)

Arguments

- **obj**: A MRexperiment object or count matrix.
- **lvl**: featureData column name from the MRexperiment object or if count matrix object a vector of labels.
- **alternate**: Use the rowname for undefined OTUs instead of aggregating to "no_match".
- **norm**: Whether to aggregate normalized counts or not.
- **log**: Whether or not to log2 transform the counts - if MRexperiment object.
- **aggfun**: Aggregation function.
- **sl**: scaling value, default is 1000.
- **featureOrder**: Hierarchy of levels in taxonomy as fData colnames
- **returnFullHierarchy**: Boolean value to indicate return single column of fData or all columns of hierarchy
- **out**: Either `MRexperiment` or 'matrix'

Value

An aggregated count matrix.

Examples

```r
data(mouseData)
aggregateByTaxonomy(mouseData[1:100,], lvl="class", norm=TRUE, aggfun=colSums)
# not run
# aggregateByTaxonomy(mouseData, lvl="class", norm=TRUE, aggfun=colMedians)
# aggTax(mouseData, lvl="phylum", norm=FALSE, aggfun=colSums)
```

---

**biom2MRexperiment**  
*Biom to MRexperiment objects*

Description

Wrapper to convert biom files to MRexperiment objects.

Usage

```
biom2MRexperiment(obj)
```
calcNormFactors

Arguments

obj The biom object file.

Value

A MRexperiment object.

See Also

loadMeta loadPhenoData newMRexperiment loadBiom

Examples

library(biomformat)
rich_dense_file = system.file("extdata", "rich_dense_otu_table.biom", package = "biomformat")
x = biomformat::read_biom(rich_dense_file)
biom2MRexperiment(x)

calcNormFactors Cumulative sum scaling (css) normalization factors

Description

Return a vector of the sum up to and including a quantile.

Usage

calcNormFactors(obj, p = cumNormStatFast(obj))

Arguments

obj An MRexperiment object or matrix.
p The pth quantile.

Value

Vector of the sum up to and including a sample’s pth quantile.

See Also

fitZig cumNormStatFast cumNorm

Examples

data(mouseData)
head(calcNormFactors(mouseData))
calcPosComponent  Positive component

Description
Fit the positive (log-normal) component

Usage
calcPosComponent(mat, mod, weights)

Arguments
mat  A matrix of normalized counts
mod  A model matrix
weights  Weight matrix for samples and counts

See Also
fitZeroLogNormal fitFeatureModel

calcShrinkParameters  Calculate shrinkage parameters

Description
Calculate the shrunken variances and variance of parameters of interest across features.

Usage
calcShrinkParameters(fit, coef, mins2, exclude = NULL)

Arguments
fit  A matrix of fits as outputted by calcZeroComponent or calcPosComponent
coef  Coefficient of interest
mins2  minimum variance estimate
exclude  Vector of features to exclude when shrinking

See Also
fitZeroLogNormal fitFeatureModel
calcStandardError

Calculate the zero-inflated log-normal statistic's standard error

Description

Calculat the se for the model. Code modified from "Adjusting for covariates in zero-inflated gamma and zero-inflated log-normal models for semicontinuous data", ED Mills

Usage

calcStandardError(mod, fitln, fitzero, coef = 2, exclude = NULL)

Arguments

mod The zero component model matrix
fitln A matrix with parameters from the log-normal fit
fitzero A matrix with parameters from the logistic fit
coef Coefficient of interest
exclude List of features to exclude

See Also

fitZeroLogNormal fitFeatureModel

calculateEffectiveSamples

Estimated effective samples per feature

Description

Calculates the number of estimated effective samples per feature from the output of a fitZig run. The estimated effective samples per feature is calculated as the sum_1^n (n = number of samples) 1-z_i where z_i is the posterior probability a feature belongs to the technical distribution.

Usage

calculateEffectiveSamples(obj)

Arguments

obj The output of fitZig run on a MReperiment object.

Value

A list of the estimated effective samples per feature.
calcZeroComponent

See Also

fitZig MRcoefs MRfulltable

calcZeroAdjustment Calculate the zero-inflated component's adjustment factor

Description

Calculate the log ratio of average marginal probabilities for each sample having a positive count. This becomes the adjustment factor for the log fold change.

Usage

calcZeroAdjustment(fitln, fitzero, mod, coef, exclude = NULL)

Arguments

fitln A matrix with parameters from the log-normal fit
fitzero A matrix with parameters from the logistic fit
mod The zero component model matrix
coef Coefficient of interest
exclude List of features to exclude

See Also

fitZeroLogNormal fitFeatureModel

calcZeroComponent Zero component

Description

Fit the zero (logistic) component

Usage

calcZeroComponent(mat, mod, weights)

Arguments

mat A matrix of normalized counts
mod A model matrix
weights Weight matrix for samples and counts

See Also

fitZeroLogNormal fitFeatureModel
**correctIndices**

Calculate the correct indices for the output of `correlationTest`

**Description**

Consider the upper triangular portion of a matrix of size nxn. Results from the `correlationTest` are output as the combination of two vectors, correlation statistic and p-values. The order of the output is 1vs2, 1vs3, 1vs4, etc. The `correctIndices` returns the correct indices to fill a correlation matrix or correlation-pvalue matrix.

**Usage**

```r
correctIndices(n)
```

**Arguments**

- `n`: The number of features compared by `correlationTest` (nrow(mat)).

**Value**

A vector of the indices for an upper triangular matrix.

**See Also**

- `correlationTest`

**Examples**

```r
data(mouseData)
mat = MRcounts(mouseData)[55:60,]
cors = correlationTest(mat)
ind = correctIndices(nrow(mat))

cormat = as.matrix(dist(mat))
cormat[cormat>0] = 0
cormat[upper.tri(cormat)][ind] = cors[,1]
table(cormat[1,-1] - cors[1:5,1])
```
correlationTest

Correlation of each row of a matrix or MReexperiment object

Description

Calculates the (pairwise) correlation statistics and associated p-values of a matrix or the correlation of each row with a vector.

Usage

```r
correlationTest(
  obj,
  y = NULL,
  method = "pearson",
  alternative = "two.sided",
  norm = TRUE,
  log = TRUE,
  cores = 1,
  override = FALSE,
  ...
)
```

Arguments

- `obj`: A MReexperiment object or count matrix.
- `y`: Vector of length ncol(obj) to compare to.
- `method`: One of 'pearson','spearman', or 'kendall'.
- `alternative`: Indicates the alternative hypothesis and must be one of 'two.sided', 'greater' (positive) or 'less'(negative). You can specify just the initial letter.
- `norm`: Whether to aggregate normalized counts or not - if MReexperiment object.
- `log`: Whether or not to log2 transform the counts - if MReexperiment object.
- `cores`: Number of cores to use.
- `override`: If the number of rows to test is over a thousand the test will not commence (unless override==TRUE).
- `...`: Extra parameters for mclapply.

Value

A matrix of size choose(number of rows, 2) by 2. The first column corresponds to the correlation value. The second column the p-value.

See Also

- `correctIndices`
Examples

# Pairwise correlation of raw counts
data(mouseData)
cors = correlationTest(mouseData[1:10,],norm=FALSE,log=FALSE)
head(cors)

mat = MRcounts(mouseData)[1:10,]
cormat = as.matrix(dist(mat))  # Creating a matrix
cormat[cormat>0] = 0  # Creating an empty matrix
ind = correctIndices(nrow(mat))
cormat[upper.tri(cormat)][ind] = cors[,1]
table(cormat[1,-1] - cors[1:9,1])

# Correlation of raw counts with a vector (library size in this case)
data(mouseData)
cors = correlationTest(mouseData[1:10,],libSize(mouseData),norm=FALSE,log=FALSE)
head(cors)

cumNorm

Cumulative sum scaling normalization

Description
Calculates each column’s quantile and calculates the sum up to and including that quantile.

Usage
cumNorm(obj, p = cumNormStatFast(obj))

Arguments
obj  An MRexperiment object.
p    The pth quantile.

Value
Object with the normalization factors stored as a vector of the sum up to and including a sample’s
pth quantile.

See Also
fitZig cumNormStat

Examples
data(mouseData)
mouseData <- cumNorm(mouseData)
head(normFactors(mouseData))
cumNormMat

Cumulative sum scaling factors.

Description
Calculates each column’s quantile and calculates the sum up to and including that quantile.

Usage
cumNormMat(obj, p = cumNormStatFast(obj), sl = 1000)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>obj</td>
<td>A matrix or MRexperiment object.</td>
</tr>
<tr>
<td>p</td>
<td>The pth quantile.</td>
</tr>
<tr>
<td>sl</td>
<td>The value to scale by (default=1000).</td>
</tr>
</tbody>
</table>

Value
Returns a matrix normalized by scaling counts up to and including the pth quantile.

See Also
fitZig cumNorm

Examples
data(mouseData)
head(cumNormMat(mouseData))

---

cumNormStat

Cumulative sum scaling percentile selection

Description
Calculates the percentile for which to sum counts up to and scale by. cumNormStat might be deprecated one day. Deviates from methods in Nature Methods paper by making use row means for generating reference.

Usage
cumNormStat(obj, qFlag = TRUE, pFlag = FALSE, rel = 0.1, ...)

Examples
data(mouseData)
head(cumNormStat(mouseData))
cumNormStatFast

Arguments

obj A matrix or MRexperiment object.
qFlag Flag to either calculate the proper percentile using R’s step-wise quantile function or approximate function.
pFlag Plot the relative difference of the median deviance from the reference.
rel Cutoff for the relative difference from one median difference from the reference to the next
... Applicable if pFlag == TRUE. Additional plotting parameters.

Value

Percentile for which to scale data

See Also

fitZig cumNorm cumNormStatFast

Examples

data(mouseData)
p = round(cumNormStat(mouseData,pFlag=FALSE),digits=2)

---
cumNormStatFast Cumulative sum scaling percentile selection

Description

Calculates the percentile for which to sum counts up to and scale by. Faster version than available in cumNormStat. Deviates from methods described in Nature Methods by making use of ro means for reference.

Usage

cumNormStatFast(obj, pFlag = FALSE, rel = 0.1, ...)

Arguments

obj A matrix or MRexperiment object.
pFlag Plot the median difference quantiles.
rel Cutoff for the relative difference from one median difference from the reference to the next.
... Applicable if pFlag == TRUE. Additional plotting parameters.
doCountMStep

Description
Maximization step is solved by weighted least squares. The function also computes counts residuals.

Usage
doceCountMStep(z, y, mmCount, stillActive, fit2 = NULL, dfMethod = "modified")

Arguments
z Matrix (m x n) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0).
y Matrix (m x n) of count observations.
mmCount Model matrix for the count distribution.
stillActive Boolean vector of size M, indicating whether a feature converged or not.
fit2 Previous fit of the count model.

dfMethod Either 'default' or 'modified' (by responsibilities)

Details
Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership \$\delta_{ij}\$ = 1 if \$y_{ij}\$ is generated from the zero point mass as latent indicator variables. The density is defined as \$f_{zig}(y_{ij} = \pi_j(S_j)*f_0(y_{ij}) + (1-\pi_j(S_j)) * f_{count}(y_{ij};\mu_i,\sigma_i^2)\$.

The log-likelihood in this extended model is \$(1-\delta_{ij}) \log f_{count}(y;\mu_i,\sigma_i^2) + \delta_{ij} \log \pi_j(s_j) + (1-\delta_{ij}) \log (1-\pi_j(s_j))\$. The responsibilities are defined as \$z_{ij} = \text{pr}(\delta_{ij}=1 | \text{data})\$. 

Value
Percentile for which to scale data

See Also
fitZig cumNorm cumNormStat

Examples
data(mouseData)
p = round(cumNormStatFast(mouseData,pFlag=FALSE),digits=2)
doEStep

Value

Update matrix (m x n) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0).

See Also

fitZig

doEStep

Compute the Expectation step.

Description

Estimates the responsibilities $z_{ij} = \frac{\pi_j}{1 - \pi_j} \cdot I(y_{ij} \pi_j < 0) \cdot I(y_{ij} + (1 - \pi_j) \cdot f_{count}(y_{ij})$.

Usage

doEStep(countResiduals, zeroResiduals, zeroIndices)

Arguments

countResiduals Residuals from the count model.
zeroResiduals Residuals from the zero model.
zeroIndices Index (matrix m x n) of counts that are zero/non-zero.

Details

Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership $\delta_{ij} = 1$ if $y_{ij}$ is generated from the zero point mass as latent indicator variables. The density is defined as $f_{zig}(y_{ij} = \pi_j(S_j) \cdot f_0(y_{ij}) + (1 - \pi_j(S_j)) \cdot f_{count}(y_{ij};\mu_i,\sigma_i^2)$. The log-likelihood in this extended model is $\log f_{count}(y_{ij};\mu_i,\sigma_i^2) + \delta_{ij} \log \pi_j(S_j) + (1 - \delta_{ij}) \log (1 - \pi_j(S_j))$. The responsibilities are defined as $z_{ij} = pr(\delta_{ij} = 1 | data)$.

Value

Updated matrix (m x n) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0).

See Also

fitZig
doZeroMStep 

Compute the zero Maximization step.

Description

Performs Maximization step calculation for the mixture components. Uses least squares to fit the parameters of the mean of the logistic distribution. \( \pi_j = \sum_i^M \frac{1}{M} z_{ij} \) Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership \( \delta_{ij} = 1 \) if \( y_{ij} \) is generated from the zero point mass as latent indicator variables. The density is defined as \( f_{zig}(y_{ij} = \pi_j(s_j) \cdot f_0(y_{ij}) + (1-\pi_j(s_j)) \cdot f_{count}(y_{ij}; \mu_i, \sigma_i^2) \). The log-likelihood in this extended model is \( (1-\delta_{ij}) \log f_{count}(y; \mu_i, \sigma_i^2) + \delta_{ij} \log \pi_j(s_j) + (1-\delta_{ij}) \log (1-\pi_j(s_j)) \). The responsibilities are defined as \( z_{ij} = \text{pr}(\delta_{ij} = 1 | \text{data}) \).

Usage

doZeroMStep(z, zeroIndices, mmZero)

Arguments

- **z**: Matrix \((m \times n)\) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0).
- **zeroIndices**: Index \((m \times n)\) of counts that are zero/non-zero.
- **mmZero**: The zero model, the model matrix to account for the change in the number of OTUs observed as a linear effect of the depth of coverage.

Value

List of the zero fit (zero mean model) coefficients, variance - scale parameter (scalar), and normalized residuals of length \( \sum(\text{zeroIndices}) \).

See Also

- fitZig

exportMat 

Export the normalized MReXperiment dataset as a matrix.

Description

This function allows the user to take a dataset of counts and output the dataset to the user's workspace as a tab-delimited file, etc.
Usage

```r
exportMat(
  obj,
  log = TRUE,
  norm = TRUE,
  sep = "\t",
  file = "~/Desktop/matrix.tsv"
)
```

Arguments

- **obj**: A MRexperiment object or count matrix.
- **log**: Whether or not to log transform the counts - if MRexperiment object.
- **norm**: Whether or not to normalize the counts - if MRexperiment object.
- **sep**: Separator for writing out the count matrix.
- **file**: Output file name.

Value

NA

See Also

cumNorm

Examples

```r
data(lungData)
dataDirectory <- system.file("extdata", package="metagenomeSeq")
exportMat(lungData[,1:5],file=file.path(dataDirectory,"tmp.tsv"))
head(read.csv(file=file.path(dataDirectory,"tmp.tsv"),sep="\t"))
```

---

**exportStats**

Various statistics of the count data.

Description

A matrix of values for each sample. The matrix consists of sample ids, the sample scaling factor, quantile value, the number identified features, and library size (depth of coverage).

Usage

```r
exportStats(obj, p = cumNormStat(obj), file = "~/Desktop/res.stats.tsv")
```
expSummary

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>obj</td>
<td>A MRexperiment object with count data.</td>
</tr>
<tr>
<td>p</td>
<td>Quantile value to calculate the scaling factor and quantiles for the various samples.</td>
</tr>
<tr>
<td>file</td>
<td>Output file name.</td>
</tr>
</tbody>
</table>

Value

None.

See Also

cumNorm quantile

Examples

data(lungData)
dataDirectory <- system.file("extdata", package="metagenomeSeq")
exportStats(lungData[,1:5],file=file.path(dataDirectory,"tmp.tsv"))
head(read.csv(file=file.path(dataDirectory,"tmp.tsv"),sep="\t"))

expSummary

Access MRexperiment object experiment data

Description

The expSummary vectors represent the column (sample specific) sums of features, i.e. the total number of reads for a sample, libSize and also the normalization factors, normFactor.

Usage

expSummary(obj)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>obj</td>
<td>a MRexperiment object.</td>
</tr>
</tbody>
</table>

Value

Experiment summary table

Author(s)

Joseph N. Paulson, jpaulson@umiacs.umd.edu
extractMR

Extract the essentials of an MRexperiment.

Description

Extract the essentials of an MRexperiment.

Usage

extractMR(obj)

Arguments

obj      MRexperiment-class object.

Value

A list containing:

  counts : Count data
  • librarySize : The column sums / library size / sequencing depth
  • normFactors : The normalization scaling factors
  • pheno : phenotype table
  • feat : feature table

Examples

data(mouseData)
expSummary(mouseData)

data(mouseData)
head(metagenomeSeq:::extractMR(mouseData))
filterData  Filter datasets according to no. features present in features with at least a certain depth.

Description
Filter the data based on the number of present features after filtering samples by depth of coverage. There are many ways to filter the object, this is just one way.

Usage
filterData(obj, present = 1, depth = 1000)

Arguments
- obj: A MRexperiment object or count matrix.
- present: Features with at least 'present' positive samples.
- depth: Samples with at least this much depth of coverage

Value
A MRexperiment object.

Examples
data(mouseData)
filterData(mouseData)

fitDO  Wrapper to calculate Discovery Odds Ratios on feature values.

Description
This function returns a data frame of p-values, odds ratios, lower and upper confidence limits for every row of a matrix. The discovery odds ratio is calculated as using Fisher’s exact test on actual counts. The test’s hypothesis is whether or not the discovery of counts for a feature (of all counts) is found in greater proportion in a particular group.

Usage
fitDO(obj, cl, norm = TRUE, log = TRUE, adjust.method = "fdr", cores = 1, ...)


fitFeatureModel

Computes differential abundance analysis using a zero-inflated log-normal model

Description

Wrapper to actually run zero-inflated log-normal model given a MRexperiment object and model matrix. User can decide to shrink parameter estimates.

Usage

fitFeatureModel(obj, mod, coef = 2, B = 1, szero = FALSE, spos = TRUE)

Arguments

- **obj**: A MRexperiment object with a count matrix, or a simple count matrix.
- **cl**: Group comparison
- **norm**: Whether or not to normalize the counts - if MRexperiment object.
- **log**: Whether or not to log2 transform the counts - if MRexperiment object.
- **adjust.method**: Method to adjust p-values by. Default is "FDR". Options include "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr", "none". See p.adjust for more details.
- **cores**: Number of cores to use.
- **...**: Extra options for makeCluster

Value

Matrix of odds ratios, p-values, lower and upper confidence intervals

See Also

cumNorm fitZig fitPA fitMeta

Examples

data(lungData)
k = grep("Extraction.Control",pData(lungData)$SampleType)
lungTrim = lungData[-k]
lungTrim = lungTrim[which(rowSums(MRcounts(lungTrim)>0)<20),]
res = fitDO(lungTrim,pData(lungTrim)$SmokingStatus);
head(res)
Arguments

obj
A MRexperiment object with count data.

mod
The model for the count distribution.

coef
Coefficient of interest to grab log fold-changes.

B
Number of bootstraps to perform if >1. If >1 performs permutation test.

szero
TRUE/FALSE, shrink zero component parameters.

spos
TRUE/FALSE, shrink positive component parameters.

Value

A list of objects including:

- call - the call made to fitFeatureModel
- fitZeroLogNormal - list of parameter estimates for the zero-inflated log normal model
- design - model matrix
- taxa - taxa names
- counts - count matrix
- pvalues - calculated p-values
- permuttedfits - permutted z-score estimates under the null

See Also
cumNorm

Examples

data(lungData)
lungData = lungData[-which(is.na(pData(lungData)$SmokingStatus))]
lungData=filterData(lungData,present=30,depth=1)
lungData <- cumNorm(lungData, p=.5)
s <- normFactors(lungData)
pd <- pData(lungData)
mod <- model.matrix(~1+SmokingStatus, data=pd)
lungres1 = fitFeatureModel(lungData,mod)
fitLogNormal

Slots

call  the call made to fitFeatureModel
fitZeroLogNormal  list of parameter estimates for the zero-inflated log normal model
design  model matrix
taxa  taxa names
counts  count matrix
pvalues  calculated p-values
permuttedFits  permuted z-score estimates under the null

fitLogNormal  Computes a log-normal linear model and permutation based p-values.

Description

Wrapper to perform the permutation test on the t-statistic. This is the original method employed by metastats (for non-sparse large samples). We include CSS normalization though (optional) and log2 transform the data. In this method the null distribution is not assumed to be a t-dist.

Usage

fitLogNormal(obj, mod, useCSSoffset = TRUE, B = 1000, coef = 2, sl = 1000)

Arguments

obj  A MReexperiment object with count data.
mod  The model for the count distribution.
useCSSoffset  Boolean, whether to include the default scaling parameters in the model or not.
B  Number of permutations.
coef  The coefficient of interest.
sl  The value to scale by (default=1000).

Value

Call made, fit object from lmFit, t-statistics and p-values for each feature.

Examples

# This is a simple demonstration
data(lungData)
k = grep("Extraction.Control",pData(lungData)$SampleType)
lungTrim = lungData[-k]
k = which(rowSums(MRcounts(lungTrim)>0)<30)
lungTrim = cumNorm(lungTrim)
lungTrim = lungTrim[-k,]
smokingStatus = pData(lungTrim)$SmokingStatus
mod = model.matrix(~smokingStatus)
fit = fitLogNormal(obj = lungTrim, mod=mod, B=1)

fitMultipleTimeSeries

Discover differentially abundant time intervals for all bacteria

Description
Calculate time intervals of significant differential abundance over all bacteria of a particularly specified level (lvl). If not lvl is specified, all OTUs are analyzed. Warning, function can take a while

Usage
fitMultipleTimeSeries(obj, lvl = NULL, B = 1, featureOrder = NULL, ...)

Arguments
obj metagenomeSeq MRexperiment-class object.
lvl Vector or name of column in featureData of MRexperiment-class object for aggregating counts (if not OTU level).
B Number of permutations to perform.
featureOrder Hierarchy of levels in taxonomy as fData colnames
... Options for fitTimeSeries, except feature.

Value
List of lists of matrices of time point intervals of interest, Difference in abundance area and p-value, fit, area permutations.

A list of lists for which each includes:

• timeIntervals - Matrix of time point intervals of interest, area of differential abundance, and pvalue.
• data - Data frame of abundance, class indicator, time, and id input.
• fit - Data frame of fitted values of the difference in abundance, standard error estimates and timepoints interpolated over.
• perm - Differential abundance area estimates for each permutation.
• call - Function call.

See Also
cumNorm fitSSTimeSeries fitTimeSeries
Examples
data(mouseData)
res = fitMultipleTimeSeries(obj=mouseData,lvl='phylum',class="status",
    id="mouseID",time="relativeTime",B=1)

fitPA

Wrapper to run Fisher's test on presence/absence of a feature.

Description
This function returns a data frame of p-values, odds ratios, lower and upper confidence limits for every row of a matrix.

Usage
fitPA(obj, cl, thres = 0, adjust.method = "fdr", cores = 1, ...)

Arguments
- **obj**: A MRexperiment object with a count matrix, or a simple count matrix.
- **cl**: Group comparison
- **thres**: Threshold for defining presence/absence.
- **adjust.method**: Method to adjust p-values by. Default is "FDR". Options include "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr", "none". See `p.adjust` for more details.
- **cores**: Number of cores to use.
- **...**: Extra parameters for `makeCluster`

Value
Matrix of odds ratios, p-values, lower and upper confidence intervals

See Also
cumNorm fitZig fitDO fitMeta

Examples
data(lungData)
k = grep("Extraction.Control",pData(lungData)$SampleType)
lungTrim = lungData[-k]
lungTrim = lungTrim[which(rowSums(MRcounts(lungTrim)>0)<20),]
res = fitPA(lungTrim,pData(lungTrim)$SmokingStatus);
head(res)
Description

Calculate time intervals of interest using SS-Anova fitted models. Fitting is performed uses Smoothing Spline ANOVA (SS-Anova) to find interesting intervals of time. Given observations at different time points for two groups, fitSSTimeSeries calculates a function that models the difference in abundance between two groups across all time. Using permutations we estimate a null distribution of areas for the time intervals of interest and report significant intervals of time. Use of the function for analyses should cite: "Finding regions of interest in high throughput genomics data using smoothing splines" Talukder H, Paulson JN, Bravo HC. (In preparation)

Usage

```r
fitSSTimeSeries(
  obj,
  formula,
  feature,
  class,
  time,
  id,
  lvl = NULL,
  include = c("class", "time:class"),
  C = 0,
  B = 1000,
  norm = TRUE,
  log = TRUE,
  sl = 1000,
  featureOrder = NULL,
  ...
)
```

Arguments

- `obj`: metagenomeSeq MRexperiment-class object.
- `formula`: Formula for ssanova. Of the form: abundance ~ ... where ... includes any pData slot value.
- `feature`: Name or row of feature of interest.
- `class`: Name of column in phenoData of MRexperiment-class object for class membership.
- `time`: Name of column in phenoData of MRexperiment-class object for relative time.
- `id`: Name of column in phenoData of MRexperiment-class object for sample id.
- `lvl`: Vector or name of column in featureData of MRexperiment-class object for aggregating counts (if not OTU level).
include Parameters to include in prediction.
C Value for which difference function has to be larger or smaller than (default 0).
B Number of permutations to perform
norm When aggregating counts to normalize or not.
log Log2 transform.
s1 Scaling value.
featureOrder Hierarchy of levels in taxonomy as fData colnames
...
Options for ssanova

Value

List of matrix of time point intervals of interest, Difference in abundance area and p-value, fit, area permutations, and call.

A list of objects including:

- timeIntervals - Matrix of time point intervals of interest, area of differential abundance, and pvalue.
- data - Data frame of abundance, class indicator, time, and id input.
- fit - Data frame of fitted values of the difference in abundance, standard error estimates and timepoints interpolated over.
- perm - Differential abundance area estimates for each permutation.
- call - Function call.

See Also
cumNorm ssFit ssIntervalCandidate ssPerm ssPermAnalysis plotTimeSeries

Examples

data(mouseData)
res = fitSSTimeSeries(obj=mouseData, feature="Actinobacteria", class="status", id="mouseID", time="relativeTime", lvl='class', B=2)
Usage

fitTimeSeries(
  obj,
  formula,
  feature,
  class,
  time,
  id,
  method = c("ssanova"),
  lvl = NULL,
  include = c("class", "time:class"),
  C = 0,
  B = 1000,
  norm = TRUE,
  log = TRUE,
  sl = 1000,
  featureOrder = NULL,
  ...
)

Arguments

obj        metagenomeSeq MRexperiment-class object.
formula    Formula for ssanova. Of the form: abundance ~ ... where ... includes any pData slot value.
feature    Name or row of feature of interest.
class      Name of column in phenoData of MRexperiment-class object for class membership.
time       Name of column in phenoData of MRexperiment-class object for relative time.
id         Name of column in phenoData of MRexperiment-class object for sample id.
method     Method to estimate time intervals of differentially abundant bacteria (only ssanova method implemented currently).
lvl        Vector or name of column in featureData of MRexperiment-class object for aggregating counts (if not OTU level).
include    Parameters to include in prediction.
C          Value for which difference function has to be larger or smaller than (default 0).
B          Number of permutations to perform.
norm       When aggregating counts to normalize or not.
log        Log2 transform.
sl          Scaling value.
featureOrder Hierarchy of levels in taxonomy as fData colnames
...        Options for ssanova
**Value**

List of matrix of time point intervals of interest, Difference in abundance area and p-value, fit, area permutations, and call.

A list of objects including:

- **timeIntervals** - Matrix of time point intervals of interest, area of differential abundance, and pvalue.
- **data** - Data frame of abundance, class indicator, time, and id input.
- **fit** - Data frame of fitted values of the difference in abundance, standard error estimates and timepoints interpolated over.
- **perm** - Differential abundance area estimates for each permutation.
- **call** - Function call.

**See Also**

cumNorm, fitSSTimeSeries, plotTimeSeries

**Examples**

data(mouseData)
res = fitTimeSeries(obj=mouseData, feature="Actinobacteria", class="status", id="mouseID", time="relativeTime", lvl='class', B=2)

---

**fitZeroLogNormal**

Compute the log fold-change estimates for the zero-inflated log-normal model

**Description**

Run the zero-inflated log-normal model given a MRexperiment object and model matrix. Not for the average user, assumes structure of the model matrix.

**Usage**

fitZeroLogNormal(obj, mod, coef = 2, szero = TRUE, spos = TRUE)

**Arguments**

- **obj** A MRexperiment object with count data.
- **mod** The model for the count distribution.
- **coef** Coefficient of interest to grab log fold-changes.
- **szero** TRUE/FALSE, shrink zero component parameters.
- **spos** TRUE/FALSE, shrink positive component parameters.
Value

A list of objects including:

- logFC - the log fold-change estimates
- adjFactor - the adjustment factor based on the zero component
- se - standard error estimates
- fitln - parameters from the log-normal fit
- fitzero - parameters from the logistic fit
- zeroRidge - output from the ridge regression
- posRidge - output from the ridge regression
- tauPos - estimated $\tau^2$ for positive component
- tauZero - estimated $\tau^2$ for zero component
- exclude - features to exclude for various reasons, e.g. all zeros
- zeroExclude - features to exclude for various reasons, e.g. all zeros

See Also

cumNorm fitFeatureModel

fitZig

Computes the weighted fold-change estimates and t-statistics.

Description

Wrapper to actually run the Expectation-maximization algorithm and estimate $f_{count}$ fits. Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership $\delta_{ij} = 1$ if $y_{ij}$ is generated from the zero point mass as latent indicator variables. The density is defined as $f_{zig}(y_{ij} = \pi_j(S_j) * f_0(y_{ij}) + (1-\pi_j(S_j)) * f_{count}(y_{ij}; \mu_i, \sigma_i^2)$. The log-likelihood in this extended model is: $\log (1-\delta_{ij}) \log f_{count}(y; \mu_i, \sigma_i^2) + \delta_{ij} \log \pi_j(s_j) + (1-\delta_{ij}) \log (1-\pi_j(s_j))$. The responsibilities are defined as $z_{ij} = pr(\delta_{ij}=1 | data)$.

Usage

```r
fitZig(
  obj,
  mod,
  zeroMod = NULL,
  useCSSoffset = TRUE,
  control = zigControl(),
  useMixedModel = FALSE,
  ...
)
```
Arguments

obj A MRexperiment object with count data.
mod The model for the count distribution.
zeroMod The zero model, the model to account for the change in the number of OTUs observed as a linear effect of the depth of coverage.
useCSSoffset Boolean, whether to include the default scaling parameters in the model or not.
control The settings for fitZig.
useMixedModel Estimate the correlation between duplicate features or replicates using duplicateCorrelation.

Value

A list of objects including:

- call - the call made to fitZig
- fit - 'MLArrayLM' Limma object of the weighted fit
- countResiduals - standardized residuals of the fit
- z - matrix of the posterior probabilities
- eb - output of eBayes, moderated t-statistics, moderated F-statistics, etc
- taxa - vector of the taxa names
- counts - the original count matrix input
- zeroMod - the zero model matrix
- zeroCoef - the zero model fitted results
- stillActive - convergence
- stillActiveNLL - nll at convergence
- dupcor - correlation of duplicates

See Also

cumNorm zigControl

Examples

# This is a simple demonstration
data(lungData)
k = grep("Extraction.Control",pData(lungData)$SampleType)
lungTrim = lungData[,-k]
k = which(rowSums(MRcounts(lungTrim)>0)<30)
lungTrim = cumNorm(lungTrim)
lungTrim = lungTrim[,-k,]
smokingStatus = pData(lungTrim)$SmokingStatus
mod = model.matrix(~smokingStatus)
# The maxit is not meant to be 1 - this is for demonstration/speed
settings = zigControl(maxit=1,verbose=FALSE)
fit = fitZig(obj = lungTrim,mod=mod,control=settings)
### fitZigResults-class

Class "fitZigResults" – a formal class for storing results from a fitZig call

**Description**

This class contains all of the same information expected from a fitZig call, but it is defined in the S4 style as opposed to being stored as a list.

**Slots**

- `call`: the call made to fitZig
- `fit`: 'MLArrayLM' Limma object of the weighted fit
- `countResiduals`: standardized residuals of the fit
- `z`: matrix of the posterior probabilities. It is defined as $z_{ij} = \text{pr}(\delta_{ij}=1 | \text{data})$
- `zUsed`: used in `getZ`
- `eb`: output of eBayes, moderated t-statistics, moderated F-statistics, etc
- `taxa`: vector of the taxa names
- `counts`: the original count matrix input
- `zeroMod`: the zero model matrix
- `zeroCoef`: the zero model fitted results
- `stillActive`: convergence
- `stillActiveNLL`: nll at convergence
- `dupcor`: correlation of duplicates

### getCountDensity

Compute the value of the count density function from the count model residuals.

**Description**

Calculate density values from a normal: $f(x) = \frac{1}{\sqrt{2 \pi} \sigma} e^{-\frac{(x - \mu)^2}{2 \sigma^2}}$. Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership $\delta_{ij} = 1$ if $y_{ij}$ is generated from the zero point mass as latent indicator variables. The density is defined as $f_{\text{zig}}(y_{ij} = \pi_j(S_j) \cdot f_0(\cdot) + (1-\pi_j(S_j)) \cdot f_{\text{count}}(\cdot))$. The log-likelihood in this extended model is $(1-\delta_{ij}) \log f_{\text{count}}(\cdot) + \delta_{ij} \log \pi_j(S_j) + (1-\delta_{ij}) \log (1-\pi_j(S_j))$. The responsibilities are defined as $z_{ij} = \text{pr}(\delta_{ij}=1 | \text{data})$.

**Usage**

```r
getCountDensity(residuals, log = FALSE)
```
**Arguments**

- **residuals**: Residuals from the count model.
- **log**: Whether or not we are calculating from a log-normal distribution.

**Value**

Density values from the count model residuals.

**See Also**

- `fitZig`

---

**Description**

Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership $\delta_{ij} = 1$ if $y_{ij}$ is generated from the zero point mass as latent indicator variables. The log-likelihood in this extended model is $(1-\delta_{ij}) \log f_{\text{count}}(y;\mu_i,\sigma_i^2) + \delta_{ij} \log \pi_j(s_j) + (1-\delta_{ij}) \log (1-\pi_j(s_j))$. The responsibilities are defined as $z_{ij} = \Pr(\delta_{ij}=1 \mid \text{data})$.

**Usage**

```r
gammaEpsilon(nll, nllOld)
```

**Arguments**

- **nll**: Vector of size M with the current negative log-likelihoods.
- **nllOld**: Vector of size M with the previous iterations negative log-likelihoods.

**Value**

Vector of size M of the relative differences between the previous and current iteration nll.

**See Also**

- `fitZig`
getNegativeLogLikelihoods

Calculate the negative log-likelihoods for the various features given the residuals.

Description

Maximum-likelihood estimates are approximated using the EM algorithm where we treat mixture membership $\delta_{ij} = 1$ if $y_{ij}$ is generated from the zero point mass as latent indicator variables. The log-likelihood in this extended model is $(1-\delta_{ij}) \log f_{count}(y_{ij}; \mu_i, \sigma_i^2) + \delta_{ij} \log \pi_j(s_j) + (1-\delta_{ij})\log (1-\pi_j(s_j))$. The responsibilities are defined as $z_{ij} = \text{pr}(\delta_{ij}=1 | \text{data and current values})$.

Usage

getNegativeLogLikelihoods(z, countResiduals, zeroResiduals)

Arguments

- **z**: Matrix (m x n) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0).
- **countResiduals**: Residuals from the count model.
- **zeroResiduals**: Residuals from the zero model.

Value

Vector of size M of the negative log-likelihoods for the various features.

See Also

fitZig

geti

Calculate the mixture proportions from the zero model / spike mass model residuals.

Description

$F(x) = 1 / (1 + \exp(-(x-m)/s))$ (the CDF of the logistic distribution). Provides the probability that a real-valued random variable X with a given probability distribution will be found at a value less than or equal to x. The output are the mixture proportions for the samples given the residuals from the zero model.

Usage

getPi(residuals)
getZ

Arguments

residuals Residuals from the zero model.

Value

Mixture proportions for each sample.

See Also

fitZig

Description

Calculate the current Z estimate responsibilities (posterior probabilities)

Usage

getZ(z, zUsed, stillActive, nll, nllUSED)

Arguments

z Matrix (m x n) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0).

zUsed Matrix (m x n) of estimate responsibilities (probabilities that a count comes from a spike distribution at 0) that are actually used (following convergence).

stillActive A vector of size M booleans saying if a feature is still active or not.

nll Vector of size M with the current negative log-likelihoods.

nllUSED Vector of size M with the converged negative log-likelihoods.

Value

A list of updated zUsed and nllUSED.

See Also

fitZig
**isItStillActive**  
*Function to determine if a feature is still active.*

**Description**

In the Expectation Maximization routine features posterior probabilities routinely converge based on a tolerance threshold. This function checks whether or not the feature’s negative log-likelihood (measure of the fit) has changed or not.

**Usage**

```r
isItStillActive(eps, tol, stillActive, stillActiveNLL, nll)
```

**Arguments**

- `eps` Vector of size M (features) representing the relative difference between the new nll and old nll.
- `tol` The threshold tolerance for the difference
- `stillActive` A vector of size M booleans saying if a feature is still active or not.
- `stillActiveNLL` A vector of size M recording the negative log-likelihoods of the various features, updated for those still active.
- `nll` Vector of size M with the current negative log-likelihoods.

**Value**

None.

**See Also**

- `fitZig`

---

**libSize**  
*Access sample depth of coverage from MRexperiment object*

**Description**

Access the libSize vector represents the column (sample specific) sums of features, i.e. the total number of reads for a sample or depth of coverage. It is used by `fitZig`.

**Usage**

```r
libSize(object)
```
libSize<-

Arguments

object a MRexperiment object

Value

Library sizes

Author(s)

Joseph N. Paulson

Examples

data(lungData)
head(libSize(lungData))

libSize<-

Replace the library sizes in a MRexperiment object

Description

Function to replace the scaling factors, aka the library sizes, of samples in a MRexperiment object.

Usage

## S4 replacement method for signature 'MRexperiment,numeric'
libSize(object) <- value

Arguments

object a MRexperiment object
value vector of library sizes

Value

vector library sizes

Author(s)

Joseph N. Paulson

Examples

data(lungData)
head(libSize(lungData)<- rnorm(1))
loadBiom

Load objects organized in the Biom format.

Description

Wrapper to load Biom formatted object.

Usage

loadBiom(file)

Arguments

file The biom object filepath.

Value

A MRexperiment object.

See Also

loadMeta loadPhenoData newMRexperiment biom2MRexperiment

Examples

#library(biomformat)
rich_dense_file = system.file("extdata", "rich_dense_otu_table.biom", package = "biomformat")
x = loadBiom(rich_dense_file)
x

loadMeta

Load a count dataset associated with a study.

Description

Load a matrix of OTUs in a tab delimited format.

Usage

loadMeta(file, sep = "\t")

Arguments

file Path and filename of the actual data file.
sep File delimiter.
loadMetaQ

Value

A list with objects 'counts' and 'taxa'.

See Also

loadPhenoData

Examples

dataDirectory <- system.file("extdata", package="metagenomeSeq")
lung = loadMeta(file.path(dataDirectory,"CHK_NAME.otus.count.csv"))

loadMetaQ Load a count dataset associated with a study set up in a Qiime format.

Description

Load a matrix of OTUs in Qiime's format

Usage

loadMetaQ(file)

Arguments

file Path and filename of the actual data file.

Value

An list with 'counts' containing the count data, 'taxa' containing the otu annotation, and 'otus'.

See Also

loadMeta loadPhenoData

Examples

# see vignette
loadPhenoData  
*Load a clinical/phenotypic dataset associated with a study.*

**Description**

Load a matrix of metadata associated with a study.

**Usage**

```r
loadPhenoData(file, tran = TRUE, sep = "\t")
```

**Arguments**

- `file` 
  Path and filename of the actual clinical file.
- `tran` 
  Boolean. If the covariates are along the columns and samples along the rows, then `tran` should equal `TRUE`.
- `sep` 
  The separator for the file.

**Value**

The metadata as a dataframe.

**See Also**

`loadMeta`

**Examples**

```r
dataDirectory <- system.file("extdata", package="metagenomeSeq")
clin = loadPhenoData(file.path(dataDirectory,"CHK_clinical.csv"),tran=TRUE)
```

---

lungData  
*OTU abundance matrix of samples from a smoker/non-smoker study*

**Description**

This is a list with a matrix of OTU counts, otu names, taxa annotations for each OTU, and phenotypic data. Samples along the columns and OTUs along the rows.

**Format**

A list of OTU matrix, taxa, otus, and phenotypes
**makeLabels**

**Value**

MRexperiment-class object of 16S lung samples.

**References**


---

**makeLabels**  
*Function to make labels simpler*

**Description**

Beginning to transition to better axes for plots

**Usage**

```r
makeLabels(x = "samples", y = "abundance", norm, log)
```

**Arguments**

- `x`  
  string for the x-axis
- `y`  
  string for the y-axis
- `norm`  
  is the data normalized?
- `log`  
  is the data logged?

**Value**

vector of x,y labels

**Examples**

```r
metagenomeSeq::makeLabels(norm=TRUE, log=TRUE)
```
mergeMRexperiments  Merge two MRexperiment objects together

Description
This function will take two MRexperiment objects and merge them together finding common OTUs. If there are OTUs not found in one of the two MRexperiments then a message will announce this and values will be coerced to zero for the second table.

Usage
mergeMRexperiments(x, y)

Arguments
x  MRexperiment-class object 1.
y  MRexperiment-class object 2.

Value
Merged MRexperiment-class object.

Examples
data(mouseData)
newobj = mergeMRexperiments(mouseData, mouseData)
newobj

# let me know if people are interested in an option to merge by keys instead of row names.
data(lungData)
newobj = mergeMRexperiments(mouseData, lungData)
newobj

mergeTable  Merge two tables

Description
Merge two tables

Usage
mergeTable(x, y)
Arguments

x  Table 1.
y  Table 2.

Value

Merged table

---

**Description**

These functions may be removed completely in the next release.

**Usage**

`deprecated_metagenomeSeq_function(x, value, ...)`

**Arguments**

- **x**: For assignment operators, the object that will undergo a replacement (object inside parenthesis).
- **value**: For assignment operators, the value to replace with (the right side of the assignment).
- **...**: For functions other than assignment operators, parameters to be passed to the modern version of the function (see table).

---

**mouseData**

*OTU abundance matrix of mice samples from a diet longitudinal study*

**Description**

This is a list with a matrix of OTU counts, taxa annotations for each OTU, otu names, and vector of phenotypic data. Samples along the columns and OTUs along the rows.

**Format**

A list of OTU matrix, taxa, otus, and phenotypes

**Value**

MRexperiment-class object of 16S mouse samples.
MRcoefs

Table of top-ranked features from fitZig or fitFeatureModel

Description

Extract a table of the top-ranked features from a linear model fit. This function will be updated soon to provide better flexibility similar to limma’s topTable.

Usage

```
MRcoefs(
  obj, 
  by = 2, 
  coef = NULL, 
  number = 10, 
  taxa = obj@taxa, 
  uniqueNames = FALSE, 
  adjustMethod = "fdr", 
  alpha = 0.1, 
  group = 0, 
  eff = 0, 
  numberEff = FALSE, 
  counts = 0, 
  file = NULL
)
```

Arguments

- **obj**: Output of fitFeatureModel or fitZig.
- **by**: Column number or column name specifying which coefficient or contrast of the linear model is of interest.
- **coef**: Column number(s) or column name(s) specifying which coefficient or contrast of the linear model to display.
- **number**: The number of bacterial features to pick out.
- **taxa**: Taxa list.
- **uniqueNames**: Number the various taxa.
- **adjustMethod**: Method to adjust p-values by. Default is "FDR". Options include "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr", "none". See `p.adjust` for more details. Additionally, options using independent hypothesis weighting (IHW) are available. See `MRihw` for more details.
- **alpha**: Value for p-value significance threshold when running IHW. The default is set to 0.1

References

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2894525/
**group**

One of five choices, 0, 1, 2, 3, 4. 0: the sort is ordered by a decreasing absolute value coefficient fit. 1: the sort is ordered by the raw coefficient fit in decreasing order. 2: the sort is ordered by the raw coefficient fit in increasing order. 3: the sort is ordered by the p-value of the coefficient fit in increasing order. 4: no sorting.

**eff**

Filter features to have at least a "eff" quantile or number of effective samples.

**numberEff**

Boolean, whether eff should represent quantile (default/False) or number.

**counts**

Filter features to have at least 'counts' counts.

**file**

Name of output file, including location, to save the table.

**Value**

Table of the top-ranked features determined by the linear fit's coefficient.

**See Also**

fitZig fitFeatureModel MRtable MRfulltable

**Examples**

```r
data(lungData)
k = grep("Extraction.Control",pData(lungData)$SampleType)
lungTrim = lungData[-k]
lungTrim = filterData(lungTrim, present = 30)
lungTrim = cumNorm(lungTrim, p = 0.5)
smokingStatus = pData(lungTrim)$SmokingStatus
mod = model.matrix(~smokingStatus)
fit = fitZig(obj = lungTrim, mod = mod)
head(MRcoefs(fit))
###
fit = fitFeatureModel(obj = lungTrim, mod = mod)
head(MRcoefs(fit))
```

---

**MRcounts**

**Accessor for the counts slot of a MRexperiment object**

**Description**

The counts slot holds the raw count data representing (along the rows) the number of reads annotated for a particular feature and (along the columns) the sample.

**Usage**

MRcounts(obj, norm = FALSE, log = FALSE, sl = 1000)
Arguments

- **obj**: a `MRexperiment` object.
- **norm**: logical indicating whether or not to return normalized counts.
- **log**: TRUE/FALSE whether or not to log2 transform scale.
- **sl**: The value to scale by (default=1000).

Value

Normalized or raw counts

Author(s)

Joseph N. Paulson, jpm@umiacs.umd.edu

Examples

```r
data(lungData)
head(MRcounts(lungData))
```

Description

This is the main class for metagenomeSeq.

Objects from the Class

Objects should be created with calls to `newMRexperiment`.

Extends

Class `eSet` (package 'Biobase'), directly. Class `VersionedBiobase` (package 'Biobase'), by class "eSet", distance 2. Class `Versioned` (package 'Biobase'), by class "eSet", distance 3.

Methods

Class-specific methods.

- Subset operation, taking two arguments and indexing the sample and variable. Returns an `MRexperiment` object, including relevant metadata. Setting `drop=TRUE` generates an error. Subsetting the data, the experiment summary slot is repopulated and pData is repopulated after calling factor (removing levels not present).
Note

Note: This is a summary for reference. For an explanation of the actual usage, see the vignette.

MRexperiments are the main class in use by metagenomeSeq. The class extends eSet and provides additional slots which are populated during the analysis pipeline.

MRexperiment dataset are created with calls to `newMRexperiment`. MRexperiment datasets contain raw count matrices (integers) accessible through `MRcounts`. Similarly, normalized count matrices can be accessed (following normalization) through `MRcounts` by calling norm=TRUE. Following an analysis, a matrix of posterior probabilities for counts is accessible through `posteriorProbs`.

The normalization factors used in analysis can be recovered by `normFactors`, as can the library sizes of samples (depths of coverage), `libSize`.

Similarly to other RNASeq bioconductor packages available, the rows of the matrix correspond to a feature (be it OTU, species, gene, etc.) and each column an experimental sample. Pertinent clinical information and potential confounding factors are stored in the phenoData slot (accessed via `pData`).

To populate the various slots in an MRexperiment several functions are run. 1) `cumNormStat` calculates the proper percentile to calculate normalization factors. The cumNormStat slot is populated. 2) `cumNorm` calculates the actual normalization factors using p = cumNormStat.

Other functions will place subsequent matrices (normalized counts (`cumNormMat`), posterior probabilities (`posteriorProbs`))

As mentioned above, MRexperiment is derived from the virtual class, eSet and thereby has a phenoData slot which allows for sample annotation. In the phenoData data frame factors are stored. The normalization factors and library size information is stored in a slot called expSummary that is an annotated data frame and is repopulated for subsetted data.

Examples

# See vignette

```r
MRexperiment2biom
```

Description

Wrapper to convert MRexperiment objects to biom objects.

Usage

```r
MRexperiment2biom(
  obj,
  id = NULL,
  norm = FALSE,
  log = FALSE,
  sl = 1000,
  qiimeVersion = TRUE
)
```
MRfulltable

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>obj</td>
<td>The MRexperiment object.</td>
</tr>
<tr>
<td>id</td>
<td>Optional id for the biom matrix.</td>
</tr>
<tr>
<td>norm</td>
<td>normalize count table</td>
</tr>
<tr>
<td>log</td>
<td>log2 transform count table</td>
</tr>
<tr>
<td>sl</td>
<td>scaling factor for normalized counts.</td>
</tr>
<tr>
<td>qiimeVersion</td>
<td>Format fData according to QIIME specifications (assumes only taxonomy in fData).</td>
</tr>
</tbody>
</table>

Value

A biom object.

See Also

loadMeta loadPhenoData newMRexperiment loadBiom biom2MRexperiment

Description

Extract a table of the top-ranked features from a linear model fit. This function will be updated soon to provide better flexibility similar to limma’s topTable. This function differs from link{MRcoefs} in that it provides other information about the presence or absence of features to help ensure significant features called are moderately present.

Usage

MRfulltable(
  obj,
  by = 2,
  coef = NULL,
  number = 10,
  taxa = obj@taxa,
  uniqueNames = FALSE,
  adjustMethod = "fdr",
  group = 0,
  eff = 0,
  numberEff = FALSE,
  ncounts = 0,
  file = NULL
)
Arguments

- **obj**: Output of `fitFeatureModel` or `fitZig`.
- **by**: Column number or column name specifying which coefficient or contrast of the linear model is of interest.
- **coef**: Column number(s) or column name(s) specifying which coefficient or contrast of the linear model to display.
- **number**: The number of bacterial features to pick out.
- **taxa**: Taxa list.
- **uniqueNames**: Number the various taxa.
- **adjustMethod**: Method to adjust p-values by. Default is "FDR". Options include "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr", "none". See `p.adjust` for more details.
- **group**: One of five choices: 0,1,2,3,4. 0: the sort is ordered by a decreasing absolute value coefficient fit. 1: the sort is ordered by the raw coefficient fit in decreasing order. 2: the sort is ordered by the raw coefficient fit in increasing order. 3: the sort is ordered by the p-value of the coefficient fit in increasing order. 4: no sorting.
- **eff**: Filter features to have at least a "eff" quantile or number of effective samples.
- **numberEff**: Boolean, whether eff should represent quantile (default/FALSE) or number.
- **ncounts**: Filter features to those with at least 'counts' counts.
- **file**: Name of output file, including location, to save the table.

Value

Table of the top-ranked features determined by the linear fit's coefficient.

See Also

`fitZig`, `fitFeatureModel`, `MRcoefs`, `MRtable`, `fitPA`

Examples

```r
data(lungData)
k = grep("Extraction.Control", pData(lungData)$SampleType)
lungTrim = lungData[,-k]
lungTrim = filterData(lungTrim, present=30)
lungTrim = cumNorm(lungTrim, p=0.5)
smokingStatus = pData(lungTrim)$SmokingStatus
mod = model.matrix(~smokingStatus)
fit = fitZig(obj = lungTrim, mod=mod)
head(MRfulltable(fit))
####
fit = fitFeatureModel(obj = lungTrim, mod=mod)
head(MRfulltable(fit))
```
**Description**

Function used in MRcoefs() when "IHW" is set as the p value adjustment method

**Usage**

```r
MRihw(obj, ...)
```

**Arguments**

- `obj` Either a fitFeatureModelResults or fitZigResults object
- `...` other parameters

---

**Description**

Function used in MRcoefs() when "IHW" is set as the p value adjustment method

**Usage**

```r
## S4 method for signature 'fitFeatureModelResults'
MRihw(obj, p, adjustMethod, alpha)
```

**Arguments**

- `obj` Either a fitFeatureModelResults or fitZigResults object
- `p` a vector of pvalues extracted from obj
- `adjustMethod` Value specifying which adjustment method and which covariate to use for IHW pvalue adjustment. For obj of class `fitFeatureModelResults-class`, options are "ihw-abundance" (median feature count per row) and "ihw-ubiquity" (number of non-zero features per row). For obj of class `fitZigResults-class`, options are "ihw-abundance" (weighted mean per feature) and "ihw-ubiquity" (number of non-zero features per row).
- `alpha` pvalue significance level specified for IHW call. Default is 0.1
**MRihw, fitZigResults-method**

*MRihw runs IHW within a MRcoefs() call*

---

### Description

Function used in MRcoefs() when "IHW" is set as the p value adjustment method

### Usage

```r
## S4 method for signature 'fitZigResults'
MRihw(obj, p, adjustMethod, alpha)
```

### Arguments

- **obj**: Either a fitFeatureModelResults or fitZigResults object
- **p**: a vector of pvalues extracted from obj
- **adjustMethod**: Value specifying which adjustment method and which covariate to use for IHW pvalue adjustment. For obj of class `fitFeatureModelResults-class`, options are "ihw-abundance" (median feature count per row) and "ihw-ubiquity" (number of non-zero features per row). For obj of class `fitZigResults-class`, options are "ihw-abundance" (weighted mean per feature) and "ihw-ubiquity" (number of non-zero features per row).
- **alpha**: pvalue significance level specified for IHW call. Default is 0.1

---

**MRtable**

*Table of top microbial marker gene from linear model fit including sequence information*

---

### Description

Extract a table of the top-ranked features from a linear model fit. This function will be updated soon to provide better flexibility similar to limma’s topTable. This function differs from `link{MRcoefs}` in that it provides other information about the presence or absence of features to help ensure significant features called are moderately present.

### Usage

```r
MRtable(
    obj,
    by = 2,
    coef = NULL,
    number = 10,
    taxa = obj@taxa,
```
uniqueNames = FALSE,
adjustMethod = "fdr",
group = 0,
eff = 0,
numberEff = FALSE,
ncounts = 0,
file = NULL
)

Arguments

obj Output of fitFeatureModel or fitZig.
by Column number or column name specifying which coefficient or contrast of the linear model is of interest.
coef Column number(s) or column name(s) specifying which coefficient or contrast of the linear model to display.
number The number of bacterial features to pick out.
taxa Taxa list.
uniqueNames Number the various taxa.
adjustMethod Method to adjust p-values by. Default is "FDR". Options include "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr", "none". See p.adjust for more details.
group One of five choices, 0,1,2,3,4. 0: the sort is ordered by a decreasing absolute value coefficient fit. 1: the sort is ordered by the raw coefficient fit in decreasing order. 2: the sort is ordered by the raw coefficient fit in increasing order. 3: the sort is ordered by the p-value of the coefficient fit in increasing order. 4: no sorting.
eff Filter features to have at least a "eff" quantile or number of effective samples.
numberEff Boolean, whether eff should represent quantile (default/FALSE) or number.
ncounts Filter features to have at least 'counts' of counts.
file Name of file, including location, to save the table.

Value

Table of the top-ranked features determined by the linear fit’s coefficient.

See Also

fitZig fitFeatureModel MRcoefs MRfulltable

Examples

data(lungData)
k = grep("Extraction.Control",pData(lungData)$SampleType)
lungTrim = lungData[,,-k]
lungTrim=filterData(lungTrim,present=30)
newMRexperiment

Description

This function creates a MRexperiment object from a matrix or data frame of count data.

Usage

newMRexperiment(
  counts,
  phenoData = NULL,
  featureData = NULL,
  libSize = NULL,
  normFactors = NULL
)

Arguments

counts A matrix or data frame of count data. The count data is representative of the number of reads annotated for a feature (be it gene, OTU, species, etc). Rows should correspond to features and columns to samples.
phenoData An AnnotatedDataFrame with pertinent sample information.
featureData An AnnotatedDataFrame with pertinent feature information.
libSize libSize, library size, is the total number of reads for a particular sample.
normFactors normFactors, the normalization factors used in either the model or as scaling factors of sample counts for each particular sample.

Details

See MRexperiment-class and eSet (from the Biobase package) for the meaning of the various slots.

Value

an object of class MRexperiment
Author(s)

Joseph N Paulson

Examples

cnts = matrix(abs(rnorm(1000)),nc=10)
obj <- newMRexperiment(cnts)

---

normFactors | Access the normalization factors in a MRexperiment object

Description

Function to access the scaling factors, aka the normalization factors, of samples in a MRexperiment object.

Usage

normFactors(object)

Arguments

object | a MRexperiment object

Value

Normalization scaling factors

Author(s)

Joseph N. Paulson

Examples

data(lungData)
head(normFactors(lungData))
normFactors<- Replace the normalization factors in a MRexperiment object

Description

Function to replace the scaling factors, aka the normalization factors, of samples in a MRexperiment object.

Usage

```r
## S4 replacement method for signature 'MRexperiment,numeric'
normFactors(object) <- value
```

Arguments

- `object`: a `MRexperiment` object
- `value`: vector of normalization scaling factors

Value

Normalization scaling factors

Author(s)

Joseph N. Paulson

Examples

```r
data(lungData)
head(normFactors(lungData) <- rnorm(1))
```

plotBubble Basic plot of binned vectors.

Description

This function plots takes two vectors, calculates the contingency table and plots circles sized by the contingency table value. Optional significance vectors of the values significant will shade the circles by proportion of significance.
Usage

plotBubble(
  yvector,
  xvector,
  sigvector = NULL,
  nbreaks = 10,
  ybreak = quantile(yvector, p = seq(0, 1, length.out = nbreaks)),
  xbreak = quantile(xvector, p = seq(0, 1, length.out = nbreaks)),
  scale = 1,
  local = FALSE,
  ...
)

Arguments

yvector  A vector of values represented along y-axis.

xvector  A vector of values represented along x-axis.

sigvector  A vector of the names of significant features (names should match x/yvector).

nbreaks  Number of bins to break yvector and xvector into.

ybreak  The values to break the yvector at.

xbreak  The values to break the xvector at.

scale  Scaling of circle bin sizes.

local  Boolean to shade by significant bin numbers (TRUE) or overall proportion (FALSE).

...  Additional plot arguments.

Value

A matrix of features along rows, and the group membership along columns.

See Also

plotMRheatmap

Examples

data(mouseData)
mouseData = mouseData[which(rowSums(mouseData)>139),]
sparsity = rowMeans(MRcounts(mouseData)==0)
lor = log(fitPA(mouseData,cl=pData(mouseData)[,3])$oddsRatio)
plotBubble(lor,sparsity,main="lor ~ sparsity")

# Example 2
x = runif(100000)
y = runif(100000)
plotBubble(y,x)
plotClassTimeSeries  Plot abundances by class

Description

Plot the abundance of values for each class using a spline approach on the estimated full model.

Usage

plotClassTimeSeries(
  res, 
  formula, 
  xlab = "Time", 
  ylab = "Abundance", 
  color0 = "black", 
  color1 = "red", 
  include = c("1", "class", "time:class"), 
  ... 
)

Arguments

res  Output of fitTimeSeries function
formula  Formula for ssanova. Of the form: abundance ~ ... where ... includes any pData slot value.
xlab  X-label.
ylab  Y-label.
color0  Color of samples from first group.
color1  Color of samples from second group.
include  Parameters to include in prediction.
...  Extra plotting arguments.

Value

Plot for abundances of each class using a spline approach on estimated null model.

See Also

  fitTimeSeries

Examples

data(mouseData)
res = fitTimeSeries(obj=mouseData,feature="Actinobacteria", 
class="status",id="mouseID",time="relativeTime",lvl='class',B=10)
plotClassTimeSeries(res,pch=21,bg=res$data$class,ylim=c(0,8))
**plotCorr**

*Basic correlation plot function for normalized or unnormalized counts.*

**Description**

This function plots a heatmap of the "n" features with greatest variance across rows.

**Usage**

```
plotCorr(obj, n, norm = TRUE, log = TRUE, fun = cor, ...)
```

**Arguments**

- `obj` A MRexperiment object with count data.
- `n` The number of features to plot. This chooses the "n" features with greatest variance.
- `norm` Whether or not to normalize the counts - if MRexperiment object.
- `log` Whether or not to log2 transform the counts - if MRexperiment object.
- `fun` Function to calculate pair-wise relationships. Default is pearson correlation
- `...` Additional plot arguments.

**Value**

Plotted correlation matrix

**See Also**

`cumNormMat`

**Examples**

```r
data(mouseData)
plotCorr(obj=mouseData, n=200, cexRow = 0.4, cexCol = 0.4, trace="none", dendrogram="none",
    col = colorRampPalette(brewer.pal(9, "RdBu"))(50))
```
plotFeature  Basic plot function of the raw or normalized data.

Description
This function plots the abundance of a particular OTU by class. The function is the typical manhattan plot of the abundances.

Usage
plotFeature(
  obj,
  otuIndex,
  classIndex,
  col = "black",
  sort = TRUE,
  sortby = NULL,
  norm = TRUE,
  log = TRUE,
  sl = 1000,
  ...
)

Arguments
  obj          A MRexperiment object with count data.
  otuIndex     The row to plot
  classIndex   A list of the samples in their respective groups.
  col          A vector to color samples by.
  sort         Boolean, sort or not.
  sortby       Default is sort by library size, alternative vector for sorting
  norm         Whether or not to normalize the counts - if MRexperiment object.
  log          Whether or not to log2 transform the counts - if MRexperiment object.
  sl           Scaling factor - if MRexperiment and norm=TRUE.
  ...          Additional plot arguments.

Value
  counts and classindex

See Also
cumNorm
Examples

```r
data(mouseData)
classIndex=list(Western=which(pData(mouseData)$diet=="Western"))
classIndex$BK=which(pData(mouseData)$diet=="BK")

par(mfrow=c(2,1))
dates = pData(mouseData)$date

plotFeature(mouseData,norm=FALSE,log=FALSE,otuIndex,classIndex,
    col=dates,sortby=dates,ylab="Raw reads")
```

---

### plotGenus

**Basic plot function of the raw or normalized data.**

**Description**

This function plots the abundance of a particular OTU by class. The function uses the estimated posterior probabilities to make technical zeros transparent.

**Usage**

```r
plotGenus(
    obj,
    otuIndex,
    classIndex,
    norm = TRUE,
    log = TRUE,
    no = 1:length(otuIndex),
    labs = TRUE,
    xlab = NULL,
    ylab = NULL,
    jitter = TRUE,
    jitter.factor = 1,
    pch = 21,
    ...)
```

**Arguments**

- `obj`: An MRexperiment object with count data.
- `otuIndex`: A list of the otus with the same annotation.
- `classIndex`: A list of the samples in their respective groups.
- `norm`: Whether or not to normalize the counts - if MRexperiment object.
- `log`: Whether or not to log2 transform the counts - if MRexperiment object.
- `no`: Which of the otuIndex to plot.
plotMRheatmap

- **labs**: Whether to include group labels or not. (TRUE/FALSE)
- **xlab**: xlabel for the plot.
- **ylab**: ylabel for the plot.
- **jitter**: Boolean to jitter the count data or not.
- **jitter.factor**: Factor value for jitter
- **pch**: Standard pch value for the plot command.
- **...**: Additional plot arguments.

**Value**

plotted data

**See Also**

cumNorm

**Examples**

data(mouseData)
classIndex=list(controls=which(pData(mouseData)$diet=="BK"))
classIndex$cases=which(pData(mouseData)$diet=="Western")
otuIndex = grep("Strep",fData(mouseData)$family)
ottIndex=ottIndex[order(rowSums(MRcounts(mouseData)[ottIndex,]),decreasing=TRUE)]
plotGenus(mouseData,ottIndex,classIndex,no=1:2,xaxt="n",norm=FALSE,ylab="Strep normalized log(cpt)")

**Description**

This function plots a heatmap of the 'n' features with greatest variance across rows (or other statistics).

**Usage**

plotMRheatmap(obj, n, norm = TRUE, log = TRUE, fun = sd, ...)

**Arguments**

- **obj**: A MRexperiment object with count data.
- **n**: The number of features to plot. This chooses the 'n' features of greatest positive statistic.
- **norm**: Whether or not to normalize the counts - if MRexperiment object.
- **log**: Whether or not to log2 transform the counts - if MRexperiment object.
- **fun**: Function to select top 'n' features.
- **...**: Additional plot arguments.
### Description

This function plots the PCA / MDS coordinates for the "n" features of interest. Potentially uncovering batch effects or feature relationships.

### Usage

```r
plotOrd(
  obj,
  tran = TRUE,
  comp = 1:2,
  norm = TRUE,
  log = TRUE,
  usePCA = TRUE,
  useDist = FALSE,
  distfun = stats:::dist,
  dist.method = "euclidian",
  n = NULL,
  ...
)
```
**plotOTU**

**Description**

This function plots the abundance of a particular OTU by class. The function uses the estimated posterior probabilities to make technical zeros transparent.

**Usage**

```r
plotOTU(
  obj,
  otu,
  classIndex,
  log = TRUE,
  norm = TRUE,
```

**Arguments**

- `obj`: A MRexperiment object or count matrix.
- `tran`: Transpose the matrix.
- `comp`: Which components to display
- `norm`: Whether or not to normalize the counts - if MRexperiment object.
- `log`: Whether or not to log2 the counts - if MRexperiment object.
- `usePCA`: TRUE/FALSE whether to use PCA or MDS coordinates (TRUE is PCA).
- `useDist`: TRUE/FALSE whether to calculate distances.
- `distfun`: Distance function, default is stats::dist
- `dist.method`: If useDist==TRUE, what method to calculate distances.
- `n`: Number of features to make use of in calculating your distances.
- `...`: Additional plot arguments.

**Value**

- `coordinates`

**See Also**

- `cumNormMat`

**Examples**

```r
data(mouseData)
c1 = pData(mouseData)[,3]
plotOrd(mouseData, tran=TRUE, useDist=TRUE, pch=21, bg=factor(c1), usePCA=FALSE)
```

---

**plotOTU**

*Basic plot function of the raw or normalized data.*
Arguments

obj      A MRexperiment object with count data.
otu     The row number/OTU to plot.
classIndex A list of the samples in their respective groups.
log     Whether or not to log2 transform the counts - if MRexperiment object.
norm    Whether or not to normalize the counts - if MRexperiment object.
jitter.factor Factor value for jitter.
pch     Standard pch value for the plot command.
labs    Whether to include group labels or not. (TRUE/FALSE)
xlab    xlabel for the plot.
ylab    ylabel for the plot.
jitter  Boolean to jitter the count data or not.
...     Additional plot arguments.

Value

Plotted values

See Also

cumNorm

Examples

data(mouseData)
classIndex=list(controls=which(pData(mouseData)$diet=="BK"))
classIndex$cases=which(pData(mouseData)$diet=="Western")
# you can specify whether or not to normalize, and to what level
plotOTU(mouseData,otu=9083,classIndex,norm=FALSE,main="9083 feature abundances")
plotRare

Plot of rarefaction effect

Description

This function plots the number of observed features vs. the depth of coverage.

Usage

plotRare(obj, cl = NULL, ...)

Arguments

obj
A MRexperiment object with count data or matrix.
cl
Vector of classes for various samples.
...
Additional plot arguments.

Value

Library size and number of detected features

See Also

plotOrd, plotMRheatmap, plotCorr, plotOTU, plotGenus

Examples

data(mouseData)
c1 = factor(pData(mouseData)[,3])
res = plotRare(mouseData,cl=c1,pch=21,bg=c1)
tmp=lapply(levels(cl), function(lv) lm(res[,"ident"]-res[,"libSize"]-1, subset=cl==lv))
for(i in 1:length(levels(cl))){
    abline(tmp[[i]], col=i)
}
legend("topleft", c("Diet 1","Diet 2"), text.col=c(1,2),box.col=NA)
plotTimeSeries

Plot difference function for particular bacteria

Description

Plot the difference in abundance for significant features.

Usage

plotTimeSeries(
  res,
  C = 0,
  xlab = "Time",
  ylab = "Difference in abundance",
  main = "SS difference function prediction",
  ...
)

Arguments

res Output of fitTimeSeries function
C Value for which difference function has to be larger or smaller than (default 0).
xlab X-label.
ylab Y-label.
main Main label.
... Extra plotting arguments.

Value

Plot of difference in abundance for significant features.

See Also

fitTimeSeries

Examples

data(mouseData)
res = fitTimeSeries(obj=mouseData,feature="Actinobacteria",
  class="status",id="mouseID",time="relativeTime",lvl='class',B=10)
plotTimeSeries(res)
posteriorProbs

**Description**

Accessing the posterior probabilities following a run through `fitZig`.

**Usage**

```r
posteriorProbs(obj)
```

**Arguments**

- `obj` a `MRexperiment` object.

**Value**

Matrix of posterior probabilities

**Author(s)**

Joseph N. Paulson

**Examples**

```r
# This is a simple demonstration
data(lungData)
k = grep("Extraction.Control", pData(lungData)$SampleType)
lungTrim = lungData[, -k]
k = which(rowSums(MRcounts(lungTrim) > 0) < 30)
lungTrim = cumNorm(lungTrim)
lungTrim = lungTrim[-k,]
smokingStatus = pData(lungTrim)$SmokingStatus
mod = model.matrix(~smokingStatus)
# The maxit is not meant to be 1 -- this is for demonstration/speed
settings = zigControl(maxit=1, verbose=FALSE)
fit = fitZig(obj = lungTrim, mod = mod, control = settings)
head(posteriorProbs(lungTrim))
```
returnAppropriateObj  
*Check if MRexperiment or matrix and return matrix*

**Description**

Function to check if object is a MRexperiment class or matrix

**Usage**

```r
returnAppropriateObj(obj, norm, log, sl = 1000)
```

**Arguments**

- `obj`: an MRexperiment or matrix object
- `norm`: return a normalized MRexperiment matrix
- `log`: return a log transformed MRexperiment matrix
- `sl`: scaling value

**Value**

Matrix

**Examples**

```r
data(lungData)
head(returnAppropriateObj(lungData, norm=FALSE, log=FALSE))
```

**ssFit**  
*smoothing-splines anova fit*

**Description**

Sets up a data-frame with the feature abundance, class information, time points, sample ids and returns the fitted values for the fitted model.

**Usage**

```r
ssFit(
  formula,
  abundance,
  class,
  time,
  id,
  include = c("class", "time:class"),
  pd,
  ...
)
```
ssIntervalCandidate

Arguments

- `formula`: Formula for ssanova. Of the form: abundance ~ ... where ... includes any pData slot value.
- `abundance`: Numeric vector of abundances.
- `class`: Class membership (factor of group membership).
- `time`: Time point vector of relative times (same length as abundance).
- `id`: Sample / patient id.
- `include`: Parameters to include in prediction.
- `pd`: Extra variable.
- `...`: Extra parameters for ssanova function (see ?ssanova).

Value

A list containing:

- `data`: Inputed data
- `fit`: The interpolated / fitted values for timePoints
- `se`: The standard error for CI intervals
- `timePoints`: The time points interpolated over

See Also

cumNorm fitTimeSeries ssPermAnalysis ssPerm ssIntervalCandidate

Examples

# Not run

ssIntervalCandidate calculate interesting time intervals

Description

Calculates time intervals of interest using SS-Anova fitted confidence intervals.

Usage

`ssIntervalCandidate(fit, standardError, timePoints, positive = TRUE, C = 0)`
ssPerm

Arguments

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fit</td>
<td>SS-Anova fits.</td>
</tr>
<tr>
<td>stderr</td>
<td>SS-Anova se estimates.</td>
</tr>
<tr>
<td>timePoints</td>
<td>Time points interpolated over.</td>
</tr>
<tr>
<td>positive</td>
<td>Positive region or negative region (difference in abundance is positive/negative).</td>
</tr>
<tr>
<td>C</td>
<td>Value for which difference function has to be larger or smaller than (default 0).</td>
</tr>
</tbody>
</table>

Value

Matrix of time point intervals of interest

See Also

cumNorm fitTimeSeries ssFit ssPerm ssPermAnalysis

Examples

# Not run

ssPerm

class permutations for smoothing-spline time series analysis

Description

Creates a list of permuted class memberships for the time series permutation tests.

Usage

ssPerm(df, B)

Arguments

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>Data frame containing class membership and sample/patient id label.</td>
</tr>
<tr>
<td>B</td>
<td>Number of permutations.</td>
</tr>
</tbody>
</table>

Value

A list of permuted class memberships

See Also

cumNorm fitTimeSeries ssFit ssPermAnalysis ssIntervalCandidate

Examples

# Not run
### Description

Calculates the fit for each permutation and estimates the area under the null (permuted) model for interesting time intervals of differential abundance.

### Usage

```r
ssPermAnalysis(
  data,  
  formula,  
  permList,  
  intTimes,  
  timePoints,  
  include = c("class", "time:class"),  
  ...  
)
```

### Arguments

- `data`  
  Data used in estimation.
- `formula`  
  Formula for ssanova. Of the form: abundance ~ ... where ... includes any pData slot value.
- `permList`  
  A list of permuted class memberships
- `intTimes`  
  Interesting time intervals.
- `timePoints`  
  Time points to interpolate over.
- `include`  
  Parameters to include in prediction.
- `...`  
  Options for ssanova

### Value

A matrix of permuted area estimates for time intervals of interest.

### See Also

- `cumNorm`
- `fitTimeSeries`
- `ssFit`
- `ssPerm`
- `ssIntervalCandidate`

### Examples

```r
# Not run
```
**trapz  Trapezoidal Integration**

**Description**

Compute the area of a function with values 'y' at the points 'x'. Function comes from the pracma package.

**Usage**

```r
trapz(x, y)
```

**Arguments**

- `x`: x-coordinates of points on the x-axis
- `y`: y-coordinates of function values

**Value**

Approximated integral of the function from 'min(x)' to 'max(x)'. Or a matrix of the same size as 'y'.

**Examples**

```r
# Calculate the area under the sine curve from 0 to pi:
set.seed(123)
N <- 101
x <- seq(0, pi, len = N)
y <- sin(x)
trapz(x, y)  #> 1.999835504

# Use a correction term at the boundary: -h^2/12*(f(b)-f(a))
h <- x[2] - x[1]
ca <- (y[2]-y[1]) / h
cb <- (y[N]-y[N-1]) / h
trapz(x, y) - h^2/12 * (cb - ca)  #> 1.999999969
```

---

**ts2MRexperiment**  
With a list of fitTimeSeries results, generate an MRexperiment that can be plotted with metaviz

**Description**

With a list of fitTimeSeries results, generate an MRexperiment that can be plotted with metavizr
Usage

ts2MReperiment(
  obj,
  sampleNames = NULL,
  sampleDescription = "timepoints",
  taxonomyLevels = NULL,
  taxonomyHierarchyRoot = "bacteria",
  taxonomyDescription = "taxonomy",
  featuresOfInterest = NULL,
  featureDataOfInterest = NULL
)

Arguments

obj Output of fitMultipleTimeSeries
sampleNames Sample names for plot
sampleDescription Description of samples for plot axis label
taxonomyLevels Feature names for plot
taxonomyHierarchyRoot Root of feature hierarchy for MReperiment
taxonomyDescription Description of features for plot axis label
featuresOfInterest The features to select from the fitMultipleTimeSeries output
featureDataOfInterest featureData for the resulting MReperiment

Value

MReperiment that contains fitTimeSeries data, featureData, and phenoData

See Also

fitTimeSeries fitMultipleTimeSeries

Examples

data(mouseData)
res = fitMultipleTimeSeries(obj=mouseData,lvl='phylum',class="status",
                           id="mouseID",time="relativeTime",B=1)
obj = ts2MReperiment(res)
obj
**uniqueFeatures**

*Table of features unique to a group*

**Description**

Creates a table of features, their index, number of positive samples in a group, and the number of reads in a group. Can threshold features by a minimum no. of reads or no. of samples.

**Usage**

```r
uniqueFeatures(obj, cl, nsamples = 0, nreads = 0)
```

**Arguments**

- `obj`: Either a MRexperiment object or matrix.
- `cl`: A vector representing assigning samples to a group.
- `nsamples`: The minimum number of positive samples.
- `nreads`: The minimum number of raw reads.

**Value**

Table of features unique to a group

**Examples**

```r
data(mouseData)
head(uniqueFeatures(mouseData[1:100,], cl=pData(mouseData)[,3]))
```

---

**wrenchNorm**

*Computes normalization factors using wrench instead of cumNorm*

**Description**

Calculates normalization factors using method published by M. Sentil Kumar et al. (2018) to compute normalization factors which considers compositional bias introduced by sequencers.

**Usage**

```r
wrenchNorm(obj, condition)
```

**Arguments**

- `obj`: an MRexperiment object
- `condition`: case control label that wrench uses to calculate normalization factors
zigControl

Value

an MRexperiment object with updated normalization factors. Accessible by `normFactors`.

See Also

cumNorm fitZig

Examples

data(mouseData)
mouseData <- wrenchNorm(mouseData, condition = mouseData$diet)
head(normFactors(mouseData))

---

**zigControl**

*Settings for the fitZig function*

Description

Settings for the fitZig function

Usage

```r
zigControl(
  tol = 1e-04,
  maxit = 10,
  verbose = TRUE,
  dfMethod = "modified",
  pvalMethod = "default"
)
```

Arguments

- `tol`  
The tolerance for the difference in negative log likelihood estimates for a feature to remain active.
- `maxit`  
The maximum number of iterations for the expectation-maximization algorithm.
- `verbose`  
Whether to display iterative step summary statistics or not.
- `dfMethod`  
Either 'default' or 'modified' (by responsibilities).
- `pvalMethod`  
Either 'default' or 'bootstrap'.

Value

The value for the tolerance, maximum no. of iterations, and the verbose warning.

Note

`fitZig` makes use of `zigControl`. 
See Also

fitZig  cumNorm  plotOTU

Examples

control = zigControl(tol=1e-10,maxit=10,verbose=FALSE)
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