Package ‘mia’

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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.

See Also

TreeSummarizedExperiment
**Description**

`agglomerateByRank` can be used to sum up data based on the association to certain taxonomic ranks given as `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, " ", " ", "	", ",", ", ");
...
)

## S4 method for signature 'SummarizedExperiment'
mergeFeaturesByRank(
x,     rank = taxonomyRanks(x)[1],
onRankOnly = FALSE,
na.rm = FALSE,
empty.fields = c(NA, " ", " ", "	", ",", ", ");
...
)

## 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, ..., agglomerateTree = FALSE)

## S4 method for signature 'TreeSummarizedExperiment'
mergeFeaturesByRank(x, ..., agglomerateTree = 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 rownames 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 too many nested alternative experiments by default (default: strip_altexp = TRUE)

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

Details

Based 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 sum up values of assays at specified taxonomic level. Certain assays, e.g. those that include binary or negative values, can lead to meaningless values, when values are summed. In those cases, consider doing agglomeration first and then transformation.

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)

# with agglomeration of the tree
x2 <- agglomerateByRank(GlobalPatterns, rank="Family",
                        agglomerateTree = 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 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. It 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 rank available
## 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),
  ...
)

calculateDMNgroup(x, ...)

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

performDMNgroupCV(x, ...)

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

## S4 method for signature 'SummarizedExperiment'
performDMNgroupCV(
  x,
  variable,
  assay.type = assay_name,
  assay_name = exprs_values,
calculateDMN

```r
eprs_values = "counts",
transposed = FALSE,
```

Arguments

- **x**: a numeric matrix with samples as rows or a `SummarizedExperiment` object.
- **...**: optional arguments not used.
- **k**: the number of Dirichlet components to fit. See `dmn`.
- **BPPARAM**: A `BiocParallelParam` object specifying whether the UniFrac calculation should be parallelized.
- **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. (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 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

```r
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
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

#### S4 method for signature 'ANY'

```r
calculateJSD(x, ...)
```

#### S4 method for signature 'SummarizedExperiment'

```r
calculateJSD(
  x,
  assay.type = assay_name,
  assay_name = exprs_values,
  exprs_values = "counts",
  transposed = FALSE,
  ...)
```

```r
runJSD(x, BPPARAM = SerialParam(), chunkSize = nrow(x))
```
**calculateJSD**

**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**


**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  

*Estimate overlap*

**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,
  ...
)
```

```r
runOverlap(x, ...)
```

**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.
- **name**
  - A single character value specifying the name of overlap matrix that is stored in `reducedDim(x)`.
- **...**
  - Optional arguments not used.
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)
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,
  ...
)

runUnifrac(
  x,
  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
calculateUnifrac

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

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)

cluster

Clustering wrapper

description

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

Usage

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

## S4 method for signature 'SummarizedExperiment'
cluster(
x,
BLUSPARAM,
cluster

```r
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

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

# Cluster on rows using Kmeans
```
```r
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
```

**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
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


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

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**  

**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'

```r
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.
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

```r
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'

```r
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'

```r
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,
  ...,
  BPPARAM = SerialParam()
)
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
# tse <- estimateDiversity(tse, index = "coverage", threshold = 0.75)
# 'quantile' and 'num_of_classes' can be used when
# 'log_modulo_skewness' is calculated
# tse <- estimateDiversity(tse, index = "log_modulo_skewness",
# quantile = 0.75, num_of_classes = 100)

# It is recommended to specify also the final names used in the output.
tse <- estimateDiversity(tse,
index = c("shannon", "gini_simpson", "inverse_simpson", "coverage", "fisher", "faith", "log_modulo_skewness"),

# The colData contains the indices by their new names provided by the user
colData(tse)[, name]

# Compare the indices visually
pairs(colData(tse)[, name])

# 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

```r
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'

```r
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,
  ...
)
```

object = tse,
        x = "SampleType",
        colour_by = "SampleType")
plots <- lapply(plots,"+",
    theme(axis.text.x = element_text(angle=45,hjust=1)))
names(plots) <- plot_index
plots$Shannon + plots$GiniSimpson + plot_layout(guides = "collect")

## 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.
\[ core\text{ abundance} = \frac{N_{core}}{N_{tot}} \]

where \( N_{core} \) is the sum of absolute abundance of the core species and \( N_{tot} \) 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:

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

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

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

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

• ‘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 \text{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

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

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

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.
estimateEvenness

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'

estimateRichness(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  index = c("ace", "chao1", "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 than 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 index 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)

# Delete 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,
```

# Shows all indices

```r
colData(esophagus)
```

---

**getExperimentCrossAssociation**

*Calculate correlations between features of two experiments.*

**Description**

Calculate correlations between features of two experiments.

**Usage**

```r
getExperimentCrossAssociation(x, ...)
```

```r
## 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,        
...     
)
```

```r
## 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.)
altexp1  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)

altexp2  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)

colData_variable1  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)

colData_variable2  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)

MARGIN  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)

method  A single character value for selecting association method ('kendall', 'pearson', or 'spearman' for continuous/numeric; 'categorical' for discrete) (By default: method = "kendall")

mode  A single character value for selecting output format Available formats are 'table' and 'matrix'. (By default: mode = "table")

p_adj_method  A single character value for selecting adjustment method of p-values. Passed to p.adjust function. (By default: p_adj_method = "fdr")

p_adj_threshold  A single numeric value (from 0 to 1) for selecting adjusted p-value threshold for filtering. (By default: p_adj_threshold = NULL)

cor_threshold  A single numeric absolute value (from 0 to 1) for selecting correlation threshold for filtering. (By default: cor_threshold = NULL)

sort  A single boolean value for selecting whether to sort features or not in result matrices. Used method is hierarchical clustering. (By default: sort = FALSE)

filter_self_correlations  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)

verbose  A single boolean value for selecting whether to get messages about progress of calculation.

test_significance  A single boolean value for selecting whether to test statistical significance of associations.

show_warnings  A single boolean value for selecting whether to show warnings that might occur when correlations and p-values are calculated.

paired  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)
getExperimentCrossAssociation

Details

These functions calculates 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]
# 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, matrix is returned
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 returns also significances
# filter_self_correlations = TRUE filters self correlations
# With p_adj_threshold it is possible to filter those features that do no have
# any correlations that have p-value under 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)

# Also getExperimentCrossAssociation 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
# variable-pairs. Use "symmetric" to choose whether to measure association for only
# other half of of variable-pairs.
result <- getExperimentCrossAssociation(mae, experiment1 = "microbiota", experiment2 = "microbiota",
assay.type1 = "counts", assay.type2 = "counts",
symmetric = TRUE)

# For big data sets, calculation might take long. To make calculations quicker, you can take
# a random sample from data. In a complex biological problems, random sample
# can describe the data enough. 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
getPrevalence

Description

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

Usage

getPrevalence(x, ...)

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

## 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, ...)

## 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,
getPrevalence

```r
rank = NULL,
prevalence = 50/100,
include_lowest = FALSE,
...
)
getRareTaxa(x, ...)

## S4 method for signature 'ANY'
getRareTaxa(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", ...)
```
getPrevalence

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.
    • for getPrevalentFeatures, getRareFeatures, subsetByPrevalentFeatures and subsetByRareFeatures additional parameters passed to getPrevalence
    • for getPrevalentAbundance additional parameters passed to getPrevalentFeatures
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)
sort
  logical scalar: Should the result be sorted by prevalence? (default: FALSE)
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

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,
    rank = "Family",
    detection = 0.001,
    prevalence = 0.55,
    as_relative = TRUE)
altExp(tse, "prevalent")

# getRareFeatures returns the inverse
rare <- getRareFeatures(tse,
    rank = "Phylum",
    detection = 1/100,
    prevalence = 50/100,
    as_relative = TRUE)
head(rare)

# Gets a subset of object that includes rare taxa
altExp(tse, "rare") <- subsetByRareFeatures(tse,
  rank = "Class",
  detection = 0.001,
  prevalence = 0.001,
  as_relative = TRUE)

altExp(tse, "rare")

# Names of both experiments, prevalent and rare, can be found from slot altExpNames
tse
data(esophagus)
getPrevalentAbundance(esophagus, assay.type = "counts")

# data can be aggregated based on prevalent taxonomic results
agglomerateByPrevalence(tse,
  rank = "Phylum",
  detection = 1/100,
  prevalence = 50/100,
  as_relative = TRUE)

GlobalPatterns

Description

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 phyloseq package, from which this data was converted to TreeSummarizedExperiment.

Usage

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
Final_Barcode  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

---

## Description

HintikkaXO 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

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

isContaminant

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  aSummarizedExperiment
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

```r
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.

- **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)
**loadFromMetaphlan**

**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
```

---

**Description**

Import Metaphlan results to `TreeSummarizedExperiment`
loadFromMetaphlan

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 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.

Value

A TreeSummarizedExperiment object

Author(s)

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

References

loadFromMothur

See Also

loadFromHumann makeTreeSEFromPhyloseq makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromQIME2

loadFromMothur

Examples

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

# File path
t_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.
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.

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

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).

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

See Also

makeTreeSEFromPhyloseq makeTreeSEFromBiom makeTreeSEFromDADA2 loadFromMothur

Examples

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 = "")
makePhyloseqFromTreeSE

Create a phyloseq object from a TreeSummarizedExperiment object

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.

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 phyloseq object that is created, (By default: tree_name = "phylo")
Details

makePhyloseqFromTreeSE is used for creating a phyloseq object from TreeSummarizedExperiment 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

Loading a biom file

Description

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

Usage

loadFromBiom(file, ...)

makeTreeSEFromBiom(
  obj,
  removeTaxaPrefixes = FALSE,
  rankFromPrefix = FALSE,
  remove.artifacts = FALSE,
  ..."
Arguments

- `file` biot file location
- `obj` object of type `biom`
- `removeTaxaPrefixes` TRUE or FALSE: Should taxonomic prefixes be removed? (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)

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",}
makeTreeSEFromDADA2

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
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
}
**makeTreeSEFromPhyloseq**

Coerce a phyloseq object to a TreeSummarizedExperiment

---

**Description**

`makeTreeSEFromPhyloseq` converts phyloseq objects into TreeSummarizedExperiment objects.

**Usage**

```r
makeTreeSEFromPhyloseq(obj)
makeTreeSummarizedExperimentFromPhyloseq(obj)
```

## S4 method for signature 'ANY'

```r
makeTreeSummarizedExperimentFromPhyloseq(obj)
```

**Arguments**

- `obj` a phyloseq object

**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 subset to given column names in `rowData`. (default: `add_row_data` = NULL)
merge-methods

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. (de-
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 syntacti-
    cally 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 analog-
ously 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.
merge-methods

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

## S4 method for signature 'TreeSummarizedExperiment'  
mergeRows(x, f, archetype = 1L, mergeTree = FALSE, mergeRefSeq = FALSE, ...)  
mergeCols(x, f, archetype = 1L, mergeTree = FALSE, ...)  
mergeFeatures(  
x,  
f,  
archetype = 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.  
archetype  
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 in-
merge-methods

teger 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 onto sumCountsAcrossFeatures, except subset_row, subset_col

mergeTree TRUE or FALSE: should to rowTree() also be merged? (Default: mergeTree = FALSE)

mergeRefSeq TRUE or FALSE: should a consensus sequence calculate? 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. Other than counts / absolute values might lead to meaningless values.

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 with the same class x with the specified entries merged into one entry in all relevant components.

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
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, ...)

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, ...)
mergeSEs

## 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`)
- **y**: a `SummarizedExperiment` object when `x` is a `SummarizedExperiment` object. Disabled when `x` is a list.

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

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

perSampleDominantTaxa

See Also
mia-datasets

---

perSampleDominantTaxa  Get dominant taxa

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

Usage

perSampleDominantFeatures(
  x,
  assay.type = assay_name,
  assay_name = "counts",
  rank = NULL,
  ...
)

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

perSampleDominantTaxa(x, ...)

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

addPerSampleDominantFeatures(x, name = "dominant_taxa", ...)

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

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()`.
- **...**: 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 the `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

```r
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

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

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

Usage

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

## S4 method for signature 'ANY'
```
calculateCCA(x, formula, variables, scores, scale = TRUE, ...)  
```

## 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, formula, variables, scores, ...)  
```

## S4 method for signature 'SummarizedExperiment'
```
calculateRDA(  
x,  
formula,  
variables,  
test.signif = TRUE,  
assay.type = assay_name,  
assay_name = exprs_values,  
```
runCCA

```r
eprs_values = "counts",
scores = "wa",
...
```

```r
## 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.

- **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.

- **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’)

- **scale**
  - A logical scalar, should the expression values be standardized? scale is disabled when using *RDA functions. Please scale before performing RDA (Check examples.)

- **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.)

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")

# 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, ...)

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

```r
## 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 `cophenetic.phylo`.

\[ y \]

\[ \text{a dist or a symmetric matrix compatible with ade4:dpcoa} \]

... 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
runNMDS

Examples

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

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

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,
  \[ \ldots \],
  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.
runNMDS

- **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.

**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**

```r
# 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

---

<table>
<thead>
<tr>
<th>splitOn</th>
<th>Split TreeSummarizedExperiment column-wise or row-wise based on grouping variable</th>
</tr>
</thead>
</table>

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)$group <- sample(1:10, nrow(tse), replace = TRUE)
colData(tse)$group <- sample(1:10, 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 modified object in which each sample has same number of total observations/counts/reads.

Usage
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,
  ...
)

## 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)
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

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))
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'
getUniqueTaxa(x, ...)

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

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**

```r
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 os specific rank
getTopFeatures(agglomerateByRank(GlobalPatterns, 
                                  rank = "Genus",
                                  na.rm = TRUE))

# Gets the overview of dominant taxa
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)

---

**taxonomy-methods**

*Functions for accessing taxonomic data stored in rowData.*

**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)
```

## S4 method for signature 'SummarizedExperiment'

taxonomyRanks(x)

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

## S4 method for signature 'SummarizedExperiment'

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

checkTaxonomy(x, ...)

## S4 method for signature 'SummarizedExperiment'

checkTaxonomy(x)

getTaxonomyLabels(x, ...)

## S4 method for signature 'SummarizedExperiment'

getTaxonomyLabels(x, ...)
```
empty.fields = c(NA, "", " ", "\t", "-", "_"),
with_rank = FALSE,
make_unique = TRUE,
resolve_loops = FALSE,
...)

taxonomyTree(x, ...)

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

addTaxonomyTree(x, ...)

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

mapTaxonomy(x, ...)

## 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 taxo-
monic 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 informa-
tion possible. If data from different levels, is to be mixed, the taxonomic level is prepended by
default.
taxonomyTree generates a phylo tree object from the available taxonomic information. Internally
it uses toTree and resolveLoop to sanitize data if needed.

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 com-
patible 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")

# adding a rowTree() based on the available taxonomic information. Please
# note that any tree already stored in rowTree() will be overwritten.
x <- GlobalPatterns
x <- addTaxonomyTree(x)
x

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/6JolaHsd 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,
  name = method,
  ...
)

## S4 method for signature 'SummarizedExperiment'
transformSamples(
  x,
  assay.type = "counts",
  assay_name = NULL,
  name = method,
transformAssay

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.
- **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 or FALSE, should the minimum value of `assay.type` be added to assay values. Alternatively, a numeric value specifying the value to be added. (default: `pseudocount = FALSE`)
- **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.
transformAssay

- `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.

\[
\log_{10} = \log_{10} x
\]

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

\[
\log_2 = \log_2 x
\]

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.
- '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

```r
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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