

# Package ‘proBatch’

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**Type** Package

**Title** Tools for Diagnostics and Corrections of Batch Effects in Proteomics

**Version** 2.0.0

**Description** These tools facilitate batch effects analysis and correction in high-throughput experiments. It was developed primarily for mass-spectrometry proteomics (DIA/SWATH), but could also be applicable to most omic data with minor adaptations. The package contains functions for diagnostics (proteome/genome-wide and feature-level), correction (normalization and batch effects correction) and quality control. Non-linear fitting based approaches were also included to deal with complex, mass spectrometry-specific signal drifts.

**biocViews** BatchEffect, Normalization, Preprocessing, Software, MassSpectrometry, Proteomics, QualityControl, Visualization

**License** GPL-3

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**BugReports** <https://github.com/Freddsle/proBatch/issues>

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**Author** Jelena Cuklina [aut],

Chloe H. Lee [aut],

Patrick Pedrioli [aut],

Olga Zolotareva [aut],

Yuliya Burankova [cre]

**Maintainer** Yuliya Burankova <yuliya.burankova@uni-hamburg.de>

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---

calculate\_feature\_CV *Calculate CV distribution for each feature*

---

### Description

Calculate CV distribution for each feature

### Usage

```
calculate_feature_CV(
  df_long,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  batch_col = NULL,
  biospecimen_id_col = NULL,
  unlog = TRUE,
  log_base = 2,
  offset = 0
)
```

### Arguments

df_long	data frame where each row is a single feature in a single sample. It minimally has a sample_id_col, a feature_id_col and a measure_col, but usually also an m_score (in OpenSWATH output result file). See help("example_proteome") for more details.
sample_annotation	data frame with: <ol style="list-style-type: none"> <li>1. sample_id_col (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See help("example_sample_annotation")
feature_id_col	name of the column with feature/gene/peptide/protein ID used in the long format representation df_long. In the wide formatted representation data_matrix this corresponds to the row names.
sample_id_col	name of the column in sample_annotation table, where the filenames (col-names of the data_matrix are found).
measure_col	if df_long is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
batch_col	column in sample_annotation that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).

biospecimen_id_col	column in sample_annotation that defines a unique bio ID, which is usually a combination of conditions or groups. Tip: if such ID is absent, but can be defined from several columns, create new biospecimen_id column
unlog	(logical) whether to reverse log transformation of the original data
log_base	base of the logarithm for transformation
offset	small positive number to prevent 0 conversion to -Inf

**Value**

data frame with Total CV for each feature & (optionally) per-batch CV

**Examples**

```
data(list = c("example_sample_annotation", "example_proteome"), package = "proBatch")
CV_df <- calculate_feature_CV(example_proteome,
  sample_annotation = example_sample_annotation,
  measure_col = "Intensity",
  batch_col = "MS_batch"
)
```

---

calculate\_peptide\_corr\_distr

*Calculate peptide correlation between and within peptides of one protein*

---

**Description**

Calculate peptide correlation between and within peptides of one protein

**Usage**

```
calculate_peptide_corr_distr(
  data_matrix,
  peptide_annotation,
  protein_col = "ProteinName",
  feature_id_col = "peptide_group_label"
)
```

**Arguments**

data_matrix	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use help("example_proteome_matrix"))
peptide_annotation	long format data frame with peptide ID and their corresponding protein and/or gene annotations. See help("example_peptide_annotation").

protein\_col column where protein names are specified

feature\_id\_col name of the column with feature/gene/peptide/protein ID used in the long format representation df\_long. In the wide formatted representation data\_matrix this corresponds to the row names.

### Value

dataframe with peptide correlation coefficients that are suggested to use for plotting in [plot\\_peptide\\_corr\\_distribution](#) as plot\_param:

### Examples

```
data(list = c("example_peptide_annotation", "example_proteome_matrix"), package = "proBatch")
selected_genes <- c("BOVINE_A1ag", "BOVINE_FetuinB", "Cyfip1")
gene_filter <- example_peptide_annotation$Gene %in% selected_genes
peptides_ann <- example_peptide_annotation$peptide_group_label
selected_peptides <- peptides_ann[gene_filter]
matrix_test <- example_proteome_matrix[selected_peptides, ]
pep_annotation_sel <- example_peptide_annotation[gene_filter, ]
corr_distribution <- calculate_peptide_corr_distr(matrix_test,
  pep_annotation_sel,
  protein_col = "Gene"
)
```

---

calculate_PVCA	<i>Calculate variance distribution by variable</i>
----------------	--

---

### Description

Calculate variance distribution by variable

### Usage

```
## Default S3 method:
calculate_PVCA(
  data_matrix,
  sample_annotation,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  factors_for_PVCA = c("MS_batch", "digestion_batch", "Diet", "Sex", "Strain"),
  pca_threshold = 0.6,
  variance_threshold = 0.01,
  fill_the_missing = -1,
  ...
)

## S3 method for class 'ProBatchFeatures'
```

```

calculate_PVCA(
  data_matrix,
  pbf_name = NULL,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  ...
)

```

### Arguments

**data\_matrix** features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example\_proteome\_matrix" for more details (to call the description, use help("example\_proteome\_matrix"))

**sample\_annotation** data frame with:

1. sample\_id\_col (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

**feature\_id\_col** name of the column with feature/gene/peptide/protein ID used in the long format representation df\_long. In the wide formatted representation data\_matrix this corresponds to the row names.

**sample\_id\_col** name of the column in sample\_annotation table, where the filenames (colnames of the data\_matrix are found).

**factors\_for\_PVCA** vector of factors from sample\_annotation, that are used in PVCA analysis

**pca\_threshold** the percentile value of the minimum amount of the variabilities that the selected principal components need to explain

**variance\_threshold** the percentile value of weight each of the factors needs to explain (the rest will be lumped together)

**fill\_the\_missing** numeric value determining how missing values should be substituted. If NULL, features with missing values are excluded.

**...** Additional arguments forwarded between methods.

**pbf\_name** Assay name(s) used when 'data\_matrix' is a 'ProBatchFeatures'.

### Value

data frame of weights of Principal Variance Components

### Examples

```

data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")
matrix_test <- na.omit(example_proteome_matrix)[1:50, ]

```

```
pvca_df <- calculate_PVCA(matrix_test, example_sample_annotation,
  factors_for_PVCA = c("MS_batch", "digestion_batch", "Diet", "Sex", "Strain"),
  pca_threshold = .6, variance_threshold = .01, fill_the_missing = -1
)
```

---

calculate\_sample\_corr\_distr

*Calculates correlation for all pairs of the samples in data matrix, labels as replicated/same\_batch/unrelated in output columns (see "Value").*

---

### Description

Calculates correlation for all pairs of the samples in data matrix, labels as replicated/same\_batch/unrelated in output columns (see "Value").

### Usage

```
calculate_sample_corr_distr(
  data_matrix,
  sample_annotation,
  repeated_samples = NULL,
  biospecimen_id_col = "EarTag",
  sample_id_col = "FullRunName",
  batch_col = "MS_batch"
)
```

### Arguments

**data\_matrix** features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example\_proteome\_matrix" for more details (to call the description, use help("example\_proteome\_matrix"))

**sample\_annotation** data frame with:

1. sample\_id\_col (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

**repeated\_samples** vector of sample IDs to evaluate, if NULL, all samples are taken into account for plotting

**biospecimen\_id\_col** column in sample\_annotation that defines a unique bio ID, which is usually a combination of conditions or groups. Tip: if such ID is absent, but can be defined from several columns, create new biospecimen\_id column

sample\_id\_col name of the column in sample\_annotation table, where the filenames (column names of the data\_matrix are found).

batch\_col column in sample\_annotation that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).

### Value

dataframe with the following columns, that are suggested to use for plotting in [plot\\_sample\\_corr\\_distribution](#) as plot\_param:

1. replicate
2. batch\_the\_same
3. batch\_replicate
4. batches

other columns are:

1. sample\_id\_1 & sample\_id\_2, both generated from sample\_id\_col variable
2. correlation - correlation of two corresponding samples
3. batch\_1 & batch\_2 or analogous, created the same as sample\_id\_1

### Examples

```
data(list = c("example_sample_annotation", "example_proteome_matrix"), package = "proBatch")
corr_distribution <- calculate_sample_corr_distr(
  data_matrix = example_proteome_matrix,
  sample_annotation = example_sample_annotation,
  batch_col = "MS_batch", biospecimen_id_col = "EarTag"
)
```

---

check\_sample\_consistency

*Check if sample annotation is consistent with data matrix and join the two*

---

### Description

Check if sample annotation is consistent with data matrix and join the two

### Usage

```
check_sample_consistency(
  sample_annotation,
  sample_id_col,
  df_long,
  batch_col = NULL,
```

```

    order_col = NULL,
    facet_col = NULL,
    merge = TRUE
  )

```

## Arguments

`sample_annotation` data frame with:

1. `sample_id_col` (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See `help("example_sample_annotation")`

`sample_id_col` name of the column in `sample_annotation` table, where the filenames (column names of the `data_matrix` are found).

`df_long` data frame where each row is a single feature in a single sample. It minimally has a `sample_id_col`, a `feature_id_col` and a `measure_col`, but usually also an `m_score` (in OpenSWATH output result file). See `help("example_proteome")` for more details.

`batch_col` column in `sample_annotation` that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).

`order_col` column in `sample_annotation` that determines sample order. It is used for initial assessment plots ([plot\\_sample\\_mean\\_or\\_boxplot](#)) and feature-level diagnostics ([feature\\_level\\_diagnostics](#)). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see [define\\_sample\\_order](#) and [date\\_to\\_sample\\_order](#)

`facet_col` column in `sample_annotation` with a batch factor to separate plots into facets; usually 2nd to `batch_col`. Most meaningful for multi-instrument MS experiments (where each instrument has its own order-associated effects (see `order_col`) or simultaneous examination of two batch factors (e.g. preparation day and measurement day). For single-instrument case should be set to 'NULL'

`merge` (logical) whether to merge `df_long` with `sample_annotation` or not

## Value

`df_long` format data frame, merged with `sample_annotation` using `inner_join` (samples represented in both)

## Examples

```

# Load necessary datasets
data(list = c("example_proteome", "example_sample_annotation"), package = "proBatch")

df_test <- check_sample_consistency(
  sample_annotation = example_sample_annotation,
  df_long = example_proteome, sample_id_col = "FullRunName",
  batch_col = NULL, order_col = NULL, facet_col = NULL
)

```

)

---

color_list_to_df	<i>Color list to data frame</i>
------------------	---------------------------------

---

**Description**

Turn color list to df (to use in the hierarchical clustering)

**Usage**

```
color_list_to_df(color_list, sample_annotation, sample_id_col = "FullRunName")
```

**Arguments**

color_list	list of colors
sample_annotation	factor-based configuration of the sample annotation

**Value**

a data frame representation of the input color list

---

convert_annotation_classes	<i>Convert factor and numeric columns</i>
----------------------------	---

---

**Description**

Convert specified factor columns to factor type and numeric columns to numeric.

**Usage**

```
convert_annotation_classes(df, factor_columns, numeric_columns)
```

**Arguments**

df	data frame with sample annotations.
factor_columns	character vector of factor columns.
numeric_columns	character vector of numeric columns.

**Value**

data frame with converted columns.

---

correct\_batch\_effects *Batch correction of normalized data*

---

## Description

Batch correction of normalized data. Batch correction brings each feature in each batch to the comparable shape. Currently the following batch correction functions are implemented:

1. Per-feature median centering: `center_feature_batch_medians_df()`. Median centering of the features (per batch median).
2. correction with ComBat: `correct_with_ComBat_df()`. Adjusts for discrete batch effects using ComBat. ComBat, described in Johnson et al. 2007. It uses either parametric or non-parametric empirical Bayes frameworks for adjusting data for batch effects. Users are returned an expression matrix that has been corrected for batch effects. The input data are assumed to be free of missing values and normalized before batch effect removal. Please note that missing values are common in proteomics, which is why in some cases corrections like `center_peptide_batch_medians_df` are more appropriate.
3. Continuous drift correction: `adjust_batch_trend_df()`. Adjust batch signal trend with the custom (continuous) fit. Should be followed by discrete corrections, e.g. `center_feature_batch_medians_df()` or `correct_with_ComBat_df()`.

Alternatively, one can call the correction function with `correct_batch_effects_df()` wrapper. Batch correction method allows correction of continuous signal drift within batch (if required) and adjustment for discrete difference across batches.

## Usage

```
center_feature_batch_medians_df(  
  df_long,  
  sample_annotation = NULL,  
  sample_id_col = "FullRunName",  
  batch_col = "MS_batch",  
  feature_id_col = "peptide_group_label",  
  measure_col = "Intensity",  
  keep_all = "default",  
  no_fit_imputed = TRUE,  
  qual_col = NULL,  
  qual_value = NULL  
)
```

```
center_feature_batch_medians_dm(  
  data_matrix,  
  sample_annotation,  
  sample_id_col = "FullRunName",  
  batch_col = "MS_batch",  
  feature_id_col = "peptide_group_label",  
  measure_col = "Intensity"
```

```
)

center_feature_batch_means_df(
  df_long,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  batch_col = "MS_batch",
  feature_id_col = "peptide_group_label",
  measure_col = "Intensity",
  keep_all = "default",
  no_fit_imputed = TRUE,
  qual_col = NULL,
  qual_value = NULL
)

center_feature_batch_means_dm(
  data_matrix,
  sample_annotation,
  sample_id_col = "FullRunName",
  batch_col = "MS_batch",
  feature_id_col = "peptide_group_label",
  measure_col = "Intensity"
)

adjust_batch_trend_df(
  df_long,
  sample_annotation = NULL,
  batch_col = "MS_batch",
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  order_col = "order",
  keep_all = "default",
  fit_func = "loess_regression",
  no_fit_imputed = TRUE,
  qual_col = NULL,
  qual_value = NULL,
  min_measurements = 8,
  ...
)

adjust_batch_trend_dm(
  data_matrix,
  sample_annotation,
  batch_col = "MS_batch",
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
```

```
    order_col = "order",
    fit_func = "loess_regression",
    return_fit_df = TRUE,
    no_fit_imputed = TRUE,
    qual_col = NULL,
    qual_value = NULL,
    min_measurements = 8,
    ...
)

correct_with_ComBat_df(
  df_long,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  measure_col = "Intensity",
  sample_id_col = "FullRunName",
  batch_col = "MS_batch",
  par.prior = TRUE,
  fill_the_missing = NULL,
  no_fit_imputed = TRUE,
  qual_col = NULL,
  qual_value = NULL,
  keep_all = "default"
)

correct_with_ComBat_dm(
  data_matrix,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  measure_col = "Intensity",
  sample_id_col = "FullRunName",
  batch_col = "MS_batch",
  par.prior = TRUE,
  fill_the_missing = NULL
)

correct_batch_effects_df(
  df_long,
  sample_annotation,
  continuous_func = NULL,
  discrete_func = c("MedianCentering", "MeanCentering", "ComBat"),
  batch_col = "MS_batch",
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  order_col = "order",
  keep_all = "default",
  no_fit_imputed = TRUE,
```

```

    qual_col = NULL,
    qual_value = NULL,
    fill_the_missing = NULL,
    min_measurements = 8,
    ...
)

correct_batch_effects_dm(
  data_matrix,
  sample_annotation,
  continuous_func = NULL,
  discrete_func = c("MedianCentering", "ComBat"),
  batch_col = "MS_batch",
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  order_col = "order",
  min_measurements = 8,
  no_fit_imputed = TRUE,
  fill_the_missing = NULL,
  ...
)

```

## Arguments

**df\_long** data frame where each row is a single feature in a single sample. It minimally has a `sample_id_col`, a `feature_id_col` and a `measure_col`, but usually also an `m_score` (in OpenSWATH output result file). See `help("example_proteome")` for more details.

**sample\_annotation** data frame with:

1. `sample_id_col` (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See `help("example_sample_annotation")`

**sample\_id\_col** name of the column in `sample_annotation` table, where the filenames (column names of the `data_matrix` are found).

**batch\_col** column in `sample_annotation` that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).

**feature\_id\_col** name of the column with feature/gene/peptide/protein ID used in the long format representation `df_long`. In the wide formatted representation `data_matrix` this corresponds to the row names.

**measure\_col** if `df_long` is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.

**keep\_all** when transforming the data (normalize, correct) - acceptable values: all/default/minimal (which set of columns be kept).

no_fit_imputed	(logical) whether to use imputed (requant) values, as flagged in qual_col by qual_value for data transformation
qual_col	column to color point by certain value denoted by qual_value. Design with inferred/requant values in OpenSWATH output data, which means argument value has to be set to m_score.
qual_value	value in qual_col to color. For OpenSWATH data, this argument value has to be set to 2 (this is an m_score value for imputed values (requant values)).
data_matrix	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use help("example_proteome_matrix"))
order_col	column in sample_annotation that determines sample order. It is used for in initial assessment plots ( <a href="#">plot_sample_mean_or_boxplot</a> ) and feature-level diagnostics ( <a href="#">feature_level_diagnostics</a> ). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see <a href="#">define_sample_order</a> and <a href="#">date_to_sample_order</a>
fit_func	function to fit the (non)-linear trend
min_measurements	the number of samples in a batch required for curve fitting.
...	other parameters, usually of <a href="#">adjust_batch_trend</a> , and <a href="#">fit_func</a> .
return_fit_df	(logical) whether to return the fit_df from <a href="#">adjust_batch_trend_dm</a> or only the data matrix
par.prior	use parametrical or non-parametrical prior
fill_the_missing	numeric value used to impute missing measurements before correction. If NULL (default) missing values are left untouched, if FALSE rows with missing values are removed prior to correction.
continuous_func	function to use for the fit (currently only <a href="#">loess_regression</a> available); if order-associated fix is not required, should be NULL.
discrete_func	function to use for adjustment of discrete batch effects ( <a href="#">MedianCentering</a> or <a href="#">ComBat</a> ).

### Value

the data in the same format as input (`data_matrix` or `df_long`). For `df_long` the data frame stores the original values of `measure_col` in another column called "preBatchCorr\_[`measure_col`]", and the normalized values in `measure_col` column.

The function `adjust_batch_trend_dm()`, if `return_fit_df` is TRUE returns list of two items:

1. `data_matrix`
2. `fit_df`, used to examine the fitting curves

### See Also

[fit\\_nonlinear](#)  
[fit\\_nonlinear, plot\\_with\\_fitting\\_curve](#)  
[fit\\_nonlinear, plot\\_with\\_fitting\\_curve](#)

**Examples**

```

data(
  list = c("example_sample_annotation", "example_proteome"),
  package = "proBatch"
)
median_centered_df <- center_feature_batch_medians_df(
  example_proteome, example_sample_annotation
)

combat_corrected_df <- correct_with_ComBat_df(
  example_proteome,
  example_sample_annotation
)

# Adjust the MS signal drift:
test_peptides <- unique(example_proteome$peptide_group_label)[1:3]
test_peptide_filter <- example_proteome$peptide_group_label %in% test_peptides
test_proteome <- example_proteome[test_peptide_filter, ]
adjusted_df <- adjust_batch_trend_df(test_proteome,
  example_sample_annotation,
  span = 0.7,
  min_measurements = 8
)
plot_fit <- plot_with_fitting_curve(
  unique(adjusted_df$peptide_group_label),
  df_long = adjusted_df,
  measure_col = "preTrendFit_Intensity",
  fit_df = adjusted_df,
  sample_annotation = example_sample_annotation
)

# Correct the data in one go:
batch_corrected_matrix <- correct_batch_effects_df(example_proteome,
  example_sample_annotation,
  continuous_func = "loess_regression",
  discrete_func = "MedianCentering",
  batch_col = "MS_batch",
  span = 0.7, min_measurements = 8
)

```

---

correct\_with\_removeBatchEffect\_dm

*Batch effect correction with removeBatchEffect from limma*

---

**Description**

Batch effect correction with removeBatchEffect.

## Usage

```
correct_with_removeBatchEffect_dm(  
  data_matrix,  
  sample_annotation,  
  feature_id_col = "peptide_group_label",  
  measure_col = "Intensity",  
  sample_id_col = "FullRunName",  
  batch_col = "MS_batch",  
  covariates_cols = NULL,  
  fill_the_missing = NULL,  
  ...  
)
```

## Arguments

<code>data_matrix</code>	data matrix with features in rows and samples in columns
<code>sample_annotation</code>	data frame with sample annotations
<code>feature_id_col</code>	column name in <code>data_matrix</code> with feature IDs
<code>measure_col</code>	column name in <code>data_matrix</code> with measured values
<code>sample_id_col</code>	column name in <code>sample_annotation</code> with sample IDs
<code>batch_col</code>	column name in <code>sample_annotation</code> with batch IDs
<code>covariates_cols</code>	vector of column names in <code>sample_annotation</code> with covariates to include in the model
<code>fill_the_missing</code>	numeric value used to impute missing measurements before correction. If FALSE rows with missing values are removed.
<code>...</code>	other parameters to pass to <code>removeBatchEffect</code>

## Value

data matrix with batch effects removed

## See Also

[removeBatchEffect](#)

## Examples

```
data(  
  list = c("example_sample_annotation", "example_proteome_matrix"),  
  package = "proBatch"  
)  
example_proteome_small <- example_proteome_matrix[1:100, ]  
batch_corrected_matrix <- correct_with_removeBatchEffect_dm(  
  example_proteome_small,
```

```
    example_sample_annotation,  
    batch_col = "MS_batch",  
    covariates_cols = c("Diet", "Sex")  
  )
```

---

create\_peptide\_annotation

*Prepare peptide annotation from long format data frame*

---

## Description

Create light-weight peptide annotation data frame for selection of illustrative proteins

## Usage

```
create_peptide_annotation(  
  df_long,  
  feature_id_col = "peptide_group_label",  
  protein_col = c("ProteinName", "Gene")  
)
```

## Arguments

**df\_long** data frame where each row is a single feature in a single sample. It minimally has a `sample_id_col`, a `feature_id_col` and a `measure_col`, but usually also an `m_score` (in OpenSWATH output result file). See `help("example_proteome")` for more details.

**feature\_id\_col** name of the column with feature/gene/peptide/protein ID used in the long format representation `df_long`. In the wide formatted representation `data_matrix` this corresponds to the row names.

**protein\_col** column where protein names are specified

## Value

data frame containing peptide annotations

## See Also

[plot\\_peptides\\_of\\_one\\_protein](#), [plot\\_protein\\_corrplot](#)

## Examples

```
data("example_proteome", package = "proBatch")  
generated_peptide_annotation <- create_peptide_annotation(  
  example_proteome,  
  feature_id_col = "peptide_group_label",  
  protein_col = c("Protein")  
)
```

---

dates_to_posix	<i>Convert date/time to POSIXct</i>
----------------	-------------------------------------

---

### Description

convert date/time column of sample\_annotation to POSIX format required to keep number-like behavior

### Usage

```
dates_to_posix(
  sample_annotation,
  time_column = c("RunDate", "RunTime"),
  new_time_column = "DateTime",
  dateTimeFormat = c("%b_%d", "%H:%M:%S"),
  tz = "GMT",
  locale = "en_US.UTF-8"
)
```

### Arguments

sample\_annotation  
data frame with:

1. sample\_id\_col (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

time\_column name of the column(s) where run date & time are specified. These will be used to determine the run order

new\_time\_column name of the new column that will contain the converted date/time value

dateTimeFormat POSIX format of the date and time. See [as.POSIXct](#) from base R for details

tz for time zone, 'GMT' by default

locale for locale, 'en\_US.UTF-8' by default

### Value

sample annotation file with a new column new\_time\_column with POSIX-formatted date

### Examples

```
data("example_sample_annotation", package = "proBatch")
date_to_posix <- dates_to_posix(example_sample_annotation,
  time_column = c("RunDate", "RunTime"),
  new_time_column = "DateTime_new",
  dateTimeFormat = c("%b_%d", "%H:%M:%S"))
```

```
)
```

---

date\_to\_sample\_order *Convert date/time to POSIXct and rank samples by it*

---

### Description

Converts date/time columns for sample\_annotation to POSIXct format and calculates sample run rank in order column

### Usage

```
date_to_sample_order(
  sample_annotation,
  time_column = c("RunDate", "RunTime"),
  new_time_column = "DateTime",
  dateTimeFormat = c("%b_%d", "%H:%M:%S"),
  new_order_col = "order",
  instrument_col = "instrument"
)
```

### Arguments

sample\_annotation  
 data frame with:

1. sample\_id\_col (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

time\_column      name of the column(s) where run date & time are specified. These will be used to determine the run order

new\_time\_column      name of the new column that will contain the converted date/time value

dateTimeFormat      POSIX format of the date and time. See [as.POSIXct](#) from base R for details

new\_order\_col      name of the column containing the generated sample run order based on time columns

instrument\_col      name of the column denoting the instrument used for measurements

### Value

sample annotation file with a new column new\_time\_column with POSIX-formatted date & new\_order\_col used in some diagnostic plots (e.g. [plot\\_irt](#), [plot\\_sample\\_mean](#))

## Examples

```
data("example_sample_annotation", package = "proBatch")
sample_annotation_wOrder <- date_to_sample_order(
  example_sample_annotation,
  time_column = c("RunDate", "RunTime"),
  new_time_column = "new_DateTime",
  dateTimeFormat = c("%b_%d", "%H:%M:%S"),
  new_order_col = "new_order",
  instrument_col = NULL
)
```

---

define\_sample\_order    *Defining sample order internally*

---

## Description

Defining sample order internally

## Usage

```
define_sample_order(
  order_col,
  sample_annotation,
  facet_col,
  batch_col,
  df_long,
  sample_id_col,
  color_by_batch
)
```

## Arguments

**order\_col**            column in `sample_annotation` that determines sample order. It is used for initial assessment plots ([plot\\_sample\\_mean\\_or\\_boxplot](#)) and feature-level diagnostics ([feature\\_level\\_diagnostics](#)). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see [define\\_sample\\_order](#) and [date\\_to\\_sample\\_order](#)

**sample\_annotation**

data frame with:

1. `sample_id_col` (this can be repeated as row names)
  2. biological covariates
  3. technical covariates (batches etc)
- . See `help("example_sample_annotation")`

facet_col	column in sample_annotation with a batch factor to separate plots into facets; usually 2nd to batch_col. Most meaningful for multi-instrument MS experiments (where each instrument has its own order-associated effects (see order_col) or simultaneous examination of two batch factors (e.g. preparation day and measurement day). For single-instrument case should be set to 'NULL'
batch_col	column in sample_annotation that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).
df_long	data frame where each row is a single feature in a single sample. It minimally has a sample_id_col, a feature_id_col and a measure_col, but usually also an m_score (in OpenSWATH output result file). See help("example_proteome") for more details.
sample_id_col	name of the column in sample_annotation table, where the filenames (col-names of the data_matrix are found).
color_by_batch	(logical) whether to color points and connecting lines by batch factor as defined by batch_col.

**Value**

list of two items: order\_col new name and new df\_long

**See Also**

[plot\\_sample\\_mean\\_or\\_boxplot](#), [feature\\_level\\_diagnostics](#)

**Examples**

```
data(list = c("example_proteome", "example_sample_annotation"), package = "proBatch")
sample_order <- define_sample_order(
  order_col = "order",
  sample_annotation = example_sample_annotation,
  facet_col = NULL, batch_col = "MS_batch", df_long = example_proteome,
  sample_id_col = "FullRunName", color_by_batch = TRUE
)
new_order_col <- sample_order$order_col
df_long <- sample_order$df_long
```

---

example\_ecoli\_data      *Example multi-center DIA LFQ E. coli proteomics (DIA-NN)*

---

**Description**

An example dataset illustrating a typical multi-center DIA (data-independent acquisition) proteomics study processed with DIA-NN. Subset of 300 proteins and 1119 precursors from the PRIDE ID PXD053812. Study design summary: - Five independent centers. - Per center: 10(9) samples of E.coli grown in different media (Pyruvate vs Glucose) The distributed object is a named list that contains the combined study-level tables derived from all centers (per-center sub-lists were removed to keep the package size below 5 MB).

**Format**

A named list with four elements:

**'all\_metadata'** 'data.frame' (118 rows × 3 columns) with per-sample annotation. Columns: 'Run', 'Lab', and 'Condition'.

**'all\_precursors'** 'data.frame' (1463 rows × 118 columns) containing the combined precursor-level Precursor.Normalised intensities (rows = precursors, columns = samples).

**'all\_protein\_groups'** 'data.frame' (400 rows × 118 columns) containing the combined protein group-level PG.MaxLFQ intensities.

**'all\_precursor\_pg\_match'** 'data.frame' (1463 rows × 2 columns) linking 'Precursor.Id' to 'Protein.Ids'.

**Value**

A named list containing the combined metadata, quantification matrices, and precursor-to-protein mapping.

**Source**

PRIDE ID PXD053812

**Examples**

```
data("example_ecoli_data", package = "proBatch")
names(example_ecoli_data)
```

---

example\_peptide\_annotation

*Peptide annotation data*

---

**Description**

This is data from Aging study annotated with gene names

**Format**

A data frame with 535 rows and 10 variables:

**peptide\_group\_label** peptide group label ID, identical to peptide\_group\_label in example\_proteome

**Gene** HUGO gene ID

**ProteinName** protein group name as specified in example\_proteome

**Value**

A data frame with 535 rows and 10 variables.

## Examples

```
data("example_peptide_annotation", package = "proBatch")
head(example_peptide_annotation)
```

---

example_proteome	<i>Example protein data in long format</i>
------------------	--

---

## Description

This is OpenSWATH-output data from Aging study with all iRT, spike-in peptides, few representative peptides and proteins for signal improvement demonstration. Using `matrix_to_long` can be converted to `example_proteome_matrix`

## Format

A data frame with 124655 rows and 7 variables:

**peptide\_group\_label** peptide ID, which is regular feature level. This column is mostly used as `feature_id_col` used for merging with "example\_peptide\_annotation"

**Intensity** peptide group intensity in given sample. Used in function as `measure_col`

**Protein** Protein group ID, specified as N/UniProtID1|UniProtID2|..., where N is number of protein peptide group maps to. If 1/UniProtID, then this is proteotypic peptide, in functions used as `protein_col`

**FullRunName** name of the file, in most functions used for `sample_id_col`

**m\_score** column marking the quality of peptide IDs, used as `qual_col` throughout the script; when `qual_value` is 2 in this column, peptide has been imputed (requantified) ...

## Value

A data frame with 124655 rows and 7 variables.

## Source

PRIDE ID will be added upon the publication of the dataset

## Examples

```
data("example_proteome", package = "proBatch")
head(example_proteome)
```

example\_proteome\_matrix

*Example protein data in matrix*

---

### Description

This is measurement data from Aging study with columns representing samples and rows representing peptides. Generated by `long_to_matrix`

### Format

A matrix with 535 rows and 233 columns:

### Value

A matrix with 535 rows and 233 columns.

### Source

PRIDE ID will be added upon the publication of the dataset

### Examples

```
data("example_proteome_matrix", package = "proBatch")
dim(example_proteome_matrix)
```

---

example\_sample\_annotation

*Sample annotation data version 1*

---

### Description

This is data from BXD mouse population aging study with mock instruments to show how instrument-specific functionality works

### Format

A data frame with 233 rows and 11 variables:

**FullRunName** name of the file with the measurement for each sample, referred to as `sample_id_col`

**MS\_batch** mass-spectrometry batch: 4-level factor of manually annotated batches

**EarTag** mouse ID, i.e. ID of the biological object. Only 14 mice have been replicated, one mouse was profiled 7 times.

**Strain** mouse strain ID from BXD population set - biological covariate #1, 51 Strain represented

**Diet** diet, biological covariate #2 - either HFD = 'High Fat Diet' or CD = 'Chow Diet'

**Sex** mice sex - biological covariate #3

**RunDate** mass-spectrometry running date. In combination with RunTime used for running order determination. Vector of class "difftime" and "hms"

**RunTime** mass-spectrometry running time. In combination with RunDate used for running order determination. Vector of class "POSIXct" and "POSIXt"

**DateTime** numeric date and time generated by date\_to\_sample\_order

**order** order of samples generated by sorting DateTime in date\_to\_sample\_order

**digestion\_batch** peptide digestion batch: 4-level factor of manually annotated batches ...

### Value

A data frame with 233 rows and 11 variables.

### Examples

```
data("example_sample_annotation", package = "proBatch")
head(example_sample_annotation)
```

---

feature\_level\_diagnostics

*Plotting peptide measurements*

---

### Description

Creates a peptide faceted ggplot2 plot of the value in measure\_col vs order\_col (if 'NULL', x-axis is simply a sample name order). Additionally, the resulting plot can also be colored either by batch factor, by quality factor (e.g. imputed/non-imputed) and, if needed, faceted by another batch factor, e.g. an instrument. If the non-linear curve was fit, this can also be added to the plot, see functions specific to each case below

### Usage

```
plot_single_feature(
  feature_name,
  df_long,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  feature_id_col = "peptide_group_label",
  geom = c("point", "line"),
  qual_col = NULL,
  qual_value = NULL,
  batch_col = "MS_batch",
  color_by_batch = FALSE,
  color_scheme = "brewer",
  order_col = "order",
```

```
vline_color = "red",
facet_col = NULL,
filename = NULL,
width = NA,
height = NA,
units = c("cm", "in", "mm"),
plot_title = NULL,
theme = "classic",
ylimits = NULL,
base_size = 20
)

plot_peptides_of_one_protein(
  protein_name,
  peptide_annotation = NULL,
  protein_col = "ProteinName",
  df_long,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  feature_id_col = "peptide_group_label",
  geom = c("point", "line"),
  qual_col = NULL,
  qual_value = NULL,
  batch_col = "MS_batch",
  color_by_batch = FALSE,
  color_scheme = "brewer",
  order_col = "order",
  vline_color = "red",
  facet_col = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = sprintf("Peptides of %s protein", protein_name),
  theme = "classic",
  base_size = 20
)

plot_spike_in(
  spike_ins = "BOVIN",
  peptide_annotation = NULL,
  protein_col = "ProteinName",
  df_long,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  feature_id_col = "peptide_group_label",
```

```
geom = c("point", "line"),
qual_col = NULL,
qual_value = NULL,
batch_col = "MS_batch",
color_by_batch = FALSE,
color_scheme = "brewer",
order_col = "order",
vline_color = "red",
facet_col = NULL,
filename = NULL,
width = NA,
height = NA,
units = c("cm", "in", "mm"),
plot_title = sprintf("Spike-in %s plots", spike_ins),
theme = "classic",
base_size = 20
)

plot_iRT(
  irt_pattern = "iRT",
  peptide_annotation = NULL,
  protein_col = "ProteinName",
  df_long,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  feature_id_col = "peptide_group_label",
  geom = c("point", "line"),
  qual_col = NULL,
  qual_value = NULL,
  batch_col = "MS_batch",
  color_by_batch = FALSE,
  color_scheme = "brewer",
  order_col = "order",
  vline_color = "red",
  facet_col = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = "iRT peptide profile",
  theme = "classic",
  base_size = 20
)

plot_with_fitting_curve(
  feature_name,
  fit_df,
```

```

fit_value_col = "fit",
df_long,
sample_annotation = NULL,
sample_id_col = "FullRunName",
measure_col = "Intensity",
feature_id_col = "peptide_group_label",
geom = c("point", "line"),
qual_col = NULL,
qual_value = NULL,
batch_col = "MS_batch",
color_by_batch = FALSE,
color_scheme = "brewer",
order_col = "order",
vline_color = "grey",
facet_col = NULL,
filename = NULL,
width = NA,
height = NA,
units = c("cm", "in", "mm"),
plot_title = sprintf("Fitting curve of %s peptide", paste(feature_name, collapse =
  " ")),
theme = "classic",
base_size = 20
)

```

### Arguments

<code>feature_name</code>	name of the selected feature (e.g. peptide) for diagnostic profiling
<code>df_long</code>	data frame where each row is a single feature in a single sample. It minimally has a <code>sample_id_col</code> , a <code>feature_id_col</code> and a <code>measure_col</code> , but usually also an <code>m_score</code> (in OpenSWATH output result file). See <code>help("example_proteome")</code> for more details.
<code>sample_annotation</code>	data frame with: <ol style="list-style-type: none"> <li>1. <code>sample_id_col</code> (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See <code>help("example_sample_annotation")</code>
<code>sample_id_col</code>	name of the column in <code>sample_annotation</code> table, where the filenames (column names of the <code>data_matrix</code> are found).
<code>measure_col</code>	if <code>df_long</code> is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
<code>feature_id_col</code>	name of the column with feature/gene/peptide/protein ID used in the long format representation <code>df_long</code> . In the wide formatted representation <code>data_matrix</code> this corresponds to the row names.
<code>geom</code>	whether to show the feature as points and/or connect by lines (accepted values are: 1. <code>point</code> , <code>line</code> and <code>c('point', 'line')</code> )

qual_col	column to color point by certain value denoted by qual_value. Design with inferred/requant values in OpenSWATH output data, which means argument value has to be set to m_score.
qual_value	value in qual_col to color. For OpenSWATH data, this argument value has to be set to 2 (this is an m_score value for imputed values (requant values)).
batch_col	column in sample_annotation that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).
color_by_batch	(logical) whether to color points and connecting lines by batch factor as defined by batch_col.
color_scheme	a named vector of colors to map to batch_col, names corresponding to the levels of the factor. For continuous variables, vector doesn't need to be named.
order_col	column in sample_annotation that determines sample order. It is used for initial assessment plots ( <a href="#">plot_sample_mean_or_boxplot</a> ) and feature-level diagnostics ( <a href="#">feature_level_diagnostics</a> ). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see <a href="#">define_sample_order</a> and <a href="#">date_to_sample_order</a>
vline_color	color of vertical lines, typically separating different MS batches in ordered runs; should be 'NULL' for experiments without intrinsic order
facet_col	column in sample_annotation with a batch factor to separate plots into facets; usually 2nd to batch_col. Most meaningful for multi-instrument MS experiments (where each instrument has its own order-associated effects (see order_col) or simultaneous examination of two batch factors (e.g. preparation day and measurement day). For single-instrument case should be set to 'NULL'
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
theme	ggplot theme, by default classic. Can be easily overridden
ylimits	range of y-axis to plot feature-level trends
base_size	base font size
protein_name	name of the protein as defined in ProteinName
peptide_annotation	long format data frame with peptide ID and their corresponding protein and/or gene annotations. See <code>help("example_peptide_annotation")</code> .
protein_col	column where protein names are specified
spike_ins	name of feature(s), typically proteins that were spiked in for control
irt_pattern	substring used to identify iRT proteins in the column 'ProteinName'
fit_df	data frame output of adjust_batch_trend_df to be plotted with the line
fit_value_col	column in fit_df where the values for fitting trend are found

**Value**

ggplot2 type plot of measure\_col vs order\_col, faceted by feature\_name and (optionally) by batch\_col

**Examples**

```
data(list = c(
  "example_sample_annotation", "example_proteome",
  "example_peptide_annotation"
), package = "proBatch")

sample_annotation <- example_sample_annotation
peptide_annotation <- example_peptide_annotation
proteome <- example_proteome

feature_id <- "10231_QDVDVWLWQQEGSSK_2"

feature_plot <- plot_single_feature(
  feature_name = feature_id,
  df_long = proteome,
  sample_annotation = sample_annotation,
  color_by_batch = TRUE,
  batch_col = "MS_batch"
)

protein_plot <- plot_peptides_of_one_protein(
  protein_name = "Haa0",
  peptide_annotation = peptide_annotation,
  df_long = proteome,
  sample_annotation = sample_annotation,
  protein_col = "Gene"
)

spike_in_plot <- plot_spike_in(
  spike_ins = "BOVINE_A1ag",
  peptide_annotation = peptide_annotation,
  df_long = proteome,
  sample_annotation = sample_annotation,
  protein_col = "Gene"
)

irt_plot <- plot_iRT(
  irt_pattern = "iRT",
  peptide_annotation = peptide_annotation,
  df_long = proteome,
  sample_annotation = sample_annotation,
  protein_col = "Gene"
)

fit_input <- adjust_batch_trend_df(
  proteome[proteome$peptide_group_label == feature_id, ],
  sample_annotation,
```

```

    span = 0.7
  )

curve_plot <- plot_with_fitting_curve(
  feature_name = feature_id,
  df_long = proteome,
  sample_annotation = sample_annotation,
  fit_df = fit_input
)

```

---

fit\_nonlinear

*Fit a non-linear trend (currently optimized for LOESS)*


---

### Description

Fit a non-linear trend (currently optimized for LOESS)

### Usage

```

fit_nonlinear(
  df_feature_batch,
  measure_col = "Intensity",
  order_col = "order",
  feature_id = NULL,
  batch_id = NULL,
  fit_func = "loess_regression",
  optimize_span = FALSE,
  no_fit_imputed = TRUE,
  qual_col = "m_score",
  qual_value = 2,
  min_measurements = 8,
  ...
)

```

### Arguments

df_feature_batch	data frame containing response variable e.g. samples in order and explanatory variable e.g. measurement for a specific feature (peptide) in a specific batch
measure_col	if df_long is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
order_col	column in sample_annotation that determines sample order. It is used for in initial assessment plots ( <a href="#">plot_sample_mean_or_boxplot</a> ) and feature-level diagnostics ( <a href="#">feature_level_diagnostics</a> ). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see <a href="#">define_sample_order</a> and <a href="#">date_to_sample_order</a>

feature_id	the name of the feature, required for warnings
batch_id	the name of the batch, required for warnings
fit_func	function to use for the fit, e.g. loess_regression
optimize_span	logical, whether to specify span or optimize it (specific entirely for LOESS regression)
no_fit_imputed	(logical) whether to fit the imputed (requant) values
qual_col	column to color point by certain value denoted by qual_value. Design with inferred/requant values in OpenSWATH output data, which means argument value has to be set to m_score.
qual_value	value in qual_col to color. For OpenSWATH data, this argument value has to be set to 2 (this is an m_score value for imputed values (requant values)).
min_measurements	the absolute threshold to filter
...	additional parameters to be passed to the fitting function

**Value**

vector of fitted response values

**Examples**

```
# Load necessary datasets
data(list = c("example_proteome", "example_sample_annotation"), package = "proBatch")

test_peptide <- example_proteome$peptide_group_label[1]
selected_peptide <- example_proteome$peptide_group_label == test_peptide
df_selected <- example_proteome[selected_peptide, ]
selected_batch <- example_sample_annotation$MS_batch == "Batch_1"
batch_selected_df <- example_sample_annotation[selected_batch, ]
df_for_test <- merge(df_selected, batch_selected_df, by = "FullRunName")
fit_values <- fit_nonlinear(df_for_test)

# for the case where are two many missing values, no curve is fit
selected_batch <- example_sample_annotation$MS_batch == "Batch_2"
batch_selected_df <- example_sample_annotation[selected_batch, ]
df_for_test <- merge(df_selected, batch_selected_df, by = "FullRunName")
fit_values <- fit_nonlinear(df_for_test)
missing_values <- df_for_test[["m_score"]] == 2
all(fit_values[!is.na(fit_values)] == df_for_test[["Intensity"]][!missing_values])
```

---

generate\_colors\_for\_numeric

*Generates color vector from continous palette*

---

**Description**

Generates a vector of colors for a vector of numeric, POSIXct (i.e. the (signed) number of seconds since the beginning of 1970), or factors

**Usage**

```
generate_colors_for_numeric(palette_type = "brewer", i = 1)
```

**Arguments**

`palette_type` 'brewer' or 'viridis'  
`i` if `palette_type` is 'brewer' the palette argument to `brewer_pal`. If `palette_type` is 'viridis' the option argument to `viridis_pal`

**Value**

vector of colors

**Examples**

```
generate_colors_for_numeric("brewer", i = 1)
```

---

<code>get_chain</code>	<i>Retrieve operation chain as vector or single string "combat_on_mediannorm_on_log"</i>
------------------------	--

---

**Description**

Retrieve operation chain as vector or single string "combat\_on\_mediannorm\_on\_log"

**Usage**

```
get_chain(object, as_string = FALSE)
```

**Arguments**

`object` A 'ProBatchFeatures' object.  
`as_string` logical(1). if 'TRUE' returns the chain as a single string of the form "combat\_on\_mediannorm\_on\_log".

**Value**

Character vector or string describing the processing chain.

## Examples

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
)

```

```
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)
```

---

get\_operation\_log      *Access the operation log (structured)*

---

### Description

Access the operation log (structured)

### Usage

```
get_operation_log(object)
```

### Arguments

object            A 'ProBatchFeatures' object.

**Value**

S4Vectors::DataFrame

**Examples**

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----

```

```

head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

guess\_factor\_columns\_if\_needed

*Guess factors if numeric columns were not provided*

---

### Description

Derive numeric columns from factor columns if guess\_factors is TRUE and numeric columns are NULL.

**Usage**

```
guess_factor_columns_if_needed(  
  factor_columns,  
  sample_annotation,  
  guess_factors  
)
```

**Arguments**

`factor_columns` character vector of factor columns.  
`sample_annotation` data frame of sample annotations.  
`guess_factors` logical indicating whether to guess numeric columns.

**Value**

Named list containing updated `factor_columns` and `numeric_columns`.

---

handle\_factor\_numeric\_overlap

*Handle factor columns that are duplicated in numeric\_columns*

---

**Description**

Remove numeric columns from factor columns if overlap is detected.

**Usage**

```
handle_factor_numeric_overlap(factor_columns, numeric_columns)
```

**Arguments**

`factor_columns` character vector of factor columns.  
`numeric_columns` character vector of numeric columns.

**Value**

List with updated `factor_columns` and a warning if overlaps exist

---

handle\_missing\_values *Handle missing values in a data matrix*

---

## Description

This function can either fill missing values with a specified value or remove rows (and columns, if applicable) with missing values. It is primarily intended for use prior to batch correction methods that cannot handle missing values, such as ComBat or limma's removeBatchEffect, or plotting functions that require complete data.

## Usage

```
handle_missing_values(data_matrix, warning_message, fill_the_missing = NULL)
```

## Arguments

`data_matrix` A numeric matrix with features in rows and samples in columns.

`warning_message` A character string with a warning shown if missing values are found.

`fill_the_missing` A control value: - FALSE: do nothing (keep NAs). - Missing (arg not supplied) or "remove"/"rm"/"REMOVE": remove rows with any NA (and matching columns if square & symmetric). - Numeric scalar: fill NAs with this value. - Non-numeric: coerced to 0 with a warning and used to fill NAs.

## Details

Semantics: - If there are no NAs: return input unchanged. - If `fill_the_missing` is explicitly FALSE: do nothing (keep NAs). - If `fill_the_missing` is missing (argument not supplied) or one of "remove","rm","REMOVE": remove rows with any NA; if the matrix is square and symmetric (`na.rm=TRUE`), remove matching rows AND columns using the same row keep-mask. - Otherwise: if non-numeric or NA, coerce to 0 with a warning; then fill NAs.

## Value

A matrix with missing values handled as specified.

## Examples

```
mat <- matrix(c(1, NA, 3, 4), nrow = 2)
suppressWarnings(proBatch::handle_missing_values(
  mat,
  warning_message = "demo",
  fill_the_missing = 0
))
```

---

long_to_matrix	<i>Long to wide data format conversion</i>
----------------	--

---

### Description

Convert from a long data frame representation to a wide matrix representation

### Usage

```
long_to_matrix(  
  df_long,  
  feature_id_col = "peptide_group_label",  
  measure_col = "Intensity",  
  sample_id_col = "FullRunName",  
  qual_col = NULL,  
  qual_value = 2  
)
```

### Arguments

df_long	data frame where each row is a single feature in a single sample. It minimally has a sample_id_col, a feature_id_col and a measure_col, but usually also an m_score (in OpenSWATH output result file). See help("example_proteome") for more details.
feature_id_col	name of the column with feature/gene/peptide/protein ID used in the long format representation df_long. In the wide formatted representation data_matrix this corresponds to the row names.
measure_col	if df_long is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
sample_id_col	name of the column in sample_annotation table, where the filenames (column names of the data_matrix are found).
qual_col	column to color point by certain value denoted by qual_value. Design with inferred/requant values in OpenSWATH output data, which means argument value has to be set to m_score.
qual_value	value in qual_col to color. For OpenSWATH data, this argument value has to be set to 2 (this is an m_score value for imputed values (requant values)).

### Value

data\_matrix ([proBatch](#)) like matrix (features in rows, samples in columns)

### See Also

Other matrix manipulation functions: [matrix\\_to\\_long\(\)](#)

**Examples**

```
data("example_proteome", package = "proBatch")
proteome_matrix <- long_to_matrix(example_proteome)
```

---

matrix\_to\_long                      *Wide to long conversion*

---

**Description**

Convert from wide matrix to a long data frame representation

**Usage**

```
matrix_to_long(
  data_matrix,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  measure_col = "Intensity",
  sample_id_col = "FullRunName",
  step = NULL
)
```

**Arguments**

**data\_matrix**        features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example\_proteome\_matrix" for more details (to call the description, use help("example\_proteome\_matrix"))

**sample\_annotation**  
                       data frame with:

1. sample\_id\_col (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

**feature\_id\_col**    name of the column with feature/gene/peptide/protein ID used in the long format representation df\_long. In the wide formatted representation data\_matrix this corresponds to the row names.

**measure\_col**        if df\_long is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.

**sample\_id\_col**     name of the column in sample\_annotation table, where the filenames (colnames of the data\_matrix are found).

**step**                normalization step (e.g. Raw or Normalized). Useful if consecutive steps are compared in plots. Note that in plots these are usually ordered alphabetically, so it's worth naming with numbers, e.g. 1\_raw, 2\_quantile

**Value**

df\_long ([proBatch](#)) like data frame

**See Also**

Other matrix manipulation functions: [long\\_to\\_matrix\(\)](#)

**Examples**

```
# Load necessary datasets
data(
  list = c("example_sample_annotation", "example_proteome_matrix"),
  package = "proBatch"
)
# Convert matrix to long format
proteome_long <- matrix_to_long(
  example_proteome_matrix,
  example_sample_annotation
)
```

---

merge_rare_levels	<i>Replaces rare levels with other</i>
-------------------	--

---

**Description**

Replaces levels with a maximal occurrence of 1 with other

**Usage**

```
merge_rare_levels(column, rare_thr = 2)
```

**Arguments**

column	column of the data whose rare categories need to be merged to "other"
rare_thr	minimal number of times for a category to be represented to be declared as "rare" and converted to "other"

**Value**

column with rare occurrences replaced by other

**Examples**

```
column <- factor(c("A", "B", "A", "C", "D", "D", "E"))
merge_rare_levels(column, rare_thr = 2)
# [1] A other A other D D other
# Levels: A D other
```

---

`normalize`*Data normalization methods*

---

### Description

Normalization of raw (usually log-transformed) data. Normalization brings the samples to the same scale. Currently the following normalization functions are implemented: #

1. Quantile normalization: `'quantile_normalize_dm()'`. Quantile normalization of the data.
2. Median normalization: `'normalize_sample_medians_dm()'`. Normalization by centering sample medians to global median of the data

Alternatively, one can call normalization function with `'normalize_data_dm()'` wrapper.

### Usage

```
quantile_normalize_dm(data_matrix)
```

```
quantile_normalize_df(  
  df_long,  
  feature_id_col = "peptide_group_label",  
  sample_id_col = "FullRunName",  
  measure_col = "Intensity",  
  no_fit_imputed = TRUE,  
  qual_col = NULL,  
  qual_value = 2,  
  keep_all = "default"  
)
```

```
normalize_sample_medians_dm(data_matrix)
```

```
normalize_sample_medians_df(  
  df_long,  
  feature_id_col = "peptide_group_label",  
  sample_id_col = "FullRunName",  
  measure_col = "Intensity",  
  no_fit_imputed = FALSE,  
  qual_col = NULL,  
  qual_value = 2,  
  keep_all = "default"  
)
```

```
normalize_data_dm(  
  data_matrix,  
  normalize_func = c("quantile", "medianCentering"),  
  log_base = NULL,  
  offset = 1
```

```

)

normalize_data_df(
  df_long,
  normalize_func = c("quantile", "medianCentering"),
  log_base = NULL,
  offset = 1,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  no_fit_imputed = TRUE,
  qual_col = NULL,
  qual_value = 2,
  keep_all = "default"
)

```

### Arguments

<code>data_matrix</code>	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use <code>help("example_proteome_matrix")</code> )
<code>df_long</code>	data frame where each row is a single feature in a single sample. It minimally has a <code>sample_id_col</code> , a <code>feature_id_col</code> and a <code>measure_col</code> , but usually also an <code>m_score</code> (in OpenSWATH output result file). See <code>help("example_proteome")</code> for more details.
<code>feature_id_col</code>	name of the column with feature/gene/peptide/protein ID used in the long format representation <code>df_long</code> . In the wide formatted representation <code>data_matrix</code> this corresponds to the row names.
<code>sample_id_col</code>	name of the column in <code>sample_annotation</code> table, where the filenames (colnames of the <code>data_matrix</code> are found).
<code>measure_col</code>	if <code>df_long</code> is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
<code>no_fit_imputed</code>	(logical) whether to use imputed (requant) values, as flagged in <code>qual_col</code> by <code>qual_value</code> for data transformation
<code>qual_col</code>	column to color point by certain value denoted by <code>qual_value</code> . Design with inferred/requant values in OpenSWATH output data, which means argument value has to be set to <code>m_score</code> .
<code>qual_value</code>	value in <code>qual_col</code> to color. For OpenSWATH data, this argument value has to be set to 2 (this is an <code>m_score</code> value for imputed values (requant values)).
<code>keep_all</code>	when transforming the data (normalize, correct) - acceptable values: all/default/minimal (which set of columns be kept).
<code>normalize_func</code>	global batch normalization method ('quantile' or 'MedianCentering')
<code>log_base</code>	whether to log transform data matrix before normalization (e.g. 'NULL', '2' or '10')
<code>offset</code>	small positive number to prevent 0 conversion to -Inf

**Value**

the data in the same format as input (data\_matrix or df\_long). For df\_long the data frame stores the original values of measure\_col in another column called "preNorm\_intensity" if "intensity", and the normalized values in measure\_col column.

**Examples**

```
data(list = c("example_proteome", "example_proteome_matrix"), package = "proBatch")

# Quantile normalization:
quantile_normalized_matrix <- quantile_normalize_dm(example_proteome_matrix)

# Median centering:
median_normalized_df <- normalize_sample_medians_df(example_proteome)

# Transform the data in one go:
quantile_normalized_matrix <- normalize_data_dm(example_proteome_matrix,
  normalize_func = "quantile", log_base = 2, offset = 1
)
```

---

pb\_add\_level

*Add a new level from an external matrix and link to an existing assay*

---

**Description**

Add a new level from an external matrix and link to an existing assay

**Usage**

```
pb_add_level(
  object,
  from,
  new_matrix,
  to_level,
  to_pipeline = NULL,
  name = NULL,
  mapping_df = NULL,
  from_id = NULL,
  to_id = NULL,
  map_strategy = c("as_is", "first", "longest"),
  link_var = "ProteinID",
  backend = c("auto", "memory", "hdf5"),
  hdf5_path = NULL
)
```

**Arguments**

object	ProBatchFeatures
from	assay name (e.g., "peptide::raw")
new_matrix	numeric matrix (features x samples)
to_level	e.g. "protein"
to_pipeline	optional pipeline name (default carries over from 'from')
name	optional final assay name override
mapping_df	data.frame with mapping from 'from' IDs to 'to' IDs
from_id	column in mapping_df for 'from' IDs (e.g., "Precursor.Id")
to_id	column in mapping_df for 'to' IDs (e.g., "Protein.Ids")
map_strategy	how to resolve multiple to-ids per from-id: "as_is" (error if not 1:1), "first" (take first), "longest" (take longest string)
link_var	rowData variable name to use for linking (e.g., "ProteinID")
backend	"memory","hdf5","auto"
hdf5_path	optional filepath for HDF5Array

**Value**

ProBatchFeatures with new assay and link added

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
```

```

pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

```

```
# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)
```

---

pb\_aggregate\_level      *Aggregate features (e.g., peptide -> protein) and store as new level*

---

### Description

Aggregate features (e.g., peptide -> protein) and store as new level

### Usage

```
pb_aggregate_level(
  object,
  from,
  feature_var,
  fun = colMedians,
  new_level = "protein",
  new_pipeline = NULL
)
```

### Arguments

object	ProBatchFeatures
from	assay name (e.g., "peptide::raw")
feature_var	name of a column in rowData(from) holding group labels (e.g. protein IDs)
fun	summarization function (e.g., matrixStats::colMedians), or name
new_level	new level label (e.g., "protein")
new_pipeline	optional pipeline name (default carries over from 'from')

### Value

ProBatchFeatures with an additional aggregated assay appended

### Examples

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
```

```

all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,

```

```

    sample_id_col = "Run",
    feature_id_col = "feature_label",
    level = "peptide"
  )

# Add proteins as a new level and link via mapping
#   all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

pb_assay_matrix	<i>Convenience accessor for assay matrix by name/index (returns the 'intensity' assay)</i>
-----------------	--

---

## Description

Convenience accessor for assay matrix by name/index (returns the 'intensity' assay)

## Usage

```
pb_assay_matrix(object, assay = NULL, name = "intensity")
```

## Arguments

object	A 'ProBatchFeatures' object.
assay	Assay identifier to extract; defaults to the current assay.
name	Assay entry to read from the underlying 'SummarizedExperiment'.

## Value

assay data matrix with features in rows and samples in columns

**Examples**

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
)

```

```

))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

pb\_as\_long

*Get current assay as LONG (via proBatch::matrix\_to\_long)*

---

## Description

Get current assay as LONG (via proBatch::matrix\_to\_long)

## Usage

```

pb_as_long(
  object,
  feature_id_col = "feature_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  pbf_name = pb_current_assay(object)
)

```

**Arguments**

object	A 'ProBatchFeatures' object.
feature_id_col	Column name used for feature identifiers in the long table.
sample_id_col	Column name used for sample identifiers in the long table.
measure_col	Column name containing measured values in the long table.
pbf_name	Assay name whose intensities should be returned in long form.

**Value**

tibble/data.frame containing one row per feature-sample combination

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
```

```

pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  new_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

**Description**

Get an assay matrix (wide)

**Usage**

```
pb_as_wide(object, assay = pb_current_assay(object), name = "intensity")
```

**Arguments**

object	A 'ProBatchFeatures' object.
assay	Assay identifier to extract; defaults to the current assay.
name	Assay entry name inside the 'SummarizedExperiment' to return.

**Value**

numeric matrix (wide) corresponding to the requested assay

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)
```

```

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

pb_current_assay	<i>Current (latest) assay name</i>
------------------	------------------------------------

---

**Description**

Current (latest) assay name

**Usage**

```
pb_current_assay(object)
```

**Arguments**

object            A 'ProBatchFeatures' object.

**Value**

character(1) assay identifier for the most recently stored assay

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
```

```

    store_fast_steps = TRUE
  )

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",

```

```

    feature_var = "ProteinID",
    new_level = "protein_new"
  )

```

---

pb\_eval

*Evaluate a pipeline and return the matrix, without storing*


---

## Description

Evaluate a pipeline and return the matrix, without storing

## Usage

```
pb_eval(object, from, steps, funs = NULL, params_list = NULL)
```

## Arguments

object	ProBatchFeatures
from	assay name (e.g., "peptide::raw")
steps	character vector, e.g. c("log2","medianNorm","combat")
funs	optional same-length vector/list of functions/names (default: steps for registry lookup)
params_list	list of parameter lists (same length as steps)

## Value

numeric matrix (features x samples)

## Examples

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

```

```

)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,

```

```

    to_level = "protein", # will name "protein::raw" by default
    mapping_df = all_precursor_pg_match,
    from_id = "Precursor.Id",
    to_id = "Protein.Ids",
    map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

pb\_missing\_helpers      *Apply 'QFeatures' missing-data helpers to stored assays*

---

## Description

These wrappers delegate to the corresponding 'QFeatures' generics while ensuring that the requested assays remain part of the 'ProBatchFeatures' object. Only assays that are already materialised can be modified. If a transformation step was applied as a "fast" step (log, log2, etc.), consider re-running it with 'store\_fast\_steps = TRUE'.

## Usage

```

pb_zeroIsNA(object, pbf_name = names(object), ...)

pb_infIsNA(object, pbf_name = names(object), ...)

pb_nNA(object, pbf_name = names(object), ...)

pb_filterNA(object, pbf_name = NULL, inplace = FALSE, final_name = NULL, ...)

```

## Arguments

object	A 'ProBatchFeatures' object.
pbf_name	Character vector of assay names. Defaults to 'names(object)' - all assays.
...	Additional parameters forwarded to the underlying 'QFeatures' method where applicable.
inplace	Logical (used by 'pb_filterNA()' only), whether to modify the object in place. Default: 'FALSE'. If 'FALSE', the modified assay(s) will be added to the object with 'final_name' (if provided) or the original name(s) with suffix '_filteredNA'.
final_name	Character (used by 'pb_filterNA()' only), name for the modified assay(s) if 'inplace' is 'FALSE'. If 'NULL' (default), the original name(s) with suffix '_filteredNA' will be used.

**Value**

'pb\_zeroIsNA()', 'pb\_infIsNA()' and 'pb\_filterNA()' return the updated 'ProBatchFeatures' object. 'pb\_nNA()' returns the output of the corresponding 'QFeatures::nNA()' call (a 'list' of 'DataFrame's).

---

pb_pipeline_name	<i>Pretty pipeline name derived from the assay</i>
------------------	--

---

**Description**

Pretty pipeline name derived from the assay

**Usage**

```
pb_pipeline_name(object, assay = pb_current_assay(object))
```

**Arguments**

object	ProBatchFeatures
assay	character(1) assay name; defaults to current assay

**Value**

character(1) pipeline string like "combat\_on\_medianNorm\_on\_log2" or "raw"

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))
```

```

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

```

```

)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

pb_register_step	<i>Allow to register/override steps at runtime (e.g., map "combat" -&gt; proBatch::combat_dm)</i>
------------------	---

---

### Description

Allow to register/override steps at runtime (e.g., map "combat" -> proBatch::combat\_dm)

### Usage

```
pb_register_step(name, fun)
```

### Arguments

name	character(1) step name
fun	function implementing the step

### Value

NULL (invisible)

### Examples

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,

```

```

    sample_id_col = "Run",
    level = "peptide"
  )

  # Register a custom step and evaluate it -----
  pb_register_step("add_one", function(x) x + 1)
  head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

  # Derived objects for downstream helpers -----
  pbf_logged <- pb_transform(
    pbf,
    from = "peptide::raw",
    steps = c("log2", "medianNorm"),
    store_fast_steps = TRUE
  )

  # Get information about the object -----
  get_operation_log(pbf_logged)
  get_chain(pbf_logged)
  get_chain(pbf_logged, as_string = TRUE)
  pb_pipeline_name(pbf_logged) # the latest pipeline
  pb_pipeline_name(pbf_logged, assay = "peptide::raw")

  # Access assays and matrices -----
  head(pb_current_assay(pbf_logged)) # the latest assay
  head(pb_assay_matrix(pbf_logged)) # the latest matrix
  head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
  head(pb_as_wide(pbf_logged)) # the latest assay in wide format
  head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

  # Pipeline evaluation without storing -----
  head(pb_eval(
    pbf,
    from = "peptide::raw",
    steps = c("log2", "medianNorm")
  ))

  # Long-format constructor -----
  long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

  ProBatchFeatures_from_long(
    df_long = long_pbf,
    sample_annotation = all_metadata,
    sample_id_col = "Run",
    feature_id_col = "feature_label",
    level = "peptide"
  )

  # Add proteins as a new level and link via mapping
  # all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
  pbf <- pb_add_level(
    object = pbf,

```

```

    from = "peptide::raw",
    new_matrix = all_protein_groups,
    to_level = "protein", # will name "protein::raw" by default
    mapping_df = all_precursor_pg_match,
    from_id = "Precursor.Id",
    to_id = "Protein.Ids",
    map_strategy = "as_is"
  )

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

pb\_transform

*Compute a pipeline and optionally store only the final result*


---

## Description

Compute a pipeline and optionally store only the final result

## Usage

```

pb_transform(
  object,
  from,
  steps,
  funs = NULL,
  params_list = NULL,
  level = NULL,
  store_fast_steps = FALSE,
  fast_steps = c("log", "log2", "medianNorm"),
  store_intermediate = FALSE,
  final_name = NULL,
  backend = c("auto", "memory", "hdf5"),
  hdf5_path = NULL
)

```

## Arguments

object	A 'ProBatchFeatures' object.
from	Assay name to start the pipeline from.
steps	character vector, e.g. c("log2","medianNorm","combat")
funs	optional same-length vector/list of functions/names (default: steps)

params\_list      list of parameter lists (same length as steps)  
 level            Optional level label to assign to the generated assay(s).  
 store\_fast\_steps      logical; if FALSE, fast steps are computed but not stored  
 fast\_steps        which steps count as fast (default: c("log","log2","medianNorm"))  
 store\_intermediate      logical; if TRUE store every step (overrides fast behavior)  
 final\_name        optional final assay name override  
 backend          "memory","hdf5","auto"  
 hdf5\_path        Optional file path used when 'backend = "hdf5"'.

### Value

ProBatchFeatures with the requested pipeline added (as log and/or assay)

### Examples

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----

```

```

get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

plot\_corr\_matrix      *Visualise correlation matrix*

---

### Description

recommended for heatmap-type visualisation of correlation matrix with <100 items. With >50 samples and ~10 replicate pairs distribution plots may be more informative.

### Usage

```
plot_corr_matrix(
  corr_matrix,
  annotation = NULL,
  annotation_id_col = "FullRunName",
  factors_to_plot = NULL,
  cluster_rows = FALSE,
  cluster_cols = FALSE,
  heatmap_color = colorRampPalette(rev(brewer.pal(n = 7, name = "RdYlBu")))(100),
  color_list = NULL,
  filename = NULL,
  width = 7,
  height = 7,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  ...
)
```

### Arguments

corr_matrix	square correlation matrix
annotation	data frame with peptide_annotation for protein correlation heatmap or sample_annotation for sample correlation heatmap
annotation_id_col	feature_id_col for protein correlation heatmap or sample_id_col for sample correlation heatmap
factors_to_plot	vector of technical and biological covariates to be plotted in this diagnostic plot (assumed to be present in sample_annotation)
cluster_rows	boolean values determining if rows should be clustered or hclust object
cluster_cols	boolean values determining if columns should be clustered or hclust object
heatmap_color	vector of colors used in heatmap.
color_list	list, as returned by sample_annotation_to_colors, where each item contains a color vector for each factor to be mapped to the color.

filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
...	parameters for the <a href="#">pheatmap</a> visualisation, for details see examples and help to corresponding functions

### Details

Plot correlation of selected samples or peptides

### Value

pheatmap object

### See Also

[pheatmap](#), [plot\\_sample\\_corr\\_distribution](#), [plot\\_peptide\\_corr\\_distribution](#)

### Examples

```
data("example_proteome_matrix", package = "proBatch")
peptides <- c("10231_QDVDVWLWQEGSSK_2", "10768_RLESELDGLR_2")
data_matrix_sub <- example_proteome_matrix[peptides, ]
corr_matrix <- cor(t(data_matrix_sub), use = "complete.obs")
corr_matrix_plot <- plot_corr_matrix(corr_matrix)
```

---

plot\_CV\_distr

*Plot CV distribution to compare various steps of the analysis*

---

### Description

Plot CV distribution to compare various steps of the analysis

### Usage

```
plot_CV_distr(
  df_long,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
```

```

    biospecimen_id_col = "EarTag",
    batch_col = NULL,
    unlog = TRUE,
    log_base = 2,
    offset = 1,
    plot_title = NULL,
    filename = NULL,
    theme = "classic"
)

```

## Arguments

<code>df_long</code>	as in <code>df_long</code> for the rest of the package, but, when it has entries for intensity, represented in <code>measure_col</code> for several steps, e.g. raw, normalized, batch corrected data, as seen in column <code>Step</code> , then multi-step CV comparison can be carried out.
<code>sample_annotation</code>	data frame with: <ol style="list-style-type: none"> <li>1. <code>sample_id_col</code> (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See <code>help("example_sample_annotation")</code>
<code>feature_id_col</code>	name of the column with feature/gene/peptide/protein ID used in the long format representation <code>df_long</code> . In the wide formatted representation <code>data_matrix</code> this corresponds to the row names.
<code>sample_id_col</code>	name of the column in <code>sample_annotation</code> table, where the filenames (col-names of the <code>data_matrix</code> are found).
<code>measure_col</code>	if <code>df_long</code> is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
<code>biospecimen_id_col</code>	column in <code>sample_annotation</code> that defines a unique bio ID, which is usually a combination of conditions or groups. Tip: if such ID is absent, but can be defined from several columns, create new <code>biospecimen_id</code> column
<code>batch_col</code>	column in <code>sample_annotation</code> that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).
<code>unlog</code>	(logical) whether to reverse log transformation of the original data
<code>log_base</code>	base of the logarithm for transformation
<code>offset</code>	small positive number to prevent 0 conversion to <code>-Inf</code>
<code>plot_title</code>	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
<code>filename</code>	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
<code>theme</code>	ggplot theme, by default <code>classic</code> . Can be easily overridden

**Value**

ggplot object with the boxplot of CVs on one or several steps

**Examples**

```
data(list = c("example_sample_annotation", "example_proteome"), package = "proBatch")
CV_plot <- plot_CV_distr(example_proteome,
  sample_annotation = example_sample_annotation,
  measure_col = "Intensity", batch_col = "MS_batch",
  plot_title = NULL, filename = NULL, theme = "classic"
)
```

---

plot_CV_distr.df	<i>Plot the distribution (boxplots) of per-batch per-step CV of features</i>
------------------	--

---

**Description**

Plot the distribution (boxplots) of per-batch per-step CV of features

**Usage**

```
plot_CV_distr.df(
  CV_df,
  plot_title = NULL,
  filename = NULL,
  theme = "classic",
  log_y_scale = TRUE
)
```

**Arguments**

CV_df	data frame with Total CV for each feature & (optionally) per-batch CV
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
theme	ggplot theme, by default classic. Can be easily overridden
log_y_scale	(logical) whether to display the CV on log-scale

**Value**

ggplot object

**Examples**

```

cv_example <- data.frame(
  Step = c("raw", "raw", "raw"),
  CV_total = c(10, 15, 12)
)
plot_CV_distr.df(cv_example, log_y_scale = FALSE)

```

---

```
plot_heatmap_diagnostic
```

*Plot the heatmap of samples (cols) vs features (rows)*

---

**Description**

Plot the heatmap of samples (cols) vs features (rows)

**Usage**

```

## Default S3 method:
plot_heatmap_diagnostic(
  data_matrix,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  factors_to_plot = NULL,
  fill_the_missing = -1,
  color_for_missing = "black",
  heatmap_color = colorRampPalette(rev(brewer.pal(n = 7, name = "RdYlBu")))(100),
  cluster_rows = TRUE,
  cluster_cols = FALSE,
  color_list = NULL,
  peptide_annotation = NULL,
  feature_id_col = NULL,
  factors_of_feature_ann = NULL,
  color_list_features = NULL,
  filename = NULL,
  width = 7,
  height = 7,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  ...
)

## S3 method for class 'ProBatchFeatures'
plot_heatmap_diagnostic(
  data_matrix,
  pbf_name = NULL,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",

```

```

    peptide_annotation = NULL,
    feature_id_col = "peptide_group_label",
    plot_title = NULL,
    return_gridExtra = FALSE,
    plot_ncol = NULL,
    ...
)

```

## Arguments

**data\_matrix** Input object: matrix-like data or a ‘ProBatchFeatures’ instance.

**sample\_annotation** data frame with:

1. **sample\_id\_col** (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

**sample\_id\_col** name of the column in **sample\_annotation** table, where the filenames (column names of the **data\_matrix** are found).

**factors\_to\_plot** vector of technical and biological factors to be plotted in this diagnostic plot (assumed to be present in **sample\_annotation**)

**fill\_the\_missing** numeric value that the missing values are substituted with, or NULL if features with missing values are to be excluded.

**color\_for\_missing** special color to make missing values. Usually black or white, depending on **heatmap\_color**

**heatmap\_color** vector of colors used in heatmap (typically a gradient)

**cluster\_rows** boolean value determining if rows should be clustered

**cluster\_cols** boolean value determining if columns should be clustered

**color\_list** list, as returned by **sample\_annotation\_to\_colors**, where each item contains a color vector for each factor to be mapped to the color.

**peptide\_annotation** long format data frame with peptide ID and their corresponding protein and/or gene annotations. See help("example\_peptide\_annotation").

**feature\_id\_col** name of the column with feature/gene/peptide/protein ID used in the long format representation **df\_long**. In the wide formatted representation **data\_matrix** this corresponds to the row names.

**factors\_of\_feature\_ann** vector of factors that characterize features, as listed in **peptide\_annotation**

**color\_list\_features** list, as returned by **sample\_annotation\_to\_colors**, but mapping **peptide\_annotation** where each item contains a color vector for each factor to be mapped to the color.

filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
...	other parameters of link[pheatmap]{pheatmap}
pbf_name	Assay name(s) used when 'data_matrix' is a 'ProBatchFeatures'.
return_gridExtra	Logical; return arranged grobs instead of a plot list.
plot_ncol	Number of columns when arranging multiple assay plots.

**Value**

object returned by link[pheatmap]{pheatmap}

**See Also**

[sample\\_annotation\\_to\\_colors](#), [pheatmap](#)

**Examples**

```
# Load necessary datasets
data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")

# Use a smaller subset for the example
example_proteome_matrix_small <- example_proteome_matrix[1:50, ]

log_transformed_matrix <- log_transform_dm(example_proteome_matrix_small)
color_list <- sample_annotation_to_colors(example_sample_annotation,
  factor_columns = c(
    "MS_batch", "EarTag", "Strain",
    "Diet", "digestion_batch", "Sex"
  ),
  numeric_columns = c("DateTime", "order")
)

log_transformed_matrix <- log_transform_dm(example_proteome_matrix)
heatmap_plot <- plot_heatmap_diagnostic(log_transformed_matrix,
  example_sample_annotation,
  factors_to_plot = c("MS_batch", "digestion_batch", "Diet", "DateTime"),
  cluster_cols = TRUE, cluster_rows = FALSE,
  color_list = color_list, # can be NULL
  show_rownames = FALSE, show_colnames = FALSE
)
```

---

plot\_heatmap\_generic *Plot the heatmap*

---

## Description

Plot the heatmap

## Usage

```
## Default S3 method:
plot_heatmap_generic(
  data_matrix,
  column_annotation_df = NULL,
  row_annotation_df = NULL,
  col_ann_id_col = NULL,
  row_ann_id_col = NULL,
  columns_for_cols = c("MS_batch", "Diet", "DateTime", "order"),
  columns_for_rows = c("KEGG_pathway", "WGCNA_module", "evolutionary_distance"),
  cluster_rows = FALSE,
  cluster_cols = TRUE,
  annotation_color_cols = NULL,
  annotation_color_rows = NULL,
  fill_the_missing = -1,
  color_for_missing = "black",
  heatmap_color = colorRampPalette(rev(brewer.pal(n = 7, name = "RdYlBu")))(100),
  filename = NULL,
  width = 7,
  height = 7,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  ...
)

## S3 method for class 'ProBatchFeatures'
plot_heatmap_generic(
  data_matrix,
  pbf_name = NULL,
  column_annotation_df = NULL,
  row_annotation_df = NULL,
  col_ann_id_col = NULL,
  row_ann_id_col = NULL,
  plot_title = NULL,
  return_gridExtra = FALSE,
  plot_ncol = NULL,
  ...
)
```

**Arguments**

<code>data_matrix</code>	Input object: matrix-like data or a 'ProBatchFeatures' instance.
<code>column_annotation_df</code>	data frame annotating columns of <code>data_matrix</code>
<code>row_annotation_df</code>	data frame annotating rows of <code>data_matrix</code>
<code>col_ann_id_col</code>	column of <code>column_annotation_df</code> whose values are unique identifiers of columns in <code>data_matrix</code>
<code>row_ann_id_col</code>	column of <code>row_annotation_df</code> whose values are unique identifiers of rows in <code>data_matrix</code>
<code>columns_for_cols</code>	vector of factors (columns) of <code>column_annotation_df</code> that will be mapped to color annotation of heatmap columns
<code>columns_for_rows</code>	vector of factors (columns) of <code>row_annotation_df</code> that will be mapped to color annotation of heatmap rows
<code>cluster_rows</code>	boolean: whether the rows should be clustered
<code>cluster_cols</code>	boolean: whether the rows should be clustered
<code>annotation_color_cols</code>	list of color vectors for column annotation, for each factor to be plotted; for factor-like variables a named vector (names should correspond to the levels of factors). Advisable to supply here color list returned by <code>sample_annotation_to_colors</code>
<code>annotation_color_rows</code>	list of color vectors for row annotation, for each factor to be plotted; for factor-like variables a named vector (names should correspond to the levels of factors). Advisable to supply here color list returned by <code>sample_annotation_to_colors</code>
<code>fill_the_missing</code>	numeric value that the missing values are substituted with, or NULL if features with missing values are to be excluded.
<code>color_for_missing</code>	special color to make missing values. Usually black or white, depending on <code>heatmap_color</code>
<code>heatmap_color</code>	vector of colors used in heatmap (typical a gradient)
<code>filename</code>	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
<code>width</code>	option determining the output image width
<code>height</code>	option determining the output image height
<code>units</code>	units: 'cm', 'in' or 'mm'
<code>plot_title</code>	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
<code>...</code>	other parameters of <code>link[pheatmap]{pheatmap}</code>
<code>pbf_name</code>	Assay name(s) used when 'data_matrix' is a 'ProBatchFeatures'.

return\_gridExtra      Logical; return arranged grobs instead of a plot list.

plot\_ncol              Number of columns when arranging multiple assay plots.

**Value**

pheatmap-type object

**Examples**

```
data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")
p <- plot_heatmap_generic(log_transform_dm(example_proteome_matrix),
  column_annotation_df = example_sample_annotation,
  columns_for_cols = c("MS_batch", "digestion_batch", "Diet", "DateTime"),
  plot_title = "test_heatmap",
  show_rownames = FALSE, show_colnames = FALSE
)
```

---

plot\_hierarchical\_clustering

*cluster the data matrix to visually inspect which confounder dominates*

---

**Description**

cluster the data matrix to visually inspect which confounder dominates

**Usage**

```
## Default S3 method:
plot_hierarchical_clustering(
  data_matrix,
  sample_annotation,
  sample_id_col = "FullRunName",
  color_list = NULL,
  factors_to_plot = NULL,
  fill_the_missing = 0,
  distance = "euclidean",
  agglomeration = "complete",
  label_samples = TRUE,
  label_font = 0.2,
  filename = NULL,
  width = 38,
  height = 25,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  ...
)
```

```
## S3 method for class 'ProBatchFeatures'
plot_hierarchical_clustering(
  data_matrix,
  pbf_name = NULL,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  plot_title = NULL,
  ...
)
```

### Arguments

<code>data_matrix</code>	Input object: matrix-like data or a 'ProBatchFeatures' instance.
<code>sample_annotation</code>	data frame with: <ol style="list-style-type: none"> <li>1. <code>sample_id_col</code> (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See <code>help("example_sample_annotation")</code>
<code>sample_id_col</code>	name of the column in <code>sample_annotation</code> table, where the filenames (column names of the <code>data_matrix</code> are found).
<code>color_list</code>	list, as returned by <code>sample_annotation_to_colors</code> , where each item contains a color vector for each factor to be mapped to the color.
<code>factors_to_plot</code>	vector of technical and biological covariates to be plotted in this diagnostic plot (assumed to be present in <code>sample_annotation</code> )
<code>fill_the_missing</code>	numeric value determining how missing values should be substituted. If <code>NULL</code> , features with missing values are excluded.
<code>distance</code>	distance metric used for clustering
<code>agglomeration</code>	agglomeration methods as used by <code>hclust</code>
<code>label_samples</code>	if <code>TRUE</code> sample IDs (column names of <code>data_matrix</code> ) will be printed
<code>label_font</code>	size of the font. Is active if <code>label_samples</code> is <code>TRUE</code> , ignored otherwise
<code>filename</code>	path where the results are saved. If <code>null</code> the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
<code>width</code>	option determining the output image width
<code>height</code>	option determining the output image height
<code>units</code>	units: 'cm', 'in' or 'mm'
<code>plot_title</code>	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
<code>...</code>	other parameters of <code>plotDendroAndColors</code> from <code>WGCNA</code> package
<code>pbf_name</code>	Assay name(s) used when 'x' is a 'ProBatchFeatures'.

**Value**

No return

**See Also**

[hclust](#), [sample\\_annotation\\_to\\_colors](#), [plotDendroAndColors](#)

**Examples**

```
# Load necessary datasets
data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")

selected_batches <- example_sample_annotation$MS_batch %in%
  c("Batch_1", "Batch_2")
selected_samples <- example_sample_annotation$FullRunName[selected_batches]
test_matrix <- example_proteome_matrix[, selected_samples]

# with defined color scheme:
color_list <- sample_annotation_to_colors(example_sample_annotation,
  factor_columns = c("MS_batch", "Strain", "Diet", "digestion_batch"),
  numeric_columns = c("DateTime", "order")
)
hierarchical_clustering_plot <- plot_hierarchical_clustering(
  example_proteome_matrix, example_sample_annotation,
  factors_to_plot = c("MS_batch", "Strain", "DateTime", "digestion_batch"),
  color_list = color_list, # can be NULL
  distance = "euclidean", agglomeration = "complete",
  label_samples = FALSE
)
```

---

plot\_NA\_density

*Plot intensity density by missingness*

---

**Description**

Compare the distribution of average intensities between features with and without missing observations.

**Usage**

```
plot_NA_density(x, ...)

## Default S3 method:
plot_NA_density(
  x,
  missing_label = "Missing Value",
  valid_label = "Valid Value",
  palette = c(`Missing Value` = "#A92C23", `Valid Value` = "#345995"),
```

```

    ...
  )

  ## S3 method for class 'ProBatchFeatures'
  plot_NA_density(
    x,
    pbf_name = NULL,
    missing_label = "Missing Value",
    valid_label = "Valid Value",
    palette = c(`Missing Value` = "#A92C23", `Valid Value` = "#345995"),
    nrow = NULL,
    ncol = NULL,
    facet_scales = "free_y",
    ...
  )

```

### Arguments

x	A data container. For the ‘ProBatchFeatures’ method this must be a ‘ProBatchFeatures’ object. The default method accepts any matrix-like input (including ‘SummarizedExperiment’).
...	Additional parameters forwarded to [pheatmap::pheatmap()].
missing_label, valid_label	Labels used to distinguish rows with and without missing values.
palette	Named vector of colours mapped to ‘missing_label’ and ‘valid_label’.
pbf_name	Character scalar or vector with assay names to plot. When ‘NULL’, the most recent assay returned by [pb_current_assay()] is used. Only used by the ‘ProBatchFeatures’ method.
nrow, ncol	Integers controlling the layout when multiple assays are plotted. If both are ‘NULL’, a roughly square layout is chosen automatically.
facet_scales	Scaling behaviour passed to [ggplot2::facet_wrap()] when multiple assays are plotted.

### Value

A ‘ggplot’ object.

---

plot_NA_frequency	<i>Plot missing-value frequency distribution</i>
-------------------	--

---

### Description

Display how many features are observed in a given number of samples.

**Usage**

```

plot_NA_frequency(x, ...)

## Default S3 method:
plot_NA_frequency(x, show_percent = FALSE, fill = "#345995", ...)

## S3 method for class 'ProBatchFeatures'
plot_NA_frequency(
  x,
  pbf_name = NULL,
  fill = "#345995",
  nrow = NULL,
  ncol = NULL,
  facet_scales = "free_y",
  show_percent = FALSE,
  ...
)

```

**Arguments**

x	A data container. For the ‘ProBatchFeatures’ method this must be a ‘ProBatchFeatures’ object. The default method accepts any matrix-like input (including ‘SummarizedExperiment’).
...	Additional parameters forwarded to [pheatmap::pheatmap()].
show_percent	Logical; display percentages instead of raw counts.
fill	Colour used for the columns in the frequency plot.
pbf_name	Character scalar or vector with assay names to plot. When ‘NULL’, the most recent assay returned by [pb_current_assay()] is used. Only used by the ‘ProBatchFeatures’ method.
nrow, ncol	Integers controlling the layout when multiple assays are plotted. If both are ‘NULL’, a roughly square layout is chosen automatically.
facet_scales	Scaling behaviour for facets when plotting multiple assays.

**Value**

A ‘ggplot’ object showing the frequency distribution.

---

plot_NA_heatmap	<i>Plot missing-value heatmap(s)</i>
-----------------	--------------------------------------

---

**Description**

Functions for visualising the missingness pattern of assay intensities as a binary heatmap. The ‘ProBatchFeatures’ method supports drawing multiple assays at once by arranging the resulting heatmaps into a user-controlled grid layout.

**Usage**

```
plot_NA_heatmap(x, ...)  
  
## Default S3 method:  
plot_NA_heatmap(  
  x,  
  sample_annotation = NULL,  
  sample_id_col = NULL,  
  color_by = NULL,  
  label_by = NULL,  
  cluster_samples = TRUE,  
  cluster_features = TRUE,  
  show_row_dend = TRUE,  
  show_column_dend = FALSE,  
  missing_color = "black",  
  valid_color = "grey90",  
  col_vector = NULL,  
  drop_complete = TRUE,  
  draw = TRUE,  
  main = NULL,  
  ...  
)  
  
## S3 method for class 'ProBatchFeatures'  
plot_NA_heatmap(  
  x,  
  pbf_name = NULL,  
  color_by = NULL,  
  label_by = NULL,  
  sample_id_col = NULL,  
  cluster_samples = TRUE,  
  cluster_features = TRUE,  
  show_row_dend = TRUE,  
  show_column_dend = FALSE,  
  missing_color = "black",  
  valid_color = "grey90",  
  col_vector = NULL,  
  drop_complete = TRUE,  
  nrow = NULL,  
  ncol = NULL,  
  draw = TRUE,  
  use_subset = TRUE,  
  ...  
)
```

**Arguments**

<code>x</code>	A data container. For the ‘ProBatchFeatures’ method this must be a ‘ProBatchFeatures’ object. The default method accepts any matrix-like input (including ‘SummarizedExperiment’).
<code>...</code>	Additional parameters forwarded to [pheatmap::pheatmap()].
<code>sample_annotation</code>	Optional data frame with sample-level metadata. Row names (or the column specified via ‘sample_id_col’) must match the column names of the intensity matrix. When ‘x’ is a ‘ProBatchFeatures’ object the sample annotation defaults to ‘as.data.frame(colData(x))’.
<code>sample_id_col</code>	Optional column in ‘sample_annotation’ providing unique sample identifiers. Use this when the data frame lacks row names matching the assay column names.
<code>color_by</code>	Optional column name in ‘sample_annotation’ used to annotate heatmap columns. Use ‘NULL’ (default) or the string "No" to omit the annotation bar.
<code>label_by</code>	Optional column name (or character vector) used for column labels. Use ‘NULL’ for default assay column names or the string "No" to suppress column labels entirely.
<code>cluster_samples, cluster_features</code>	Logical flags controlling whether the heatmap columns/rows are clustered.
<code>show_row_dend, show_column_dend</code>	Logical, whether dendrograms should be drawn for the clustered rows/columns.
<code>missing_color, valid_color</code>	Colours used for missing (‘0’) and observed (‘1’) values respectively.
<code>col_vector</code>	Optional vector of colours that will be recycled to colour the unique values of ‘color_by’.
<code>drop_complete</code>	Logical, drop features without any missing values before plotting. Defaults to ‘TRUE’ to focus on missingness patterns.
<code>draw</code>	Logical, draw the heatmap(s). Set to ‘FALSE’ to obtain the grob(s) without plotting. For multiple assays, the arranged grob is returned invisibly when ‘draw = TRUE’.
<code>main</code>	Optional title passed to [pheatmap::pheatmap()] for single assays.
<code>pbf_name</code>	Character scalar or vector with assay names to plot. When ‘NULL’, the most recent assay returned by [pb_current_assay()] is used. Only used by the ‘ProBatchFeatures’ method.
<code>nrow, ncol</code>	Integers controlling the layout when multiple assays are plotted. If both are ‘NULL’, a roughly square layout is chosen automatically.
<code>use_subset</code>	Logical; randomly subset to 5000 rows/columns when assays exceed that size (only used for ‘ProBatchFeatures’ inputs).

**Value**

For a single assay the returned value is the ‘pheatmap’ object. When multiple assays are requested a list is returned invisibly with elements ‘grob’ (the arranged heatmaps) and ‘heatmaps’ (individual ‘pheatmap’ objects). Assays without missing values are skipped with a warning.

---

plot_PCA	<i>plot PCA plot</i>
----------	----------------------

---

### Description

plot PCA plot

### Usage

```
## Default S3 method:
plot_PCA(
  data_matrix,
  sample_annotation,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  color_by = "MS_batch",
  shape_by = NULL,
  PC_to_plot = c(1, 2),
  fill_the_missing = -1,
  color_scheme = "brewer",
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  theme = "classic",
  base_size = 10,
  point_size = 3,
  point_alpha = 0.8,
  ...
)

## S3 method for class 'ProBatchFeatures'
plot_PCA(
  data_matrix,
  pbf_name = NULL,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  plot_title = NULL,
  return_gridExtra = FALSE,
  plot_ncol = NULL,
  ...
)
```

### Arguments

`data_matrix` features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example\_proteome\_matrix" for more

details (to call the description, use `help("example_proteome_matrix")`)

<code>sample_annotation</code>	data frame with: <ol style="list-style-type: none"> <li>1. <code>sample_id_col</code> (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See <code>help("example_sample_annotation")</code>
<code>feature_id_col</code>	name of the column with feature/gene/peptide/protein ID used in the long format representation <code>df_long</code> . In the wide formatted representation <code>data_matrix</code> this corresponds to the row names.
<code>sample_id_col</code>	name of the column in <code>sample_annotation</code> table, where the filenames (col-names of the <code>data_matrix</code> are found).
<code>color_by</code>	column name (as in <code>sample_annotation</code> ) to color by
<code>shape_by</code>	Optional column used for point shapes in the PCA plot.
<code>PC_to_plot</code>	principal component numbers for x and y axis
<code>fill_the_missing</code>	numeric value determining how missing values should be substituted. If <code>NULL</code> , features with missing values are excluded. If <code>NULL</code> , features with missing values are excluded.
<code>color_scheme</code>	a named vector of colors to map to <code>batch_col</code> , names corresponding to the levels of the factor. For continuous variables, vector doesn't need to be named.
<code>filename</code>	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
<code>width</code>	option determining the output image width
<code>height</code>	option determining the output image height
<code>units</code>	units: 'cm', 'in' or 'mm'
<code>plot_title</code>	title of the plot (e.g., processing step + representation level (fragments, transi-tions, proteins) + purpose (meanplot/corrplot etc))
<code>theme</code>	ggplot theme, by default <code>classic</code> . Can be easily overridden
<code>base_size</code>	base size of the text in the plot
<code>point_size</code>	Point size supplied to <code>'ggplot2::geom_point()'</code> .
<code>point_alpha</code>	Alpha transparency for plotted points.
<code>...</code>	Additional arguments forwarded to lower-level plotting helpers.
<code>pbf_name</code>	Assay name(s) used when <code>'data_matrix'</code> is a <code>'ProBatchFeatures'</code> .
<code>return_gridExtra</code>	Logical; return arranged grobs instead of a plot list.
<code>plot_ncol</code>	Number of columns when arranging multiple assay plots.

**Value**

ggplot scatterplot colored by factor levels of column specified in `factor_to_color`

**See Also**

[autoplot.pca\\_common](#), [ggplot](#)

**Examples**

```

data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")
matrix_test <- na.omit(example_proteome_matrix)[1:50, ]
pca_plot <- plot_PCA(matrix_test, example_sample_annotation,
  color_by = "MS_batch", plot_title = "PCA colored by MS batch"
)
pca_plot <- plot_PCA(matrix_test, example_sample_annotation,
  color_by = "DateTime", plot_title = "PCA colored by DateTime"
)

color_list <- sample_annotation_to_colors(example_sample_annotation,
  factor_columns = c("MS_batch", "digestion_batch"),
  numeric_columns = c("DateTime", "order")
)
pca_plot <- plot_PCA(matrix_test, example_sample_annotation,
  color_by = "DateTime", color_scheme = color_list[["DateTime"]]
)

pca_file <- tempfile("pca_plot", fileext = ".png")
pca_plot <- plot_PCA(matrix_test, example_sample_annotation,
  color_by = "DateTime", plot_title = "PCA colored by DateTime",
  filename = pca_file, width = 14, height = 9, units = "cm"
)
unlink(pca_file)

```

---

plot\_peptide\_corr\_distribution

*Create violin plot of peptide correlation distribution*

---

**Description**

Plot distribution of peptide correlations within one protein and between proteins

**Usage**

```

plot_peptide_corr_distribution(
  data_matrix,
  peptide_annotation,
  protein_col = "ProteinName",
  feature_id_col = "peptide_group_label",
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),

```

```

plot_title = "Distribution of peptide correlation",
theme = "classic"
)

plot_peptide_corr_distribution.corrDF(
  corr_distribution,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = "Correlation of peptides",
  theme = "classic",
  base_size = 20
)

```

### Arguments

data_matrix	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use help("example_proteome_matrix"))
peptide_annotation	long format data frame with peptide ID and their corresponding protein and/or gene annotations. See help("example_peptide_annotation").
protein_col	column where protein names are specified
feature_id_col	name of the column with feature/gene/peptide/protein ID used in the long format representation df_long. In the wide formatted representation data_matrix this corresponds to the row names.
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
theme	ggplot theme, by default classic. Can be easily overridden
corr_distribution	data frame with peptide correlation distribution
base_size	base font size

### Value

ggplot object (violin plot of peptide correlation)

### See Also

[calculate\\_peptide\\_corr\\_distr](#), [ggplot](#)

**Examples**

```

data(list = c("example_peptide_annotation", "example_proteome_matrix"), package = "proBatch")
peptide_corr_distribution <- plot_peptide_corr_distribution(
  example_proteome_matrix,
  example_peptide_annotation,
  protein_col = "Gene"
)

data(list = c("example_peptide_annotation", "example_proteome_matrix"), package = "proBatch")
selected_genes <- c("BOVINE_A1ag", "BOVINE_FetuinB", "Cyfip1")
gene_filter <- example_peptide_annotation$Gene %in% selected_genes
peptides_ann <- example_peptide_annotation$peptide_group_label
selected_peptides <- peptides_ann[gene_filter]
matrix_test <- example_proteome_matrix[selected_peptides, ]
pep_annotation_sel <- example_peptide_annotation[gene_filter, ]
corr_distribution <- calculate_peptide_corr_distr(matrix_test,
  pep_annotation_sel,
  protein_col = "Gene"
)
peptide_corr_distribution <- plot_peptide_corr_distribution.corrDF(corr_distribution)

peptide_corr_file <- tempfile("peptide_corr", fileext = ".png")
peptide_corr_distribution <- plot_peptide_corr_distribution.corrDF(corr_distribution,
  filename = peptide_corr_file,
  width = 28, height = 28, units = "cm"
)
unlink(peptide_corr_file)

```

---

plot\_protein\_corrplot *Peptide correlation matrix (heatmap)*

---

**Description**

Plots correlation plot of peptides from a single protein

**Usage**

```

plot_protein_corrplot(
  data_matrix,
  protein_name,
  peptide_annotation = NULL,
  protein_col = "ProteinName",
  feature_id_col = "peptide_group_label",
  factors_to_plot = c("ProteinName"),
  cluster_rows = FALSE,
  cluster_cols = FALSE,
  heatmap_color = colorRampPalette(rev(brewer.pal(n = 7, name = "RdYlBu")))(100),
  color_list = NULL,

```

```

filename = NULL,
width = NA,
height = NA,
units = c("cm", "in", "mm"),
plot_title = NULL,
...
)

```

### Arguments

<code>data_matrix</code>	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use <code>help("example_proteome_matrix")</code> )
<code>protein_name</code>	the name of the protein
<code>peptide_annotation</code>	long format data frame with peptide ID and their corresponding protein and/or gene annotations. See <code>help("example_peptide_annotation")</code> .
<code>protein_col</code>	column where protein names are specified
<code>feature_id_col</code>	name of the column with feature/gene/peptide/protein ID used in the long format representation <code>df_long</code> . In the wide formatted representation <code>data_matrix</code> this corresponds to the row names.
<code>factors_to_plot</code>	vector of technical and biological covariates to be plotted in this diagnostic plot (assumed to be present in <code>sample_annotation</code> )
<code>cluster_rows</code>	boolean values determining if rows should be clustered or <code>hclust</code> object
<code>cluster_cols</code>	boolean values determining if columns should be clustered or <code>hclust</code> object
<code>heatmap_color</code>	vector of colors used in heatmap.
<code>color_list</code>	list, as returned by <code>sample_annotation_to_colors</code> , where each item contains a color vector for each factor to be mapped to the color.
<code>filename</code>	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
<code>width</code>	option determining the output image width
<code>height</code>	option determining the output image height
<code>units</code>	units: 'cm', 'in' or 'mm'
<code>plot_title</code>	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
<code>...</code>	parameters for the corrplot visualisation

### Value

heatmap object

**Examples**

```

data(list = c("example_peptide_annotation", "example_proteome_matrix"), package = "proBatch")
protein_corrplot_plot <- plot_protein_corrplot(example_proteome_matrix,
  protein_name = "Hao", peptide_annotation = example_peptide_annotation,
  protein_col = "Gene"
)

protein_corrplot_plot <- plot_protein_corrplot(example_proteome_matrix,
  protein_name = c("Hao", "Dhtkd1"),
  peptide_annotation = example_peptide_annotation,
  protein_col = "Gene", factors_to_plot = "Gene"
)

```

---

plot\_PVCA

*Plot variance distribution by variable*


---

**Description**

Plot variance distribution by variable

**Usage**

```

## Default S3 method:
plot_PVCA(
  data_matrix,
  sample_annotation,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  technical_factors = c("MS_batch", "instrument"),
  biological_factors = c("cell_line", "drug_dose"),
  fill_the_missing = -1,
  pca_threshold = 0.6,
  variance_threshold = 0.01,
  colors_forBars = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  theme = "classic",
  base_size = 15,
  ...
)

## S3 method for class 'ProBatchFeatures'
plot_PVCA(

```

```

data_matrix,
pbf_name = NULL,
sample_annotation = NULL,
feature_id_col = "peptide_group_label",
sample_id_col = "FullRunName",
plot_title = NULL,
return_gridExtra = FALSE,
plot_ncol = NULL,
...
)

```

## Arguments

**data\_matrix** Input object: matrix-like data or a ‘ProBatchFeatures’ instance.

**sample\_annotation**  
data frame with:

1. **sample\_id\_col** (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See `help("example_sample_annotation")`

**feature\_id\_col** name of the column with feature/gene/peptide/protein ID used in the long format representation `df_long`. In the wide formatted representation `data_matrix` this corresponds to the row names.

**sample\_id\_col** name of the column in `sample_annotation` table, where the filenames (column names of the `data_matrix` are found).

**technical\_factors**  
vector `sample_annotation` column names that are technical covariates

**biological\_factors**  
vector `sample_annotation` column names, that are biologically meaningful covariates

**fill\_the\_missing**  
numeric value determining how missing values should be substituted. If `NULL`, features with missing values are excluded. If `NULL`, features with missing values are excluded.

**pca\_threshold** the percentile value of the minimum amount of the variabilities that the selected principal components need to explain

**variance\_threshold**  
the percentile value of weight each of the covariates needs to explain (the rest will be lumped together)

**colors\_forBars**  
four-item color vector, specifying colors for the following categories: `c('residual', 'biological', 'biol:techn', 'technical')`

**filename** path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported

width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
theme	ggplot theme, by default classic. Can be easily overridden
base_size	base size of the text in the plot
...	Additional arguments passed to lower-level methods.
pbf_name	Assay name(s) used when 'data_matrix' is a 'ProBatchFeatures'.
return_gridExtra	Logical; return arranged grobs instead of a plot list.
plot_ncol	Number of columns when arranging multiple assay plots.

**Value**

ggplot object with the plot

**See Also**

[sample\\_annotation\\_to\\_colors](#), [ggplot](#)

**Examples**

```
data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")
matrix_test <- na.omit(example_proteome_matrix)[1:50, ]
```

```
pvca_file <- tempfile("pvca", fileext = ".png")
pvca_plot <- plot_PVCA(
  matrix_test,
  example_sample_annotation,
  technical_factors = c("MS_batch", "digestion_batch"),
  biological_factors = c("Diet", "Sex", "Strain"),
  filename = pvca_file, # save to file, can be NULL
  width = 12, height = 8, units = "cm"
)
unlink(pvca_file)
```

---

plot\_PVCA.df

*plot PVCA, when the analysis is completed*

---

**Description**

plot PVCA, when the analysis is completed

**Usage**

```
## S3 method for class 'df'
plot_PVCA(
  data_matrix,
  pbf_name = NULL,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  colors_for_bars = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  theme = "classic",
  base_size = 15,
  return_gridExtra = FALSE,
  plot_ncol = NULL,
  ...
)
```

**Arguments**

data_matrix	Data frame of PVCA weights, typically the result of 'prepare_PVCA_df()', or a 'ProBatchFeatures' object.
pbf_name	Assay name(s) used when 'data_matrix' is a 'ProBatchFeatures'.
sample_annotation	data frame with: <ol style="list-style-type: none"> <li>1. sample_id_col (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See help("example_sample_annotation")
feature_id_col	name of the column with feature/gene/peptide/protein ID used in the long format representation df_long. In the wide formatted representation data_matrix this corresponds to the row names.
sample_id_col	name of the column in sample_annotation table, where the filenames (column names of the data_matrix) are found.
colors_for_bars	four-item color vector, specifying colors for the following categories: c('residual', 'biological', 'biol:techn', 'technical')
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height

units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
theme	ggplot theme, by default classic. Can be easily overridden
base_size	base size of the text in the plot
return_gridExtra	Logical; return arranged grobs instead of a plot list.
plot_ncol	Number of columns when arranging multiple assay plots.
...	Additional arguments. When 'data_matrix' is a 'ProBatchFeatures', these are forwarded to 'prepare_PVCA_df()'.

**Value**

ggplot object with bars as weights, colored by bio/tech factors

**Examples**

```
data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")
matrix_test <- na.omit(example_proteome_matrix)[1:50, ]
pvca_df_res <- prepare_PVCA_df(matrix_test, example_sample_annotation,
  technical_factors = c("MS_batch", "digestion_batch"),
  biological_factors = c("Diet", "Sex", "Strain"),
  pca_threshold = .6, variance_threshold = .01, fill_the_missing = -1
)
colors_for_bars <- c("grey", "green", "blue", "red")
names(colors_for_bars) <- c("residual", "biological", "biol:techn", "technical")

pvca_plot <- plot_PVCA.df(pvca_df_res, colors_for_bars)
```

---

plot\_sample\_corr\_distribution

*Create violin plot of sample correlation distribution*

---

**Description**

Useful to visualize within batch vs within replicate vs non-related sample correlation

**Usage**

```
plot_sample_corr_distribution(
  data_matrix,
  sample_annotation,
  repeated_samples = NULL,
  sample_id_col = "FullRunName",
  batch_col = "MS_batch",
  biospecimen_id_col = "EarTag",
```

```

filename = NULL,
width = NA,
height = NA,
units = c("cm", "in", "mm"),
plot_title = "Sample correlation distribution",
plot_param = "batch_replicate",
theme = "classic"
)

plot_sample_corr_distribution.corrDF(
  corr_distribution,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = "Sample correlation distribution",
  plot_param = "batch_replicate",
  theme = "classic",
  base_size = 20
)

```

### Arguments

**data\_matrix** features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example\_proteome\_matrix" for more details (to call the description, use `help("example_proteome_matrix")`)

**sample\_annotation** data frame with:

1. `sample_id_col` (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See `help("example_sample_annotation")`

**repeated\_samples** if NULL, correlation of all samples is plotted

**sample\_id\_col** name of the column in `sample_annotation` table, where the filenames (colnames of the `data_matrix` are found).

**batch\_col** column in `sample_annotation` that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).

**biospecimen\_id\_col** column in `sample_annotation` that captures the biological sample, that (possibly) was profiled several times as technical replicates. Tip: if such ID is absent, but can be defined from several columns, create new `biospecimen_id` column

**filename** path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported

**width** option determining the output image width

height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
plot_param	columns, defined in correlation_df, which is output of calculate_sample_corr_distr, specifically, <ol style="list-style-type: none"> <li>1. replicate</li> <li>2. batch_the_same</li> <li>3. batch_replicate</li> <li>4. batches</li> </ol>
theme	ggplot theme, by default classic. Can be easily overridden
corr_distribution	data frame with correlation distribution, as returned by calculate_sample_corr_distr
base_size	base font size

**Value**

ggplot type object with violin plot for each plot\_param

**See Also**

[calculate\\_sample\\_corr\\_distr](#), [ggplot](#)

**Examples**

```

data(list = c("example_sample_annotation", "example_proteome_matrix"), package = "proBatch")
sample_corr_distribution_plot <- plot_sample_corr_distribution(
  example_proteome_matrix,
  example_sample_annotation,
  batch_col = "MS_batch",
  biospecimen_id_col = "EarTag",
  plot_param = "batch_replicate"
)

data(list = c("example_sample_annotation", "example_proteome_matrix"), package = "proBatch")
corr_distribution <- calculate_sample_corr_distr(
  data_matrix = example_proteome_matrix,
  sample_annotation = example_sample_annotation,
  batch_col = "MS_batch", biospecimen_id_col = "EarTag"
)
sample_corr_distribution_plot <- plot_sample_corr_distribution.corrDF(corr_distribution,
  plot_param = "batch_replicate"
)

sample_corr_file <- tempfile("sample_corr", fileext = ".png")
sample_corr_distribution_plot <- plot_sample_corr_distribution.corrDF(corr_distribution,
  plot_param = "batch_replicate",
  filename = sample_corr_file,
  width = 28, height = 28, units = "cm"
)

```

```
)
  unlink(sample_corr_file)
```

---

```
plot_sample_corr_heatmap
```

```
  Sample correlation matrix (heatmap)
```

---

## Description

Plot correlation of selected samples

## Usage

```
plot_sample_corr_heatmap(
  data_matrix,
  samples_to_plot = NULL,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  factors_to_plot = NULL,
  cluster_rows = FALSE,
  cluster_cols = FALSE,
  heatmap_color = colorRampPalette(rev(brewer.pal(n = 7, name = "RdYlBu")))(100),
  color_list = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = sprintf("Correlation matrix of%s samples",
    ifelse(is.null(samples_to_plot), "", " selected")),
  ...
)
```

## Arguments

<code>data_matrix</code>	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use <code>help("example_proteome_matrix")</code> )
<code>samples_to_plot</code>	string vector of samples in <code>data_matrix</code> to be used in the plot
<code>sample_annotation</code>	data frame with: <ol style="list-style-type: none"> <li>1. <code>sample_id_col</code> (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See <code>help("example_sample_annotation")</code>

sample_id_col	name of the column in sample_annotation table, where the filenames (column names of the data_matrix are found).
factors_to_plot	vector of technical and biological covariates to be plotted in this diagnostic plot (assumed to be present in sample_annotation)
cluster_rows	boolean values determining if rows should be clustered or hclust object
cluster_cols	boolean values determining if columns should be clustered or hclust object
heatmap_color	vector of colors used in heatmap.
color_list	list, as returned by sample_annotation_to_colors, where each item contains a color vector for each factor to be mapped to the color.
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
...	parameters for the <a href="#">pheatmap</a> visualisation, for details see examples and help to corresponding functions

**Value**

pheatmap object

**See Also**

[pheatmap](#)

**Examples**

```
data(list = c("example_sample_annotation", "example_proteome_matrix"), package = "proBatch")
specified_samples <- example_sample_annotation$FullRunName[
  which(example_sample_annotation$order %in% 110:115)
]

sample_corr_heatmap <- plot_sample_corr_heatmap(example_proteome_matrix,
  samples_to_plot = specified_samples,
  factors_to_plot = c("MS_batch", "Diet", "DateTime", "digestion_batch"),
  cluster_rows = FALSE, cluster_cols = FALSE,
  annotation_names_col = TRUE, annotation_legend = FALSE,
  show_colnames = FALSE
)

color_list <- sample_annotation_to_colors(example_sample_annotation,
  factor_columns = c(
    "MS_batch", "EarTag", "Strain",
```

```

      "Diet", "digestion_batch", "Sex"
    ),
    numeric_columns = c("DateTime", "order")
  )
sample_corr_heatmap_annotated <- plot_sample_corr_heatmap(log_transform_dm(example_proteome_matrix),
  sample_annotation = example_sample_annotation,
  factors_to_plot = c("MS_batch", "Diet", "DateTime", "digestion_batch"),
  cluster_rows = FALSE, cluster_cols = FALSE,
  annotation_names_col = TRUE,
  show_colnames = FALSE, color_list = color_list
)

```

---

plot\_sample\_mean\_or\_boxplot

*Plot per-sample mean or boxplots for initial assessment*

---

### Description

Plot per-sample mean or boxplots (showing median and quantiles). In ordered samples, e.g. consecutive MS runs, order-associated effects are visualised.

### Usage

```

## Default S3 method:
plot_sample_mean(
  x,
  sample_annotation,
  sample_id_col = "FullRunName",
  batch_col = "MS_batch",
  color_by_batch = FALSE,
  color_scheme = "brewer",
  order_col = "order",
  vline_color = "grey",
  facet_col = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  theme_name = c("classic", "minimal", "bw", "light", "dark"),
  base_size = 20,
  ylimits = NULL,
  pbf_name = NULL,
  ...
)

## Default S3 method:

```

```

plot_boxplot(
  x,
  sample_annotation,
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  batch_col = "MS_batch",
  color_by_batch = TRUE,
  color_scheme = "brewer",
  order_col = "order",
  facet_col = NULL,
  filename = NULL,
  width = NA,
  height = NA,
  units = c("cm", "in", "mm"),
  plot_title = NULL,
  theme_name = c("classic", "minimal", "bw", "light", "dark"),
  base_size = 20,
  ylimits = NULL,
  outliers = TRUE,
  pbf_name = NULL,
  ...
)

## S3 method for class 'ProBatchFeatures'
plot_sample_mean(x, pbf_name = NULL, plot_title = NULL, ...)

## S3 method for class 'ProBatchFeatures'
plot_boxplot(
  x,
  pbf_name = NULL,
  sample_id_col = NULL,
  plot_title = NULL,
  plot_ncol = NULL,
  return_gridExtra = FALSE,
  ...
)

plot_sample_mean(x, ...)

plot_boxplot(x, ...)

```

### Arguments

- x** Input object supplied to the generics (matrix, long data frame, or 'ProBatchFeatures').
- sample\_annotation** data frame with:
1. **sample\_id\_col** (this can be repeated as row names)

	2. biological covariates
	3. technical covariates (batches etc)
	. See help("example_sample_annotation")
sample_id_col	name of the column in sample_annotation table, where the filenames (column names of the data_matrix are found).
batch_col	column in sample_annotation that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).
color_by_batch	(logical) whether to color points and connecting lines by batch factor as defined by batch_col.
color_scheme	named vector, names corresponding to unique batch values of batch_col in sample_annotation. Best created with <a href="#">sample_annotation_to_colors</a>
order_col	column in sample_annotation that determines sample order. It is used for initial assessment plots ( <a href="#">plot_sample_mean_or_boxplot</a> ) and feature-level diagnostics ( <a href="#">feature_level_diagnostics</a> ). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see <a href="#">define_sample_order</a> and <a href="#">date_to_sample_order</a>
vline_color	color of vertical lines, typically denoting different MS batches in ordered runs; should be NULL for experiments without intrinsic order
facet_col	column in sample_annotation with a batch factor to separate plots into facets; usually 2nd to batch_col. Most meaningful for multi-instrument MS experiments (where each instrument has its own order-associated effects (see order_col) or simultaneous examination of two batch factors (e.g. preparation day and measurement day). For single-instrument case should be set to 'NULL'
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
theme_name	Name of the ggplot theme to apply to the resulting plot.
base_size	base font size
ylimits	range of y-axis to compare two plots side by side, if required.
pbf_name	Assay name(s) used when 'x' is a 'ProBatchFeatures'.
...	Additional arguments forwarded between methods.
measure_col	if df_long is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
outliers	keep (default) or remove the boxplot outliers
plot_ncol	Number of columns when arranging multiple assay plots.
return_gridExtra	Logical; return arranged grobs instead of a plot list.

**Details**

functions for quick visual assessment of trends associated, overall or specific covariate-associated (see `batch_col` and `facet_col`)

**Value**

ggplot2 class object. Thus, all aesthetics can be overridden

**See Also**

[ggplot](#), [date\\_to\\_sample\\_order](#)

**Examples**

```
data(list = c(
  "example_proteome", "example_sample_annotation",
  "example_proteome_matrix"
), package = "proBatch")

demo_ids <- colnames(example_proteome_matrix)[1:6]
demo_matrix <- example_proteome_matrix[, demo_ids]
demo_annotation <- example_sample_annotation[
  example_sample_annotation$FullRunName %in% demo_ids,
]

plot_sample_mean(
  demo_matrix,
  demo_annotation,
  order_col = "order",
  batch_col = "MS_batch"
)

demo_proteome <- example_proteome[
  example_proteome$FullRunName %in% demo_ids,
]
plot_boxplot(
  demo_proteome,
  sample_annotation = demo_annotation,
  batch_col = "MS_batch"
)
```

---

plot\_split\_violin\_with\_boxplot

*Plot split violin plot (convenient to compare distribution before and after)*

---

**Description**

Plot split violin plot (convenient to compare distribution before and after)

**Usage**

```
plot_split_violin_with_boxplot(
  df,
  y_col = "y",
  col_for_color = "m",
  col_for_box = "x",
  colors_for_plot = c("#8f1811", "#F8C333"),
  hlineintercept = NULL,
  plot_title = NULL,
  theme = "classic"
)
```

**Arguments**

df	data.frame with y_col, col_for_color, col_for_box
y_col	value to explore the distribution of
col_for_color	column to use to map to two colors
col_for_box	column to use to do group comparison
colors_for_plot	colors to map to col_for_color
hlineintercept	NULL: no intercept line; non-null: intercept value ...
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
theme	ggplot theme, by default classic. Can be easily overridden

**Value**

ggplot object

**Examples**

```
df <- data.frame(x = rep(c("A", "B"), each = 100), y = rnorm(200), m = rep(c("C", "D"), 100))
plot_split_violin_with_boxplot(df, y_col = "y", col_for_color = "m", col_for_box = "x")
```

---

```
prepare_PVCA_df
```

```
prepare the weights of Principal Variance Components
```

---

**Description**

prepare the weights of Principal Variance Components

**Usage**

```
## Default S3 method:
prepare_PVCA_df(
  data_matrix,
  sample_annotation,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  technical_factors = c("MS_batch", "instrument"),
  biological_factors = c("cell_line", "drug_dose"),
  fill_the_missing = -1,
  pca_threshold = 0.6,
  variance_threshold = 0.01,
  ...
)

## S3 method for class 'ProBatchFeatures'
prepare_PVCA_df(
  data_matrix,
  pbf_name = NULL,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  ...
)
```

**Arguments**

**data\_matrix** features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example\_proteome\_matrix" for more details (to call the description, use help("example\_proteome\_matrix"))

**sample\_annotation** data frame with:

1. sample\_id\_col (this can be repeated as row names)
2. biological covariates
3. technical covariates (batches etc)

. See help("example\_sample\_annotation")

**feature\_id\_col** name of the column with feature/gene/peptide/protein ID used in the long format representation df\_long. In the wide formatted representation data\_matrix this corresponds to the row names.

**sample\_id\_col** name of the column in sample\_annotation table, where the filenames (colnames of the data\_matrix are found).

**technical\_factors** vector sample\_annotation column names that are technical covariates

**biological\_factors** vector sample\_annotation column names, that are biologically meaningful covariates

fill_the_missing	numeric value determining how missing values should be substituted. If NULL, features with missing values are excluded. If NULL, features with missing values are excluded.
pca_threshold	the percentile value of the minimum amount of the variabilities that the selected principal components need to explain
variance_threshold	the percentile value of weight each of the covariates needs to explain (the rest will be lumped together)
...	Additional arguments forwarded between methods.
pbf_name	Assay name(s) used when 'data_matrix' is a 'ProBatchFeatures'.

**Value**

data frame with weights and factors, combined in a way ready for plotting

**Examples**

```
data(list = c("example_proteome_matrix", "example_sample_annotation"), package = "proBatch")
matrix_test <- na.omit(example_proteome_matrix)[1:50, ]

pvca_df_res <- prepare_PVCA_df(matrix_test, example_sample_annotation,
  technical_factors = c("MS_batch", "digestion_batch"),
  biological_factors = c("Diet", "Sex", "Strain"),
  pca_threshold = .6, variance_threshold = .01, fill_the_missing = -1
)
```

---

proBatch	<i>proBatch: A package for diagnostics and correction of batch effects, primarily in proteomics</i>
----------	---

---

**Description**

The proBatch package contains functions for analyzing and correcting batch effects (unwanted technical variation) from high-throughput experiments. Although the package has primarily been developed for mass spectrometry proteomics (DIA/SWATH), it has been designed to be applicable to most omic data with minor adaptations. It addresses the following needs:

- prepare the data for analysis
- Visualize batch effects in sample-wide and feature-level;
- Normalize and correct for batch effects.

**Arguments**

<code>df_long</code>	data frame where each row is a single feature in a single sample. It minimally has a <code>sample_id_col</code> , a <code>feature_id_col</code> and a <code>measure_col</code> , but usually also an <code>m_score</code> (in OpenSWATH output result file). See <code>help("example_proteome")</code> for more details.
<code>data_matrix</code>	features (in rows) vs samples (in columns) matrix, with feature IDs in rownames and file/sample names as colnames. See "example_proteome_matrix" for more details (to call the description, use <code>help("example_proteome_matrix")</code> )
<code>sample_annotation</code>	data frame with: <ol style="list-style-type: none"> <li>1. <code>sample_id_col</code> (this can be repeated as row names)</li> <li>2. biological covariates</li> <li>3. technical covariates (batches etc)</li> </ol> . See <code>help("example_sample_annotation")</code>
<code>sample_id_col</code>	name of the column in <code>sample_annotation</code> table, where the filenames (colnames of the <code>data_matrix</code> are found).
<code>measure_col</code>	if <code>df_long</code> is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
<code>feature_id_col</code>	name of the column with feature/gene/peptide/protein ID used in the long format representation <code>df_long</code> . In the wide formatted representation <code>data_matrix</code> this corresponds to the row names.
<code>batch_col</code>	column in <code>sample_annotation</code> that should be used for batch comparison (or other, non-batch factor to be mapped to color in plots).
<code>order_col</code>	column in <code>sample_annotation</code> that determines sample order. It is used for in initial assessment plots ( <a href="#">plot_sample_mean_or_boxplot</a> ) and feature-level diagnostics ( <a href="#">feature_level_diagnostics</a> ). Can be 'NULL' if sample order is irrelevant (e.g. in genomic experiments). For more details, order definition/inference, see <a href="#">define_sample_order</a> and <a href="#">date_to_sample_order</a>
<code>facet_col</code>	column in <code>sample_annotation</code> with a batch factor to separate plots into facets; usually 2nd to <code>batch_col</code> . Most meaningful for multi-instrument MS experiments (where each instrument has its own order-associated effects (see <code>order_col</code> ) or simultaneous examination of two batch factors (e.g. preparation day and measurement day). For single-instrument case should be set to 'NULL'
<code>color_by_batch</code>	(logical) whether to color points and connecting lines by batch factor as defined by <code>batch_col</code> .
<code>peptide_annotation</code>	long format data frame with peptide ID and their corresponding protein and/or gene annotations. See <code>help("example_peptide_annotation")</code> .
<code>color_scheme</code>	a named vector of colors to map to <code>batch_col</code> , names corresponding to the levels of the factor. For continuous variables, vector doesn't need to be named.
<code>color_list</code>	list, as returned by <code>sample_annotation_to_colors</code> , where each item contains a color vector for each factor to be mapped to the color.

factors_to_plot	vector of technical and biological covariates to be plotted in this diagnostic plot (assumed to be present in sample_annotation)
protein_col	column where protein names are specified
no_fit_imputed	(logical) whether to use imputed (requant) values, as flagged in qual_col by qual_value for data transformation
qual_col	column to color point by certain value denoted by qual_value. Design with inferred/requant values in OpenSWATH output data, which means argument value has to be set to m_score.
qual_value	value in qual_col to color. For OpenSWATH data, this argument value has to be set to 2 (this is an m_score value for imputed values (requant values)).
plot_title	title of the plot (e.g., processing step + representation level (fragments, transitions, proteins) + purpose (meanplot/corrplot etc))
keep_all	when transforming the data (normalize, correct) - acceptable values: all/default/minimal (which set of columns be kept).
theme	ggplot theme, by default classic. Can be easily overridden
filename	path where the results are saved. If null the object is returned to the active window; otherwise, the object is save into the file. Currently only pdf and png format is supported
width	option determining the output image width
height	option determining the output image height
units	units: 'cm', 'in' or 'mm'
base_size	base font size

## Details

To learn more about proBatch, start with the vignettes: `browseVignettes(package = "proBatch")`

## Section

Common arguments to the functions.

## Author(s)

**Maintainer:** Yuliya Burankova <yuliya.burankova@uni-hamburg.de>

Authors:

- Jelena Cuklina <chuklina.jelena@gmail.com>
- Chloe H. Lee <chloe.h.lee94@gmail.com>
- Patrick Pedrioli <pedrioli@gmail.com>
- Olga Zolotareva <olga.zolotareva@uni-hamburg.de>

**See Also**

Useful links:

- <https://github.com/Freddsle/proBatch>
- Report bugs at <https://github.com/Freddsle/proBatch/issues>

**Examples**

```
if (interactive()) {
  browseVignettes(package = "proBatch")
}
```

---

ProBatchFeatures	<i>Construct a ProBatchFeatures object from a wide matrix + sample annotation.</i>
------------------	--

---

**Description**

Construct a ProBatchFeatures object from a wide matrix + sample annotation.

**Usage**

```
ProBatchFeatures(
  data_matrix,
  sample_annotation = NULL,
  sample_id_col = "FullRunName",
  name = NULL,
  level = "feature"
)
```

**Arguments**

data_matrix	numeric matrix (features x samples)
sample_annotation	data.frame with sample metadata (rows = samples)
sample_id_col	character(1), column in sample_annotation that matches colnames(data_matrix) If missing, rownames(sample_annotation) are used.
name	character(1), optional; if missing, name is "<level>::raw". If only a single value is provided to the function, without specifying whether it is a name or level, it will be used as the name value.
level	character label like "peptide"/"protein" (default "feature").

**Value**

A 'ProBatchFeatures' object.

**Examples**

```

# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
)

```

```

))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

ProBatchFeatures-class

*ProBatchFeatures: QFeatures subclass with operation log, levels/pipelines, and lazy storage*

---

## Description

Assay naming convention: "<level>:<pipeline>" e.g., "peptide::raw", "protein::median\_on\_log"

Pipelines are strings produced by `get_chain(as_string=TRUE)`, e.g., "combat\_on\_medianNorm\_on\_log".

## Details

Ephemeral "fast" steps are computed but not stored by default (`store_fast_steps = FALSE`). Use `pb_eval()` to compute and return data after a step/pipeline without storing. Use `pb_transform()` to build pipelines and optionally materialize the final assay.

**Slots**

chain character() ordered list of steps (e.g., c("log","medianNorm","combat")).  
 oplog S4Vectors::DataFrame with columns: - step (character), fun (character), from (character),  
 to (character), params (list), timestamp (POSIXct), pkg (character)

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format
```

```

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",
  to_id = "Protein.Ids",
  map_strategy = "as_is"
)

# Aggregate and add levels -----
pb_aggregate_level(
  pbf,
  from = "peptide::raw",
  feature_var = "ProteinID",
  new_level = "protein_new"
)

```

---

ProBatchFeatures\_from\_long

*Construct from LONG df via proBatch::long\_to\_matrix*

---

### Description

Construct from LONG df via proBatch::long\_to\_matrix

**Usage**

```
ProBatchFeatures_from_long(
  df_long,
  sample_annotation = NULL,
  feature_id_col = "peptide_group_label",
  sample_id_col = "FullRunName",
  measure_col = "Intensity",
  level = "feature",
  name = NULL
)
```

**Arguments**

<code>df_long</code>	Data frame in long format with feature/sample/value columns.
<code>sample_annotation</code>	Optional sample metadata aligned to the samples.
<code>feature_id_col</code>	Column containing feature identifiers in ‘df_long’.
<code>sample_id_col</code>	Column containing sample identifiers in ‘df_long’.
<code>measure_col</code>	Column with the measured intensity values.
<code>level</code>	Character label describing the biological level of the assay.
<code>name</code>	Optional pipeline name; defaults to ‘<level>::raw’ when missing.

**Value**

A ‘ProBatchFeatures’ object constructed from the long-format input.

**Examples**

```
# Shared setup for ProBatchFeatures documentation examples -----
data("example_ecoli_data", package = "proBatch")

# Extract data
all_metadata <- example_ecoli_data$all_metadata
all_precursors <- example_ecoli_data$all_precursors
all_protein_groups <- example_ecoli_data$all_protein_groups
all_precursor_pg_match <- example_ecoli_data$all_precursor_pg_match

# Keep only essential
rm(example_ecoli_data)

# Construct a ProBatchFeatures object -----
pbf <- ProBatchFeatures(
  data_matrix = all_precursors,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  level = "peptide"
)

# Register a custom step and evaluate it -----
```

```

pb_register_step("add_one", function(x) x + 1)
head(pb_eval(pbf, from = "peptide::raw", steps = "add_one"))

# Derived objects for downstream helpers -----
pbf_logged <- pb_transform(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm"),
  store_fast_steps = TRUE
)

# Get information about the object -----
get_operation_log(pbf_logged)
get_chain(pbf_logged)
get_chain(pbf_logged, as_string = TRUE)
pb_pipeline_name(pbf_logged) # the latest pipeline
pb_pipeline_name(pbf_logged, assay = "peptide::raw")

# Access assays and matrices -----
head(pb_current_assay(pbf_logged)) # the latest assay
head(pb_assay_matrix(pbf_logged)) # the latest matrix
head(pb_assay_matrix(pbf_logged, assay = "peptide::raw")) # the latest matrix
head(pb_as_wide(pbf_logged)) # the latest assay in wide format
head(pb_as_long(pbf_logged, sample_id_col = "Run")) # the latest assay in long format

# Pipeline evaluation without storing -----
head(pb_eval(
  pbf,
  from = "peptide::raw",
  steps = c("log2", "medianNorm")
))

# Long-format constructor -----
long_pbf <- pb_as_long(pbf_logged, sample_id_col = "Run") # the latest assay in long format

ProBatchFeatures_from_long(
  df_long = long_pbf,
  sample_annotation = all_metadata,
  sample_id_col = "Run",
  feature_id_col = "feature_label",
  level = "peptide"
)

# Add proteins as a new level and link via mapping
# all_precursor_pg_match has columns: "Precursor.Id", "Protein.Ids"
pbf <- pb_add_level(
  object = pbf,
  from = "peptide::raw",
  new_matrix = all_protein_groups,
  to_level = "protein", # will name "protein::raw" by default
  mapping_df = all_precursor_pg_match,
  from_id = "Precursor.Id",

```

```

    to_id = "Protein.Ids",
    map_strategy = "as_is"
  )

  # Aggregate and add levels -----
  pb_aggregate_level(
    pbf,
    from = "peptide::raw",
    feature_var = "ProteinID",
    new_level = "protein_new"
  )

```

---

```

sample_annotation_to_colors
  Generate colors for sample annotation

```

---

## Description

Convert the sample annotation data frame to list of colors the list is named as columns included to use in plotting functions

## Usage

```

## Default S3 method:
sample_annotation_to_colors(
  sample_annotation,
  sample_id_col = "FullRunName",
  factor_columns = NULL,
  numeric_columns = NULL,
  rare_categories_to_other = TRUE,
  guess_factors = FALSE,
  numeric_palette_type = "brewer",
  ...
)

## S3 method for class 'ProBatchFeatures'
sample_annotation_to_colors(sample_annotation, ...)

sample_annotation_to_colors(sample_annotation, ...)

```

## Arguments

`sample_annotation` Input object supplied to the generic (data frame or 'ProBatchFeatures').

`sample_id_col` name of the column in `sample_annotation` table, where the filenames (column names of the `data_matrix` are found).

`factor_columns` columns of `sample_annotation` to be treated as factors. Sometimes categorical variables are depicted as integers (e.g. in column "Batch", values are 1, 2 and 3), specification here allows to map them correctly to qualitative palettes.

`numeric_columns` columns of `sample_annotation` to be treated as continuous numeric values.

`rare_categories_to_other` if True rare categories will be merged into the value "other"

`guess_factors` whether attempt which of the `factor_columns` are actually numeric

`numeric_palette_type` palette to be used for numeric values coloring (can be 'brewer' and 'viridis')

... Additional arguments forwarded to method implementations.

**Value**

list of colors for the selected annotation columns. Use `color_list_to_df` if a data frame representation is needed.

**Examples**

```
data("example_sample_annotation", package = "proBatch")
color_scheme <- sample_annotation_to_colors(
  example_sample_annotation,
  factor_columns = c(
    "MS_batch", "EarTag", "Strain",
    "Diet", "digestion_batch", "Sex"
  ),
  numeric_columns = c("DateTime", "order")
)
```

---

`subset_keep_cols`      *Subset columns according to 'keep\_all' argument*

---

**Description**

Helper for data transformation functions to consistently keep a predefined set of columns.

**Usage**

```
subset_keep_cols(
  df,
  keep_all = "default",
  default_cols = names(df),
  minimal_cols = default_cols
)
```

**Arguments**

df                    data frame to subset  
 keep\_all            one of "all", "default" or "minimal"  
 default\_cols        columns to keep when 'keep\_all = "default"  
 minimal\_cols        columns to keep when 'keep\_all = "minimal"

**Value**

data frame with selected columns

**Examples**

```
## Not run:
df <- data.frame(a = 1:3, b = 4:6, c = 7:9)
subset_keep_cols(df, keep_all = "minimal", minimal_cols = c("a", "c"))

## End(Not run)
```

---

transform\_raw\_data      *Functions to log transform raw data before normalization and batch correction*

---

**Description**

Functions to log transform raw data before normalization and batch correction

Log transformation of the data long format.

"Unlog" transformation of the data to pre-log form (for quantification, forcing log-transform)

Log transformation of the data matrix format.

**Usage**

```
log_transform_df(df_long, log_base = 2, offset = 1, measure_col = "Intensity")
```

```
unlog_df(df_long, log_base = 2, offset = 1, measure_col = "Intensity")
```

```
log_transform_dm(x, ...)
```

```
## Default S3 method:
```

```
log_transform_dm(x, log_base = 2, offset = 1, ...)
```

```
## S3 method for class 'ProBatchFeatures'
```

```
log_transform_dm(
  x,
  log_base = 2,
  offset = 1,
```

```

    pbf_name = NULL,
    final_name = NULL,
    ...
)

unlog_dm(x, ...)

## Default S3 method:
unlog_dm(x, log_base = 2, offset = 1, ...)

## S3 method for class 'ProBatchFeatures'
unlog_dm(x, log_base = 2, offset = 1, pbf_name = NULL, final_name = NULL, ...)

```

### Arguments

df_long	data frame where each row is a single feature in a single sample. It minimally has a sample_id_col, a feature_id_col and a measure_col, but usually also an m_score (in OpenSWATH output result file). See help("example_proteome") for more details.
log_base	base of the logarithm for transformation
offset	small positive number to prevent 0 conversion to -Inf
measure_col	if df_long is among the parameters, it is the column with expression/abundance/intensity; otherwise, it is used internally for consistency.
x	Input object supplied to the generics (long data frame, matrix, or 'ProBatchFeatures').
...	Additional arguments forwarded between method implementations.
pbf_name	Assay name to transform when 'x' is a 'ProBatchFeatures'.
final_name	Optional name for the stored assay produced by the S3 methods.

### Value

'log\_transform\_df()' returns df\_long-size data frame, with measure\_col log transformed; with old value in another column called "beforeLog\_intensity" if "intensity" was the value of measure\_col; 'log\_transform\_dm()' returns data\_matrix format matrix

### Examples

```

data(list = c("example_proteome", "example_proteome_matrix"), package = "proBatch")

log_transformed_df <- log_transform_df(example_proteome)

log_transformed_matrix <- log_transform_dm(example_proteome_matrix,
  log_base = 10, offset = 1
)

```

---

warn\_unmapped\_columns *Warn about unmapped columns*

---

### Description

Emit a warning if some columns will not be mapped to colors.

### Usage

```
warn_unmapped_columns(
  sample_annotation,
  columns_for_color_mapping,
  sample_id_col
)
```

### Arguments

`sample_annotation` data frame containing sample annotations.

`columns_for_color_mapping` character vector of columns to be mapped.

`sample_id_col` character, the ID column.

### Value

No return value, called for side effects (warning).

---

[,ProBatchFeatures,ANY,ANY,ANY-method  
*Subset 'ProBatchFeatures' objects without dropping metadata.*

---

### Description

Ensures the '[' method returns a 'ProBatchFeatures' instance so the subclass-specific slots remain available after subsetting.

### Usage

```
## S4 method for signature 'ProBatchFeatures,ANY,ANY,ANY'
x[i, j, ..., drop = TRUE]
```

**Arguments**

x	A 'ProBatchFeatures' object.
i	Row indices passed to the underlying 'QFeatures' subset.
j	Column indices passed to the underlying 'QFeatures' subset.
...	Additional arguments forwarded to the next method.
drop	Logical flag controlling dimension dropping; defaults to 'TRUE'.

**Value**

A 'ProBatchFeatures' object containing the requested subset.

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