

# Package ‘OmicFlow’

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**Title** Fast and Efficient (Automated) Analysis of Sparse Omics Data

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**Description** A generalised data structure for fast and efficient loading and data munching of sparse omics data. The 'OmicFlow' requires an up-front validated metadata template from the user, which serves as a guide to connect all the pieces together by aligning them into a single object that is defined as an 'omics' class. Once this unified structure is established, users can perform manual subsetting, visualisation, and statistical analysis, or leverage the automated 'autoFlow' method to generate a comprehensive report.

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**BugReports** <https://github.com/agusinac/OmicFlow/issues>

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---

bray

*Compute Bray-Curtis Dissimilarity from a Dense or Sparse Matrix.*

---

## Description

Calculates the Bray-Curtis dissimilarity of a Matrix pairwise for each column.

## Usage

```
bray(x, weighted = TRUE, threads = 1)
```

**Arguments**

x	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> .
weighted	A boolean value, to use abundances (weighted = TRUE) or absence/presence (weighted=FALSE) (default: TRUE).
threads	A wholenumber, the number of threads to use in <a href="#">setThreadOptions</a> (default: 1).

**Details**

The Bray-Curtis dissimilarity between two samples  $A$  and  $B$ , each of length  $n$ , is defined as:

$$d(A, B) = \frac{\sum_i^n |A_i - B_i|}{\sum_i^n (A_i + B_i)}$$

where  $A_i$  and  $B_i$  are the abundances of the  $i$ -th feature in sample  $A$  and  $B$ , respectively. When `weighted` is set to `FALSE`, counts are replaced by presence/absence data.

**Value**

A column x column [dist](#) object.

**References**

Bray, J.R. & Curtis, J.T. (1957) An Ordination of the Upland Forest Communities of Southern Wisconsin. *Ecological Monographs*, 27(4), 325–349.

**Examples**

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")

taxa <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
  treeData = tree_file
)

taxa$feature_subset(Kingdom == "Bacteria")
taxa$normalize()

bray(taxa$countData)
```

---

canberra *Compute Canberra Dissimilarity from a from a Dense or Sparse Matrix.*

---

### Description

Calculates the Canberra dissimilarity of a Matrix pairwise for each column.

### Usage

```
canberra(x, weighted = TRUE, threads = 1)
```

### Arguments

`x` A [matrix](#), [sparseMatrix](#) or [Matrix](#).

`weighted` A boolean value, to use abundances (`weighted = TRUE`) or absence/presence (`weighted=FALSE`) (default: `TRUE`).

`threads` A wholenumber, the number of threads to use in [setThreadOptions](#) (default: 1).

### Details

The Canberra dissimilarity between two samples  $A$  and  $B$ , each of length  $n$ , is defined as:

$$d(A, B) = \frac{1/NZ^n \sum_i |A_i - B_i|}{\sum_i |A_i| + |B_i|}$$

where  $A_i$  and  $B_i$  are the abundances of the  $i$ -th feature in sample  $A$  and  $B$ , respectively.  $NZ$  is the number of non-zero entries. When `weighted` is set to `FALSE`, counts are replaced by presence/absence data.

### Value

A column x column [dist](#) object.

### References

Lance, G.N. & Williams, W.T. (1967) Mixed-data classificatory programs. I. Agglomerative systems. *Australian Computer Journal*, 1(1), 15-20.

### Examples

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")

taxa <- metagenomics$new(
  metaData = metadata_file,
```

```
countData = counts_file,
featureData = features_file,
treeData = tree_file
)

taxa$feature_subset(Kingdom == "Bacteria")
taxa$normalize()

canberra(taxa$countData)
```

---

colormap

*Color map of a variable*

---

### Description

Creates an object of hexcode colors with names given a vector of characters. This function is built into the ordination method from the abstract class [omics](#) and inherited by other omics classes, such as; [metagenomics](#) and [proteomics](#).

### Usage

```
colormap(data, col_name, Brewer.palID = "Set2")
```

### Arguments

`data` A [data.frame](#) or [data.table](#).

`col_name` A column name of a categorical variable.

`Brewer.palID` A character name that exists in [brewer.pal](#) (Default: "Set2").

### Value

A [setNames](#).

### Examples

```
library("data.table")
dt <- data.table(
  "SAMPLE_ID" = c("sample_1", "sample_2", "sample_3"),
  "treatment" = c("healthy", "tumor", NA)
)

colors <- colormap(data = dt,
  col_name = "treatment")
```

---

column_exists	<i>Checks if column exists in table</i>
---------------	-----------------------------------------

---

### Description

Mainly used within [omics](#) and other functions to check if given column name does exist in the table and is not completely empty (containing NAs).

### Usage

```
column_exists(column, table)
```

### Arguments

column	A character of length 1.
table	A <a href="#">data.table</a> or <a href="#">data.frame</a> .

### Value

A boolean value.

---

composition_plot	<i>Compositional plot</i>
------------------	---------------------------

---

### Description

Creates a stacked barchart of features. It is possible to both show barcharts for each sample or group them by a categorical variable. The function is compatible with the class [omics](#) method `composition()`.

### Usage

```
composition_plot(
  data,
  palette,
  feature_rank,
  title_name = NULL,
  group_by = NULL
)
```

### Arguments

data	A <a href="#">data.frame</a> or <a href="#">data.table</a> .
palette	An object with names and hexcode or color names, see <a href="#">colormap</a> .
feature_rank	A character variable of the feature column.
title_name	A character to set the ggtitle of the <a href="#">ggplot</a> , (Default: NULL).
group_by	A character variable to aggregate the stacked bars by group (Default: NULL).

**Value**

A `ggplot2` object to be further modified

**Examples**

```
library("ggplot2")

# Create mock_data as data.frame (data.table is also supported)
mock_data <- data.frame(
  SAMPLE_ID = rep(paste0("Sample", 1:10), each = 5),
  Genus = rep(c("GenusA", "GenusB", "GenusC", "GenusD", "GenusE"), times = 10),
  value = c(
    0.1119, 0.1303, 0.0680, 0.5833, 0.1065, # Sample1
    0.2080, 0.1179, 0.0211, 0.4578, 0.1951, # Sample2
    0.4219, 0.1189, 0.2320, 0.1037, 0.1235, # Sample3
    0.4026, 0.0898, 0.1703, 0.1063, 0.2309, # Sample4
    0.1211, 0.0478, 0.5721, 0.1973, 0.0618, # Sample5
    0.2355, 0.0293, 0.2304, 0.1520, 0.3528, # Sample6
    0.2904, 0.0347, 0.3651, 0.0555, 0.2544, # Sample7
    0.4138, 0.0299, 0.0223, 0.4996, 0.0345, # Sample8
    0.4088, 0.0573, 0.0155, 0.2888, 0.2296, # Sample9
    0.4941, 0.0722, 0.2331, 0.1023, 0.0983 # Sample10
  ),
  Group = rep(c("Group1", "Group2", "Group1",
                "Group1", "Group2", "Group2",
                "Group1", "Group1", "Group1", "Group2"),
              each = 5)
)

# Create a colormap
mock_palette <- c(
  GenusA = "#1f77b4", # blue
  GenusB = "#ff7f0e", # orange
  GenusC = "#2ca02c", # green
  GenusD = "#d62728", # red
  GenusE = "#9467bd" # purple
)

# Optionally: Use OmicFlow::colormap()
mock_palette <- colormap(
  data = mock_data,
  col_name = "Genus",
  Brewer.palID = "RdYlBu"
)

composition_plot(
  data = mock_data,
  palette = mock_palette,
  feature_rank = "Genus",
  title_name = "Mock Genus Composition"
)
```

```
composition_plot(
  data = mock_data,
  palette = mock_palette,
  feature_rank = "Genus",
  title_name = "Mock Genus Composition by Group",
  group_by = "Group"
)
```

---

cosine

---

*Compute Cosine Dissimilarity from a Dense or Sparse Matrix.*


---

### Description

Calculates the cosine dissimilarity of a Matrix pairwise for each column.

### Usage

```
cosine(x, weighted = TRUE, threads = 1)
```

### Arguments

x	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> .
weighted	A boolean value, to use abundances (weighted = TRUE) or absence/presence (weighted=FALSE) (default: TRUE).
threads	A wholenumber, the number of threads to use in <a href="#">setThreadOptions</a> (default: 1).

### Details

The cosine dissimilarity between two samples  $A$  and  $B$ , each of length  $n$ , is defined as:

$$d(A, B) = 1 - \frac{\sum_i^n A_i B_i}{\sqrt{\sum_i^n A_i^2} \sqrt{\sum_i^n B_i^2}}$$

where  $A_i$  and  $B_i$  are the abundances of the  $i$ -th feature in sample  $A$  and  $B$ , respectively. When weighted is set to FALSE, counts are replaced by presence/absence data.

### Value

A column x column [dist](#) object.

### References

Deza, M. M., & Deza, E. (2009). Encyclopedia of Distances. Springer Science & Business Media., 308.

## Examples

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")

taxa <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
  treeData = tree_file
)

taxa$feature_subset(Kingdom == "Bacteria")
taxa$normalize()

cosine(taxa$countData)
```

---

diversity

*Sparse implementation of Alpha Diversity Metrics*

---

## Description

Computes the alpha diversity based on Shannon index, simpson or invsimpson. Code is adapted from [diversity](#) and uses [sparseMatrix](#) in triplet format over the dense matrix. The code is much faster and memory efficient, while still being mathematically correct. This function is built into the class [omics](#) with method `alpha_diversity()` and inherited by other omics classes, such as [metagenomics](#) and [proteomics](#).

## Usage

```
diversity(
  x,
  metric = c("shannon", "simpson", "invsimpson"),
  normalize = TRUE,
  base = exp(1)
)
```

## Arguments

x	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> .
metric	A character variable for metric; shannon, simpson or invsimpson.
normalize	A boolean variable for sample normalization by column sums.
base	Input for <a href="#">log</a> to use natural logarithmic scale, log2, log10 or other.

**Value**

A numeric vector with type double.

**See Also**

[diversity](#)

**Examples**

```
n_row <- 1000
n_col <- 100
density <- 0.2
num_entries <- n_row * n_col
num_nonzero <- round(num_entries * density)

set.seed(123)
positions <- sample(num_entries, num_nonzero, replace=FALSE)
row_idx <- ((positions - 1) %% n_row) + 1
col_idx <- ((positions - 1) %% n_row) + 1

values <- runif(num_nonzero, min = 0, max = 1)
sparse_mat <- sparseMatrix(
  i = row_idx,
  j = col_idx,
  x = values,
  dims = c(n_row, n_col)
)

# Alpha diversity is computed on column level
## Transpose the sparseMatrix if required with t() from Matrix R package.
result <- OmicFlow::diversity(
  x = sparse_mat,
  metric = "shannon"
)
```

---

diversity\_plot

*Diversity plot*

---

**Description**

Creates an Alpha diversity plot. This function is built into the class [omics](#) with method `alpha_diversity()`. It computes the pairwise wilcox test, paired or non-paired, given a data frame and adds useful labelling.

**Usage**

```
diversity_plot(
  data,
  values,
```

```

    col_name,
    group_by = NULL,
    palette,
    method,
    paired = FALSE,
    p.adjust.method = "fdr"
  )

```

### Arguments

<code>data</code>	A <a href="#">data.frame</a> or <a href="#">data.table</a> computed from <a href="#">diversity</a> .
<code>values</code>	A column name of a continuous variable.
<code>col_name</code>	A column name of a categorical variable.
<code>group_by</code>	A column name to perform grouped statistical test (default: NULL).
<code>palette</code>	An object with names and hexcode or color names, see <a href="#">colormap</a> .
<code>method</code>	A character variable indicating what method is used to compute the diversity.
<code>paired</code>	A boolean value to perform paired analysis in <a href="#">wilcox.test</a> .
<code>p.adjust.method</code>	A character variable to specify the <code>p.adjust.method</code> to be used (Default: <code>fdr</code> ).

### Value

A [ggplot2](#) object to be further modified

### Examples

```

library("ggplot2")

n_row <- 1000
n_col <- 100
density <- 0.2
num_entries <- n_row * n_col
num_nonzero <- round(num_entries * density)

set.seed(123)
positions <- sample(num_entries, num_nonzero, replace=FALSE)
row_idx <- ((positions - 1) %% n_row) + 1
col_idx <- ((positions - 1) %% n_row) + 1

values <- runif(num_nonzero, min = 0, max = 1)
sparse_mat <- Matrix::sparseMatrix(
  i = row_idx,
  j = col_idx,
  x = values,
  dims = c(n_row, n_col)
)

div <- OmicFlow::diversity(
  x = sparse_mat,

```

```

    metric = "shannon"
  )

dt <- data.table::data.table(
  "shannon" = div,
  "treatment" = c(rep("healthy", n_col / 2), rep("tumor", n_col / 2)),
  "sex" = c(rep("male", n_col / 4), rep("female", n_col / 4))
)

colors <- OmicFlow::colormap(dt, "treatment")

# Comparing two groups
plt <- OmicFlow::diversity_plot(
  data = dt,
  values = "shannon",
  col_name = "treatment",
  palette = colors,
  method = "shannon",
  paired = FALSE,
  p.adjust.method = "fdr"
)

# Performing a test while stratifying the plot in two groups
plt <- OmicFlow::diversity_plot(
  data = dt,
  values = "shannon",
  col_name = "treatment",
  group_by = "sex",
  palette = colors,
  method = "shannon",
  paired = FALSE,
  p.adjust.method = "fdr"
)

```

---

foldchange

*Computes  $\text{Log}_2(A) - \text{Log}_2(B)$  Fold Change of (non-) paired data.*


---

### Description

Computes (non-)paired  $\text{Log}_2(A) - \text{Log}_2(B)$  Fold Change. This function is built into the class `omics` with method `DFE()` and inherited by other omics classes, such as; `metagenomics` and `proteomics`. The function handles zero's, and doesn't return +/- infinities.

### Usage

```

foldchange(
  data,
  feature_rank,
  condition_A,
  condition_B,

```

```

    condition_labels,
    paired = FALSE
  )

```

### Arguments

**data** A [data.table](#).

**feature\_rank** A character variable of the feature level (e.g. "Genus" in taxonomy).

**condition\_A** A vector of categorical characters, it is possible to specify multiple labels.

**condition\_B** A vector of categorical characters, it is possible to specify multiple labels.

**condition\_labels** A vector character wherein condition\_A and condition\_B are present.

**paired** A Boolean value to perform paired or non-paired test, see [wilcox.test](#).

### Value

A [data.table](#)

### Examples

```

#-----#
##      NON-PAIRED      ##
#-----#
library(data.table)

# Define parameters and variables
sample_ids <- c("S1", "S2", "S3", "S4", "S5", "S6")
groups <- c("A", "A", "B", "B", "C", "C")
feature_ids <- c("Feature1", "Feature2", "Feature3")

# Simulated abundance matrix (features x samples)
abundances <- matrix(
  c(
    100, 120, 110, 55, 60, 65,
    50, 65, 60, 130, 120, 125,
    80, 85, 90, 80, 85, 90
  ),
  nrow = 3, byrow = TRUE,
  dimnames = list(feature_ids, sample_ids)
)

# Convert to a data.table
mock_data <- OmicFlow::matrix_to_dtable(abundances)
mock_data$Genus <- feature_ids

# It uses exact matching and multiple conditions are allowed.
res <- foldchange(
  data = mock_data,
  feature_rank = "Genus",
  condition_A = c("A", "B"),

```

```

    condition_B = c("B", "C"),
    condition_labels = groups,
    paired = FALSE
  )
  print(res)

#-----#
##      PAIRED      ##
#-----#
library(data.table)

# In the paired case both conditions A and B must be of the same length!
# We re-use the above mock_data and only change group labels
groups <- c("A", "A", "B", "B", "A", "B")

res <- foldchange(
  data = mock_data,
  feature_rank = "Genus",
  condition_A = c("A"),
  condition_B = c("B"),
  condition_labels = groups,
  paired = TRUE
)
print(res)

```

---

hill\_taxa

*Sparse implementation of Hill numbers*


---

### Description

Computes the hill numbers for  $q$  is 0, 1 or 2. Code is adapted from [hill\\_taxa](#) and uses `sparseMatrix` in triplet format over the dense matrix. The code is much faster and memory efficient, while still being mathematical correct.

### Usage

```
hill_taxa(x, q = 0, normalize = TRUE, base = exp(1))
```

### Arguments

<code>x</code>	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> .
<code>q</code>	A wholenumber for 0, 1 or 2, default is 0.
<code>normalize</code>	A boolean variable for sample normalization by column sums.
<code>base</code>	Input for <a href="#">log</a> to use natural logarithmic scale, log2, log10 or other.

### Value

A numeric vector with type double.

**See Also**[hill\\_taxa](#)**Examples**

```

library("Matrix")

n_row <- 1000
n_col <- 100
density <- 0.2
num_entries <- n_row * n_col
num_nonzero <- round(num_entries * density)

set.seed(123)
positions <- sample(num_entries, num_nonzero, replace=FALSE)
row_idx <- ((positions - 1) %% n_row) + 1
col_idx <- ((positions - 1) %% n_row) + 1

values <- runif(num_nonzero, min = 0, max = 1)
sparse_mat <- sparseMatrix(
  i = row_idx,
  j = col_idx,
  x = values,
  dims = c(n_row, n_col)
)

result <- OmicFlow::hill_taxa(
  x = sparse_mat,
  q = 2
)

```

jaccard

*Compute Jaccard Dissimilarity from a Dense or Sparse Matrix.***Description**

Calculates the Jaccard dissimilarity of a Matrix pairwise for each column.

**Usage**

```
jaccard(x, weighted = TRUE, threads = 1)
```

**Arguments**

x	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> .
weighted	A boolean value, to use abundances (weighted = TRUE) or absence/presence (weighted=FALSE) (default: TRUE).
threads	A wholenumber, the number of threads to use in <a href="#">setThreadOptions</a> (default: 1).

**Details**

The weighted Jaccard dissimilarity between two samples  $A$  and  $B$ , each of length  $n$ , is defined as:

$$d(A, B) = 1 - \frac{\sum_i^n \min(A_i, B_i)}{\sum_i^n \max(A_i, B_i)}$$

where  $A_i$  and  $B_i$  are the abundances of the  $i$ -th feature in sample  $A$  and  $B$ , respectively. When `weighted` is set to `FALSE`, abundances are changed to 1 (classical Jaccard for binary data).

**Value**

A column x column `dist` object.

**References**

Jaccard, P. (1912) The distribution of the flora in the alpine zone. *New Phytologist*, 11(2), 37–50.  
`library("OmicFlow")`

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")
```

```
taxa <- metagenomics$new( metaData = metadata_file, countData = counts_file, featureData = features_file, treeData = tree_file )
```

```
taxa$feature_subset(Kingdom == "Bacteria") taxa$normalize()
```

```
jaccard(taxa$countData)
```

---

 jsd

---

*Compute Jensen-Shannon Divergence from a Dense or Sparse Matrix.*


---

**Description**

Calculates the Jensen-Shannon divergence of a Matrix pairwise for each column.

**Usage**

```
jsd(x, weighted = TRUE, threads = 1)
```

**Arguments**

<code>x</code>	A <code>matrix</code> , <code>sparseMatrix</code> or <code>Matrix</code> .
<code>weighted</code>	A boolean value, to use abundances ( <code>weighted = TRUE</code> ) or absence/presence ( <code>weighted=FALSE</code> ) (default: <code>TRUE</code> ).
<code>threads</code>	A wholenumber, the number of threads to use in <code>setThreadOptions</code> (default: 1).

**Details**

The Jensen-Shannon divergence between two probability distributions  $A$  and  $B$ , each of length  $n$ , is defined as:

$$d(A, B) = \frac{1}{2}D_{KL}(A \parallel M) + \frac{1}{2}D_{KL}(B \parallel M)$$

where  $M = \frac{1}{2}(A + B)$  is the mixture distribution, and  $D_{KL}$  is the Kullback-Leibler divergence. When `weighted` is set to `FALSE`, counts are replaced by presence/absence data.

**Value**

A column x column `dist` object.

**References**

Lin, J. (1991). Divergence measures based on the Shannon entropy. *IEEE Transactions on Information Theory*, 37(1), 145-151.

**Examples**

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")

taxa <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
  treeData = tree_file
)

taxa$feature_subset(Kingdom == "Bacteria")
taxa$normalize()

jsd(taxa$countData)
```

---

manhattan

---

*Compute Manhattan Dissimilarity from a Dense or Sparse Matrix.*


---

**Description**

Calculates the Manhattan dissimilarity of a Matrix pairwise for each column.

**Usage**

```
manhattan(x, weighted = TRUE, threads = 1)
```

**Arguments**

x	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> .
weighted	A boolean value, to use abundances (weighted = TRUE) or absence/presence (weighted=FALSE) (default: TRUE).
threads	A wholenumber, the number of threads to use in <a href="#">setThreadOptions</a> (default: 1).

**Details**

The Manhattan dissimilarity between two samples  $A$  and  $B$ , each of length  $n$ , is defined as:

$$d(A, B) = \sum_i^n |A_i - B_i|$$

where  $A_i$  and  $B_i$  are the abundances of the  $i$ -th feature in sample  $A$  and  $B$ , respectively. When weighted is set to FALSE, counts are replaced by presence/absence data.

**Value**

A column x column [dist](#) object.

**References**

Deza, M. M., & Deza, E. (2009). Encyclopedia of Distances. Springer Science & Business Media., 313.

**Examples**

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")

taxa <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
  treeData = tree_file
)

taxa$feature_subset(Kingdom == "Bacteria")
taxa$normalize()

manhattan(taxa$countData)
```

---

matrix_to_dtable	<i>Converting a Matrix to data.table</i>
------------------	------------------------------------------

---

### Description

Wrapper function that converts a sparseMatrix to data.table

### Usage

```
matrix_to_dtable(x)
```

### Arguments

x                    A [matrix](#), [sparseMatrix](#) or [Matrix](#).

### Value

A [data.table](#) class.

---

metagenomics	<i>Sub-class metagenomics</i>
--------------	-------------------------------

---

### Description

This is a sub-class that is compatible to data obtained from either 16S rRNA marker-gene sequencing or shot-gun metagenomics sequencing. It inherits all methods from the abstract class [omics](#) and only adapts the `initialize` function. It supports BIOM format data (v2.1.0 from <http://biom-format.org/>) in both HDF5 and JSON format, also pre-existing data structures can be used or text files. When omics data is very large, data loading becomes very expensive. It is therefore recommended to use the `reset()` method to reset your changes. Every omics class creates an internal memory efficient back-up of the data, the resetting of changes is an instant process.

### Super class

```
OmicFlow::omics -> metagenomics
```

### Active bindings

treeData A "phylo" class, see [as.phylo](#).

## Methods

### Public methods:

- [metagenomics\\$new\(\)](#)
- [metagenomics\\$write\\_biom\(\)](#)
- [metagenomics\\$clone\(\)](#)

**Method** `new()`: Initializes the metagenomics class object with `metagenomics$new()`

*Usage:*

```
metagenomics$new(
  countData = NULL,
  metaData = NULL,
  featureData = NULL,
  treeData = NULL,
  biomData = NULL,
  feature_names = c("Kingdom", "Phylum", "Class", "Order", "Family", "Genus", "Species")
)
```

*Arguments:*

`countData` A path to an existing file or a dense/sparse [Matrix](#) format.

`metaData` A path to an existing file, [data.table](#) or `data.frame`.

`featureData` A path to an existing file, [data.table](#) or `data.frame`.

`treeData` A path to an existing newick file or class "phylo", see [read.tree](#).

`biomData` A path to an existing biom file, version 2.1.0 (<http://biom-format.org/>), see [h5read](#).

`feature_names` A character vector to name the feature names that fit the supplied `featureData`.

*Returns:* A new metagenomics object.

**Method** `write_biom()`: Creates a BIOM file in HDF5 format of the loaded items via `'new()'`, which is compatible to the python biom-format version 2.1, see <http://biom-format.org>.

*Usage:*

```
metagenomics$write_biom(filename)
```

*Arguments:*

`filename` A character variable of either the full path of filename of the biom file (e.g. `output.biom`)

*Examples:*

```
library("OmicFlow")
```

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")
```

```
taxa <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
  treeData = tree_file
```

```
)  
  
taxa$write_biom(filename = "output.biom")  
file.remove("output.biom")
```

**Method** `clone()`: The objects of this class are cloneable with this method.

*Usage:*

```
metagenomics$clone(deep = FALSE)
```

*Arguments:*

`deep` Whether to make a deep clone.

## See Also

[omics](#)

## Examples

```
## -----  
## Method `metagenomics$write_biom`  
## -----  
  
library("OmicFlow")  
  
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")  
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")  
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")  
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")  
  
taxa <- metagenomics$new(  
  metaData = metadata_file,  
  countData = counts_file,  
  featureData = features_file,  
  treeData = tree_file  
)  
  
taxa$write_biom(filename = "output.biom")  
file.remove("output.biom")
```

---

omics

*Abstract omics class*

---

## Description

This is the abstract class 'omics', contains a variety of methods that are inherited and applied in the omics classes: [metagenomics](#), proteomics and metabolomics.

## Details

Every class is created with the [R6Class](#) method. Methods are either public or private, and only the public components are inherited by other omic classes. The omics class by default uses a [sparseMatrix](#) and [data.table](#) data structures for quick and efficient data manipulation and returns the object by reference, same as the R6 class. The method by reference is very efficient when dealing with big data.

## Value

A list of components:

- div A [data.frame](#) from [diversity](#).
- stats A pairwise statistics from [pairwise\\_wilcox\\_test](#).
- plot A [ggplot](#) object.

A list of components:

- data A [data.table](#) of feature compositions.
- palette A [setNames](#) palette from [colormap](#).

A list of components:

- distmat A distance dissimilarity in [matrix](#) format.
- stats A statistical test as a [data.frame](#).
- pcs principal components as a [data.frame](#).
- scree\_plot A [ggplot](#) object.
- anova\_plot A [ggplot](#) object.
- scores\_plot A [ggplot](#) object.
- dfe A long [data.table](#) table.
- volcano\_plot A [ggplot](#) object.

## Active bindings

metaData A [data.table](#) with SAMPLE\_ID column.

featureData A [data.table](#) with FEATURE\_ID column.

countData A dense or sparse [Matrix](#).

## Methods

### Public methods:

- [omics\\$new\(\)](#)
- [omics\\$validate\(\)](#)
- [omics\\$print\(\)](#)
- [omics\\$reset\(\)](#)
- [omics\\$removeNAs\(\)](#)

- `omics$feature_subset()`
- `omics$sample_subset()`
- `omics$samplepair_subset()`
- `omics$feature_merge()`
- `omics$transform()`
- `omics$normalize()`
- `omics$rankstat()`
- `omics$alpha_diversity()`
- `omics$composition()`
- `omics$distance()`
- `omics$ordination()`
- `omics$DFE()`
- `omics$autoFlow()`
- `omics$clone()`

**Method** `new()`: Wrapper function that is inherited and adapted for each omics class. The omics classes requires a metadata samplesheet, that is validated by the `metadata_schema.json`. It requires a column `SAMPLE_ID` and optionally a `SAMPLEPAIR_ID` can be supplied. The `SAMPLE_ID` will be used to link the `metaData` to the `countData`, and will act as the key during subsetting of other columns. To create a new object use `new()` method. Do notice that the abstract class only checks if the metadata is valid! The `countData` and `featureData` will not be checked, these are handled by the sub-classes. Using the omics class to load your data is not supported and still experimental.

*Usage:*

```
omics$new(countData = NULL, featureData = NULL, metaData = NULL)
```

*Arguments:*

`countData` A path to an existing file or a dense/sparse [Matrix](#) format.

`featureData` A path to an existing file, [data.table](#) or `data.frame`.

`metaData` A path to an existing file, [data.table](#) or `data.frame`.

*Returns:* A new omics object.

**Method** `validate()`: Validates an input metadata against the JSON schema. The metadata should look as follows and should not contain any empty spaces. For example; 'sample 1' is not allowed, whereas 'sample1' is allowed!

Acceptable column headers:

- `SAMPLE_ID` (required)
- `SAMPLEPAIR_ID` (optional)
- `CONTRAST_` (optional), used for `autoFlow()`.
- `VARIABLE_` (optional), not supported yet.

This function is used during the creation of a new object via `new()` to validate the supplied metadata via a filepath or existing [data.table](#) or `data.frame`.

*Usage:*

```
omics$validate()
```

*Returns:* None

**Method** `print()`: Displays parameters of the omics class via stdout.

*Usage:*

```
omics$print()
```

*Returns:* object in place

*Examples:*

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")

obj <- omics$new(
  metaData = metadata_file,
  countData = counts_file
)

# method 1 to call print function
obj

# method 2 to call print function
obj$print()
```

**Method** `reset()`: Upon creation of a new omics object a small backup of the original data is created. Since modification of the object is done by reference and duplicates are not made, it is possible to reset changes to the class. The methods from the abstract class `omics` also contains a private method to prevent any changes to the original object when using methods such as ordination `alpha_diversity` or `$DFE`.

*Usage:*

```
omics$reset()
```

*Returns:* object in place

*Examples:*

```
library(ggplot2)
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

taxa <- omics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file
)

# Performs modifications
taxa$transform(log2)
```

```
# resets
taxa$reset()

# An inbuilt reset function prevents unwanted modification to the taxa object.
taxa$rankstat(feature_ranks = c("Kingdom", "Phylum", "Family", "Genus", "Species"))
```

**Method** `removeNAs()`: Remove NAs from metaData and updates the countData.

*Usage:*

```
omics$removeNAs(column)
```

*Arguments:*

`column` The column from where NAs should be removed, this can be either a wholenumbers or characters. Vectors are also supported.

*Returns:* object in place

*Examples:*

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$removeNAs(column = "treatment")
```

**Method** `feature_subset()`: Feature subset (based on featureData), automatically applies data synchronization.

*Usage:*

```
omics$feature_subset(...)
```

*Arguments:*

`...` Expressions that return a logical value, and are defined in terms of the variables in featureData. Only rows for which all conditions evaluate to TRUE are kept.

*Returns:* object in place

*Examples:*

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
```

```
obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$feature_subset(Genus == "Pseudomonas")
```

**Method** `sample_subset()`: Sample subset (based on `metaData`), automatically applies synchronization.

*Usage:*

```
omics$sample_subset(...)
```

*Arguments:*

... Expressions that return a logical value, and are defined in terms of the variables in `metaData`. Only rows for which all conditions evaluate to TRUE are kept.

*Returns:* object in place

*Examples:*

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$sample_subset(treatment == "tumor")
```

**Method** `samplepair_subset()`: Samplepair subset (based on `metaData`), automatically applies synchronization.

*Usage:*

```
omics$samplepair_subset(num_unique_pairs = NULL)
```

*Arguments:*

`num_unique_pairs` An integer value to define the number of pairs to subset. The default is NULL, meaning the maximum number of unique pairs will be used to subset the data. Let's say you have three samples for each pair, then the `num_unique_pairs` will be set to 3.

*Returns:* object in place

**Method** `feature_merge()`: Agglomerates features by column, automatically applies synchronization.

*Usage:*

```
omics$feature_merge(feature_rank, feature_filter = NULL)
```

*Arguments:*

feature\_rank A character value or vector of columns to aggregate from the featureData.

feature\_filter A character value or vector of characters to remove features via regex pattern.

*Returns:* object in place

*Examples:*

```
library("OmicFlow")
```

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
```

```
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
```

```
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
```

```
obj <- metagenomics$new(  
  metaData = metadata_file,  
  countData = counts_file,  
  featureData = features_file,  
)
```

```
obj$feature_merge(feature_rank = c("Kingdom", "Phylum"))
```

```
obj$feature_merge(feature_rank = "Genus", feature_filter = c("uncultured", "metagenome"))
```

**Method transform():** Performs transformation on the positive values from the countData.

*Usage:*

```
omics$transform(FUN)
```

*Arguments:*

FUN A function such as log2, log

*Returns:* object in place

*Examples:*

```
library("OmicFlow")
```

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
```

```
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
```

```
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
```

```
obj <- metagenomics$new(  
  metaData = metadata_file,  
  countData = counts_file,  
  featureData = features_file,  
)
```

```
obj$transform(log2)
```

**Method** `normalize()`: Relative abundance computation by column sums on the `countData`.

*Usage:*

```
omics$normalize()
```

*Returns:* object in place

*Examples:*

```
library("OmicFlow")
```

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
```

```
obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)
```

```
obj$normalize()
```

**Method** `rankstat()`: Rank statistics based on `featureData`

*Usage:*

```
omics$rankstat(feature_ranks, unique = FALSE)
```

*Arguments:*

`feature_ranks` A vector of characters or integers that match the `featureData`.

`unique` A boolean value to display only unique entries in `feature_ranks`.

*Details:* Counts the number of features identified for each column, for example in case of 16S metagenomics it would be the number of OTUs or ASVs on different taxonomy levels.

*Returns:* A [ggplot](#) object.

*Examples:*

```
library("ggplot2")
library("OmicFlow")
```

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
```

```
obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)
```

```
plt <- obj$rankstat(feature_ranks = c("Kingdom", "Phylum", "Family", "Genus", "Species"))
plt
```

**Method** `alpha_diversity()`: Alpha diversity based on [diversity](#)

*Usage:*

```
omics$alpha_diversity(
  col_name,
  metric = c("shannon", "invsimpson", "simpson"),
  Brewer.palID = "Set2",
  group_by = NULL,
  evenness = FALSE,
  paired = FALSE,
  p.adjust.method = "fdr"
)
```

*Arguments:*

`col_name` A character variable from the metaData.  
`metric` An alpha diversity metric as input to [diversity](#).  
`Brewer.palID` A character name for the palette set to be applied, see [brewer.pal](#) or [colormap](#).  
`group_by` A column name to perform grouped statistical test in [diversity\\_plot](#) (default: NULL).  
`evenness` A boolean whether to divide diversity by number of species, see [specnumber](#).  
`paired` A boolean value to perform paired analysis in [wilcox.test](#) and samplepair subsetting via [samplepair\\_subset\(\)](#)  
`p.adjust.method` A character variable to specify the p.adjust.method to be used, default is 'fdr'.

*Examples:*

```
library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

plt <- obj$alpha_diversity(col_name = "treatment",
  metric = "shannon")
```

**Method** `composition()`: Creates a table most abundant compositional features. Also assigns a color blind friendly palette for visualizations.

*Usage:*

```
omics$composition(
  feature_rank,
  feature_filter = NULL,
  col_name = NULL,
```

```

normalize = TRUE,
feature_top = c(10, 15),
Brewer.palID = "RdYlBu"
)

```

*Arguments:*

`feature_rank` A character variable in `featureData` to aggregate via `feature_merge()`.

`feature_filter` A character or vector of characters to removes features by regex pattern.

`col_name` Optional, a character or vector of characters to add to the final compositional data output.

`normalize` A boolean value, whether to `normalize()` by total sample sums (Default: TRUE).

`feature_top` A wholenumber of the top features to visualize, the max is 15, due to a limit of palettes.

`Brewer.palID` A character name for the palette set to be applied, see `brewer.pal` or `colormap`.

*Examples:*

```

library("ggplot2")
library("OmicFlow")

```

```

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

```

```

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

```

```

result <- obj$composition(feature_rank = "Genus",
  feature_filter = c("uncultured"),
  feature_top = 10)

```

```

plt <- composition_plot(data = result$data,
  palette = result$palette,
  feature_rank = "Genus")

```

**Method** `distance()`: Compute a distance metric from `countData`

*Usage:*

```
omics$distance(metric, normalized = TRUE, weighted = TRUE, threads = 1)
```

*Arguments:*

`metric` A dissimilarity metric to be applied on the `countData`, thus far supports 'bray', 'jaccard', 'cosine', 'manhattan', 'jsd' (jensen-shannon divergence), 'canberra' and 'unifrac' when a tree is provided via `treeData`, see `distance()`.

`normalized` A boolean value, whether to `normalize()` by total sample sums (Default: TRUE).

`weighted` A boolean value, to use abundances (`weighted = TRUE`) or absence/presence (`weighted=FALSE`) (default: TRUE).

threads A wholenumber, indicating the number of threads to use (Default: 1).

Returns: A column x column [dist](#) object.

Examples:

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file
)

obj$feature_subset(Kingdom == "Bacteria")
dist <- obj$distance(metric = "bray")
```

**Method** ordination(): Ordination of countData with statistical testing.

Usage:

```
omics$ordination(
  metric = "bray",
  method = c("pcoa", "nmds"),
  group_by,
  distmat = NULL,
  weighted = TRUE,
  normalize = TRUE,
  threads = 1,
  perm_design = NULL,
  perm = 999
)
```

Arguments:

metric A dissimilarity or similarity metric to be applied on the countData, thus far supports 'bray', 'jaccard', 'cosine', 'manhattan', 'jsd' (jensen-shannon divergence), 'canberra' and 'unifrac' when a tree is provided via treeData, see [distance\(\)](#).

method Ordination method, supports "pcoa" and "nmds", see [wcmdscales](#).

group\_by A character variable in metaData to be used for the [pairwise\\_adonis](#) or [pairwise\\_anosim](#) statistical test.

distmat A custom distance matrix in either [dist](#) or [Matrix](#) format.

weighted A boolean value, whether to compute weighted or unweighted dissimilarities (Default: TRUE).

normalize A boolean value, whether to [normalize\(\)](#) by total sample sums (Default: TRUE).

threads A wholenumber, indicating the number of threads to use (Default: 1).

perm\_design A function that takes metaData and constructs a permutation design with [how](#) (default: NULL).

perm A wholenumber, number of permutations to compare against the null hypothesis of [adonis2](#) and [anosim](#) (default: perm=999).

*Examples:*

```
library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

pcoa_plots <- obj$ordination(metric = "bray",
                             method = "pcoa",
                             group_by = "treatment",
                             weighted = TRUE,
                             normalize = TRUE)

pcoa_plots
```

**Method DFE():** Differential feature expression (DFE) using the [foldchange](#) for both paired and non-paired test.

*Usage:*

```
omics$DFE(
  feature_rank,
  feature_filter = NULL,
  paired = FALSE,
  normalize = TRUE,
  condition.group,
  condition_A,
  condition_B,
  pvalue.threshold = 0.05,
  logfold.threshold = 0.06,
  abundance.threshold = 0
)
```

*Arguments:*

`feature_rank` A character or vector of characters in the `featureData` to aggregate via [feature\\_merge\(\)](#).

`feature_filter` A character or vector of characters to remove features via regex pattern (Default: NULL).

`paired` A boolean value, the paired is only applicable when a `SAMPLEPAIR_ID` column exists within the `metaData`. See [wilcox.test](#) and [samplepair\\_subset\(\)](#).

`normalize` A boolean value, whether to [normalize\(\)](#) by total sample sums (Default: TRUE).

`condition.group` A character variable of an existing column name in `metaData`, wherein the conditions A and B are located.

`condition_A` A character value or vector of characters.

`condition_B` A character value or vector of characters.

`pvalue.threshold` A numeric value used as a p-value threshold to label and color significant features (Default: 0.05).

`logfold.threshold` A numeric value used as a fold-change threshold to label and color significantly expressed features (Default: 0.06).

`abundance.threshold` A numeric value used as an abundance threshold to size the scatter dots based on their mean abundance (default: 0.01).

*Examples:*

```
library("ggplot2")
library("OmicFlow")
```

```
metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
```

```
obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)
```

```
unpaired <- obj$DFE(feature_rank = "Genus",
  paired = FALSE,
  condition.group = "treatment",
  condition_A = c("healthy"),
  condition_B = c("tumor"))
```

**Method** `autoFlow()`: Automated Omics Analysis based on the `metaData`, see `validate()`. For now only works with headers that start with prefix `CONTRAST_`. If the data is from the class `omics` or `proteomics` than FDR adjusted p-values are computed for the volcano plots.

*Usage:*

```
omics$autoFlow(
  feature_contrast = "FEATURE_ID",
  feature_filter = NULL,
  feature_ranks = NULL,
  distance_metrics = c("unifrac"),
  beta_div_table = NULL,
  alpha_div_table = NULL,
  normalize = TRUE,
  weighted = TRUE,
  pvalue.threshold = 0.05,
  logfold.threshold = 1,
  abundance.threshold = 0.01,
```

```

perm = 999,
threads = 1,
report = TRUE,
filename = paste0(getwd(), "/report.html")
)

```

*Arguments:*

`feature_contrast` A character vector of feature columns in the `featureData` to aggregate via `feature_merge()` (default: "FEATURE\_ID").

`feature_filter` A character vector to filter unwanted features, (default: NULL).

`feature_ranks` A character vector as input to `rankstat()` (default: NULL).

`distance_metrics` A character vector specifying what (dis)similarity metrics to use (default: `c("unifrac")`).

`beta_div_table` A path to an existing file or a dense/sparse `Matrix` format (default: NULL).

`alpha_div_table` A path to pre-computed alpha diversity table, with columns: `alpha_div` (containing diversity values) and the same `CONTRAST` columns from `metaData` (default: NULL).

`normalize` A boolean value, whether to `normalize()` by total sample sums (default: TRUE).

`weighted` A boolean value, whether to compute weighted or unweighted dissimilarities (default: TRUE).

`pvalue.threshold` A numeric value, the p-value is used to include/exclude composition and foldchanges plots coming from alpha- and beta diversity analysis (default: 0.05).

`logfold.threshold` A numeric value used as a fold-change threshold to label and color significantly expressed features, see `DFE()` (Default: 1).

`abundance.threshold` A numeric value used as an abundance threshold to size the scatter dots based on their mean abundance, see `DFE()` (default: 0.01).

`perm` A wholenumber, number of permutations to compare against the null hypothesis of `adonis2` or `anosim` (default: 999).

`threads` Number of threads to use, only used in `distance()` when `beta_div_table` is not supplied (default: 1).

`report` A boolean value to create a HTML markdown report (default: FALSE). If FALSE a nested list of the plots and data is returned.

`filename` A character to name the HTML report to be saved in the current working directory (default: `paste0(getwd(), "/report.html")`). The `getwd()` is required for `rmarkdown` to save it in the right path.

*Returns:* List of plots/data or rendered HTML report

**Method** `clone()`: The objects of this class are cloneable with this method.

*Usage:*

```
omics$clone(deep = FALSE)
```

*Arguments:*

`deep` Whether to make a deep clone.

**See Also**

[diversity\\_plot](#)  
[composition\\_plot](#)  
[bray](#), [canberra](#), [cosine](#), [jaccard](#), [jsd](#), [manhattan](#), [unifrac](#)  
[ordination\\_plot](#), [plot\\_pairwise\\_stats](#), [pairwise\\_anosim](#), [pairwise\\_adonis](#)  
[volcano\\_plot](#), [foldchange](#)

**Examples**

```

## -----
## Method `omics$print`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")

obj <- omics$new(
  metaData = metadata_file,
  countData = counts_file
)

# method 1 to call print function
obj

# method 2 to call print function
obj$print()

## -----
## Method `omics$reset`
## -----

library(ggplot2)
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

taxa <- omics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file
)

# Performs modifications
taxa$transform(log2)

```

```

# resets
taxa$reset()

# An inbuilt reset function prevents unwanted modification to the taxa object.
taxa$rankstat(feature_ranks = c("Kingdom", "Phylum", "Family", "Genus", "Species"))

## -----
## Method `omics$removeNAs`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$removeNAs(column = "treatment")

## -----
## Method `omics$feature_subset`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$feature_subset(Genus == "Pseudomonas")

## -----
## Method `omics$sample_subset`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")

```

```

features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$sample_subset(treatment == "tumor")

## -----
## Method `omics$feature_merge`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$feature_merge(feature_rank = c("Kingdom", "Phylum"))
obj$feature_merge(feature_rank = "Genus", feature_filter = c("uncultured", "metagenome"))

## -----
## Method `omics$transform`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$transform(log2)

## -----
## Method `omics$normalize`
## -----

```

```

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

obj$normalize()

## -----
## Method `omics$rankstat`
## -----

library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

plt <- obj$rankstat(feature_ranks = c("Kingdom", "Phylum", "Family", "Genus", "Species"))
plt

## -----
## Method `omics$alpha_diversity`
## -----

library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

```

```

plt <- obj$alpha_diversity(col_name = "treatment",
                          metric = "shannon")

## -----
## Method `omics$composition`
## -----

library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

result <- obj$composition(feature_rank = "Genus",
                          feature_filter = c("uncultured"),
                          feature_top = 10)

plt <- composition_plot(data = result$data,
                        palette = result$palette,
                        feature_rank = "Genus")

## -----
## Method `omics$distance`
## -----

library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file
)

obj$feature_subset(Kingdom == "Bacteria")
dist <- obj$distance(metric = "bray")

## -----
## Method `omics$ordination`
## -----

```

```

library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

pcoa_plots <- obj$ordination(metric = "bray",
                             method = "pcoa",
                             group_by = "treatment",
                             weighted = TRUE,
                             normalize = TRUE)

pcoa_plots

## -----
## Method `omics$DFE`
## -----

library("ggplot2")
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")

obj <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
)

unpaired <- obj$DFE(feature_rank = "Genus",
                    paired = FALSE,
                    condition.group = "treatment",
                    condition_A = c("healthy"),
                    condition_B = c("tumor"))

```

## Description

Creates an ordination plot pre-computed principal components from [wcmdscale](#). This function is built into the class [omics](#) with method `ordination()` and inherited by other omics classes, such as; [metagenomics](#) and [proteomics](#).

## Usage

```
ordination_plot(  
  data,  
  col_name,  
  pair,  
  dist_explained = NULL,  
  dist_metric = NULL  
)
```

## Arguments

<code>data</code>	A <a href="#">data.frame</a> or <a href="#">data.table</a> of Principal Components as columns and rows as loading scores.
<code>col_name</code>	A categorical variable to color the contrasts (e.g. "groups").
<code>pair</code>	A vector of character variables indicating what dimension names (e.g. PC1, NMDS2).
<code>dist_explained</code>	A vector of numeric values of the percentage dissimilarity explained for the dimension pairs, default is NULL.
<code>dist_metric</code>	A character variable indicating what metric is used (e.g. unfrac, bray-curtis), default is NULL.

## Value

A [ggplot2](#) object to be further modified

## Examples

```
library(ggplot2)  
  
# Mock principal component scores  
set.seed(123)  
mock_data <- data.frame(  
  SampleID = paste0("Sample", 1:10),  
  PC1 = rnorm(10, mean = 0, sd = 1),  
  PC2 = rnorm(10, mean = 0, sd = 1),  
  groups = rep(c("Group1", "Group2"), each = 5)  
)  
  
# Basic usage  
ordination_plot(  
  data = mock_data,  
  col_name = "groups",  
  pair = c("PC1", "PC2")
```

```

)

# Adding variance/dissimilarity explained.
ordination_plot(
  data = mock_data,
  col_name = "groups",
  pair = c("PC1", "PC2"),
  dist_explained = c(45, 22),
  dist_metric = "bray-curtis"
)

```

---

pairwise\_adonis

*Pairwise adonis2 (PERMANOVA) computation*


---

## Description

Computes pairwise [adonis2](#), given a distance matrix and a vector of labels. This function is built into the class [omics](#) with method `ordination()` and inherited by other omics classes, such as; [metagenomics](#) and [proteomics](#).

## Usage

```

pairwise_adonis(
  x,
  groups,
  metadata = NULL,
  perm_design = NULL,
  p.adjust.method = "bonferroni",
  perm = 999
)

```

## Arguments

x	A distance matrix in the form of <a href="#">dist</a> . Obtained from a dissimilarity metric, in the case of similarity metric please use 1-dist
groups	A character vector (column from a table) of labels.
metadata	A data.table or data.frame of extra metadata for perm_design (default: NULL).
perm_design	A function that takes a data.frame and constructs a permutation design with <a href="#">how</a> (default: NULL).
p.adjust.method	P adjust method see <a href="#">p.adjust</a> .
perm	Number of permutations to compare against the null hypothesis of adonis2 (default: perm=999).

**Value**

A [data.frame](#) of

- pairs that are used
- Degrees of freedom (Df)
- Sums of Squares of H\_0
- F.Model of H\_0
- R2 of H\_0
- p value of  $F^p > F$
- p adjusted

**See Also**

[adonis2](#)

**Examples**

```
# Create random data
set.seed(42)
mock_data <- matrix(rnorm(15 * 10), nrow = 15, ncol = 10)

# Create euclidean dissimilarity matrix
mock_dist <- dist(mock_data, method = "euclidean")

# Define group labels, should be equal to number of columns and rows to dist
mock_groups <- rep(c("A", "B", "C"), each = 5)

# Compute pairwise adonis (PERMANOVA)
result <- pairwise_adonis(x = mock_dist,
                          groups = mock_groups,
                          p.adjust.method = "bonferroni",
                          perm = 99)
```

---

pairwise\_anosim

*Pairwise anosim (ANOSIM) computation*

---

**Description**

Computes pairwise [anosim](#), given a distance matrix and a vector of labels. This function is built into the class [omics](#) with method `ordination()` and inherited by other omics classes, such as; [metagenomics](#) and [proteomics](#).

**Usage**

```
pairwise_anosim(
  x,
  groups,
  metadata = NULL,
  perm_design = NULL,
  p.adjust.method = "bonferroni",
  perm = 999
)
```

**Arguments**

x	A distance matrix in the form of <a href="#">dist</a> . Obtained from a dissimilarity metric, in the case of similarity metric please use 1-dist
groups	A vector (column from a table) of labels.
metadata	A data.table or data.frame of extra metadata for perm_design (default: NULL).
perm_design	A function that takes a data.frame and constructs a permutation design with <a href="#">how</a> (default: NULL).
p.adjust.method	P adjust method see <a href="#">p.adjust</a>
perm	Number of permutations to compare against the null hypothesis of anosim (default: perm=999).

**Value**

A [data.frame](#) of

- pairs that are used
- R2 of H<sub>0</sub>
- p value of F<sup>p</sup> > F
- p adjusted

**See Also**

[anosim](#)

**Examples**

```
# Create random data
set.seed(42)
mock_data <- matrix(rnorm(15 * 10), nrow = 15, ncol = 10)

# Create euclidean dissimilarity matrix
mock_dist <- dist(mock_data, method = "euclidean")

# Define group labels, should be equal to number of columns and rows to dist
mock_groups <- rep(c("A", "B", "C"), each = 5)
```

```
# Compute pairwise anosim
result <- pairwise_anosim(x = mock_dist,
                          groups = mock_groups,
                          p.adjust.method = "bonferroni",
                          perm = 99)
```

---

plot\_pairwise\_stats    *Create pairwise stats plot*

---

## Description

Creates a pairwise stats plot from [pairwise\\_adonis](#) or [pairwise\\_anosim](#) results. This function is built into the class [omics](#) with method `ordination()` and inherited by other omics classes, such as; [metagenomics](#) and [proteomics](#).

## Usage

```
plot_pairwise_stats(
  data,
  stats_col,
  group_col,
  label_col,
  y_axis_title = NULL,
  plot_title = NULL
)
```

## Arguments

data	A <a href="#">data.frame</a> or <a href="#">data.table</a> .
stats_col	A column name of a continuous variable.
group_col	A column name of a categorical variable.
label_col	A column name of a categorical variable to label the bars.
y_axis_title	A character variable to name the Y - axis title (default: NULL).
plot_title	A character variable to name the plot title (default: NULL).

## Value

A [ggplot2](#) object to be further modified

## Examples

```
library("ggplot2")

# Create random data
set.seed(42)
mock_data <- matrix(rnorm(15 * 10), nrow = 15, ncol = 10)
```

```

# Create euclidean dissimilarity matrix
mock_dist <- dist(mock_data, method = "euclidean")

# Define group labels, should be equal to number of columns and rows to dist
mock_groups <- rep(c("A", "B", "C"), each = 5)

# Compute pairwise adonis
adonis_res <- pairwise_adonis(x = mock_dist,
                             groups = mock_groups,
                             p.adjust.method = "bonferroni",
                             perm = 99)

# Compute pairwise anosim
anosim_res <- pairwise_anosim(x = mock_dist,
                              groups = mock_groups,
                              p.adjust.method = "bonferroni",
                              perm = 99)

# Visualize PERMANOVA pairwise stats
plot_pairwise_stats(data = adonis_res,
                    group_col = "pairs",
                    stats_col = "F.Model",
                    label_col = "p.adj",
                    y_axis_title = "Pseudo F test statistic",
                    plot_title = "PERMANOVA")

# Visualize ANOSIM pairwise stats
plot_pairwise_stats(data = anosim_res,
                    group_col = "pairs",
                    stats_col = "anosimR",
                    label_col = "p.adj",
                    y_axis_title = "ANOSIM R statistic",
                    plot_title = "ANOSIM")

```

---

proteomics

*Sub-class proteomics*


---

## Description

This is a sub-class that is compatible to preprocessed data obtained from <https://fragpipe.nesvilab.org/>. It inherits all methods from the abstract class `omics` and only adapts the `initialize` function. It supports pre-existing data structures or paths to text files. When omics data is very large, data loading becomes very expensive. It is therefore recommended to use the `reset()` method to reset your changes. Every omics class creates an internal memory efficient back-up of the data, the resetting of changes is an instant process.

## Super class

`OmicFlow::omics` -> proteomics

**Active bindings**

treeData A "phylo" class, see [as.phylo](#).

**Methods****Public methods:**

- [proteomics\\$new\(\)](#)
- [proteomics\\$clone\(\)](#)

**Method** `new()`: Initializes the proteomics class object with `proteomics$new()`

*Usage:*

```
proteomics$new(  
  countData = NULL,  
  metaData = NULL,  
  featureData = NULL,  
  treeData = NULL  
)
```

*Arguments:*

countData A path to an existing file or a dense/sparse [Matrix](#) format.

metaData A path to an existing file, [data.table](#) or data.frame.

featureData A path to an existing file, [data.table](#) or data.frame.

treeData A path to an existing newick file or class "phylo", see [read.tree](#).

*Returns:* A new proteomics object.

**Method** `clone()`: The objects of this class are cloneable with this method.

*Usage:*

```
proteomics$clone(deep = FALSE)
```

*Arguments:*

deep Whether to make a deep clone.

**See Also**

[omics](#)

---

unifrac

*Compute UniFrac Dissimilarity from a Dense or Sparse Matrix.*

---

**Description**

Calculates the UniFrac dissimilarity between samples based on phylogenetic branch lengths and abundance or presence/absence data.

**Usage**

```
unifrac(x, tree, weighted = TRUE, normalized = TRUE, threads = 1)
```

## Arguments

x	A <a href="#">matrix</a> , <a href="#">sparseMatrix</a> or <a href="#">Matrix</a> of strictly positive counts or presence/absence data.
tree	A phylo class tree.
weighted	A boolean value, to use abundances (weighted = TRUE) or absence/presence (weighted=FALSE) (default: TRUE).
normalized	A boolean value, whether to normalize weighted UniFrac distances to be between 0 and 1 (default: TRUE). Unweighted UniFrac is always normalized.
threads	A wholenumber, the number of threads to use in <a href="#">setThreadOptions</a> (default: 1).

## Details

The UniFrac distance between two samples  $A$  and  $B$ , with phylogenetic tree edges  $i = 1 \dots n$  of lengths  $L_i$ , is computed differently depending on the weighted and normalized flags. When weighted = FALSE, input counts are first converted to presence/absence data.

**Weighted UniFrac** (normalized = FALSE **and** weighted = TRUE):  $d(A, B) = \frac{\sum_i^n L_i |A_i - B_i|}{\sum_i^n L_i (A_i + B_i)}$

**Normalized Weighted UniFrac** (normalized = TRUE **and** weighted = TRUE):  $d(A, B) = \frac{\sum_i^n L_i |A_i - B_i|}{\sum_i^n L_i \max(A_i, B_i)}$

**Unweighted UniFrac** (weighted = FALSE, **unweighted is always normalized**):  $d(A, B) = \frac{\sum_i^n L_i |A_i - B_i|}{\sum_i^n L_i \max(A_i, B_i)}$

## Value

A column x column [dist](#) object.

## References

Lozupone, C., & Knight, R. (2005). UniFrac: a new phylogenetic method for comparing microbial communities. *Applied and Environmental Microbiology*, 71(12), 8228–8235.

## Examples

```
library("OmicFlow")

metadata_file <- system.file("extdata", "metadata.tsv", package = "OmicFlow")
counts_file <- system.file("extdata", "counts.tsv", package = "OmicFlow")
features_file <- system.file("extdata", "features.tsv", package = "OmicFlow")
tree_file <- system.file("extdata", "tree.newick", package = "OmicFlow")

taxa <- metagenomics$new(
  metaData = metadata_file,
  countData = counts_file,
  featureData = features_file,
  treeData = tree_file
)

taxa$feature_subset(Kingdom == "Bacteria")
taxa$normalize()
```

```
# Weighted UniFrac
unifrac(x = taxa$countData, tree = taxa$treeData, weighted=TRUE, normalized=FALSE)

# Weighted Normalized UniFrac
unifrac(x = taxa$countData, tree = taxa$treeData, weighted=TRUE, normalized=TRUE)

# Unweighted UniFrac
unifrac(x = taxa$countData, tree = taxa$treeData, weighted=FALSE)
```

---

volcano\_plot

*Volcano plot*

---

## Description

Creates a Volcano plot from the output of [foldchange](#), it plots the foldchanges on the x-axis, log10 transformed p-values on the y-axis and adjusts the scatter size based on the percentage abundance of the features. This function is built into the class [omics](#) with method `DFE()` and inherited by other omics classes, such as; [metagenomics](#) and [proteomics](#).

## Usage

```
volcano_plot(
  data,
  logfold_col,
  pvalue_col,
  feature_rank,
  abundance_col,
  pvalue.threshold = 0.05,
  logfold.threshold = 0.6,
  abundance.threshold = 0.01,
  label_A = "A",
  label_B = "B"
)
```

## Arguments

data	A <a href="#">data.table</a> .
logfold_col	A column name of a continuous variable.
pvalue_col	A column name of a continuous variable.
feature_rank	A character variable of the feature column.
abundance_col	A column name of a continuous variable.
pvalue.threshold	A P-value threshold (default: 0.05).
logfold.threshold	A Log <sub>2</sub> (A/B) Fold Change threshold (default: 0.6).

abundance.threshold  
An abundance threshold (default: 0.01).

label\_A  
A character to describe condition A.

label\_B  
A character to describe condition B.

### Value

A `ggplot2` object to be further modified.

### Examples

```
library(data.table)
library(ggplot2)

# Create mock data frame
mock_volcano_data <- data.table(

  # Feature names (feature_rank)
  Feature = paste0("Gene", 1:20),

  # Log2 fold changes (X)
  log2FC = c(1.2, -1.5, 0.3, -0.7, 2.3,
            -2.0, 0.1, 0.5, -1.0, 1.8,
            -0.4, 0.7, -1.4, 1.5, 0.9,
            -2.1, 0.2, 1.0, -0.3, -1.8),

  # P-values (Y)
  pvalue = c(0.001, 0.02, 0.3, 0.04, 0.0005,
            0.01, 0.7, 0.5, 0.02, 0.0008,
            0.15, 0.06, 0.01, 0.005, 0.3,
            0.02, 0.8, 0.04, 0.12, 0.03),

  # Mean (relative) abundance for point sizing
  rel_abun = runif(20, 0.01, 0.1)
)

volcano_plot(
  data = mock_volcano_data,
  logfold_col = "log2FC",
  pvalue_col = "pvalue",
  abundance_col = "rel_abun",
  feature_rank = "Feature",
)
```

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