Package ‘mia’

April 6, 2024

Type Package
Version 1.11.9
Title Microbiome analysis
Description mia implements tools for microbiome analysis based on the
    SummarizedExperiment, SingleCellExperiment and TreeSummarizedExperiment
    infrastructure. Data wrangling and analysis in the context of taxonomic data
    is the main scope. Additional functions for common task are implemented such
    as community indices calculation and summarization.
biocViews Microbiome, Software, DataImport
License Artistic-2.0 | file LICENSE
Encoding UTF-8
LazyData false
Depends R (>= 4.0), SummarizedExperiment, SingleCellExperiment,
    TreeSummarizedExperiment (>= 1.99.3), MultiAssayExperiment
Imports methods, stats, utils, MASS, ape, decontam, vegan,
    BiocGenerics, S4Vectors, IRanges, Biostrings, DECIPHER,
    BiocParallel, DelayedArray, DelayedMatrixStats, scuttle,
    scater, DirichletMultinomial, rlang, dplyr, tibble, tidyr,
    bluster, MatrixGenerics
Suggests testthat, knitr, patchwork, BiocStyle, yaml, phyloseq, dada2,
    stringr, biomformat, reldist, ade4, microbiomeDataSets,
    markdown
URL https://github.com/microbiome/mia
BugReports https://github.com/microbiome/mia/issues
Roxygen list(markdown = TRUE)
RoxygenNote 7.3.1
VignetteBuilder knitr
git_url https://git.bioconductor.org/packages/mia
git_branch devel
git_last_commit ecd661f
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mia-package

Package.

Description

mia implements tools for microbiome analysis based on the SummarizedExperiment, SingleCellExperiment and TreeSummarizedExperiment infrastructure. Data wrangling and analysis in the context of taxonomic data is the main scope. Additional functions for common task are implemented such as community indices calculation and summarization.

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agglomerate-methods

Agglomerate data using taxonomic information

Description

`agglomerateByRank` can be used to sum up data based on associations with certain taxonomic ranks, as defined in `rowData`. Only available `taxonomyRanks` can be used.

Usage

```r
agglomerateByRank(x, ...) 
mergeFeaturesByRank(x, ...) 
```

```r
## S4 method for signature 'SummarizedExperiment'
agglomerateByRank(
x, 
rank = taxonomyRanks(x)[1],
onRankOnly = FALSE, 
na.rm = FALSE, 
empty.fields = c(NA, "", "", "\t", "-", "_"), 
...
)
```

```r
## S4 method for signature 'SummarizedExperiment'
mergeFeaturesByRank(
x, 
rank = taxonomyRanks(x)[1],
onRankOnly = FALSE, 
na.rm = FALSE, 
empty.fields = c(NA, "", "", "\t", "-", "_"), 
...
)
```
## S4 method for signature 'SingleCellExperiment'
agglomerateByRank(x, ..., altexp = NULL, strip_altexp = TRUE)

## S4 method for signature 'SingleCellExperiment'
mergeFeaturesByRank(x, ..., altexp = NULL, strip_altexp = TRUE)

## S4 method for signature 'TreeSummarizedExperiment'
agglomerateByRank(
  x,
  ...,
  agglomerate.tree = agglomerateTree,
  agglomerateTree = FALSE
)

## S4 method for signature 'TreeSummarizedExperiment'
mergeFeaturesByRank(x, ..., agglomerate.tree = FALSE)

Arguments

x
  a SummarizedExperiment object

... arguments passed to agglomerateByRank function for SummarizedExperiment objects, mergeRows and sumCountsAcrossFeatures.
  - remove_empty_ranks: A single boolean value for selecting whether to remove those columns of rowData that include only NAs after agglomeration. (By default: remove_empty_ranks = FALSE)
  - make_unique: A single boolean value for selecting whether to make row-names unique. (By default: make_unique = TRUE)

rank
  a single character defining a taxonomic rank. Must be a value of taxonomyRanks() function.

onRankOnly
  TRUE or FALSE: Should information only from the specified rank be used or from ranks equal and above? See details. (default: onRankOnly = FALSE)

na.rm
  TRUE or FALSE: Should taxa with an empty rank be removed? Use it with caution, since empty entries on the selected rank will be dropped. This setting can be tweaked by defining empty.fields to your needs. (default: na.rm = TRUE)

empty.fields
  a character value defining, which values should be regarded as empty. (Default: c(NA, "\"", "\"t\")). They will be removed if na.rm = TRUE before agglomeration.

altexp
  String or integer scalar specifying an alternative experiment containing the input data.

strip_altexp
  TRUE or FALSE: Should alternative experiments be removed prior to agglomeration? This prevents to many nested alternative experiments by default (default: strip_altexp = TRUE)

agglomerate.tree
  TRUE or FALSE: should rowTree() also be agglomerated? (Default: agglomerate.tree = FALSE)
agglomerateTree

alias for agglomerate.tree.

Details

Depending on the available taxonomic data and its structure, setting onRankOnly = TRUE has certain implications on the interpretability of your results. If no loops exist (loops meaning two higher ranks containing the same lower rank), the results should be comparable. You can check for loops using detectLoop.

Agglomeration sums up the values of assays at the specified taxonomic level. With certain assays, e.g. those that include binary or negative values, this summing can produce meaningless values. In those cases, consider performing agglomeration first, and then applying the transformation afterwards.

Value

A taxonomically-agglomerated, optionally-pruned object of the same class as x.

See Also

mergeRows, sumCountsAcrossFeatures

Examples

data(GlobalPatterns)
# print the available taxonomic ranks
colnames(rowData(GlobalPatterns))
taxonomyRanks(GlobalPatterns)

# agglomerate at the Family taxonomic rank
x1 <- agglomerateByRank(GlobalPatterns, rank="Family")
## How many taxa before/after agglomeration?
nrow(GlobalPatterns)
nrow(x1)

# agglomerate the tree as well
x2 <- agglomerateByRank(GlobalPatterns, rank="Family", agglomerate.tree = TRUE)
nrow(x2) # same number of rows, but
rowTree(x1) # ... different
rowTree(x2) # ... tree

# If assay contains binary or negative values, summing might lead to meaningless 
# values, and you will get a warning. In these cases, you might want to do
# agglomeration again at chosen taxonomic level.
tse <- transformAssay(GlobalPatterns, method = "pa")
tse <- agglomerateByRank(tse, rank = "Genus")
tse <- transformAssay(tse, method = "pa")

# removing empty labels by setting na.rm = TRUE
sum(is.na(rowData(GlobalPatterns)$Family))
x3 <- agglomerateByRank(GlobalPatterns, rank="Family", na.rm = TRUE)
nrow(x3) # different from x2

# Because all the rownames are from the same rank, rownames do not include
# prefixes, in this case "Family:"
print(rownames(x3[1:3,]))

# To add them, use getTaxonomyLabels function.
rownames(x3) <- getTaxonomyLabels(x3, with_rank = TRUE)
print(rownames(x3[1:3,]))

# use 'remove_empty_ranks' to remove columns that include only NAs
x4 <- agglomerateByRank(GlobalPatterns, rank="Phylum", remove_empty_ranks = TRUE)
head(rowData(x4))

# If the assay contains NAs, you might want to consider replacing them,
# since summing-up NAs lead to NA
x5 <- GlobalPatterns
# Replace first value with NA
assay(x5)[1,1] <- NA
x6 <- agglomerateByRank(x5, "Kingdom")
head( assay(x6) )
# Replace NAs with 0. This is justified when we are summing-up counts.
assay(x5)[ is.na(assay(x5)) ] <- 0
x6 <- agglomerateByRank(x5, "Kingdom")
head( assay(x6) )

## Look at enterotype dataset...
data(enterotype)
## Print the available taxonomic ranks. Shows only 1 available rank,
## not useful for agglomerateByRank
taxonomyRanks(enterotype)

calculateDMN

Dirichlet-Multinomial Mixture Model: Machine Learning for Microbiome Data

Description

These functions are accessors for functions implemented in the DirichletMultinomial package

Usage

calculateDMN(x, ...)

## S4 method for signature 'ANY'
calculateDMN(x,
  k = 1,
  BPPARAM = SerialParam(),
  seed = runif(1, 0, .Machine$integer.max),
## S4 method for signature 'SummarizedExperiment'
calculateDMN(
  x,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  transposed = FALSE,
  ...
)

runDMN(x, name = "DMN", ...)

getDMN(x, name = "DMN", ...)

## S4 method for signature 'SummarizedExperiment'
getDMN(x, name = "DMN")

bestDMNFit(x, name = "DMN", type = c("laplace", "AIC", "BIC"), ...)

## S4 method for signature 'SummarizedExperiment'
bestDMNFit(x, name = "DMN", type = c("laplace", "AIC", "BIC"))

getBestDMNFit(x, name = "DMN", type = c("laplace", "AIC", "BIC"), ...)

## S4 method for signature 'SummarizedExperiment'
getBestDMNFit(x, name = "DMN", type = c("laplace", "AIC", "BIC"))

calculateDMNgroup(x, ...)

## S4 method for signature 'ANY'
calculateDMNgroup(
  x,
  variable,
  k = 1,
  seed = runif(1, 0, .Machine$integer.max),
  ...
)

## S4 method for signature 'SummarizedExperiment'
calculateDMNgroup(
  x,
  variable,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  ...
Arguments

- **x**: a numeric matrix with samples as rows or a `SummarizedExperiment` object.
- **k**: the number of Dirichlet components to fit. See `dmn`.
- **seed**: random number seed. See `dmn`.
- **assay.type**: a single character value for specifying which assay to use for calculation.
- **assay.name**: a single character value for specifying which assay to use for calculation.
- **exprs.values**: a single character value for specifying which assay to use for calculation.
- **transposed**: Logical scalar, is x transposed with samples in rows?
- **name**: the name to store the result in `metadata`.
- **type**: the type of measure used for the goodness of fit. One of 'laplace', 'AIC' or 'BIC'.
- **variable**: a variable from `colData` to use as a grouping variable. Must be a character of factor.
Value

calculateDMN and getDMN return a list of DMN objects, one element for each value of k provided.
bestDMNFit returns the index for the best fit and getBestDMNFit returns a single DMN object.
calculateDMNGroup returns a DMNGroup object
performDMNGroupCV returns a data.frame

See Also

DMN-class, DMNGroup-class, dmn, dmngroup, cvdmngroup, accessors for DMN objects

Examples

fl <- system.file(package="DirichletMultinomial", "extdata", "Twins.csv")
counts <- as.matrix(read.csv(fl, row.names=1))
fl <- system.file(package="DirichletMultinomial", "extdata", "TwinStudy.t")
pheno0 <- scan(fl)
lvls <- c("Lean", "Obese", "Overwt")
pheno <- factor(lvls[pheno0 + 1], levels=lvls)
colData <- DataFrame(pheno = pheno)

tse <- TreeSummarizedExperiment(assays = list(counts = counts),
colData = colData)

library(bluster)

# Compute DMM algorithm and store result in metadata
tse <- cluster(tse, name = "DMM", DmmParam(k = 1:3, type = "laplace"),
MARGIN = "samples", full = TRUE)

# Get the list of DMN objects
metadata(tse)$DMM$dmm

# Get and display which objects fits best
bestFit <- metadata(tse)$DMM$best
bestFit

# Get the model that generated the best fit
bestModel <- metadata(tse)$DMM$dmm[[bestFit]]
bestModel

# Get the sample-cluster assignment probability matrix
head(metadata(tse)$DMM$prob)

# Get the weight of each component for the best model
bestModel@mixture$Weight
calculateJSD  

**Calculate the Jensen-Shannon Divergence**

**Description**

This function calculates the Jensen-Shannon Divergence (JSD) in a `SummarizedExperiment` object.

**Usage**

```r
## S4 method for signature 'ANY'
calculateJSD(x, ...)

## S4 method for signature 'SummarizedExperiment'
calculateJSD(
  x,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  transposed = FALSE,
  ...
)

runJSD(x, BPPARAM = SerialParam(), chunkSize = nrow(x))
```

**Arguments**

- `x`: a numeric matrix or a `SummarizedExperiment`.
- `...`: optional arguments not used.
- `assay.type`: a single character value for specifying which assay to use for calculation.
- `assay_name`: a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)
- `exprs_values`: a single character value for specifying which assay to use for calculation. (Please use assay.type instead.)
- `transposed`: Logical scalar, is x transposed with cells in rows?
- `BPPARAM`: A `BiocParallelParam` object specifying whether the JSD calculation should be parallelized.
- `chunkSize`: an integer scalar, defining the size of data send to the individual worker. Only has an effect, if BPPARAM defines more than one worker. (default: chunkSize = nrow(x))

**Value**

a sample-by-sample distance matrix, suitable for NMDS, etc.
Author(s)
Susan Holmes <susan@stat.stanford.edu>. Adapted for phyloseq by Paul J. McMurdie. Adapted for mia by Felix G.M. Ernst

References
Jensen-Shannon Divergence and Hilbert space embedding. Bent Fuglede and Flemming Topsøe University of Copenhagen, Department of Mathematics http://www.math.ku.dk/~topsoe/ISIT2004JSD.pdf

See Also

Examples
```r
data(enterotype)
library(scater)

jsd <- calculateJSD(enterotype)
class(jsd)
head(jsd)

enterotype <- runMDS(enterotype, FUN = calculateJSD, name = "JSD",
                   exprs_values = "counts")
head(reducedDim(enterotype))
head(attr(reducedDim(enterotype),"eig"))
attr(reducedDim(enterotype),"GOF")
```

```
calculateOverlap

Description
This function calculates overlap for all sample-pairs in a SummarizedExperiment object.

Usage
```r
calculateOverlap(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  detection = 0,
  ...
)
```
calculateOverlap(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  detection = 0,
  ...
)

runOverlap(x, ...)

## S4 method for signature 'SummarizedExperiment'
runOverlap(x, name = "overlap", ...)

Arguments

- **x**: a `SummarizedExperiment` object containing a tree.
- **assay.type**: A single character value for selecting the assay to calculate the overlap.
- **assay_name**: a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)
- **detection**: A single numeric value for selecting detection threshold for absence/presence of features. Feature that has abundance under threshold in either of samples, will be discarded when evaluating overlap between samples.
- **...**: Optional arguments not used.
- **name**: A single character value specifying the name of overlap matrix that is stored in reducedDim(x).

Details

These function calculates overlap between all the sample-pairs. Overlap reflects similarity between sample-pairs.

When overlap is calculated using relative abundances, the higher the value the higher the similarity is. When using relative abundances, overlap value 1 means that all the abundances of features are equal between two samples, and 0 means that samples have completely different relative abundances.

Value

calculateOverlap returns sample-by-sample distance matrix. runOverlap returns x that includes overlap matrix in its reducedDim.

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

See Also

calculateJSD calculateUnifrac
Examples

data(esophagus)
tse <- esophagus
tse <- transformAssay(tse, method = "relabundance")
overlap <- calculateOverlap(tse, assay_name = "relabundance")
overlap

# Store result to reducedDim
tse <- runOverlap(tse, assay.type = "relabundance", name = "overlap_between_samples")
head(reducedDims(tse)$overlap_between_samples)

calculateUnifrac  Calculate weighted or unweighted (Fast) Unifrac distance

Description

This function calculates the (Fast) Unifrac distance for all sample-pairs in a TreeSummarizedExperiment object.

Usage

calculateUnifrac(x, tree, ...)

## S4 method for signature 'ANY,phylo'
calculateUnifrac(
  x,
  tree,
  weighted = FALSE,
  normalized = TRUE,
  BPPARAM = SerialParam(),
  ...
)

## S4 method for signature 'TreeSummarizedExperiment,missing'
calculateUnifrac(
  x,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  tree_name = "phylo",
  transposed = FALSE,
  ...
)

r runUnifrac(
  x,

calculateUnifrac

tree, weighted = FALSE, normalized = TRUE, nodeLab = NULL, BPPARAM = SerialParam(), ...
)

Arguments

x a numeric matrix or a TreeSummarizedExperiment object containing a tree. Please note that runUnifrac expects a matrix with samples per row and not per column. This is implemented to be compatible with other distance calculations such as dist as much as possible.

tree if x is a matrix, a phylo object matching the matrix. This means that the phylo object and the columns should relate to the same type of features (aka. microorganisms).

... optional arguments not used.

weighted TRUE or FALSE: Should use weighted-Unifrac calculation? Weighted-Unifrac takes into account the relative abundance of species/taxa shared between samples, whereas unweighted-Unifrac only considers presence/absence. Default is FALSE, meaning the unweighted-Unifrac distance is calculated for all pairs of samples.

normalized TRUE or FALSE: Should the output be normalized such that values range from 0 to 1 independent of branch length values? Default is TRUE. Note that (unweighted) Unifrac is always normalized by total branch-length, and so this value is ignored when weighted == FALSE.

BPPARAM A BiocParallelParam object specifying whether the Unifrac calculation should be parallelized.

assay.type a single character value for specifying which assay to use for calculation.

assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)

exprs_values a single character value for specifying which assay to use for calculation. (Please use assay.type instead.)

tree_name a single character value for specifying which tree will be used in calculation. (By default: tree_name = "phylo")

transposed Logical scalar, is x transposed with cells in rows, i.e., is Unifrac distance calculated based on rows (FALSE) or columns (TRUE). (By default: transposed = FALSE)

nodeLab if x is a matrix, a character vector specifying links between rows/columns and tips of tree. The length must equal the number of rows/columns of x. Furthermore, all the node labs must be present in tree.

Details

Please note that if calculateUnifrac is used as a FUN for runMDS, the argument ntop has to be set to nrow(x).
Value

A sample-by-sample distance matrix, suitable for NMDS, etc.

Author(s)

Paul J. McMurdie. Adapted for mia by Felix G.M. Ernst

References

http://bmf.colorado.edu/unifrac/

The main implementation (Fast Unifrac) is adapted from the algorithm’s description in:


See also additional descriptions of Unifrac in the following articles:


Lozupone, Hamady, Kelley and Knight, “Quantitative and qualitative (beta) diversity measures lead to different insights into factors that structure microbial communities.” Appl Environ Microbiol. 2007


Examples

```r
data(esophagus)
library(scater)
calculateUnifrac(esophagus, weighted = FALSE)
calculateUnifrac(esophagus, weighted = TRUE)
calculateUnifrac(esophagus, weighted = TRUE, normalized = FALSE)
# for using calculateUnifrac in conjunction with runMDS the tree argument
# has to be given separately. In addition, subsetting using ntop must
# be disabled
esophagus <- runMDS(esophagus, FUN = calculateUnifrac, name = "Unifrac",
                   tree = rowTree(esophagus),
                   exprs_values = "counts",
                   ntop = nrow(esophagus))
reducedDim(esophagus)
```

Description

This function returns a SummarizedExperiment with clustering information in its colData or row-Data.
Usage

```r
cluster(
  x,
  BLUSPARAM,
  assay.type = assay_name,
  assay_name = "counts",
  MARGIN = "features",
  full = FALSE,
  name = "clusters",
  clust.col = "clusters",
  ...
)
```

```r
## S4 method for signature 'SummarizedExperiment'
cluster(
  x,
  BLUSPARAM,
  assay.type = assay_name,
  assay_name = "counts",
  MARGIN = "features",
  full = FALSE,
  name = "clusters",
  clust.col = "clusters",
  ...
)
```

Arguments

- **x**: A `SummarizedExperiment` object.
- **BLUSPARAM**: A `BlusterParam` object specifying the algorithm to use.
- **assay.type**: a single character value for specifying which assay to use for calculation.
- **assay_name**: a single character value for specifying which assay to use for calculation. (Please use `assay.type` instead. At some point `assay_name` will be disabled.)
- **MARGIN**: A single character value for specifying whether the transformation is applied sample (column) or feature (row) wise. (By default: `MARGIN = "samples"`) 
- **full**: Logical scalar indicating whether the full clustering statistics should be returned for each method.
- **name**: the name to store the result in `metadata`
- **clust.col**: A single character value indicating the name of the `rowData` (or `colData`) where the data will be stored.
- **...**: Additional parameters to use altExps for example

Details

This is a wrapper for the `clusterRows` function from the `bluster` package. 
When setting `full = TRUE`, the clustering information will be stored in the metadata of the object. 
By default, clustering is done on the features.
Value

cluster returns an object of the same type as the x parameter with clustering information named clusters stored in colData or rowData.

Author(s)

Basil Courbayre

Examples

library(bluster)
data(GlobalPatterns, package = "mia")
tse <- GlobalPatterns

# Cluster on rows using Kmeans
tse <- cluster(tse, KmeansParam(centers = 3))

# Clustering done on the samples using Hclust
tse <- cluster(tse,
    MARGIN = "samples",
    HclustParam(metric = "bray", dist.fun = vegan::vegdist))

# Getting the clusters
colData(tse)$clusters

deprecate

These functions will be deprecated. Please use other functions instead.

Description

These functions will be deprecated. Please use other functions instead.

Usage

addTaxonomyTree(x, ...)

## S4 method for signature 'SummarizedExperiment'
addTaxonomyTree(x)
taxonomyTree(x, ...)
    
## S4 method for signature 'SummarizedExperiment'
taxonomyTree(x)

Arguments

x a SummarizedExperiment object-
... 

**dmn_se**

**Description**

dmn_se is a dataset on twins’ microbiome where samples are stratified by their community composition through Dirichlet Multinomial Mixtures (DMM). It was derived from the DirichletMultinomial package.

**Usage**

data(dmn_se)

**Format**

A SummarizedExperiment with 130 features and 278 samples. The rowData contains no taxonomic information. The colData includes:

- **pheno** participant’s weight condition (Lean, Overwt and Obese)

**Author(s)**

Turnbaugh, PJ et al.

**References**


**See Also**

mia-datasets calculateDMN

**enterotype**

**Description**

The enterotype data of the human gut microbiome includes taxonomic profiling for 280 fecal samples from 22 subjects based on shotgun DNA sequencing. The authors claimed that the data naturally clumps into three community-level clusters, or "enterotypes", that are not immediately explained by sequencing technology or demographic features of the subjects. In a later addendum from 2014 the authors stated that enterotypes should not be seen as discrete clusters, but as a way of stratifying samples to reduce complexity. It was converted into a TreeSummarizedExperiment from the phyloseq package.
Usage

data(enterotype)

Format

A TreeSummarizedExperiment with 553 features and 280 samples. The rowData contains taxonomic information at Genus level. The colData includes:

- **Enterotype** enterotype the sample belongs to (1, 2 and 3)
- **Sample_ID** sample ID of samples from all studies
- **SeqTech** sequencing technology
- **SampleID** sample ID of complete samples
- **Project** original project from which sample was obtained (gill06, turnbaugh09, MetaHIT, MicroObes, MicroAge and kurokawa07)
- **Nationality** participant’s nationality (american, danish, spanish, french, italian and japanese)
- **Gender** participant’s gender (F or M)
- **Age** participant’s age (0.25 – 87)
- **ClinicalStatus** participant’s clinical status (healthy, obese, CD, UC and elderly)

Author(s)

Arumugam, M., Raes, J., et al.

Source


References


See Also

mia-datasets
Description

This small dataset from a human esophageal community includes 3 samples from 3 human adults based on biopsies analysed with 16S rDNA PCR. The 16S rRNA sequence processing is provided in the mothur wiki from the link below. It was converted into a TreeSummarizedExperiment from the phyloseq package.

Usage

```r
data(esophagus)
```

Format

A TreeSummarizedExperiment with 58 features and 3 samples. The rowData contains no taxonomic information. The colData is empty.

Author(s)

Pei et al. <zhiheng.pei@med.nyu.edu>.

Source

http://www.mothur.org/wiki/Esophageal_community_analysis

References


See Also

mia-datasets
estimateDivergence  Estimate divergence

Description

Estimate divergence against a given reference sample.

Usage

```r
estimateDivergence(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  name = "divergence",
  reference = "median",
  FUN = vegan::vegdist,
  method = "bray",
  ...
)

## S4 method for signature 'SummarizedExperiment'

estimateDivergence(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  name = "divergence",
  reference = "median",
  FUN = vegan::vegdist,
  method = "bray",
  ...
)
```

Arguments

- `x`: a `SummarizedExperiment` object.
- `assay.type`: the name of the assay used for calculation of the sample-wise estimates.
- `assay_name`: a single character value for specifying which assay to use for calculation. (Please use `assay.type` instead. At some point `assay_name` will be disabled.)
- `name`: a name for the column of the colData the results should be stored in. By default, name is "divergence".
- `reference`: a numeric vector that has length equal to number of features, or a non-empty character value; either 'median' or 'mean'. reference specifies the reference that is used to calculate divergence. by default, reference is "median".
- `FUN`: a function for distance calculation. The function must expect the input matrix as its first argument. With rows as samples and columns as features. By default, `FUN` is `vegan::vegdist`. 
estimateDivergence

method

a method that is used to calculate the distance. Method is passed to the function that is specified by FUN. By default, method is “bray”.

... optional arguments

Details

Microbiota divergence (heterogeneity / spread) within a given sample set can be quantified by the average sample dissimilarity or beta diversity with respect to a given reference sample.

This measure is sensitive to sample size. Subsampling or bootstrapping can be applied to equalize sample sizes between comparisons.

Value

x with additional colData named *name*

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

See Also

plotColData

• estimateRichness
• estimateEvenness
• estimateDominance

Examples

data(GlobalPatterns)
tse <- GlobalPatterns

# By default, reference is median of all samples. The name of column where results # is “divergence” by default, but it can be specified.
tse <- estimateDivergence(tse)

# The method that are used to calculate distance in divergence and # reference can be specified. Here, euclidean distance and dist function from # stats package are used. Reference is the first sample.
tse <- estimateDivergence(tse, name = "divergence_first_sample", reference = assays(tse)$counts[,1],
FUN = stats::dist, method = "euclidean")

# Reference can also be median or mean of all samples.
# By default, divergence is calculated by using median. Here, mean is used.
tse <- estimateDivergence(tse, name = "divergence_average", reference = "mean")

# All three divergence results are stored in colData.
colData(tse)
estimateDiversity

Estimate (alpha) diversity measures

Description

Several functions for calculating (alpha) diversity indices, including the vegan package options and some others.

Usage

estimateDiversity(
  x,
  assay.type = "counts",
  assay.name = NULL,
  index = c("coverage", "fisher", "gini_simpson", "inverse_simpson",
             "log_modulo_skewness", "shannon"),
  name = index,
  ...
)

## S4 method for signature 'SummarizedExperiment'
estimateDiversity(
  x,
  assay.type = "counts",
  assay.name = NULL,
  index = c("coverage", "fisher", "gini_simpson", "inverse_simpson",
             "log_modulo_skewness", "shannon"),
  name = index,
  ...
, BPPARAM = SerialParam()
)

## S4 method for signature 'TreeSummarizedExperiment'
estimateDiversity(
  x,
  assay.type = "counts",
  assay.name = NULL,
  index = c("coverage", "faith", "fisher", "gini_simpson", "inverse_simpson",
             "log_modulo_skewness", "shannon"),
  name = index,
  tree.name = "phylo",
  ...
, BPPARAM = SerialParam()
)

estimateFaith(
  x,
estimateDiversity

tree = "missing",
assay.type = "counts",
assay_name = NULL,
name = "faith",
...
)

## S4 method for signature 'SummarizedExperiment,phylo'
estimateFaith(
  x,
  tree,
  assay.type = "counts",
  assay_name = NULL,
  name = "faith",
  node_lab = NULL,
  ...
)

## S4 method for signature 'TreeSummarizedExperiment,missing'
estimateFaith(
  x,
  assay.type = "counts",
  assay_name = NULL,
  name = "faith",
  tree_name = "phylo",
  ...
)

Arguments

x a SummarizedExperiment object or TreeSummarizedExperiment. The latter is recommended for microbiome data sets and tree-based alpha diversity indices.

assay.type the name of the assay used for calculation of the sample-wise estimates.

assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)

index a character vector, specifying the diversity measures to be calculated.

name a name for the column(s) of the colData the results should be stored in. By default this will use the original names of the calculated indices.

... optional arguments:

• threshold A numeric value in the unit interval, determining the threshold for coverage index. By default, threshold is 0.9.

• quantile Arithmetic abundance classes are evenly cut up to to this quantile of the data. The assumption is that abundances higher than this are not common, and they are classified in their own group. By default, quantile is 0.5.
num_of_classes The number of arithmetic abundance classes from zero to the quantile cutoff indicated by quantile. By default, num_of_classes is 50.

only.tips A boolean value specifying whether to remove internal nodes when Faith’s index is calculated. When only.tips=TRUE, those rows that are not tips of tree are removed. (By default: only.tips=FALSE)

BPPARAM A BiocParallelParam object specifying whether calculation of estimates should be parallelized.

tree_name a single character value for specifying which rowTree will be used to calculate faith index. (By default: tree_name = "phylo")

tree A phylogenetic tree that is used to calculate 'faith' index. If x is a TreeSummarizedExperiment, rowTree(x) is used by default.

node_lab NULL or a character vector specifying the links between rows and node labels of tree. If a certain row is not linked with the tree, missing instance should be noted as NA. When NULL, all the rownames should be found from the tree. (By default: node_lab = NULL)

Details


Alpha diversity is a joint quantity that combines elements or community richness and evenness. Diversity increases, in general, when species richness or evenness increase.

By default, this function returns all indices.

- ‘coverage’ Number of species needed to cover a given fraction of the ecosystem (50 percent by default). Tune this with the threshold argument.

- ‘faith’ Faith’s phylogenetic alpha diversity index measures how long the taxonomic distance is between taxa that are present in the sample. Larger values represent higher diversity. Using this index requires rowTree. (Faith 1992)

  If the data includes features that are not in tree’s tips but in internal nodes, there are two options. First, you can keep those features, and prune the tree to match features so that each tip can be found from the features. Other option is to remove all features that are not tips. (See only.tips parameter)

- ‘fisher’ Fisher’s alpha; as implemented in vegan::fisher.alpha. (Fisher et al. 1943)

- ‘gini_simpson’ Gini-Simpson diversity i.e. $1 - \lambda$, where $\lambda$ is the Simpson index, calculated as the sum of squared relative abundances. This corresponds to the diversity index ‘simpson’ in vegan::diversity. This is also called Gibbs–Martin, or Blau index in sociology, psychology and management studies. The Gini-Simpson index $(1-\lambda)$ should not be confused with Simpson’s dominance (\lambda), Gini index, or inverse Simpson index $(1/\lambda)$.

- ‘inverse_simpson’ Inverse Simpson diversity: $1/\lambda$ where $\lambda = \text{sum}(p^2)$ and p refers to relative abundances. This corresponds to the diversity index ‘invsimpson’ in vegan::diversity. Don’t confuse this with the closely related Gini-Simpson index
• ‘log_modulo_skewness’ The rarity index characterizes the concentration of species at low abundance. Here, we use the skewness of the frequency distribution of arithmetic abundance classes (see Magurran & McGill 2011). These are typically right-skewed; to avoid taking log of occasional negative skews, we follow Locey & Lennon (2016) and use the log-modulo transformation that adds a value of one to each measure of skewness to allow logarithmization.

• ‘shannon’ Shannon diversity (entropy).

Value

x with additional colData named *name*

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

References


See Also

plotColData

• estimateRichness

• estimateEvenness

• estimateDominance

• diversity

• estimateR
Examples

data(GlobalPatterns)
tse <- GlobalPatterns

# All index names as known by the function
index <- c("shannon", "gini_simpson", "inverse_simpson", "coverage", "fisher", "faith", "log_modulo_skewness")

# Corresponding polished names

# Calculate diversities
tse <- estimateDiversity(tse, index = index)

# The colData contains the indices with their code names by default
colData(tse)[, index]

# Removing indices
colData(tse)[, index] <- NULL

# 'threshold' can be used to determine threshold for 'coverage' index
# 'quantile' and 'num_of_classes' can be used when 'log_modulo_skewness' is calculated
# It is recommended to specify also the final names used in the output.
tse <- estimateDiversity(tse, index = "coverage", threshold = 0.75)

# Plotting the diversities - use the selected names
library(scater)
plotColData(tse, "Shannon")
# ... by sample type
plotColData(tse, "Shannon", "SampleType")
# Not run:
# combining different plots
library(patchwork)
plot_index <- c("Shannon", "GiniSimpson")
plots <- lapply(plot_index, plotColData,
estimateDominance

Estimate dominance measures

Description


Usage

estimateDominance(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  index = c("absolute", "dbp", "core_abundance", "gini", "dmn", "relative",
            "simpson_lambda"),
  ntaxa = 1,
  aggregate = TRUE,
  name = index,
  ...
)

## S4 method for signature 'SummarizedExperiment'

estimateDominance(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  index = c("absolute", "dbp", "core_abundance", "gini", "dmn", "relative",
            "simpson_lambda"),
  ntaxa = 1,
  aggregate = TRUE,
  name = index,
  ...
)

# End(Not run)
estimateDominance

Arguments

**x**
a `SummarizedExperiment` object

**assay.type**
A single character value for selecting the assay to calculate the sample-wise estimates.

**assay.name**
a single character value for specifying which assay to use for calculation. (Please use `assay.type` instead. At some point `assay.name` will be disabled.)

**index**
a character vector, specifying the indices to be calculated.

**ntaxa**
Optional and only used for the Absolute and Relative dominance indices: The n-th position of the dominant taxa to consider (default: `ntaxa = 1`). Disregarded for the indices “dbp”, “core_abundance”, “Gini”, “dmn”, and “Simpson”.

**aggregate**
Optional and only used for the Absolute, dbp, Relative, and dmn dominance indices: Aggregate the values for top members selected by `ntaxa` or not. If `TRUE`, then the sum of relative abundances is returned. Otherwise the relative abundance is returned for the single taxa with the indicated rank (default: `aggregate = TRUE`). Disregarded for the indices “core_abundance”, “gini”, “dmn”, and “simpson”.

**name**
A name for the column(s) of the colData where the calculated Dominance indices should be stored in.

**...**
additional arguments currently not used.

**BPPARAM**
A `BiocParallelParam` object specifying whether calculation of estimates should be parallelized. (Currently not used)

Details

A dominance index quantifies the dominance of one or few species in a community. Greater values indicate higher dominance.

Dominance indices are in general negatively correlated with alpha diversity indices (species richness, evenness, diversity, rarity). More dominant communities are less diverse.

`estimateDominance` calculates the following community dominance indices:

- **'absolute'** Absolute index equals to the absolute abundance of the most dominant n species of the sample (specify the number with the argument `ntaxa`). Index gives positive integer values.

- **'dbp'** Berger-Parker index (See Berger & Parker 1970) calculation is a special case of the 'relative' index. dbp is the relative abundance of the most abundant species of the sample. Index gives values in interval 0 to 1, where bigger value represent greater dominance.

\[ dbp = \frac{N_1}{N_{tot}} \]

where \( N_1 \) is the absolute abundance of the most dominant species and \( N_{tot} \) is the sum of absolute abundances of all species.

- **'core_abundance'** Core abundance index is related to core species. Core species are species that are most abundant in all samples, i.e., in whole data set. Core species are defined as those species that have prevalence over 50\% species must be prevalent in 50\% calculate the core abundance index. Core abundance index is sum of relative abundances of core species in the sample. Index gives values in interval 0 to 1, where bigger value represent greater dominance.
\[ core\text{abundance} = \frac{N_{\text{core}}}{N_{\text{tot}}} \]

where \( N_{\text{core}} \) is the sum of absolute abundance of the core species and \( N_{\text{tot}} \) is the sum of absolute abundances of all species.

- ‘gini’ Gini index is probably best-known from socio-economic contexts (Gini 1921). In economics, it is used to measure, for example, how unevenly income is distributed among population. Here, Gini index is used similarly, but income is replaced with abundance. If there is small group of species that represent large portion of total abundance of microbes, the inequality is large and Gini index closer to 1. If all species has equally large abundances, the equality is perfect and Gini index equals 0. This index should not be confused with Gini-Simpson index, which quantifies diversity.

- ‘dmn’ McNaughton’s index is the sum of relative abundances of the two most abundant species of the sample (McNaughton & Wolf, 1970). Index gives values in the unit interval:

\[ dmn = \frac{(N_1 + N_2)}{N_{\text{tot}}} \]

where \( N_1 \) and \( N_2 \) are the absolute abundances of the two most dominant species and \( N_{\text{tot}} \) is the sum of absolute abundances of all species.

- ‘relative’ Relative index equals to the relative abundance of the most dominant \( n \) species of the sample (specify the number with the argument \( n\text{taxa} \)). This index gives values in interval 0 to 1.

\[ \text{relative} = \frac{N_1}{N_{\text{tot}}} \]

where \( N_1 \) is the absolute abundance of the most dominant species and \( N_{\text{tot}} \) is the sum of absolute abundances of all species.

- ‘simpson\_lambda’ Simpson’s (dominance) index or Simpson’s lambda is the sum of squared relative abundances. This index gives values in the unit interval. This value equals the probability that two randomly chosen individuals belongs to the same species. The higher the probability, the greater the dominance (See e.g. Simpson 1949).

\[ \lambda = \sum (p^2) \]

where \( p \) refers to relative abundances.

There is also a more advanced Simpson dominance index (Simpson 1949). However, this is not provided and the simpler squared sum of relative abundances is used instead as the alternative index is not in the unit interval and it is highly correlated with the simpler variant implemented here.

Value

`x` with additional `colData` named `*name*`

Author(s)

Leo Lahti and Tuomas Borman. Contact: `microbiome.github.io`
References


See Also

- estimateRichness
- estimateEvenness
- estimateDiversity

Examples

data(esophagus)

# Calculates Simpson's lambda (can be used as a dominance index)
esophagus <- estimateDominance(esophagus, index=“simpson_lambda”)

# Shows all indices
colData(esophagus)

# Indices must be written correctly (e.g. dbp, not dbp), otherwise an error gets thrown
## Not run: esophagus <- estimateDominance(esophagus, index=“dbp”)
# Calculates dbp and Core Abundance indices
esophagus <- estimateDominance(esophagus, index=c(“dbp”, “core_abundance”))

# Shows all indices
colData(esophagus)

# Shows dbp index
colData(esophagus)$dbp

# Deletes dbp index
colData(esophagus)$dbp <- NULL

# Shows all indices, dbp is deleted
colData(esophagus)

# Deletes all indices
colData(esophagus) <- NULL

# Calculates all indices
esophagus <- estimateDominance(esophagus)

# Shows all indices
colData(esophagus)

# Deletes all indices
colData(esophagus) <- NULL

# Calculates all indices with explicitly specified names
esophagus <- estimateDominance(esophagus,
estimateEvenness

Estimate Evenness measures

Description

This function calculates community evenness indices. These include the ‘Camargo’, ‘Pielou’, ‘Simpson’, ‘Evar’ and ‘Bulla’ evenness measures. See details for more information and references.

Usage

```r
estimateEvenness(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  index = c("pielou", "camargo", "simpson_evenness", "evar", "bulla"),
  name = index,
  ...
)
```

## S4 method for signature 'SummarizedExperiment'

```r
estimateEvenness(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  index = c("camargo", "pielou", "simpson_evenness", "evar", "bulla"),
  name = index,
  ...
  BPPARAM = SerialParam()
)
```

Arguments

- `x`: a `SummarizedExperiment` object
- `assay.type`: A single character value for selecting the `assay` used for calculation of the sample-wise estimates.
- `assay_name`: a single character value for specifying which assay to use for calculation. (Please use `assay.type` instead. At some point `assay_name` will be disabled.)
- `index`: a character vector, specifying the evenness measures to be calculated.
name

a name for the column(s) of the colData the results should be stored in.

... optional arguments:

- threshold a numeric threshold. assay values below or equal to this threshold will be set to zero.

BPPARAM

A BiocParallelParam object specifying whether calculation of estimates should be parallelized.

Details

Evenness is a standard index in community ecology, and it quantifies how evenly the abundances of different species are distributed. The following evenness indices are provided:

By default, this function returns all indices.

The available evenness indices include the following (all in lowercase):

- 'camargo' Camargo’s evenness (Camargo 1992)
- 'simpson_evenness' Simpson’s evenness is calculated as inverse Simpson diversity \((1/\lambda)\) divided by observed species richness \(S\): \((1/\lambda)/S\).
- ‘pielou’ Pielou’s evenness (Pielou, 1966), also known as Shannon or Shannon-Weaver/Wiener/Weiner evenness; \(H/\ln(S)\). The Shannon-Weaver is the preferred term; see Spellerberg and Fedor (2003).
- ‘evar’ Smith and Wilson’s Evar index (Smith & Wilson 1996).
- ‘bulla’ Bulla’s index \((O)\) (Bulla 1994).

Desirable statistical evenness metrics avoid strong bias towards very large or very small abundances; are independent of richness; and range within the unit interval with increasing evenness (Smith & Wilson 1996). Evenness metrics that fulfill these criteria include at least camargo, simpson, smith-wilson, and bulla. Also see Magurran & McGill (2011) and Beisel et al. (2003) for further details.

Value

\(x\) with additional colData named \(*name*\)

References


**See Also**

- `plotColData`
- `estimateRichness`
- `estimateDominance`
- `estimateDiversity`

**Examples**

```r
data(esophagus)
tse <- esophagus

# Specify index and their output names
index <- c("pielou", "camargo", "simpson_evenness", "evar", "bulla")
name <- c("Pielou", "Camargo", "SimpsonEvenness", "Evar", "Bulla")

# Estimate evenness and give polished names to be used in the output
tse <- estimateEvenness(tse, index = index, name = name)

# Check the output
head(colData(tse))
```

---

**estimateRichness**  
*Estimate richness measures*

**Description**

Several functions for calculation of community richness indices available via wrapper functions. They are implemented via the vegan package.

**Usage**

```r
estimateRichness(
x,  
assay.type = assay_name,  
assay_name = "counts",  
index = c("ace", "chao1", "hill", "observed"),  
name = index,  
detection = 0,  
...,  
BPPARAM = SerialParam()
```
## S4 method for signature 'SummarizedExperiment'

```r
estimateRichness(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  index = c("ace", "chaol", "hill", "observed"),
  name = index,
  detection = 0,
  ...
  BPPARAM = SerialParam()
)
```

### Arguments

- **x**
  - a `SummarizedExperiment` object.

- **assay.type**
  - the name of the assay used for calculation of the sample-wise estimates.

- **assay_name**
  - a single character value for specifying which assay to use for calculation. (Please use `assay.type` instead. At some point `assay_name` will be disabled.)

- **index**
  - a character vector, specifying the richness measures to be calculated.

- **name**
  - a name for the column(s) of the colData the results should be stored in.

- **detection**
  - a numeric value for selecting detection threshold for the abundances. The default detection threshold is 0.

- **...**
  - additional parameters passed to `estimateRichness`

- **BPPARAM**
  - A `BiocParallelParam` object specifying whether calculation of estimates should be parallelized.

### Details

These include the ‘ace’, ‘Chao1’, ‘Hill’, and ‘Observed’ richness measures. See details for more information and references.

The richness is calculated per sample. This is a standard index in community ecology, and it provides an estimate of the number of unique species in the community. This is often not directly observed for the whole community but only for a limited sample from the community. This has led to alternative richness indices that provide different ways to estimate the species richness.

Richness index differs from the concept of species diversity or evenness in that it ignores species abundance, and focuses on the binary presence/absence values that indicate simply whether the species was detected.

The function takes all index names in full lowercase. The user can provide the desired spelling through the argument `name` (see examples).

The following richness indices are provided.

- **‘ace’**
  - Abundance-based coverage estimator (ACE) is another nonparametric richness index that uses sample coverage, defined based on the sum of the probabilities of the observed species. This method divides the species into abundant (more than 10 reads or observations)
and rare groups in a sample and tends to underestimate the real number of species. The ACE index ignores the abundance information for the abundant species, based on the assumption that the abundant species are observed regardless of their exact abundance. We use here the bias-corrected version (O’Hara 2005, Chiu et al. 2014) implemented in estimateR. For an exact formulation, see estimateR. Note that this index comes with an additional column with standard error information.

• ‘chao1’ This is a nonparametric estimator of species richness. It assumes that rare species carry information about the (unknown) number of unobserved species. We use here the bias-corrected version (O’Hara 2005, Chiu et al. 2014) implemented in estimateR. This index implicitly assumes that every taxa has equal probability of being observed. Note that it gives a lower bound to species richness. The bias-corrected for an exact formulation, see estimateR. This estimator uses only the singleton and doubleton counts, and hence it gives more weight to the low abundance species. Note that this index comes with an additional column with standard error information.

• ‘hill’ Effective species richness aka Hill index (see e.g. Chao et al. 2016). Currently only the case 1D is implemented. This corresponds to the exponent of Shannon diversity. Intuitively, the effective richness indicates the number of species whose even distribution would lead to the same diversity as the observed community, where the species abundances are unevenly distributed.

• ‘observed’ The observed richness gives the number of species that is detected above a given detection threshold in the observed sample (default 0). This is conceptually the simplest richness index. The corresponding index in the vegan package is "richness".

Value

x with additional colData named *name*

Author(s)

Leo Lahti. Contact: microbiome.github.io

References


See Also

plotColData

• estimateR
**Examples**

```r
data(esophagus)

# Calculates all richness indices by default
esophagus <- estimateRichness(esophagus)

# Shows all indices
colData(esophagus)

# Shows Hill index
colData(esophagus)$hill

# Deletes hill index
colData(esophagus)$hill <- NULL

# Shows all indices, hill is deleted
colData(esophagus)

# Delete the remaining indices
colData(esophagus)[, c("observed", "chao1", "ace")]<- NULL

# Calculates observed richness index and saves them with specific names
esophagus <- estimateRichness(esophagus,
   index = c("observed", "chao1", "ace", "hill"),
   name = c("Observed", "Chao1", "ACE", "Hill"))

# Show the new indices
colData(esophagus)

# Deletes all colData (including the indices)
colData(esophagus) <- NULL

# Calculate observed richness excluding singletons (detection limit 1)
esophagus <- estimateRichness(esophagus, index="observed", detection = 1)

# Deletes all colData (including the indices)
colData(esophagus) <- NULL

# Indices must be written correctly (all lowercase), otherwise an error
# gets thrown
## Not run: esophagus <- estimateRichness(esophagus, index="ace")

# Calculates Chao1 and ACE indices only
esophagus <- estimateRichness(esophagus, index=c("chao1", "ace"),
   name=c("Chao1", "ACE"))

# Deletes all colData (including the indices)
colData(esophagus) <- NULL

# Names of columns can be chosen arbitrarily, but the length of arguments
# must match.
esophagus <- estimateRichness(esophagus,
```

getExperimentCrossAssociation

index = c("ace", "chao1"),
name = c("index1", "index2"))

# Shows all indices
colData(esophagus)

getExperimentCrossAssociation

Calculate correlations between features of two experiments.

Description

Calculate correlations between features of two experiments.

Usage

getExperimentCrossAssociation(x, ...)

## S4 method for signature 'MultiAssayExperiment'
getExperimentCrossAssociation(
x,
experiment1 = 1,
experiment2 = 2,
assay.type1 = assay_name1,
assay_name1 = "counts",
assay.type2 = assay_name2,
assay_name2 = "counts",
altexp1 = NULL,
altexp2 = NULL,
colData_variable1 = NULL,
colData_variable2 = NULL,
MARGIN = 1,
method = c("kendall", "spearman", "categorical", "pearson"),
mode = "table",
p_adj_method = c("fdr", "BH", "bonferroni", "BY", "hochberg", "holm", "hommel", "none"),
p_adj_threshold = NULL,
cor_threshold = NULL,
sort = FALSE,
filter_self_correlations = FALSE,
verbose = TRUE,
test_significance = FALSE,
show_warnings = TRUE,
paired = FALSE,
...)

## S4 method for signature 'SummarizedExperiment'
getExperimentCrossAssociation(x, experiment2 = x, ...)

testExperimentCrossAssociation(x, ...)

## S4 method for signature 'ANY'
testExperimentCrossAssociation(x, ...)

testExperimentCrossCorrelation(x, ...)

## S4 method for signature 'ANY'
testExperimentCrossCorrelation(x, ...)

getExperimentCrossCorrelation(x, ...)

## S4 method for signature 'ANY'
getExperimentCrossCorrelation(x, ...)

Arguments

x 
A MultiAssayExperiment or SummarizedExperiment object.

... 
Additional arguments:

• symmetric A single boolean value for specifying if measure is symmetric or not. When symmetric = TRUE, associations are calculated only for unique variable-pairs, and they are assigned to corresponding variable-pair. This decreases the number of calculations in 2-fold meaning faster execution. (By default: symmetric = FALSE)

• association_FUN A function that is used to calculate (dis-)similarity between features. Function must take matrix as an input and give numeric values as an output. Adjust method and other parameters correspondingly. Supported functions are, for example, stats::dist and vegan::vegdist.

experiment1 A single character or numeric value for selecting the experiment 1 from experiments(x) of MultiassayExperiment object. (By default: experiment1 = 1)

experiment2 A single character or numeric value for selecting the experiment 2 from experiments(x) of MultiAssayExperiment object or altExp(x) of TreeSummarizedExperiment object. Alternatively, experiment2 can also be TreeSE object when x is TreeSE object. (By default: experiment2 = 2 when x is MAE and experiment2 = x when x is TreeSE)

assay.type1 A single character value for selecting the assay of experiment 1 to be transformed. (By default: assay.type1 = "counts")

assay_name1 A single character value for specifying which assay of experiment 1 to use for calculation. (Please use assay.type1 instead. At some point assay_name1 will be disabled.)

assay.type2 A single character value for selecting the assay of experiment 2 to be transformed. (By default: assay.type2 = "counts")

assay_name2 A single character value for specifying which assay of experiment 2 to use for calculation. (Please use assay.type2 instead. At some point assay_name2 will be disabled.)
getExperimentCrossAssociation

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<th>Parameter</th>
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<tbody>
<tr>
<td>altexp1</td>
<td>A single numeric or character value specifying alternative experiment from the altExp of experiment 1. If NULL, then the experiment is itself and altExp option is disabled. (By default: altexp1 = NULL)</td>
</tr>
<tr>
<td>altexp2</td>
<td>A single numeric or character value specifying alternative experiment from the altExp of experiment 2. If NULL, then the experiment is itself and altExp option is disabled. (By default: altexp2 = NULL)</td>
</tr>
<tr>
<td>colData_variable1</td>
<td>A character value specifying column(s) from colData of experiment 1. If colData_variable1 is used, assay.type1 is disabled. (By default: colData_variable1 = NULL)</td>
</tr>
<tr>
<td>colData_variable2</td>
<td>A character value specifying column(s) from colData of experiment 2. If colData_variable2 is used, assay.type2 is disabled. (By default: colData_variable2 = NULL)</td>
</tr>
<tr>
<td>MARGIN</td>
<td>A single numeric value for selecting if association are calculated row-wise / for features (1) or column-wise / for samples (2). Must be 1 or 2. (By default: MARGIN = 1)</td>
</tr>
<tr>
<td>method</td>
<td>A single character value for selecting association method ('kendall', 'pearson', or 'spearman' for continuous/numeric; 'categorical' for discrete) (By default: method = &quot;kendall&quot;)</td>
</tr>
<tr>
<td>mode</td>
<td>A single character value for selecting output format Available formats are 'table' and 'matrix'. (By default: mode = &quot;table&quot;)</td>
</tr>
<tr>
<td>p_adj_method</td>
<td>A single character value for selecting adjustment method of p-values. Passed to p.adjust function. (By default: p_adj_method = &quot;fdr&quot;)</td>
</tr>
<tr>
<td>p_adj_threshold</td>
<td>A single numeric value (from 0 to 1) for selecting adjusted p-value threshold for filtering. (By default: p_adj_threshold = NULL)</td>
</tr>
<tr>
<td>cor_threshold</td>
<td>A single numeric absolute value (from 0 to 1) for selecting correlation threshold for filtering. (By default: cor_threshold = NULL)</td>
</tr>
<tr>
<td>sort</td>
<td>A single boolean value for selecting whether to sort features or not in result matrices. Used method is hierarchical clustering. (By default: sort = FALSE)</td>
</tr>
<tr>
<td>filter_self_correlations</td>
<td>A single boolean value for selecting whether to filter out correlations between identical items. Applies only when correlation between experiment itself is tested, i.e., when assays are identical. (By default: filter_self_correlations = FALSE)</td>
</tr>
<tr>
<td>verbose</td>
<td>A single boolean value for selecting whether to get messages about progress of calculation.</td>
</tr>
<tr>
<td>test_significance</td>
<td>A single boolean value for selecting whether to test statistical significance of associations.</td>
</tr>
<tr>
<td>show_warnings</td>
<td>A single boolean value for selecting whether to show warnings that might occur when correlations and p-values are calculated.</td>
</tr>
<tr>
<td>paired</td>
<td>A single boolean value for specifying if samples are paired or not. colnames must match between two experiments. paired is disabled when MARGIN = 1. (By default: paired = FALSE)</td>
</tr>
</tbody>
</table>
Details

These functions calculate associations between features of two experiments. `getExperimentCrossAssociation` calculates only associations by default. `testExperimentCrossAssociation` calculates also significance of associations.

We recommend the non-parametric Kendall's tau as the default method for association analysis. Kendall's tau has desirable statistical properties and robustness at lower sample sizes. Spearman rank correlation can provide faster solutions when running times are critical.

Value

These functions return associations in table or matrix format. In table format, returned value is a data frame that includes features and associations (and p-values) in columns. In matrix format, returned value is a one matrix when only associations are calculated. If also significances are tested, then returned value is a list of matrices.

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

Examples

data(HintikkaXOData)
mae <- HintikkaXOData

# Subset so that less observations / quicker to run, just for example
mae[[1]] <- mae[[1]][1:20, 1:10]
mae[[2]] <- mae[[2]][1:20, 1:10]

# Several rows in the counts assay have a standard deviation of zero
# Remove them, since they do not add useful information about cross-association
mae[[1]] <- mae[[1]][rowSds(assay(mae[[1]])) > 0, ]

# Transform data
mae[[1]] <- transformAssay(mae[[1]], method = "rclr")

# Calculate cross-correlations
result <- getExperimentCrossAssociation(mae, method = "pearson", assay.type2 = "nmr")

# Show first 5 entries
head(result, 5)

# Use altExp option to specify alternative experiment from the experiment
altExp(mae[[1]], "Phylum") <- agglomerateByRank(mae[[1]], rank = "Phylum")

# Transform data
altExp(mae[[1]], "Phylum") <- transformAssay(altExp(mae[[1]], "Phylum"), method = "relabundance")

# When mode = "matrix", the return value is a matrix
result <- getExperimentCrossAssociation(mae, experiment2 = 2, assay.type1 = "relabundance", assay.type2 = "nmr", altexp1 = "Phylum", method = "pearson", mode = "matrix")

# Show first 5 entries
head(result, 5)

# testExperimentCorrelation additionally returns significances
getExperimentCrossAssociation

# filter_self_correlations = TRUE filters self correlations
# p_adj_threshold can be used to filter those features that do not
# have any correlations whose p-value is lower than the threshold
result <- testExperimentCrossAssociation(mae[[1]], experiment2 = mae[[1]], method = "pearson",
                         filter_self_correlations = TRUE,
                         p_adj_threshold = 0.05)

# Show first 5 entries
head(result, 5)

# getExperimentCrossAssociation also returns significances when
# test_significance = TRUE
# Warnings can be suppressed by using show_warnings = FALSE
result <- getExperimentCrossAssociation(mae[[1]], experiment2 = mae[[2]], method = "pearson",
                         assay.type2 = "nmr",
                         mode = "matrix", test_significance = TRUE,
                         show_warnings = FALSE)

# Returned value is a list of matrices
names(result)

# Calculate Bray-Curtis dissimilarity between samples. If dataset includes
# paired samples, you can use paired = TRUE.
result <- getExperimentCrossAssociation(mae[[1]], mae[[1]], MARGIN = 2, paired = FALSE,
                         association_FUN = vegan::vegdist, method = "bray")

# If experiments are equal and measure is symmetric (e.g., taxa1 vs taxa2 == taxa2 vs taxa1),
# it is possible to speed-up calculations by calculating association only for unique
# other half of variable-pairs. Use "symmetric" to choose whether to measure association for only
result <- getExperimentCrossAssociation(mae, experiment1 = "microbiota", experiment2 = "microbiota",
                         assay.type1 = "counts", assay.type2 = "counts",
                         symmetric = TRUE)

# For big data sets, the calculations might take a long time.
# To speed them up, you can take a random sample from the data.
# When dealing with complex biological problems, random samples can be
# enough to describe the data. Here, our random sample is 30 % of whole data.
sample_size <- 0.3
tse <- mae[[1]]
tse_sub <- tse[ sample( seq_len( nrow(tse) ), sample_size * nrow(tse) ), ]
result <- testExperimentCrossAssociation(tse_sub)

# It is also possible to choose variables from colData and calculate association
# between assay and sample metadata or between variables of sample metadata
mae[[1]] <- estimateDiversity(mae[[1]])
# colData_variable works similarly to assay.type. Instead of fetching an assay
# named assay.type from assay slot, it fetches a column named colData_variable
# from colData.
result <- getExperimentCrossAssociation(mae[[1]], assay.type1 = "counts",
                         colData_variable2 = c("shannon", "coverage"))
getPrevalence  Calculation prevalence information for features across samples

Description

These functions calculate the population prevalence for taxonomic ranks in a `SummarizedExperiment-class` object.

Usage

```r
getPrevalence(x, ...)

## S4 method for signature 'ANY'
getPrevalence(
  x,
  detection = 0,
  include_lowest = FALSE,
  sort = FALSE,
  na.rm = TRUE,
  ...
)

## S4 method for signature 'SummarizedExperiment'
getPrevalence(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  as.relative = FALSE,
  rank = NULL,
  ...
)

getPrevalentFeatures(x, ...)

## S4 method for signature 'ANY'
getPrevalentFeatures(x, prevalence = 50/100, include_lowest = FALSE, ...)

## S4 method for signature 'SummarizedExperiment'
getPrevalentFeatures(
  x,
  rank = NULL,
  prevalence = 50/100,
  include_lowest = FALSE,
  ...
)

getPrevalentTaxa(x, ...)
```
getPrevalence

## S4 method for signature 'ANY'
getPrevalentTaxa(x, ...)

getRareFeatures(x, ...)

## S4 method for signature 'ANY'
getRareFeatures(x, prevalence = 50/100, include_lowest = FALSE, ...)

## S4 method for signature 'SummarizedExperiment'
getRareFeatures(
  x,
  rank = NULL,
  prevalence = 50/100,
  include_lowest = FALSE,
  ...
)

generateTaxa(x, ...)

## S4 method for signature 'ANY'
generateTaxa(x, ...)

subsetByPrevalentFeatures(x, ...)

## S4 method for signature 'SummarizedExperiment'
subsetByPrevalentFeatures(x, rank = NULL, ...)

subsetByPrevalentTaxa(x, ...)

## S4 method for signature 'ANY'
subsetByPrevalentTaxa(x, ...)

subsetByRareFeatures(x, ...)

## S4 method for signature 'SummarizedExperiment'
subsetByRareFeatures(x, rank = NULL, ...)

subsetByRareTaxa(x, ...)

## S4 method for signature 'ANY'
subsetByRareTaxa(x, ...)

getPrevalentAbundance(
  x,
  assay.type = assay_name,
  assay_name = "relabundance",
  ...
### S4 method for signature 'ANY'

getPrevalentAbundance(
  x,
  assay.type = assay_name,
  assay_name = "relabundance",
  ...
)

### S4 method for signature 'SummarizedExperiment'

getPrevalentAbundance(x, assay.type = assay_name, assay_name = "counts", ...)

agglomerateByPrevalence(x, ...)

mergeFeaturesByPrevalence(x, ...)

### S4 method for signature 'SummarizedExperiment'

agglomerateByPrevalence(
  x,
  rank = taxonomyRanks(x)[1L],
  other_label = "Other",
  ...
)

### S4 method for signature 'SummarizedExperiment'

mergeFeaturesByPrevalence(
  x,
  rank = taxonomyRanks(x)[1L],
  other_label = "Other",
  ...
)

#### Arguments

- x 
  - a `SummarizedExperiment` object
  - additional arguments
    - If `!is.null(rank)` arguments are passed on to `agglomerateByRank`. See `?agglomerateByRank` for more details. Note that you can specify whether to remove empty ranks with `agg.na.rm` instead of `na.rm`. (default: `FALSE`)
    - for `getPrevalentFeatures`, `getRareFeatures`, `subsetByPrevalentFeatures` and `subsetByRareFeatures` additional parameters passed to `getPrevalence`
    - for `getPrevalentAbundance` additional parameters passed to `getPrevalence`
  - detection
    - Detection threshold for absence/presence. Either an absolute value compared directly to the values of x or a relative value between 0 and 1, if `as_relative = FALSE`.
  - include_lowest
    - logical scalar: Should the lower boundary of the detection and prevalence cutoffs be included? (default: `FALSE`)
getPrevalence

sort logical scalar: Should the result be sorted by prevalence? (default: FALSE)

na.rm logical scalar: Should NA values be omitted when calculating prevalence? (default: na.rm = TRUE)

assay.type A single character value for selecting the assay to use for prevalence calculation.

assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)

as_relative logical scalar: Should the detection threshold be applied on compositional (relative) abundances? (default: FALSE)

rank a single character defining a taxonomic rank. Must be a value of taxonomyRanks() function.

prevalence Prevalence threshold (in 0 to 1). The required prevalence is strictly greater by default. To include the limit, set include_lowest to TRUE.

other_label A single character valued used as the label for the summary of non-prevalent taxa. (default: other_label = "Other")

Details

getPrevalence calculates the relative frequency of samples that exceed the detection threshold. For SummarizedExperiment objects, the prevalence is calculated for the selected taxonomic rank, otherwise for the rows. The absolute population prevalence can be obtained by multiplying the prevalence by the number of samples (ncol(x)). If as_relative = FALSE the relative frequency (between 0 and 1) is used to check against the detection threshold.

The core abundance index from getPrevalentAbundance gives the relative proportion of the core species (in between 0 and 1). The core taxa are defined as those that exceed the given population prevalence threshold at the given detection level as set for getPrevalentFeatures.

subsetPrevalentFeatures and subsetRareFeatures return a subset of x. The subset includes the most prevalent or rare taxa that are calculated with getPrevalentFeatures or getRareFeatures respectively.

getPrevalentFeatures returns taxa that are more prevalent with the given detection threshold for the selected taxonomic rank.

getRareFeatures returns complement of getPrevalentTaxa.

Value

subsetPrevalentFeatures and subsetRareFeatures return subset of x.

All other functions return a named vectors:

- getPrevalence returns a numeric vector with the names being set to either the row names of x or the names after agglomeration.
- getPrevalentAbundance returns a numeric vector with the names corresponding to the column name of x and include the joint abundance of prevalent taxa.
- getPrevalentTaxa and getRareFeatures return a character vector with only the names exceeding the threshold set by prevalence, if the rownames of x is set. Otherwise an integer vector is returned matching the rows in x.
Author(s)
Leo Lahti For getPrevalentAbundance: Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

References
A Salonen et al. The adult intestinal core microbiota is determined by analysis depth and health status. Clinical Microbiology and Infection 18(S4):16 20, 2012. To cite the R package, see citation('mia')

See Also
agglomerateByRank, getTopTaxa

Examples
```r
data(GlobalPatterns)
tse <- GlobalPatterns
# Get prevalence estimates for individual ASV/OTU
prevalence.frequency <- getPrevalence(tse,
  detection = 0,
  sort = TRUE,
  as_relative = TRUE)
head(prevalence.frequency)

# Get prevalence estimates for phylums
# - the getPrevalence function itself always returns population frequencies
prevalence.frequency <- getPrevalence(tse,
  rank = "Phylum",
  detection = 0,
  sort = TRUE,
  as_relative = TRUE)
head(prevalence.frequency)

# - to obtain population counts, multiply frequencies with the sample size,
# which answers the question "In how many samples is this phylum detectable"
prevalence.count <- prevalence.frequency * ncol(tse)
head(prevalence.count)

# Detection threshold 1 (strictly greater by default);
# Note that the data (GlobalPatterns) is here in absolute counts
# (and not compositional, relative abundances)
# Prevalence threshold 50 percent (strictly greater by default)
prevalent <- getPrevalentFeatures(tse,
  rank = "Phylum",
  detection = 10,
  prevalence = 50/100,
  as_relative = FALSE)
head(prevalent)

# Gets a subset of object that includes prevalent taxa
altExp(tse, "prevalent") <- subsetByPrevalentFeatures(tse,
```

getPrevalence
GlobalPatterns compared the microbial communities from 25 environmental samples and three known "mock communities" at an average depth of 3.1 million reads per sample. Authors reproduced diversity patterns seen in many other published studies, while investigating technical bias by applying the same techniques to simulated microbial communities of known composition. Special thanks are given to J. Gregory Caporaso for providing the OTU-clustered data files for inclusion in the `phylodex` package, from which this data was converted to `TreeSummarizedExperiment`.

**Usage**

```r
data(GlobalPatterns)
```
Format

A `TreeSummarizedExperiment` with 19216 features and 26 samples. The rowData contains taxonomic information at Kingdom, Phylum, Class, Order, Family, Genus and Species levels. The colData includes:

- **X.SampleID** Sample ID taken from the corresponding study
- **Primer** primer used for sequencing
- **FinalBarcode** final barcode (6 nucleotides)
- **Barcode_truncated_plus_T** truncated barcode with an added tyrosine (6 nucleotides)
- **Barcode_full_length** complete barcode with a length of 11 nucleotides
- **SampleType** sampling type by collection site (Soil, Feces, Skin, Tongue, Freshwater, Creek Freshwater, Ocean, Estuary Sediment and Mock)
- **Description** additional information (sampling location, environmental factors and study type)

Author(s)

Caporaso, J. G., et al.

References


See Also

- mia-datasets

---

hierarchy-tree  
*Calculate hierarchy tree*

Description

These functions generate a hierarchy tree using taxonomic information from a `SummarizedExperiment` object and add this hierarchy tree into the rowTree.

Usage

```r
getHierarchyTree(x, ...)
```

```r
## S4 method for signature 'SummarizedExperiment'
getHierarchyTree(x)
```

```r
addHierarchyTree(x, ...)
```

```r
## S4 method for signature 'SummarizedExperiment'
addHierarchyTree(x)
```
Arguments

x a `SummarizedExperiment` object

Details

addHierarchyTree calculates hierarchy tree from the available taxonomic information and add it to rowTree.

getHierarchyTree generates a hierarchy tree from the available taxonomic information. Internally it uses `toTree` and `resolveLoop` to sanitize data if needed.

Value

- addHierarchyTree: a `TreeSummarizedExperiment` whose phylo tree represents the hierarchy among available taxonomy information
- getHierarchyTree: a phylo tree representing the hierarchy among available taxonomy information.

Examples

```r
# Generating a hierarchy tree based on available taxonomic information.
data(GlobalPatterns)
tse <- GlobalPatterns
getHierarchyTree(tse)

# Adding a hierarchy tree based on the available taxonomic information.
# Please note that any tree already stored in rowTree() will be overwritten.
tse <- addHierarchyTree(tse)
tse
```

Description

`HintikkaXOData` is a multiomics dataset from a rat experiment studying effect of fat and prebiotics in diet. It contains high-throughput profiling data from 40 rat samples, including 39 biomarkers, 38 metabolites (NMR), and 12706 OTUs from 318 species, measured from Cecum. This is diet comparison study with High/Low fat diet and xylo-oligosaccharide supplementation. Column metadata is common for all experiments (microbiota, metabolites, biomarkers) and is described below.

Usage

data(HintikkaXOData)
Format
A MultiAssayExperiment with 3 experiments (microbiota, metabolites and biomarkers). rowData of the microbiota experiment contains taxonomic information at Phylum, Class, Order, Family, Genus, Species and OTU levels. The metabolites and biomarkers experiments contain 38 NMR metabolites and 39 biomarkers, respectively. The colData includes:

Sample  Sample ID (character)
Rat  Rat ID (factor)
Site  Site of measurement ("Cecum"); single value
Diet  Diet group (factor; combination of the Fat and XOS fields)
Fat  Fat in Diet (factor; Low/High)
XOS  XOS Diet Supplement (numeric; 0/1)

Author(s)
Hintikka L et al.

References

See Also
mia-datasets

isContaminant  decontam functions

Description
The decontam functions isContaminant and isNotContaminant are made available for SummarizedExperiment objects.

Usage
```r
## S4 method for signature 'SummarizedExperiment'
isContaminant(
  seqtab,
  assay.type = assay_name,
  assay_name = "counts",
  name = "isContaminant",
  concentration = NULL,
  control = NULL,
)```
isContaminant

batch = NULL,
threshold = 0.1,
normalize = TRUE,
detailed = TRUE,
...
)

## S4 method for signature 'SummarizedExperiment'
isNotContaminant(
  seqtab,
  assay.type = assay_name,
  assay_name = "counts",
  name = "isNotContaminant",
  control = NULL,
  threshold = 0.5,
  normalize = TRUE,
  detailed = FALSE,
  ...
)

addContaminantQC(x, name = "isContaminant", ...)

## S4 method for signature 'SummarizedExperiment'
addContaminantQC(x, name = "isContaminant", ...)

addNotContaminantQC(x, name = "isNotContaminant", ...)

## S4 method for signature 'SummarizedExperiment'
addNotContaminantQC(x, name = "isNotContaminant", ...)

Arguments

seqtab, x a SummarizedExperiment
assay.type A single character value for selecting the assay to use.
assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)
name A name for the column of the colData in which the contaminant information should be stored.
concentration NULL or a single character value. Defining a column with numeric values from the colData to use as concentration information. (default: concentration = NULL)
control NULL or a single character value. Defining a column with logical values from the colData to define control and non-control samples. (default: control = NULL)
batch NULL or a single character value. Defining a column with values interpretable as a factor from the colData to use as batch information. (default: batch = NULL)
threshold numeric scalar. See `decontam:isContaminant` or `decontam:isNotContaminant` normalize, detailed
    logical scalar. See `decontam:isContaminant` or `decontam:isNotContaminant` ...
    • for isContaminant/isNotContaminant: arguments passed on to `decontam:isContaminant` or `decontam:isNotContaminant`
    • for addContaminantQC/addNotContaminantQC: arguments passed on to isContaminant/isNotContaminant

Value

for isContaminant/isNotContaminant a DataFrame or for addContaminantQC/addNotContaminantQC a modified object of class(x)

See Also

`decontam:isContaminant`, `decontam:isNotContaminant`

Examples

data(esophagus)
# setup of some mock data
colData(esophagus)$concentration <- c(1,2,3)
colData(esophagus)$control <- c(FALSE,FALSE,TRUE)

isContaminant(esophagus, method = "frequency", concentration = "concentration")
esophagus <- addContaminantQC(esophagus, method = "frequency", concentration = "concentration")
colData(esophagus)

isNotContaminant(esophagus, control = "control")
esophagus <- addNotContaminantQC(esophagus, control = "control")
colData(esophagus)

loadFromHumann

Import HUMAnN results to TreeSummarizedExperiment

Description

Import HUMAnN results to TreeSummarizedExperiment

Arguments

file a single character value defining the file path of the HUMAnN file. The file must be in merged HUMAnN format.
loadFromHumann

colData a DataFrame-like object that includes sample names in rownames, or a single character value defining the file path of the sample metadata file. The file must be in tsv format (default: colData = NULL).

... additional arguments:

• assay.type: A single character value for naming assay (default: assay.type = "counts")
• removeTaxaPrefixes: TRUE or FALSE: Should taxonomic prefixes be removed? (default: removeTaxaPrefixes = FALSE)
• remove.suffix: TRUE or FALSE: Should suffixes of sample names be removed? HUMAnN pipeline adds suffixes to sample names. Suffixes are formed from file names. By selecting remove.suffix = TRUE, you can remove pattern from end of sample names that is shared by all. (default: remove.suffix = FALSE)

Details

Import HUMAnN (currently version 3.0 supported) results of functional predictions based on metagenome composition (e.g. pathways or gene families). The input must be in merged HUMAnN format. (See the HUMAnN documentation and humann_join_tables method.)

The function parses gene/pathway information along with taxonomy information from the input file. This information is stored to rowData. Abundances are stored to assays.

Usually the workflow includes also taxonomy data from Metaphlan. See loadFromMetaphlan to load the data to TreeSE.

Value

A TreeSummarizedExperiment object

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

References


See Also

loadFromMetaphlan makeTreeSEFromPhyloseq makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromQIIME2 loadFromMothur
Examples

```r
# File path
file_path <- system.file("extdata", "humann_output.tsv", package = "mia")
# Import data
 tse <- loadFromHumann(file_path)
 tse
```

---

loadFromMetaphlan  Import Metaphlan results to TreeSummarizedExperiment

Description

Import Metaphlan results to TreeSummarizedExperiment

Arguments

- **file**
  - a single character value defining the file path of the Metaphlan file. The file must be in merged Metaphlan format.

- **colData**
  - a DataFrame-like object that includes sample names in rownames, or a single character value defining the file path of the sample metadata file. The file must be in tsv format (default: colData = NULL).

- **sample_meta**
  - a DataFrame-like object that includes sample names in rownames, or a single character value defining the file path of the sample metadata file. The file must be in tsv format (default: sample_meta = NULL).

- **phy_tree**
  - a single character value defining the file path of the phylogenetic tree. (default: phy_tree = NULL).

- ... additional arguments:
  - `assay.type`: A single character value for naming `assay` (default: `assay.type = "counts"`).
  - `assay_name`: A single character value for specifying which assay to use for calculation. (Please use `assay.type` instead. At some point `assay_name` will be disabled.)
  - `removeTaxaPrefixes`: TRUE or FALSE: Should taxonomic prefixes be removed? (default: `removeTaxaPrefixes = FALSE`)
  - `remove.suffix`: TRUE or FALSE: Should suffixes of sample names be removed? Metaphlan pipeline adds suffixes to sample names. Suffixes are formed from file names. By selecting `remove.suffix = TRUE`, you can remove pattern from end of sample names that is shared by all. (default: `remove.suffix = FALSE`)
Details

Import Metaphlan (versions 2, 3 and 4 supported) results. Input must be in merged Metaphlan format. (See the Metaphlan documentation and merge_metaphlan_tables method.) Data is imported so that data at the lowest rank is imported as a TreeSummarizedExperiment object. Data at higher rank is imported as a SummarizedExperiment objects which are stored to altExp of TreeSummarizedExperiment object.

Currently Metaphlan versions 2, 3, and 4 are supported.

Value

A TreeSummarizedExperiment object

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

References


See Also

loadFromHumann makeTreeSEFromPhyloseq makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromQIIME2 loadFromMothur

Examples

# (Data is from tutorial
# https://github.com/biobakery/biobakery/wiki/metaphlan3#merge-outputs)

# File path
file_path <- system.file("extdata", "merged_abundance_table.txt", package = "mia")
# Import data
tse <- loadFromMetaphlan(file_path)
# Data at the lowest rank
tse
# Data at higher rank is stored in altExp
altExps(tse)
# Higher rank data is in SE format, for example, Phylum rank
altExp(tse, "Phylum")
loadFromMothur

Import Mothur results as a TreeSummarizedExperiment

Description

This method creates a TreeSummarizedExperiment object from Mothur files provided as input.

Usage

loadFromMothur(sharedFile, taxonomyFile = NULL, designFile = NULL)

Arguments

sharedFile a single character value defining the file path of the feature table to be imported. The File has to be in shared file format as defined in Mothur documentation.

taxonomyFile a single character value defining the file path of the taxonomy table to be imported. The File has to be in taxonomy file or constaxonomy file format as defined in Mothur documentation. (default: taxonomyFile = NULL).

designFile a single character value defining the file path of the sample metadata to be imported. The File has to be in desing file format as defined in Mothur documentation. (default: designFile = NULL).

Details

Results exported from Mothur can be imported as a SummarizedExperiment using loadFromMothur. Except for the sharedFile, the other data types, taxonomyFile, and designFile, are optional, but are highly encouraged to be provided.

Value

A TreeSummarizedExperiment object

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

References


See Also

makeTreeSEFromPhyloseq makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromQIIME2
Examples

# Abundance table
counts <- system.file("extdata", "mothur_example.shared", package = "mia")
# Taxa table (in "cons.taxonomy" or "taxonomy" format)
taxa <- system.file("extdata", "mothur_example.cons.taxonomy", package = "mia"
#taxa <- system.file("extdata", "mothur_example.taxonomy", package = "mia")
# Sample meta data
meta <- system.file("extdata", "mothur_example.design", package = "mia")

# Creates se object from files
se <- loadFromMothur(counts, taxa, meta)
# Convert SE to TreeSE
tse <- as(se, "TreeSummarizedExperiment")
tse

loadFromQIIME2

Import QIIME2 results to TreeSummarizedExperiment

Description

Results exported from QIMME2 can be imported as a TreeSummarizedExperiment using loadFromQIIME2. Except for the featureTableFile, the other data types, taxonomyTableFile, refSeqFile and phyTreeFile, are optional, but are highly encouraged to be provided.

Import the QIIME2 artifacts to R.

Usage

loadFromQIIME2(
  featureTableFile,
taxonomyTableFile = NULL,
sampleMetaFile = NULL,
featureNamesAsRefSeq = TRUE,
refSeqFile = NULL,
phyTreeFile = NULL,
...)

readQZA(file, temp = tempdir(), ...)

Arguments

featureTableFile
  a single character value defining the file path of the feature table to be imported.
taxonomyTableFile
  a single character value defining the file path of the taxonomy table to be imported. (default: taxonomyTableFile = NULL).
loadFromQIIME2

sampleMetaFile  a single character value defining the file path of the sample metadata to be imported. The file has to be in tsv format. (default: sampleMetaFile = NULL).

featureNamesAsRefSeq
  TRUE or FALSE: Should the feature names of the feature table be regarded as reference sequences? This setting will be disregarded, if refSeqFile is not NULL. If the feature names do not contain valid DNA characters only, the reference sequences will not be set.

refSeqFile  a single character value defining the file path of the reference sequences for each feature. (default: refSeqFile = NULL).

phyTreeFile  a single character value defining the file path of the phylogenetic tree. (default: phyTreeFile = NULL).

... additional arguments:
  • temp: the temporary directory used for decompressing the data. (default: tempdir())
  • removeTaxaPrefixes: TRUE or FALSE: Should taxonomic prefixes be removed? (default: removeTaxaPrefixes = FALSE)

file  character, path of the input qza file. Only files in format of BIOMV210DirFmt (feature table), TSVTaxonomyDirectoryFormat (taxonomic table), NewickDirectoryFormat (phylogenetic tree) and DNASequencesDirectoryFormat (representative sequences) are supported right now.

temp  character, a temporary directory in which the qza file will be decompressed to, default tempdir().

Details

Both arguments featureNamesAsRefSeq and refSeqFile can be used to define reference sequences of features. featureNamesAsRefSeq is only taken into account, if refSeqFile is NULL. No reference sequences are tried to be created, if featureNameAsRefSeq is FALSE and refSeqFile is NULL.

Value

A TreeSummarizedExperiment object

matrix object for feature table, DataFrame for taxonomic table, ape::phylo object for phylogenetic tree, Biostrings::DNAStringSet for representative sequences of taxa.

Author(s)

Yang Cao

References

https://qiime2.org
makePhyloseqFromTreeSE

See Also

makeTreeSEFromPhyloseq makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromMothur

Examples

```r
featureTableFile <- system.file("extdata", "table.qza", package = "mia")
taxonomyTableFile <- system.file("extdata", "taxonomy.qza", package = "mia")
sampleMetaFile <- system.file("extdata", "sample-metadata.tsv", package = "mia")
phyTreeFile <- system.file("extdata", "tree.qza", package = "mia")
refSeqFile <- system.file("extdata", "refseq.qza", package = "mia")
tse <- loadFromQIIME2(
  featureTableFile = featureTableFile,
taxonomyTableFile = taxonomyTableFile,
sampleMetaFile = sampleMetaFile,
  refSeqFile = refSeqFile,
  phyTreeFile = phyTreeFile
)

tse # Read individual files
featureTableFile <- system.file("extdata", "table.qza", package = "mia")
taxonomyTableFile <- system.file("extdata", "taxonomy.qza", package = "mia")
sampleMetaFile <- system.file("extdata", "sample-metadata.tsv", package = "mia")

assay <- readQZA(featureTableFile)
rowdata <- readQZA(taxonomyTableFile, removeTaxaPrefixes = TRUE)
coldata <- read.table(sampleMetaFile, header = TRUE, sep = "\t", comment.char = "")

# Assign rownames
rownames(coldata) <- coldata[, 1]
coldata[, 1] <- NULL

# Order coldata based on assay
coldata <- coldata[match(colnames(assay), rownames(coldata)), ]

# Create SE from individual files
se <- SummarizedExperiment(assays = list(assay), rowData = rowdata, colData = coldata)
se
```

Description

This function creates a phyloseq object from a TreeSummarizedExperiment object. By using assay.type, it is possible to specify which table from assay is added to the phyloseq object.
makePhyloseqFromTreeSE

Usage

makePhyloseqFromTreeSE(x, ...)

## S4 method for signature 'SummarizedExperiment'
makePhyloseqFromTreeSE(x, assay.type = "counts", assay_name = NULL, ...)

## S4 method for signature 'TreeSummarizedExperiment'
makePhyloseqFromTreeSE(x, tree_name = "phylo", ...)

makePhyloseqFromTreeSummarizedExperiment(x, ...)

## S4 method for signature 'ANY'
makePhyloseqFromTreeSummarizedExperiment(x, ...)

Arguments

x  a TreeSummarizedExperiment object
...
additional arguments
assay.type A single character value for selecting the assay to be included in the phyloseq
object that is created. (By default: assay.type = "counts")
assay_name a single character value for specifying which assay to use for calculation.
(Please use assay.type instead. At some point assay_name will be disabled.)
tree_name a single character value for specifying which tree will be included in the phylo-
seq object that is created, (By default: tree_name = "phylo")

Details

makePhyloseqFromTreeSE is used for creating a phyloseq object from TreeSummarizedExperi-
ment object.

Value

An object of class Phyloseq object.

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

Examples

# Get tse object
data(GlobalPatterns)
tse <- GlobalPatterns

# Create a phyloseq object from it
phy <- makePhyloseqFromTreeSE(tse)
phy

# By default the chosen table is counts, but if there are other tables,
# they can be chosen with assay.type.

# Counts relative abundances table
tse <- transformAssay(tse, method = "relabundance")
phy2 <- makePhyloseqFromTreeSE(tse, assay.type = "relabundance")
phy2

---

## Description

For convenience a few functions are available to convert data from a ‘biom’ file or object into a `TreeSummarizedExperiment`.

### Usage

```r
loadFromBiom(file, ...)
```

```r
makeTreeSEFromBiom(
  obj,
  removeTaxaPrefixes = FALSE,
  rankFromPrefix = FALSE,
  remove.artifacts = FALSE,
  ...
)
```

```r
makeTreeSummarizedExperimentFromBiom(obj, ...)
```

### Arguments

- **file**: biom file location
- **...**: additional arguments
  - `pattern` character value specifying artifacts to be removed. If `patterns = "auto"`, special characters are removed. (default: `pattern = "auto"`)
- `obj`: object of type `biom`
- `removeTaxaPrefixes`: TRUE or FALSE: Should taxonomic prefixes be removed? The prefixes is removed only from detected taxa columns meaning that `rankFromPrefix` should be enabled in the most cases. (default `removeTaxaPrefixes = FALSE`)
- `rankFromPrefix`: TRUE or FALSE: If file does not have taxonomic ranks on feature table, should they be scraped from prefixes? (default `rankFromPrefix = FALSE`)
- `remove.artifacts`: TRUE or FALSE: If file have some taxonomic character naming artifacts, should they be removed. (default `remove.artifacts = FALSE`)
makeTreeSEFromDADA2

Value
An object of class `TreeSummarizedExperiment`

See Also
makeTreeSEFromPhyloseq, makeTreeSEFromDADA2, loadFromQIIME2, loadFromMothur

Examples

```r
# Load biom file
library(biomformat)
biom_file <- system.file("extdata", "rich_dense_otu_table.biom",
                        package = "biomformat")

# Make TreeSE from biom file
tse <- loadFromBiom(biom_file)

# Make TreeSE from biom object
biom_object <- biomformat::read_biom(biom_file)
tse <- makeTreeSEFromBiom(biom_object)

# Get taxonomyRanks from prefixes and remove prefixes
tse <- loadFromBiom(biom_file,
                   rankFromPrefix = TRUE,
                   removeTaxaPrefixes = TRUE)

# Load another biom file
biom_file <- system.file("extdata/testdata", "Aggregated_humanization2.biom",
                        package = "mia")

# Clean artifacts from taxonomic data
tse <- loadFromBiom(biom_file,
                   remove.artifacts = TRUE)
```

Description

`makeTreeSEFromDADA2` is a wrapper for the `mergePairs` function from the `dada2` package.

Usage

`makeTreeSEFromDADA2(...)`

`makeTreeSummarizedExperimentFromDADA2(...)`

Arguments

`...` See `mergePairs` function for more details.
Details

A count matrix is constructed via `makeSequenceTable(mergePairs(...))` and rownames are dynamically created as ASV(N) with N from 1 to nrow of the count tables. The colnames and rownames from the output of `makeSequenceTable` are stored as colnames and in the `referenceSeq` slot of the `TreeSummarizedExperiment`, respectively.

Value

An object of class `TreeSummarizedExperiment`

See Also

`makeTreeSEFromPhyloseq` `makeTreeSEFromBiom` `loadFromQIIME2` `loadFromMothur`

Examples

```r
if(requireNamespace("dada2")) {
  fnF <- system.file("extdata", "sam1F.fastq.gz", package="dada2")
  fnR = system.file("extdata", "sam1R.fastq.gz", package="dada2")
  dadaF <- dada2::dada(fnF, selfConsist=TRUE)
  dadaR <- dada2::dada(fnR, selfConsist=TRUE)

  tse <- makeTreeSEFromDADA2(dadaF, fnF, dadaR, fnR)
  tse
}
```

Details

All data stored in a phyloseq object is transferred.

Value

An object of class TreeSummarizedExperiment

See Also

makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromQIIME2 loadFromMothur

Examples

```r
if (requireNamespace("phyloseq")) {
  data(GlobalPatterns, package="phyloseq")
  makeTreeSEFromPhyloseq(GlobalPatterns)
  data(enterotype, package="phyloseq")
  makeTreeSEFromPhyloseq(enterotype)
  data(esophagus, package="phyloseq")
  makeTreeSEFromPhyloseq(esophagus)
}
```

---

meltAssay

Converting a SummarizedExperiment object into a long data.frame

Description

meltAssay Converts a SummarizedExperiment object into a long data.frame which can be used for tidyverse-tools.

Usage

```r
meltAssay(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  add_row_data = NULL,
  add_col_data = NULL,
  feature_name = "FeatureID",
  sample_name = "SampleID",
  ...
)
```

## S4 method for signature 'SummarizedExperiment'

```r
meltAssay(
  x,
  assay.type = assay_name,
  assay_name = "counts",
```
add_row_data = NULL,
add_col_data = NULL,
feature_name = "FeatureID",
sample_name = "SampleID",
...)

Arguments

x          A numeric matrix or a SummarizedExperiment
assay.type a character value to select an assayNames
assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)
add_row_data NULL, TRUE or a character vector to select information from the rowData to add to the molten assay data. If add_row_data = NULL no data will be added, if add_row_data = TRUE all data will be added and if add_row_data is a character vector, it will be used to subsetting to given column names in rowData. (default: add_row_data = NULL)
add_col_data NULL, TRUE or a character vector to select information from the colData to add to the molten assay data. If add_col_data = NULL no data will be added, if add_col_data = TRUE all data will be added and if add_col_data is a character vector, it will be used to subsetting to given column names in colData. (default: add_col_data = NULL)
feature_name a character scalar to use as the output’s name for the feature identifier. (default: feature_name = "FeatureID")
sample_name a character scalar to use as the output’s name for the sample identifier. (default: sample_name = "SampleID")
...optional arguments:
  • check_names A boolean value passed to data.frame function’s check.name argument. Determines if sample names are checked that they are syntactically valid variable names and are not duplicated. If they are not, sample names are modified. (default: check_names = TRUE)

Details

If the colData contains a column “SampleID” or the rowData contains a column “FeatureID”, they will be renamed to “SampleID_col” and “FeatureID_row”, if row names or column names are set.

Value

A tibble with the molten data. The assay values are given in a column named like the selected assay assay.type. In addition, a column “FeatureID” will contain the rownames, if set, and analogously a column “SampleID” with the colnames, if set.

Author(s)

Sudarshan A. Shetty
Examples

data(GlobalPatterns)
molten_tse <- meltAssay(GlobalPatterns,
    assay.type = "counts",
    add_row_data = TRUE,
    add_col_data = TRUE
)
molten_tse

merge-methods

Merge a subset of the rows or columns of a SummarizedExperiment

Description

mergeRows/mergeCols merge data on rows or columns of a SummarizedExperiment as defined by
a factor alongside the chosen dimension. Metadata from the rowData or colData are retained as
defined by archetype.

Usage

mergeRows(x, f, archetype = 1L, ...)
mergeCols(x, f, archetype = 1L, ...)
mergeFeatures(x, f, archetype = 1L, ...)
mergeSamples(x, f, archetype = 1L, ...)

## S4 method for signature 'SummarizedExperiment'
mergeRows(x, f, archetype = 1L, ...)

## S4 method for signature 'SummarizedExperiment'
mergeCols(x, f, archetype = 1L, ...)

## S4 method for signature 'SummarizedExperiment'
mergeFeatures(x, f, archetype = 1L, ...)

## S4 method for signature 'SummarizedExperiment'
mergeSamples(x, f, archetype = 1L, ...)

## S4 method for signature 'TreeSummarizedExperiment'
mergeRows(x, f, archetype = 1L, mergeTree = FALSE, mergeRefSeq = FALSE, ...)

## S4 method for signature 'TreeSummarizedExperiment'
mergeCols(x, f, archetype = 1L, mergeTree = FALSE, ...)

## S4 method for signature 'TreeSummarizedExperiment'
mergeMethods

mergeFeatures(
x,
f,
archetyp = 1L,
mergeTree = FALSE,
mergeRefSeq = FALSE,
...
)

## S4 method for signature 'TreeSummarizedExperiment'
mergeSamples(x, f, archetype = 1L, mergeTree = FALSE, ...)

Arguments

x a SummarizedExperiment or a TreeSummarizedExperiment
f A factor for merging. Must be the same length as nrow(x)/ncol(x). Rows/Cols corresponding to the same level will be merged. If length(levels(f)) == nrow(x)/ncol(x), x will be returned unchanged.
archetyp Of each level of f, which element should be regarded as the archetype and metadata in the columns or rows kept, while merging? This can be single integer value or an integer vector of the same length as levels(f). (Default: archetype = 1L, which means the first element encountered per factor level will be kept)
...
Optional arguments:
- Passed on to sumCountsAcrossFeatures, with the exception of subset_row, subset_col
mergeTree TRUE or FALSE: Should rowTree() also be merged? (Default: mergeTree = FALSE)
mergeRefSeq TRUE or FALSE: Should a consensus sequence be calculated? If set to FALSE, the result from archetype is returned; If set to TRUE the result from DECIPHER::ConsensusSequence is returned. (Default: mergeRefSeq = FALSE)

Details

assay are agglomerated, i.e. summed up. If the assay contains values other than counts or absolute values, this can lead to meaningless values being produced.

These functions are similar to sumCountsAcrossFeatures. However, additional support for TreeSummarizedExperiment was added and science field agnostic names were used. In addition the archetype argument lets the user select how to preserve row or column data.

For merge data of assays the function from scuttle are used.

Value

An object of the same class as x with the specified entries merged into one entry in all relevant components.
mergeSEs

Merge SE objects into single SE object.

Description

Merge SE objects into single SE object.

Usage

mergeSEs(x, ...)

## S4 method for signature 'SimpleList'
mergeSEs(
x,
  assay.type = "counts",
  assay_name = NULL,
  join = "full",
  missing_values = NA,
  collapse_samples = FALSE,
  collapse_features = TRUE,
  verbose = TRUE,
  ...
)

## S4 method for signature 'SummarizedExperiment'
mergeSEs(x, y = NULL, ...)

## S4 method for signature 'list'
mergeSEs(x, ...)

See Also

sumCountsAcrossFeatures

Examples

data(esophagus)
esophagus
plot(rowTree(esophagus))
# get a factor for merging
f <- factor(regmatches(rownames(esophagus),
  regexpr("^[0-9]*_[0-9]*", rownames(esophagus))))
merged <- mergeRows(esophagus, f, mergeTree = TRUE)
plot(rowTree(merged))
#
data(GlobalPatterns)
GlobalPatterns
merged <- mergeCols(GlobalPatterns, colData(GlobalPatterns)$SampleType)
merged
full_join(x, ...)

## S4 method for signature 'ANY'
full_join(x, ...)

inner_join(x, ...)

## S4 method for signature 'ANY'
inner_join(x, ...)

left_join(x, ...)

## S4 method for signature 'ANY'
left_join(x, ...)
	right_join(x, ...)

## S4 method for signature 'ANY'
right_join(x, ...)

Arguments

x a SummarizedExperiment object or a list of SummarizedExperiment objects.

... optional arguments (not used).

assay.type A character value for selecting the assay to be merged. (By default: assay.type = "counts")

assay_name (Deprecated) alias for assay.type.

join A single character value for selecting the joining method. Must be 'full', 'inner', 'left', or 'right'. 'left' and 'right' are disabled when more than two objects are being merged. (By default: join = "full")

missing_values NA, 0, or a single character values specifying the notation of missing values. (By default: missing_values = NA)

collapse_samples A boolean value for selecting whether to collapse identically named samples to one. (By default: collapse_samples = FALSE)

collapse_features A boolean value for selecting whether to collapse identically named features to one. Since all taxonomy information is taken into account, this concerns rownames-level (usually strain level) comparison. Often OTU or ASV level is just an arbitrary number series from sequencing machine meaning that the OTU information is not comparable between studies. With this option, it is possible to specify whether these strains are combined if their taxonomy information along with OTU number matches. (By default: collapse_features = TRUE)

verbose A single boolean value to choose whether to show messages. (By default: verbose = TRUE)
Details

This function merges multiple SummarizedExperiment objects. It combines rowData, assays, and colData so that the output includes each unique row and column ones. The merging is done based on rownames and colnames. rowTree and colTree are preserved if linkage between rows/cols and the tree is found.

Equally named rows are interpreted as equal. Further matching based on rowData is not done. For samples, collapsing is disabled by default meaning that equally named samples that are stored in different objects are interpreted as unique. Collapsing can be enabled with collapse.samples = TRUE when equally named samples describe the same sample.

If, for example, all rows are not shared with individual objects, there are missing values in assays. The notation of missing can be specified with the missing_values argument. If input consists of TreeSummarizedExperiment objects, also rowTree, colTree, and referenceSeq are preserved if possible. The data is preserved if all the rows or columns can be found from it.

Compared to cbind and rbind mergeSEs allows more freely merging since cbind and rbind expect that rows and columns are matching, respectively.

You can choose joining methods from 'full', 'inner', 'left', and 'right'. In all the methods, all the samples are included in the result object. However, with different methods, it is possible to choose which rows are included.

- full – all unique features
- inner – all shared features
- left – all the features of the first object
- right – all the features of the second object

You can also do e.g., a full join by using a function full_join which is an alias for mergeSEs. Also other joining methods have dplyr-like aliases.

The output depends on the input. If the input contains SummarizedExperiment object, then the output will be SummarizedExperiment. When all the input objects belong to TreeSummarizedExperiment, the output will be TreeSummarizedExperiment.

Value

A single SummarizedExperiment object.

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

See Also

- TreeSummarizedExperiment::cbind
- TreeSummarizedExperiment::rbind
- full_join
• `inner_join`
• `left_join`
• `right_join`

**Examples**

data(GlobalPatterns)
data(esophagus)
data(enterotype)

# Take only subsets so that it wont take so long
tse1 <- GlobalPatterns[1:100, ]
tse2 <- esophagus
tse3 <- enterotype[1:100, ]

# Merge two TreeSEs
tse <- mergeSEs(tse1, tse2)

# Merge a list of TreeSEs
list <- SimpleList(tse1, tse2, tse3)
tse <- mergeSEs(list, assay.type = "counts", missing_values = 0)
tse

# With 'join', it is possible to specify the merging method. Subsets are used
# here just to show the functionality
tse_temp <- mergeSEs(tse[1:10, 1:10], tse[5:100, 11:20], join = "left")
tse_temp

# You can also do a left_join by using alias "left_join"
tse_temp <- left_join(tse[1:10, 1:10], tse[5:100, 11:20])

# If your objects contain samples that describe one and same sample,
# you can collapse equally named samples to one by specifying 'collapse_samples'
tse_temp <- inner_join(list(tse[1:10, 1], tse[1:20, 1], tse[1:5, 1]),
                       collapse_samples = TRUE)
tse_temp

# Merge all available assays
tse <- transformAssay(tse, method="relabundance")
tse1 <- transformAssay(tse1, method="relabundance")
tse_temp <- mergeSEs(tse, tse1, assay.type = assayNames(tse))

---

**Description**

`mia` provides various datasets derived from independent experimental studies. The datasets represent instances of the TreeSummarizedExperiment and MultiAssayExperiment containers and can serve as tools to practice the `mia` functionality.
Details

Currently, the following datasets are available:

- **dmn_se**: A SummarizedExperiment with 130 features and 278 samples
- **enterotype**: A TreeSummarizedExperiment with 553 features and 280 samples
- **esophagus**: A TreeSummarizedExperiment with 58 features and 3 samples
- **GlobalPatterns**: A TreeSummarizedExperiment with 19216 features and 26 samples
- **HintikkaXOData**: A MultiAssayExperiment with 3 experiments (microbiota, metabolites and biomarkers)
- **peerj13075**: A TreeSummarizedExperiment with 674 features and 58 samples
- **Tengeler2020**: A TreeSummarizedExperiment with 151 features and 27 samples

Examples

```r
# Load dataset from mia
library(mia)
data("GlobalPatterns", package = "mia")

# In this case, the dataset is a TreeSE, so it is renamed as tse
tse <- GlobalPatterns

# Print summary
tse
```

Description

peerj13075 includes skin microbial profiles of 58 volunteers with multiple factors. 16S r-RNA sequencing of V3-V4 regions was done to generate millions of read using illumina platform. A standard bioinformatic and statistical analysis done to explore skin bacterial diversity and its association with age, diet, geographical locations. The authors investigated significant association of skin microbiota with individual’s geographical location.

Usage

```r
data(peerj13075)
```

Format

A TreeSummarizedExperiment with 674 features and 58 samples. The rowData contains taxonomic information at kingdom, phylum, class, order, family and genus level. The colData includes:

- **Sample** sample ID
- **Geographical_location** city where participant lives (Ahmednagar, Pune and Nashik)
**Gender**  participant’s gender (Male or Female)  
**Age**  participant’s age group (Middle_age, Adult and Elderly)  
**Diet**  participant’s diet (Veg or Mixed)

**Author(s)**  
Potbhare, R., et al.

**References**  

**See Also**

mia-datasets

---

### perSampleDominantTaxa  
*Get dominant taxa*

**Description**  
These functions return information about the most dominant taxa in a *SummarizedExperiment* object.

**Usage**

```r
perSampleDominantFeatures(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  rank = NULL,
  other.name = "Other",
  n = NULL,
  complete = TRUE,
  ...)
```

```r
## S4 method for signature 'SummarizedExperiment'
perSampleDominantFeatures(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  rank = NULL,
  ...)
```
other.name = "Other",
n = NULL,
complete = TRUE,
...)

perSampleDominantTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
perSampleDominantTaxa(x, ...)

addPerSampleDominantFeatures(
  x,
  name = "dominant_taxa",
  other.name = "Other",
  n = NULL,
  ...
)

## S4 method for signature 'SummarizedExperiment'
addPerSampleDominantFeatures(
  x,
  name = "dominant_taxa",
  other.name = "Other",
  n = NULL,
  complete = FALSE,
  ...
)

addPerSampleDominantTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
addPerSampleDominantTaxa(x, ...)

Arguments

x A SummarizedExperiment object.

assay.type A single character value for selecting the assay to use for identifying dominant taxa.

assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)

rank A single character defining a taxonomic rank. Must be a value of the output of taxonomyRanks().

other.name A name for features that are not included in n the most frequent dominant features in the data. Default is "Other".

n The number of features that are the most frequent dominant features. Default is NULL, which defaults that each sample is assigned a dominant taxon.
relabundance

complete  A boolean value to manage multiple dominant taxa for a sample. Default for perSampleDominantTaxa is TRUE to include all equally dominant taxa for each sample. complete = FALSE samples one taxa for the samples that have multiple. Default for addPerSampleDominantTaxa is FALSE to add a column with only one dominant taxon assigned for each sample into colData. complete = TRUE adds a list that includes all dominant taxa for each sample into colData.

... Additional arguments passed on to agglomerateByRank() when rank is specified.

name  A name for the column of the colData where the dominant taxa will be stored in when using addPerSampleDominantFeatures.

Details

addPerSampleDominantFeatures extracts the most abundant taxa in a SummarizedExperiment object, and stores the information in the colData. It is a wrapper for perSampleDominantFeatures.

With rank parameter, it is possible to agglomerate taxa based on taxonomic ranks. E.g. if ‘Genus’ rank is used, all abundances of same Genus are added together, and those families are returned. See agglomerateByRank() for additional arguments to deal with missing values or special characters.

Value

perSampleDominantFeatures returns a named character vector x while addPerSampleDominantFeatures returns SummarizedExperiment with additional column in colData named *name*.

Author(s)

Leo Lahti, Tuomas Borman and Sudarshan A. Shetty.

Examples

data(GlobalPatterns)
x <- GlobalPatterns

# Finds the dominant taxa.
sim.dom <- perSampleDominantFeatures(x, rank="Genus")

# Add information to colData
x <- addPerSampleDominantFeatures(x, rank = "Genus", name="dominant_genera")
colData(x)

relabundance  Getter / setter for relative abundance data

Description

This function is being deprecated and will be removed in future releases. Please use assay(x, "relabundance") instead, which provides a more flexible and robust way to access and modify relative abundance data stored in the assay slot of a TreeSummarizedExperiment object.
Usage
relabundance(x, ...)
relabundance(x) <- value

## S4 method for signature 'SummarizedExperiment'
relabundance(x)

## S4 replacement method for signature 'SummarizedExperiment'
relabundance(x) <- value

Arguments

- **x**: a `TreeSummarizedExperiment` object
- **...**: optional arguments not used currently.
- **value**: a matrix to store as the ‘relabundance’ assay

Value

For `relabundance`, the matrix stored with the name “relabundance”.

Examples

```r
data(GlobalPatterns)
# Calculates relative abundances
GlobalPatterns <- transformAssay(GlobalPatterns, method="relabundance")
# Fetches calculated relative abundances
# head(assay(GlobalPatterns, "relabundance"))
```

runCCA

**Canonical Correspondence Analysis and Redundancy Analysis**

Description

These functions perform Canonical Correspondence Analysis on data stored in a `SummarizedExperiment`.

Usage

```r
calculateCCA(x, ...)
runCCA(x, ...)
calculateRDA(x, ...)
runRDA(x, ...)

## S4 method for signature 'ANY'
```
calculateCCA(x, ...)  

## S4 method for signature 'SummarizedExperiment'  
calculateCCA(  
  x,  
  formula,  
  variables,  
  test.signif = TRUE,  
  assay.type = assay_name,  
  assay_name = exprs_values,  
  exprs_values = "counts",  
  scores = "wa",  
  ...  
)  

## S4 method for signature 'SingleCellExperiment'  
runCCA(x, formula, variables, altexp = NULL, name = "CCA", ...)  

## S4 method for signature 'ANY'  
calculateRDA(x, ...)  

## S4 method for signature 'SummarizedExperiment'  
calculateRDA(  
  x,  
  formula,  
  variables,  
  test.signif = TRUE,  
  assay.type = assay_name,  
  assay_name = exprs_values,  
  exprs_values = "counts",  
  scores = "wa",  
  ...  
)  

## S4 method for signature 'SingleCellExperiment'  
runRDA(x, formula, variables, altexp = NULL, name = "RDA", ...)  

Arguments  

x  

For calculate* a **SummarizedExperiment** or a numeric matrix with columns as samples  
For run* a **SingleCellExperiment** or a derived object.  

...  

additional arguments passed to vegan::cca or vegan::dbRDA and other internal functions.  

- method a dissimilarity measure to be applied in dbRDA and possible following homogeneity test. (By default: method="euclidean")  
- scale a logical scalar, should the expression values be standardized? scale is disabled when using *RDA functions. Please scale before performing
runCCA

RDA. (By default: scale=TRUE)

- full a logical scalar, should all the results from the significance calculations be returned. When full=FALSE, only summary tables are returned. (By default: full=FALSE)

- homogeneity.test a single character value for specifying the significance test used to analyse vegan::betadisper results. Options include 'permanova' (vegan::permutest), 'anova' (stats::anova) and 'tukeyhsd' (stats::TukeyHSD). (By default: homogeneity.test="permanova")

**formula** If x is a SummarizedExperiment a formula can be supplied. Based on the right-hand side of the given formula colData is subset to variables. variables and formula can be missing, which turns the CCA analysis into a CA analysis and dbRDA into PCoA/MDS.

**variables** When x is a SummarizedExperiment, variables can be used to specify variables from colData.

When x is a matrix, variables is a data.frame or an object coercible to one containing the variables to use.

All variables are used. Please subset, if you want to consider only some of them. variables and formula can be missing, which turns the CCA analysis into a CA analysis and dbRDA into PCoA/MDS.

**test.signif** a logical scalar, should the PERMANOVA and analysis of multivariate homogeneity of group dispersions be performed. (By default: test.signif = TRUE)

**assay.type** a single character value for specifying which assay to use for calculation.

**assay.name** a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay.name will be disabled.)

**exprs_values** a single character value for specifying which assay to use for calculation. (Please use assay.type instead.)

**scores** A string specifying scores to be returned. Must be 'wa' (site scores found as weighted averages (cca) or weighted sums (rda) of v with weights Xbar, but the multiplying effect of eigenvalues removed) or 'u' ((weighted) orthonormal site scores). (By default: scores='wa')

**altexp** String or integer scalar specifying an alternative experiment containing the input data.

**name** String specifying the name to be used to store the result in the reducedDims of the output.

**Details**

*CCA functions utilize vegan::cca and *RDA functions vegan::dbRDA. By default dbRDA is done with euclidean distances which equals to RDA.

Significance tests are done with vegan::anova.cca (PERMANOVA). Group dispersion, i.e., homogeneity within groups is analyzed with vegan::betadisper (multivariate homogeneity of groups dispersions (variances)) and statistical significance of homogeneity is tested with a test specified by homogeneity.test parameter.
Value

For `calculateCCA` a matrix with samples as rows and CCA dimensions as columns. Attributes include calculated `cca/rda` object and significance analysis results.

For `runCCA` a modified x with the results stored in `reducedDim` as the given name.

See Also

For more details on the actual implementation see `cca` and `dbrda`

Examples

```r
library(scater)
data(GlobalPatterns)
GlobalPatterns <- runCCA(GlobalPatterns, data ~ SampleType)
plotReducedDim(GlobalPatterns,"CCA", colour_by = "SampleType")

# Fetch significance results
attr(reducedDim(GlobalPatterns, "CCA"), "significance")

GlobalPatterns <- runRDA(GlobalPatterns, data ~ SampleType)
plotReducedDim(GlobalPatterns,"CCA", colour_by = "SampleType")

# Specify dissimilarity measure
GlobalPatterns <- transformAssay(GlobalPatterns, method = "relabundance")
GlobalPatterns <- runRDA(
  GlobalPatterns, data ~ SampleType, assay.type = "relabundance", method = "bray")

# To scale values when using *RDA functions, use transformAssay(MARGIN = "features", ...) 
tse <- GlobalPatterns
tse <- transformAssay(tse, MARGIN = "features", method = "z")
# Data might include taxa that do not vary. Remove those because after z-transform 
# their value is NA
tse <- tse[ rowSums( is.na( assay(tse, "z") ) ) == 0, ]
# Calculate RDA
tse <- runRDA(tse, formula = data ~ SampleType, assay.type = "z", name = "rda_scaled", na.action = na.omit)
# Plot
plotReducedDim(tse,"rda_scaled", colour_by = "SampleType")
# A common choice along with PERMANOVA is ANOVA when statistical significance 
# of homogeneity of groups is analysed. Moreover, full significance test results 
# can be returned.
tse <- runRDA(tse, data ~ SampleType, homogeneity.test = "anova", full = TRUE)
```
Description

Double Principal Correspondance analysis is made available via the ade4 package in typical fashion. Results are stored in the reducedDims and are available for all the expected functions.

Usage

calculateDPCoA(x, y, ...)

## S4 method for signature 'ANY,ANY'
calculateDPCoA(
  x,
  y,
  ncomponents = 2,
  ntop = NULL,
  subset_row = NULL,
  scale = FALSE,
  transposed = FALSE,
  ...
)

## S4 method for signature 'TreeSummarizedExperiment,missing'
calculateDPCoA(
  x,
  ...

  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  tree_name = "phylo"
)

runDPCoA(x, ..., altexp = NULL, name = "DPCoA")

Arguments

- **x**
  For calculateDPCoA, a numeric matrix of expression values where rows are features and columns are cells. Alternatively, a TreeSummarizedExperiment containing such a matrix.

  For runDPCoA a TreeSummarizedExperiment containing the expression values as well as a rowTree to calculate y using cophetic.phylo.

- **y**
  a dist or a symmetric matrix compatible with ade4:dpcoa

- **...**
  Currently not used.

- **ncomponents**
  Numeric scalar indicating the number of DPCoA dimensions to obtain.

- **ntop**
  Numeric scalar specifying the number of features with the highest variances to use for dimensionality reduction. Alternatively NULL, if all features should be used. (default: ntop = NULL)
subset_row Vector specifying the subset of features to use for dimensionality reduction. This can be a character vector of row names, an integer vector of row indices or a logical vector.
scale Logical scalar, should the expression values be standardized?
transposed Logical scalar, is x transposed with cells in rows?
assay.type a single character value for specifying which assay to use for calculation.
assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)
exprs_values a single character value for specifying which assay to use for calculation. (Please use assay.type instead.)
tree_name a single character value for specifying which rowTree will be used in calculation. (By default: tree_name = "phylo")
altexp String or integer scalar specifying an alternative experiment containing the input data.
name String specifying the name to be used to store the result in the reducedDims of the output.

Details
In addition to the reduced dimension on the features, the reduced dimension for samples are returned as well as sample_red attribute. eig, feature_weights and sample_weights are returned as attributes as well.

Value
For calculateDPCoA a matrix with samples as rows and CCA dimensions as columns
For runDPCoA a modified x with the results stored in reducedDim as the given name

See Also
plotReducedDim reducedDims

Examples

data(esophagus)
dpcoa <- calculateDPCoA(esophagus)
head(dpcoa)
esophagus <- runDPCoA(esophagus)
reducedDims(esophagus)

library(scater)
plotReducedDim(esophagus, "DPCoA")

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runNMDS

Perform non-metric MDS on sample-level data

Description

Perform non-metric multi-dimensional scaling (nMDS) on samples, based on the data in a SingleCellExperiment object.

Usage

calculateNMDS(x, ...)

## S4 method for signature 'ANY'
calculateNMDS(
  x,
  FUN = vegdist,
  nmdsFUN = c("isoMDS", "monoMDS"),
  ncomponents = 2,
  ntop = 500,
  subset_row = NULL,
  scale = FALSE,
  transposed = FALSE,
  keep_dist = FALSE,
  ...
)

## S4 method for signature 'SummarizedExperiment'
calculateNMDS(
  x,
  ...,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  FUN = vegdist
)

## S4 method for signature 'SingleCellExperiment'
calculateNMDS(
  x,
  ...,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  dimred = NULL,
  n_dimred = NULL,
  FUN = vegdist
)
runNMDS(x, ..., altexp = NULL, name = "NMDS")

plotNMDS(x, ..., ncomponents = 2)

Arguments

x For calculateNMDS, a numeric matrix of expression values where rows are features and columns are cells. Alternatively, a TreeSummarizedExperiment containing such a matrix.

For runNMDS a SingleCellExperiment

... additional arguments to pass to FUN and nmdsFUN.

FUN a function or character value with a function name returning a dist object

nmdsFUN a character value to choose the scaling implementation, either “isoMDS” for MASS::isoMDS or “monoMDS” for vegan::monoMDS

ncomponents Numeric scalar indicating the number of NMDS dimensions to obtain.

ntop Numeric scalar specifying the number of features with the highest variances to use for dimensionality reduction.

subset_row Vector specifying the subset of features to use for dimensionality reduction. This can be a character vector of row names, an integer vector of row indices or a logical vector.

scale Logical scalar, should the expression values be standardized?

transposed Logical scalar, is x transposed with cells in rows?

keep_dist Logical scalar indicating whether the dist object calculated by FUN should be stored as ‘dist’ attribute of the matrix returned/stored by calculateNMDS/runNMDS.

assay.type a single character value for specifying which assay to use for calculation.

assay_name a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay.name will be disabled.)

exprs_values a single character value for specifying which assay to use for calculation. (Please use assay.type instead.)

dimred String or integer scalar specifying the existing dimensionality reduction results to use.

n_dimred Integer scalar or vector specifying the dimensions to use if dimred is specified.

altexp String or integer scalar specifying an alternative experiment containing the input data.

name String specifying the name to be used to store the result in the reducedDims of the output.

Details

Either MASS::isoMDS or vegan::monoMDS are used internally to compute the NMDS components. If you supply a custom FUN, make sure that the arguments of FUN and nmdsFUN do not collide.
splitByRanks

Value

For calculateNMDS, a matrix is returned containing the MDS coordinates for each sample (row) and dimension (column).

Author(s)

Felix Ernst

See Also

MASS::isoMDS, vegan::monoMDS for NMDS component calculation. plotMDS, to quickly visualize the results.

Examples

# generate some example data
mat <- matrix(1:60, nrow = 6)
df <- DataFrame(n = c(1:6))
tse <- TreeSummarizedExperiment(assays = list(counts = mat),
                              rowData = df)

# calculateNMDS(tse)

# data(esophagus)
esophagus <- runNMDS(esophagus, FUN = vegan::vegdist, name = "BC")
esophagus <- runNMDS(esophagus, FUN = vegan::vegdist, name = "euclidean",
                     method = "euclidean")
reducedDims(esophagus)

---

splitByRanks  Split/Unsplit a SingleCellExperiment by taxonomic ranks

Description

splitByRanks takes a SummarizedExperiment, splits it along the taxonomic ranks, aggregates the data per rank, converts the input to a SingleCellExperiment objects and stores the aggregated data as alternative experiments.

Usage

splitByRanks(x, ...)

## S4 method for signature 'SummarizedExperiment'
splitByRanks(x, ranks = taxonomyRanks(x), na.rm = TRUE, ...)

## S4 method for signature 'SingleCellExperiment'
splitByRanks(x, ranks = taxonomyRanks(x), na.rm = TRUE, ...)
## S4 method for signature 'TreeSummarizedExperiment'
splitByRanks(x, ranks = taxonomyRanks(x), na.rm = TRUE, ...)

unsplitByRanks(x, ...)

## S4 method for signature 'SingleCellExperiment'
unsplitByRanks(x, ranks = taxonomyRanks(x), keep_reducedDims = FALSE, ...)

## S4 method for signature 'TreeSummarizedExperiment'
unsplitByRanks(x, ranks = taxonomyRanks(x), keep_reducedDims = FALSE, ...)

### Arguments

- **x**: a SummarizedExperiment object
- **...**: arguments passed to agglomerateByRank function for SummarizedExperiment objects and other functions. See agglomerateByRank for more details.
- **ranks**: a character vector defining taxonomic ranks. Must all be values of taxonomyRanks() function.
- **na.rm**: TRUE or FALSE: Should taxa with an empty rank be removed? Use it with caution, since results with NA on the selected rank will be dropped. This setting can be tweaked by defining empty.fields to your needs. (default: na.rm = TRUE)
- **keep_reducedDims**: TRUE or FALSE: Should the reducedDims(x) be transferred to the result? Please note, that this breaks the link between the data used to calculate the reduced dims. (default: keep_reducedDims = FALSE)

### Details

unsplitByRanks takes these alternative experiments and flattens them again into a single SummarizedExperiment. splitByRanks will use by default all available taxonomic ranks, but this can be controlled by setting ranks manually. NA values are removed by default, since they would not make sense, if the result should be used for unsplitByRanks at some point. The input data remains unchanged in the returned SingleCellExperiment objects.

unsplitByRanks will remove any NA value on each taxonomic rank so that no ambiguous data is created. In additional, a column taxonomicLevel is created or overwritten in the rowData to specify from which alternative experiment this originates from. This can also be used for splitAltExps to split the result along the same factor again. The input data from the base objects is not returned, only the data from the altExp(). Be aware that changes to rowData of the base object are not returned, whereas only the colData of the base object is kept.

### Value

- For splitByRanks: SummarizedExperiment objects in a SimpleList.
- For unsplitByRanks: x, with rowData and assay data replaced by the unsplit data. colData of x is kept as well and any existing rowTree is dropped as well, since existing rowLinks are not valid anymore.
See Also

splitOn unsplitOn mergeRows, sumCountsAcrossFeatures, agglomerateByRank, altExps, splitAltExps

Examples

data(GlobalPatterns)
# print the available taxonomic ranks
taxonomyRanks(GlobalPatterns)

# splitByRanks
altExps(GlobalPatterns) <- splitByRanks(GlobalPatterns)
altExps(GlobalPatterns)
altExp(GlobalPatterns, "Kingdom")
altExp(GlobalPatterns, "Species")

# unsplitByRanks
x <- unsplitByRanks(GlobalPatterns)
x

### Description

Split TreeSummarizedExperiment column-wise or row-wise based on grouping variable

### Usage

splitOn(x, ...)

## S4 method for signature 'SummarizedExperiment'
splitOn(x, f = NULL, ...)

## S4 method for signature 'SingleCellExperiment'
splitOn(x, f = NULL, ...)

## S4 method for signature 'TreeSummarizedExperiment'
splitOn(x, f = NULL, update_rowTree = FALSE, ...)

unsplitOn(x, ...)

## S4 method for signature 'list'
unsplitOn(x, update_rowTree = FALSE, ...)

## S4 method for signature 'SimpleList'
unsplitOn(x, update_rowTree = FALSE, ...)
## S4 method for signature 'SingleCellExperiment'

unsplitOn(x, altExpNames = names(altExps(x)), keep_reducedDims = FALSE, ...)

### Arguments

- **x**
  A `SummarizedExperiment` object or a list of `SummarizedExperiment` objects.

- **...**
  Arguments passed to `mergeRows/mergeCols` function for `SummarizedExperiment` objects and other functions. See `mergeRows` for more details.

  - `use_names` A single boolean value to select whether to name elements of list by their group names.

- **f**
  A single character value for selecting the grouping variable from `rowData` or `colData` or a factor or vector with the same length as one of the dimensions. If `f` matches with both dimensions, `MARGIN` must be specified. Split by cols is not encouraged, since this is not compatible with storing the results in `altExps`.

- **update_rowTree**
  TRUE or FALSE: Should the rowTree be updated based on splitted data? Option is enabled when `x` is a `TreeSummarizedExperiment` object or a list of such objects. (By default: `update_rowTree = FALSE`)

- **altExpNames**
  a character vector specifying the alternative experiments to be unsplit. (By default: `altExpNames = names(altExps(x))`)

- **keep_reducedDims**
  TRUE or FALSE: Should the reducedDims(x) be transferred to the result? Please note, that this breaks the link between the data used to calculate the reduced dims. (By default: `keep_reducedDims = FALSE`)

### Details

`splitOn` split data based on grouping variable. Splitting can be done column-wise or row-wise. The returned value is a list of `SummarizedExperiment` objects; each element containing members of each group.

### Value

For `splitOn`: `SummarizedExperiment` objects in a `SimpleList`.

For `unsplitOn`: `x`, with `rowData` and assay data replaced by the unsplit data. `colData` of `x` is kept as well and any existing rowTree is dropped as well, since existing rowLinks are not valid anymore.

### Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

### See Also

`splitByRanks` `unsplitByRanks` `mergeRows`, `sumCountsAcrossFeatures`, `agglomerateByRank`, `altExps`, `splitAltExps`
Examples

data(GlobalPatterns)
tse <- GlobalPatterns
# Split data based on SampleType.
se_list <- splitOn(tse, f = "SampleType")

# List of SE objects is returned.
se_list

# Create arbitrary groups
rowData(tse)$group <- sample(1:3, nrow(tse), replace = TRUE)
colData(tse)$group <- sample(1:3, ncol(tse), replace = TRUE)

# Split based on rows
# Each element is named based on their group name. If you don't want to name
# elements, use use_name = FALSE. Since "group" can be found from rowdata and colData
# you must use MARGIN.
se_list <- splitOn(tse, f = "group", use_names = FALSE, MARGIN = 1)

# When column names are shared between elements, you can store the list to altExps
altExps(tse) <- se_list

altExps(tse)

# If you want to split on columns and update rowTree, you can do
se_list <- splitOn(tse, f = colData(tse)$group, update_rowTree = TRUE)

# If you want to combine groups back together, you can use unsplitBy
unsplitOn(se_list)

---

**subsampleCounts**  
**Subsample Counts**

**Description**

subsampleCounts will randomly subsample counts in SummarizedExperiment and return the a modified object in which each sample has same number of total observations/counts/reads.

**Usage**

```r
subsampleCounts(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  min_size = min(colSums2(assay(x))),
  seed = runif(1, 0, .Machine$integer.max),
  replace = TRUE,
  name = "subsampled",
```
subsampleCounts

verbose = TRUE,
...
)

## S4 method for signature 'SummarizedExperiment'

subsampleCounts(
x,
assay.type = assay_name,
assay_name = "counts",
min_size = min(colSums2(assay(x))),
seed = runif(1, 0, .Machine$integer.max),
replace = TRUE,
name = "subsampled",
verbose = TRUE,
...
)

Arguments

x             A SummarizedExperiment object.
assay.type    A single character value for selecting the SummarizedExperiment assay used
              for random subsampling. Only counts are useful and other transformed data as
              input will give meaningless output.
assay_name    a single character value for specifying which assay to use for calculation.
              (Please use assay.type instead. At some point assay_name will be disabled.)
min_size      A single integer value equal to the number of counts being simulated this can
              equal to lowest number of total counts found in a sample or a user specified
              number.
seed          A random number seed for reproducibility of sampling.
replace       Logical Default is TRUE. The default is with replacement (replace=TRUE). See
              phyloseq::rarefy_even_depth for details on implications of this parameter.
name          A single character value specifying the name of transformed abundance table.
verbose       Logical Default is TRUE. When TRUE an additional message about the random
              number used is printed.
...            additional arguments not used

Details

Although the subsampling approach is highly debated in microbiome research, we include the
subsampleCounts function because there may be some instances where it can be useful. Note
that the output of subsampleCounts is not the equivalent as the input and any result have to be
verified with the original dataset.

Value

subsampleCounts return x with subsampled data.
Author(s)
Sudarshan A. Shetty and Felix G.M. Ernst

References

Examples
# When samples in TreeSE are less than specified min_size, they will be removed.
# If after subsampling features are not present in any of the samples,
# they will be removed.
data(GlobalPatterns)
tse <- GlobalPatterns
tse.subsampled <- subsampleCounts(tse,
  min_size = 60000,
  name = "subsampled",
  seed = 123)
tse.subsampled
dim(tse)
dim(tse.subsampled)

subsetSamples Subset functions

Description
To make a transition from phyloseq easier, the subsetSamples and subsetFeatures functions are implemented. To avoid name clashes they are named differently.

Usage
subsetSamples(x, ...)
subsetFeatures(x, ...)
subsetTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
subsetSamples(x, ...)
## S4 method for signature 'SummarizedExperiment'
subsetFeatures(x, ...)

## S4 method for signature 'SummarizedExperiment'
subsetTaxa(x, ...)

### Arguments
- **x**: a `SummarizedExperiment` object
- **...**: See `subset`, `drop` is not supported.

### Details
However, the use of these functions is discouraged since subsetting using `[` works on both dimension at the same time, is more flexible and is used throughout R to subset data with two or more dimension. Therefore, these functions will be removed in Bioconductor release 3.15 (April, 2022).

### Value
A subset of `x`

### Examples
```r
data(GlobalPatterns)
subsetSamples(GlobalPatterns, colData(GlobalPatterns)$SampleType == "Soil")
# Vector that is used to specify subset must not include NAs
subsetFeatures(GlobalPatterns, rowData(GlobalPatterns)$Phylum == "Actinobacteria" &
!is.na(rowData(GlobalPatterns)$Phylum))
```

---

### summaries

**Summarizing microbiome data**

### Description
To query a `SummarizedExperiment` for interesting features, several functions are available.

### Usage
```r
getTopFeatures(
  x,
  top = 5L,
  method = c("mean", "sum", "median"),
  assay.type = assay_name,
  assay_name = "counts",
  na.rm = TRUE,
  ...
)```
## S4 method for signature 'SummarizedExperiment'
getTopFeatures(
  x,
  top = 5L,
  method = c("mean", "sum", "median", "prevalence"),
  assay.type = assay_name,
  assay_name = "counts",
  na.rm = TRUE,
  ...
)

getTopTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
getTopTaxa(x, ...)

getUniqueFeatures(x, ...)

## S4 method for signature 'SummarizedExperiment'
getUniqueFeatures(x, rank = NULL, ...)

getUniqueTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
countDominantFeatures(x, group = NULL, name = "dominant_taxa", ...)

## S4 method for signature 'SummarizedExperiment'
countDominantTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
countDominantTaxa(x, ...)

## S4 method for signature 'SummarizedExperiment'
summary(object, assay.type = assay_name, assay_name = "counts")

### Arguments

- **x**: A `SummarizedExperiment` object.
- **top**: Numeric value, how many top taxa to return. Default return top five taxa.
- **method**: Specify the method to determine top taxa. Either sum, mean, median or prevalence. Default is ‘mean’.
- **assay.type**: a character value to select an `assayNames`. By default it expects count data.
assay_name  a single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)

na.rm  For getTopFeatures logical argument for calculation method specified to argument method. Default is TRUE.

...  Additional arguments passed on to agglomerateByRank() when rank is specified for countDominantFeatures.

rank  A single character defining a taxonomic rank. Must be a value of the output of taxonomyRanks().

group  With group, it is possible to group the observations in an overview. Must be one of the column names of colData.

name  The column name for the features. The default is 'dominant_taxa'.

object  A SummarizedExperiment object.

Details

The getTopFeatures extracts the most top abundant “FeatureID”s in a SummarizedExperiment object.

The getUniqueFeatures is a basic function to access different taxa at a particular taxonomic rank.

countDominantFeatures returns information about most dominant taxa in a tibble. Information includes their absolute and relative abundances in whole data set.

The summary will return a summary of counts for all samples and features in SummarizedExperiment object.

Value

The getTopFeatures returns a vector of the most top abundant “FeatureID”s

The getUniqueFeatures returns a vector of unique taxa present at a particular rank

The countDominantFeatures returns an overview in a tibble. It contains dominant taxa in a column named *name* and its abundance in the data set.

The summary returns a list with two tibbles

Author(s)

Leo Lahti, Tuomas Borman and Sudarshan A. Shetty

See Also

getPrevalentFeatures

perCellQCMetrics, perFeatureQCMetrics, addPerCellQC, addPerFeatureQC, quickPerCellQC
Examples

data(GlobalPatterns)
top_taxa <- getTopFeatures(GlobalPatterns,
    method = "mean",
    top = 5,
    assay.type = "counts")
top_taxa

# Use 'detection' to select detection threshold when using prevalence method
top_taxa <- getTopFeatures(GlobalPatterns,
    method = "prevalence",
    top = 5,
    assay.name = "counts",
    detection = 100)
top_taxa

# Top taxa of specific rank
getTopFeatures(agglomerateByRank(GlobalPatterns,
    rank = "Genus",
    na.rm = TRUE))

dominant_taxa <- countDominantFeatures(GlobalPatterns,
    rank = "Genus")
dominant_taxa

# With group, it is possible to group observations based on specified groups
# Gets the overview of dominant taxa
dominant_taxa <- countDominantFeatures(GlobalPatterns,
    rank = "Genus",
    group = "SampleType",
    na.rm = TRUE)
dominant_taxa

# Get an overview of sample and taxa counts
summary(GlobalPatterns, assay.name= "counts")

# Get unique taxa at a particular taxonomic rank
# sort = TRUE means that output is sorted in alphabetical order
# With na.rm = TRUE, it is possible to remove NAs
# sort and na.rm can also be used in function getTopFeatures
getUniqueFeatures(GlobalPatterns, "Phylum", sort = TRUE)
**Description**

These function work on data present in rowData and define a way to represent taxonomic data alongside the features of a SummarizedExperiment.

**Usage**

**TAXONOMY_RANKS**

taxonomyRanks(x)

```r
## S4 method for signature 'SummarizedExperiment'
taxonomyRanks(x)
```

taxonomyRankEmpty(
  x,
  rank = taxonomyRanks(x)[1L],
  empty.fields = c(NA, "", " ", "\t", "-", "_")
)

```r
## S4 method for signature 'SummarizedExperiment'
taxonomyRankEmpty(
  x,
  rank = taxonomyRanks(x)[1],
  empty.fields = c(NA, "", " ", "\t", "-", "_")
)
```

cHECKTaxonomy(x, ...)

```r
## S4 method for signature 'SummarizedExperiment'
cHECKTaxonomy(x)
```

gETTaxonomyLabels(x, ...)

```r
## S4 method for signature 'SummarizedExperiment'
gETTaxonomyLabels(
  x,
  empty.fields = c(NA, "", " ", "\t", "-", "_"),
  with_rank = FALSE,
  make_unique = TRUE,
  resolve_loops = FALSE,
  ...
)
```

mapTaxonomy(x, ...)

```r
## S4 method for signature 'SummarizedExperiment'
mapTaxonomy(x, taxa = NULL, from = NULL, to = NULL, use_grepl = FALSE)
```
IdTaxaToDataFrame(from)

**Arguments**

- **x**: a `SummarizedExperiment` object
- **rank**: a single character defining a taxonomic rank. Must be a value of `taxonomyRanks()` function
- **empty.fields**: a character value defining, which values should be regarded as empty. (Default: `c(NA, "", " ", "\t")`). They will be removed if `na.rm = TRUE` before agglomeration
- **...**: optional arguments not used currently.
- **with_rank**: TRUE or FALSE: Should the level be add as a suffix? For example: "Phylum:Crenarchaeota" (default: `with_rank = FALSE`)
- **make_unique**: TRUE or FALSE: Should the labels be made unique, if there are any duplicates? (default: `make_unique = TRUE`)
- **resolve_loops**: TRUE or FALSE: Should `resolveLoops` be applied to the taxonomic data? Please note that has only an effect, if the data is unique. (default: `resolve_loops = TRUE`)
- **taxa**: a character vector, which is used for subsetting the taxonomic information. If no information is found, `NULL` is returned for the individual element. (default: `NULL`)
- **from**: • For `mapTaxonomy`: a scalar character value, which must be a valid taxonomic rank. (default: `NULL`) • otherwise a `Taxa` object as returned by `IdTaxa`
- **to**: a scalar character value, which must be a valid taxonomic rank. (default: `NULL`)
- **use_grepl**: TRUE or FALSE: should pattern matching via `grepl` be used? Otherwise literal matching is used. (default: `FALSE`)

**Format**

a character vector of length 8 containing the taxonomy ranks recognized. In functions this is used as case insensitive.

**Details**

taxonomyRanks returns, which columns of `rowData(x)` are regarded as columns containing taxonomic information.
taxonomyRankEmpty checks, if a selected rank is empty of information.
checkTaxonomy checks, if taxonomy information is valid and whether it contains any problems. This is a soft test, which reports some diagnostic and might mature into a data validator used upon object creation.
getTaxonomyLabels generates a character vector per row consisting of the lowest taxonomic information possible. If data from different levels, is to be mixed, the taxonomic level is prepended by default.
IdTaxaToDataFrame extracts taxonomic results from results of IdTaxa.

mapTaxonomy maps the given features (taxonomic groups; taxa) to the specified taxonomic level (to argument) in rowData of the SummarizedExperiment data object (i.e. rowData(x)[, taxonomyRanks(x)]). If the argument to is not provided, then all matching taxonomy rows in rowData will be returned. This function allows handy conversions between different

Taxonomic information from the IdTaxa function of DECIPHER package are returned as a special class. With as(taxa, "DataFrame") the information can be easily converted to a DataFrame compatible with storing the taxonomic information a rowData. Please note that the assigned confidence information are returned as metadata and can be accessed using metadata(df)$confidence.

Value

- taxonomyRanks: a character vector with all the taxonomic ranks found in colnames(rowData(x))
- taxonomyRankEmpty: a logical value
- mapTaxonomy: a list per element of taxa. Each element is either a DataFrame, a character or NULL. If all character results have the length of one, a single character vector is returned.

See Also

agglomerateByRank, toTree, resolveLoop

Examples

data(GlobalPatterns)
GlobalPatterns
taxonomyRanks(GlobalPatterns)

checkTaxonomy(GlobalPatterns)

table(taxonomyRankEmpty(GlobalPatterns,"Kingdom"))
table(taxonomyRankEmpty(GlobalPatterns,"Species"))

getTaxonomyLabels(GlobalPatterns[1:20,])

# mapTaxonomy
## returns the unique taxonomic information
mapTaxonomy(GlobalPatterns)
# returns specific unique taxonomic information
mapTaxonomy(GlobalPatterns, taxa = "Escherichia")
# returns information on a single output
mapTaxonomy(GlobalPatterns, taxa = "Escherichia", to="Family")
Description

Tengeler2020 includes gut microbiota profiles of 27 persons with ADHD. A standard bioinformatic and statistical analysis done to demonstrate that altered microbial composition could be a driver of altered brain structure and function and concomitant changes in the animals’ behavior. This was investigated by colonizing young, male, germ-free C57BL/6JOLA Hsd mice with microbiota from individuals with and without ADHD.

Usage

data(Tengeler2020)

Format

A TreeSummarizedExperiment with 151 features and 27 samples. The rowData contains taxonomic information at Kingdom, Phylum, Class, Order, Family and Genus level. The colData includes:

patient_status clinical status of the patient (ADHD or Control)
cohort cohort to which the patient belongs (Cohort_1, Cohort_2 and Cohort_3)
patient_status_vs_cohort combination of patient_status and cohort
sample_name unique sample ID

Author(s)

A.C. Tengeler, et al.

References


See Also

mia-datasets
transformAssay

Transform assay

Description

Variety of transformations for abundance data, stored in assay. See details for options.

Usage

transformSamples(
  x,
  assay.type = "counts",
  assay_name = NULL,
  method = c("alr", "chi.square", "clr", "frequency", "hellinger", "log", "log10",
            "log2", "normalize", "pa", "rank", "rclr", "relabundance", "rrank", "total"),
  name = method,
  ...
)

## S4 method for signature 'SummarizedExperiment'
transformSamples(
  x,
  assay.type = "counts",
  assay_name = NULL,
  method = c("alr", "chi.square", "clr", "frequency", "hellinger", "log", "log10",
            "log2", "normalize", "pa", "rank", "rclr", "relabundance", "rrank", "total"),
  name = method,
  pseudocount = FALSE,
  ...
)

transformAssay(
  x,
  assay.type = "counts",
  assay_name = NULL,
  method = c("alr", "chi.square", "clr", "frequency", "hellinger", "log", "log10",
            "log2", "max", "normalize", "pa", "range", "rank", "rclr", "relabundance", "rrank",
            "standardize", "total", "z"),
  MARGIN = "samples",
  name = method,
  pseudocount = FALSE,
  ...
)

transformCounts(x, ...)

## S4 method for signature 'SummarizedExperiment'
transformAssay(
x,  
assay.type = "counts",  
assay_name = NULL,  
method = c("alr", "chi.square", "clr", "frequency", "hellinger", "log", "log10",  
"log2", "max", "normalize", "pa", "range", "rank", "rclr", "relabundance", "rrank",  
"standardize", "total", "z"),  
MARGIN = "samples",  
name = method,  
pseudocount = FALSE,  
...  
)

transformFeatures(
  x,  
  assay.type = "counts",  
  assay_name = NULL,  
  method = c("frequency", "log", "log10", "log2", "max", "pa", "range", "standardize",  
             "z"),  
  name = method,  
  pseudocount = FALSE,  
  ...  
)

## S4 method for signature 'SummarizedExperiment'

transformFeatures(
  x,  
  assay.type = "counts",  
  assay_name = NULL,  
  method = c("frequency", "log", "log10", "log2", "max", "pa", "range", "standardize",  
             "z"),  
  name = method,  
  pseudocount = FALSE,  
  ...  
)

ZTransform(x, MARGIN = "features", ...)

## S4 method for signature 'SummarizedExperiment'

ZTransform(x, MARGIN = "features", ...)

relAbundanceCounts(x, ...)

## S4 method for signature 'SummarizedExperiment'

relAbundanceCounts(x, ...)

Arguments

  x  
      A SummarizedExperiment object.
**transformAssay**

- **assay.type** A single character value for selecting the assay to be transformed.
- **assay_name** A single character value for specifying which assay to use for calculation. (Please use assay.type instead. At some point assay_name will be disabled.)
- **method** A single character value for selecting the transformation method.
- **name** A single character value specifying the name of transformed abundance table.
- Additional arguments passed on to vegan:decostand:
  - **ref_vals**: A single value which will be used to fill reference sample’s column in returned assay when calculating alr. (default: ref_vals = NA)
- **pseudocount** TRUE, FALSE, or a numeric value. When TRUE, automatically adds the minimum positive value of assay.type. When FALSE, does not add any pseudocount (pseudocount = 0). Alternatively, a user-specified numeric value can be added as pseudocount.
- **MARGIN** A single character value for specifying whether the transformation is applied sample (column) or feature (row) wise. (By default: MARGIN = "samples")

**Details**

These transformCount function provides a variety of options for transforming abundance data. The transformed data is calculated and stored in a new assay. The previously available wrappers transformSamples, transformFeatures ZTransform, and relAbundanceCounts have been deprecated. The transformAssay provides sample-wise (column-wise) or feature-wise (row-wise) transformation to the abundance table (assay) based on specified MARGIN.

The available transformation methods include:

- **'alr'** Additive log ratio (alr) transformation, please refer to decostand for details.
- **'chi.square'** Chi square transformation, please refer to decostand for details.
- **'clr'** Centered log ratio (clr) transformation, please refer to decostand for details.
- **'frequency'** Frequency transformation, please refer to decostand for details.
- **'hellinger'** Hellinger transformation, please refer to decostand for details.
- **'log'** Logarithmic transformation, please refer to decostand for details.
- **'log10'** log10 transformation can be used for reducing the skewness of the data.
  
  \[ \log_{10} x \]

  where \( x \) is a single value of data.
- **'log2'** log2 transformation can be used for reducing the skewness of the data.
  
  \[ \log_2 x \]

  where \( x \) is a single value of data.
- **'normalize'** Make margin sum of squares equal to one. Please refer to decostand for details.
- **'pa'** Transforms table to presence/absence table. Please refer to decostand for details.
- **'rank'** Rank transformation, please refer to decostand for details.
- **'rclr'** Robust clr transformation, please refer to decostand for details.
transformAssay

- 'relabundance' Relative transformation (alias for 'total'), please refer to decostand for details.
- 'rrank' Relative rank transformation, please refer to decostand for details.
- 'standardize' Scale 'x' to zero mean and unit variance (alias for 'z'), please refer to decostand for details.
- 'total' Divide by margin total (alias for 'relabundance'), please refer to decostand for details.
- 'z' Z transformation (alias for 'standardize'), please refer to decostand for details.

Value

transformAssay returns the input object x, with a new transformed abundance table named name added in the assay.

Author(s)

Leo Lahti and Tuomas Borman. Contact: microbiome.github.io

Examples

data(esophagus, package="mia")
tse <- esophagus

# By specifying 'method', it is possible to apply different transformations, # e.g. compositional transformation.
tse <- transformAssay(tse, method = "relabundance")

# The target of transformation can be specified with "assay.type" # Pseudocount can be added by specifying 'pseudocount'.
# Perform CLR with smallest positive value as pseudocount
tse <- transformAssay(tse, assay.type = "relabundance", method = "clr", pseudocount = TRUE)

head(assay(tse, "clr"))

# With MARGIN, you can specify the if transformation is done for samples or # for features. Here Z-transformation is done feature-wise.
tse <- transformAssay(tse, method = "z", MARGIN = "features")
head(assay(tse, "z"))

# Name of the stored table can be specified.
tse <- transformAssay(tse, method="hellinger", name="test")
head(assay(tse, "test"))

# pa returns presence absence table.
tse <- transformAssay(tse, method = "pa")
head(assay(tse, "pa"))

# rank returns ranks of taxa.
tse <- transformAssay(tse, method = "rank")
head(assay(tse, "rank"))
# In order to use other ranking variants, modify the chosen assay directly:
assay(tse, "rank_average", withDimnames = FALSE) <- colRanks(assay(tse, "counts"),
ties.method="average",
preserveShape = TRUE)
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