Package 'ISAnalytics'

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Title Analyze gene therapy vector insertion sites data identified from genomics next generation sequencing reads for clonal tracking studies

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Description In gene therapy, stem cells are modified using viral vectors to deliver the therapeutic transgene and replace functional properties since the genetic modification is stable and inherited in all cell progeny. The retrieval and mapping of the sequences flanking the virus-host DNA junctions allows the identification of insertion sites (IS), essential for monitoring the evolution of genetically modified cells in vivo. A comprehensive toolkit for the analysis of IS is required to foster clonal trackign studies and supporting the assessment of safety and long term efficacy in vivo. This package is aimed at (1) supporting automation of IS workflow, (2) performing base and advance analysis for IS tracking (clonal abundance, clonal expansions and statistics for insertional mutagenesis, etc.), (3) providing basic biology insights of transduced stem cells in vivo.

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URL https://calabrialab.github.io/ISAnalytics, https://github.com//calabrialab/isanalytics

BugReports https://github.com/calabrialab/ISAnalytics/issues

biocViews BiomedicalInformatics, Sequencing, SingleCell

Depends R (>= 4.1),
magrittr

Imports utils,
dplyr,
readr,
tidyr,
purrr,
rlang,
tibble,
BiocParallel,
stringr,
fs,
lubridate,
lifecycle,

ggplot2,
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stats,
psych,
data.table,
readxl,
tools,
Rcapture,
grDevices,
zip

Encoding UTF-8

LazyData false

Roxygen list(markdown = TRUE)

RoxygenNote 7.1.1

Suggests testthat,
covr,
knitr,
BiocStyle,
sessioninfo,
rmarkdown,
roxygen2,
vegan,
withr,
extraDistr,
ggalluvial,
scales,
gridExtra,
R.utils,
RefManageR,
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gtools,
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R topics documented:

`aggregate_metadata` *Performs aggregation on metadata contained in the association file.*

Description

[Stable] Groups metadata by the specified grouping keys and returns a summary of info for each group. For more details on how to use this function: `vignette("aggregate_function_usage",package = "ISAnalytics")`

Usage

```
aggregate_metadata(
  association_file,
  grouping_keys = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  aggregating_functions = default_meta_agg(),
  import_stats = lifecycle::deprecated()
)
```

Arguments

`association_file`
: The imported association file (via import_association_file)

`grouping_keys`
: A character vector of column names to form a grouping operation

`aggregating_functions`
: A data frame containing specifications of the functions to be applied to columns in the association file during aggregation. It defaults to default_meta_agg. The structure of this data frame should be maintained if the user wishes to change the defaults.

`import_stats`
: **[Deprecated]** The import of VISPA2 stats has been moved to its dedicated function, see import_Vispa2_stats.

Value

An aggregated data frame

See Also

Other Aggregate functions: `aggregate_values_by_key()`, `default_meta_agg()`

Examples

```
data("association_file", package = "ISAnalytics")
aggreg_meta <- aggregate_metadata(
    association_file = association_file
)
head(aggreg_meta)
```

`aggregate_values_by_key` *Aggregates matrices values based on specified key.*

Description

[Stable] Performs aggregation on values contained in the integration matrices based on the key and the specified lambda. For more details on how to use this function: `vignette("aggregate_function_usage",package = "ISAnalytics")`

Usage

```
aggregate_values_by_key(
  x,
  association_file,
  value_cols = "Value",
  key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  lambda = list(sum = ~sum(.x, na.rm = TRUE)),
  group = c(mandatory_IS_vars(), annotation_IS_vars()),
  join_af_by = "CompleteAmplificationID"
)
```

Arguments

`x`	A single integration matrix or a list of imported integration matrices
`association_file`	The imported association file
`value_cols`	A character vector containing the names of the columns to apply the given lambdas. Must be numeric or integer columns.
`key`	A string or a character vector with column names of the association file to take as key
`lambda`	A named list of functions or purrr-style lambdas. See details section.
`group`	Other variables to include in the grouping besides `key`, can be set to NULL
`join_af_by`	A character vector representing the joining key between the matrix and the metadata. Useful to re-aggregate already aggregated matrices.

Details

Setting the lambda parameter:

The lambda parameter should always contain a named list of either functions or purrr-style lambdas. It is also possible to specify the namespace of the function in both ways, for example:

```
lambda = list(sum = sum, desc = psych::describe)
```

Using purrr-style lambdas allows to specify arguments for the functions, keeping in mind that the first parameter should always be `.x`:

```
lambda = list(sum = ~sum(.x, na.rm = TRUE))
```

It is also possible to use custom user-defined functions, keeping in mind that the symbol will be evaluated in the calling environment, for example if the function is called in the global environment and lambda contains "foo" as a function, "foo" will be evaluated in the global environment.

```
foo <- function(x) {
  sum(x)
}

lambda = list(sum = ~sum(.x, na.rm = TRUE), foo = foo)

# Or with lambda notation
lambda = list(sum = ~sum(.x, na.rm = TRUE), foo = ~foo(.x))
```

Constraints on aggregation functions:

Functions passed in the lambda parameters must respect a few constraints to properly work and it's the user responsibility to ensure this.

- Functions have to accept as input a numeric or integer vector
- Function should return a single value or a list/data frame: if a list or a data frame is returned as a result, all the columns will be added to the final data frame.

Value

A list of tibbles or a single tibble aggregated according to the specified arguments

See Also

Other Aggregate functions: `aggregate_metadata()`, `default_meta_agg()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
head(aggreg)
```

annotation_IS_vars *Names of the annotation variables for an integration matrix.*

Description

Contains the names of the columns that are present if the integration matrix is annotated.

Usage

```
annotation_IS_vars()
```

Value

A character vector

Examples

```
annotation_IS_vars()
```

association_file *Example of association file.*

Description

This file is a simple example of association file. Use it as reference to properly fill out yours. To generate an empty association file to fill see the `generate_blank_association_file()` function.

Usage

```
data("association_file")
```

Format

An object of class `data.table` (inherits from `data.frame`) with 53 rows and 83 columns.

Details

The data was obtained manually by simulating real research data.

See Also

`generate_blank_association_file`

association_file_columns *Names of the columns in the association file.*

Description

All the names of the columns present in the association file.

Usage

```
association_file_columns()
```

Value

A character vector

Examples

```
association_file_columns()
```

as_sparse_matrix *Converts tidy integration matrices in the original sparse matrix form.*

Description

[Stable] This function is particularly useful when a sparce matrix structure is needed by a specific function (mainly from other packages).

Usage

```
as_sparse_matrix(
  x,
  fragmentEstimate = "fragmentEstimate",
  seqCount = "seqCount",
  barcodeCount = "barcodeCount",
  cellCount = "cellCount",
  ShsCount = "ShsCount"
)
```

Arguments

x	A single tidy integration matrix or a list of integration matrices. Supports also multi-quantification matrices obtained via comparison_matrix
fragmentEstimate	For multi-quantification matrix support: the name of the fragment estimate values column
seqCount	For multi-quantification matrix support: the name of the sequence count values column
barcodeCount	For multi-quantification matrix support: the name of the barcode count values column
cellCount	For multi-quantification matrix support: the name of the cell count values column
ShsCount	For multi-quantification matrix support: the name of the Shs Count values column

Value

Depending on input, 2 possible outputs:

- A single sparce matrix (tibble) if input is a single quantification matrix
- A list of sparce matrices divided by quantification if input is a single multi-quantification matrix or a list of matrices

See Also

Other Utility functions: `generate_Vispa2_launch_AF()`, `generate_blank_association_file()`, `unzip_file_system()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
sparse <- as_sparse_matrix(integration_matrices)
```

---

available_outlier_tests

A character vector containing all the names of the currently supported outliers tests that can be called in the function outlier_filter.

Description

A character vector containing all the names of the currently supported outliers tests that can be called in the function outlier_filter.

Usage

```
available_outlier_tests()
```

Value

A character vector

See Also

Other Outlier tests: `outliers_by_pool_fragments()`

Examples

```
available_outlier_tests()
```

`blood_lineages_default` *Default blood lineages info*

Description

A default table with info relative to different blood lineages associated with cell markers that can be supplied as a parameter to `HSC_population_size_estimate`

Usage

```
blood_lineages_default()
```

Value

A data frame

Examples

```
blood_lineages_default()
```

`circos_genomic_density` *Trace a circos plot of genomic densities.*

Description

[Experimental] For this functionality the suggested package circlize is required. Please note that this function is a simple wrapper of basic `circlize` functions, for an in-depth explanation on how the functions work and additional arguments please refer to the official documentation Circular Visualization in R

Usage

```
circos_genomic_density(
  data,
  gene_labels = NULL,
  label_col = NULL,
  cytoband_specie = "hg19",
  track_colors = "navyblue",
  grDevice = c("png", "pdf", "svg", "jpeg", "bmp", "tiff", "default"),
  file_path = getwd(),
  ...
)
```

Arguments

data	Either a single integration matrix or a list of integration matrices. If a list is provided, a separate density track for each data frame is plotted.
gene_labels	Either NULL or a data frame in bed format. See details.
label_col	Numeric index of the column of gene_labels that contains the actual labels. Relevant only if gene_labels is not set to NULL.
cytoband_specie	Specie for initializing the cytoband
track_colors	Colors to give to density tracks. If more than one integration matrix is provided as data should be of the same length. Values are recycled if length of track_colors is smaller than the length of the input data.
grDevice	The graphical device where the plot should be traced. default, if executing from RStudio is the viewer.
file_path	If a device other than default is chosen, the path on disk where the file should be saved. Defaults to {current directory}/circos_plot.{device}.
...	Additional named arguments to pass on to chosen device, circlize::circos.par(), circlize::circos.genomicDensity() and circlize::circos.genomicLabels()

Details

Providing genomic labels:

If genomic labels should be plotted alongside genomic density tracks, the user should provide them as a simple data frame in standard bed format, namely chr, start, end plus a column containing the labels. NOTE: if the user decides to plot on the default device (viewer in RStudio), he must ensure there is enough space for all elements to be plotted, otherwise an error message is thrown.

Value

NULL

See Also

Other Plotting functions: CIS_volcano_plot(), HSC_population_plot(), integration_alluvial_plot(), sharing_heatmap(), sharing_venn(), top_abund_tableGrob()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
by_subj <- aggreg %>%
    dplyr::group_by(.data$SubjectID) %>%
    dplyr::group_split()
circos_genomic_density(by_subj,
    track_colors = c("navyblue", "gold"),
    grDevice = "default", track.height = 0.1
)
```

CIS_grubbs *Grubbs test for Common Insertion Sites (CIS).*

Description

[Stable] Statistical approach for the validation of common insertion sites significance based on the comparison of the integration frequency at the CIS gene with respect to other genes contained in the surrounding genomic regions. For more details please refer to this paper: https://ashpublications.org/blood/article/117/20/5332/21206/Lentiviral-vector-common-integration-sites-in

Usage

```
CIS_grubbs(
  x,
  genomic_annotation_file = "hg19",
  grubbs_flanking_gene_bp = 1e+05,
  threshold_alpha = 0.05,
  by = NULL
)
```

Arguments

x	An integration matrix, must include the `mandatory_IS_vars()` columns and the `annotation_IS_vars()` columns
genomic_annotation_file	Database file for gene annotation, see details.
grubbs_flanking_gene_bp	Number of base pairs flanking a gene
threshold_alpha	Significance threshold

by — Either NULL or a character vector of column names. If not NULL, the function will perform calculations for each group and return a list of data frames with the results. E.g. for by = "SubjectID", CIS will be computed for each distinct SubjectID found in the table (of course, "SubjectID" column must be included in the input data frame).

Details

Genomic annotation file:

This file is a data base, or more simply a .tsv file to import, with genes annotation for the specific genome. The annotations for the human genome (hg19) and murine genome (mm9) are already included in this package: to use one of them just set the argument genomic_annotation_file to either "hg19" or "mm9". If for any reason the user is performing an analysis on another genome, this file needs to be changed respecting the USCS Genome Browser format, meaning the input file headers should include:

name2 chrom strand min_txStart max_txEnd minmax_TxLen average_TxLen name min_cdsStart max_cdsEnd minmax_CdsLen average_CdsLen

Value

A data frame

See Also

Other Analysis functions: comparison_matrix(), compute_abundance(), cumulative_count_union(), cumulative_is(), is_sharing(), iss_source(), purity_filter(), sample_statistics(), separate_quant_matrices(), threshold_filter(), top_integrations()

Examples

```
data("integration_matrices", package = "ISAnalytics")
cis <- CIS_grubbs(integration_matrices)
head(cis)
```

CIS_volcano_plot *Trace volcano plot for computed CIS data.*

Description

[Stable] Traces a volcano plot for IS frequency and CIS results.

Usage

```
CIS_volcano_plot(
  x,
  onco_db_file = "proto_oncogenes",
  tumor_suppressors_db_file = "tumor_suppressors",
  species = "human",
```

```
  known_onco = known_clinical_oncogenes(),
  suspicious_genes = clinical_relevant_suspicious_genes(),
  significance_threshold = 0.05,
  annotation_threshold_ontots = 0.1,
  highlight_genes = NULL,
  title_prefix = NULL,
  return_df = FALSE
)
```

Arguments

x	Either a simple integration matrix or a data frame resulting from the call to CIS_grubbs with add_standard_padjust = TRUE
onco_db_file	Uniprot file for proto-oncogenes (see details). If different from default, should be supplied as a path to a file.
tumor_suppressors_db_file	Uniprot file for tumor-suppressor genes. If different from default, should be supplied as a path to a file.
species	One between "human", "mouse" and "all"
known_onco	Data frame with known oncogenes. See details.
suspicious_genes	Data frame with clinical relevant suspicious genes. See details.
significance_threshold	The significance threshold
annotation_threshold_ontots	Value above which genes are annotated with colorful labels
highlight_genes	Either NULL or a character vector of genes to be highlighted in the plot even if they're not above the threshold
title_prefix	A string or character vector to be displayed in the title - usually the project name and other characterizing info. If a vector is supplied, it is concatenated in a single string via paste()
return_df	Return the data frame used to generate the plot? This can be useful if the user wants to manually modify the plot with ggplot2. If TRUE the function returns a list containing both the plot and the data frame.

Details

Input data frame:

Users can supply as x either a simple integration matrix or a data frame resulting from the call to CIS_grubbs. In the first case an internal call to the function CIS_grubbs() is performed.

Oncogene and tumor suppressor genes files:

These files are included in the package for user convenience and are simply UniProt files with gene annotations for human and mouse. For more details on how this files were generated use the help ?tumor_suppressors, ?proto_oncogenes

Known oncogenes:

The default values are included in this package and it can be accessed by doing:

```
head(known_clinical_oncogenes())
```

```
## # A tibble: 5 × 2
##   GeneName KnownClonalExpansion
##   <chr>    <lgl>
## 1 MECOM    TRUE
## 2 CCND2    TRUE
## 3 TAL1     TRUE
## 4 LMO2     TRUE
## 5 HMGA2    TRUE
```

If the user wants to change this parameter the input data frame must preserve the column structure. The same goes for the `suspicious_genes` parameter (DOIReference column is optional):

```
head(clinical_relevant_suspicious_genes())
```

```
## # A tibble: 6 × 3
##   GeneName ClinicalRelevance DOIReference
##   <chr>    <lgl>             <chr>
## 1 DNMT3A   TRUE              https://doi.org/10.1182/blood-2018-01-829937
## 2 TET2     TRUE              https://doi.org/10.1182/blood-2018-01-829937
## 3 ASXL1    TRUE              https://doi.org/10.1182/blood-2018-01-829937
## 4 JAK2     TRUE              https://doi.org/10.1182/blood-2018-01-829937
## 5 CBL      TRUE              https://doi.org/10.1182/blood-2018-01-829937
## 6 TP53     TRUE              https://doi.org/10.1182/blood-2018-01-829937
```

Value

A plot or a list containing a plot and a data frame

See Also

Other Plotting functions: `HSC_population_plot()`, `circos_genomic_density()`, `integration_alluvial_plot()`, `sharing_heatmap()`, `sharing_venn()`, `top_abund_tableGrob()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
cis_plot <- CIS_volcano_plot(integration_matrices,
    title_prefix = "PJ01"
)
cis_plot
```

clinical_relevant_suspicious_genes *Clinical relevant suspicious genes (for mouse and human).*

Description

Clinical relevant suspicious genes (for mouse and human).

Usage

```
clinical_relevant_suspicious_genes()
```

Value

A data frame

See Also

Other Plotting function helpers: `known_clinical_oncogenes()`

Examples

```
clinical_relevant_suspicious_genes()
```

comparison_matrix *obtain a single integration matrix from individual quantification matrices.*

Description

[Stable] Takes a list of integration matrices referring to different quantification types and merges them in a single data frame that has multiple value columns, each renamed according to their quantification type of reference.

Usage

```
comparison_matrix(
  x,
  fragmentEstimate = "fragmentEstimate",
  seqCount = "seqCount",
  barcodeCount = "barcodeCount",
  cellCount = "cellCount",
  ShsCount = "ShsCount"
)
```

Arguments

x	A named list of integration matrices, ideally obtained via import_parallel_Vispa2Matrices_interactive or import_parallel_Vispa2Matrices_auto. Names must be quantification types.
fragmentEstimate	The name of the output column for fragment estimate values
seqCount	The name of the output column for sequence count values
barcodeCount	The name of the output column for barcode count values
cellCount	The name of the output column for cell count values
ShsCount	The name of the output column for Shs count values

Value

A tibble

See Also

quantification_types

Other Analysis functions: CIS_grubbs(), compute_abundance(), cumulative_count_union(), cumulative_is(), is_sharing(), iss_source(), purity_filter(), sample_statistics(), separate_quant_matrices(), threshold_filter(), top_integrations()

Examples

```
fs_path <- system.file("extdata", "fs.zip", package = "ISAnalytics")
fs <- unzip_file_system(fs_path, "fs")
af_path <- system.file("extdata", "asso.file.tsv.gz",
    package = "ISAnalytics"
)
af <- import_association_file(af_path,
    root = fs,
    import_iss = FALSE,
    report_path = NULL
)
matrices <- import_parallel_Vispa2Matrices(af,
    c("seqCount", "fragmentEstimate"),
    mode = "AUTO", report_path = NULL, multi_quant_matrix = FALSE
)
multi_quant <- comparison_matrix(matrices)
head(multi_quant)
```

---

compute_abundance *Computes the abundance for every integration event in the input data frame.*

Description

[Stable] Abundance is obtained for every integration event by calculating the ratio between the single value and the total value for the given group.

Usage

```
compute_abundance(
  x,
  columns = c("fragmentEstimate_sum"),
  percentage = TRUE,
  key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  keep_totals = FALSE
)
```

Arguments

x	An integration matrix - aka a data frame that includes the `mandatory_IS_vars()` as columns. The matrix can either be aggregated (via `aggregate_values_by_key()`) or not.
columns	A character vector of column names to process, must be numeric or integer columns
percentage	Add abundance as percentage?
key	The key to group by when calculating totals
keep_totals	A value between `TRUE`, `FALSE` or `df`. If `TRUE`, the intermediate totals for each group will be kept in the output data frame as a dedicated column with a trailing "_tot". If `FALSE`, totals won't be included in the output data frame. If `df`, the totals are returned to the user as a separate data frame, together with the abundance data frame.

Details

Abundance will be computed upon the user selected columns in the `columns` parameter. For each column a corresponding relative abundance column (and optionally a percentage abundance column) will be produced.

Value

Either a single data frame with computed abundance values or a list of 2 data frames (abundance_df, quant_totals)

See Also

Other Analysis functions: `CIS_grubbs()`, `comparison_matrix()`, `cumulative_count_union()`, `cumulative_is()`, `is_sharing()`, `iss_source()`, `purity_filter()`, `sample_statistics()`, `separate_quant_matrices()`, `threshold_filter()`, `top_integrations()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
abund <- compute_abundance(
    x = integration_matrices,
    columns = "fragmentEstimate",
    key = "CompleteAmplificationID"
)
head(abund)
```

`compute_near_integrations` *Scans input matrix to find and merge near integration sites.*

Description

[Stable] This function scans the input integration matrix to detect eventual integration sites that are too "near" to each other and merges them into single integration sites adjusting their values if needed.

Usage

```
compute_near_integrations(
  x,
  threshold = 4,
  keep_criteria = "max_value",
  strand_specific = TRUE,
  value_columns = c("seqCount", "fragmentEstimate"),
  max_value_column = "seqCount",
  map_as_file = TRUE,
  file_path = default_report_path()
)
```

Arguments

`x`	An integration matrix
`threshold`	A single integer that represents an absolute number of bases for which two integrations are considered distinct. If the threshold is set to 3 it means, provided fields `chr` and `strand` are the same, integrations sites which have at least 3 bases in between them are considered distinct (e.g. (1, 14576, +) and (1, 14580, +) are considered distinct)
`keep_criteria`	While scanning, which integration should be kept? The 2 possible choices for this parameter are: • "max_value": keep the integration site which has the highest value (and collapse other values on that integration). • "keep_first": keeps the first integration

`strand_specific`
: Should strand be considered? If yes, for example these two integration sites (chr = "1", strand = "+", integration_locus = 14568) and (chr = "1", strand = "-", integration_locus = 14568) are considered different and not grouped together.

`value_columns`
: Character vector, contains the names of the numeric experimental columns

`max_value_column`
: The column that has to be considered for searching the maximum value

`map_as_file`
: Produce recalibration map as a .tsv file?

`file_path`
: String representing the path were the file will be saved. Can be either a folder or a file. Relevant only if `map_as_file` is `TRUE`.

Details

The whole matrix is scanned with a sliding window mechanism: for each row in the integration matrix an interval is calculated based on the `threshold` value, then a "look ahead" operation is performed to detect subsequent rows which integration locuses fall in the interval. If `CompleteAmplificationIDs` of the near integrations are different only the locus value (and optionally `GeneName` and `GeneStrand` if the matrix is annotated) is modified, otherwise rows with the same id are aggregated and values are summed. The function will also produce a re-calibration map: this data frame contains the reference of pre-recalibration values for `chr`, `strand` and `integration_locus` and the value to which that integration was changed to.

Value

An integration matrix with same or less number of rows

Note

We do recommend to use this function in combination with comparison_matrix to automatically perform re-calibration on all quantification matrices.

Examples

```
data("integration_matrices", package = "ISAnalytics")
rec <- compute_near_integrations(
    x = integration_matrices, map_as_file = FALSE
)
head(rec)
```

---

cumulative_count_union

Integrations cumulative count in time by sample

Description

[Experimental] This function computes the cumulative number of integrations observed in each sample at different time points by assuming that if an integration is observed at time point "t" then it is also observed in time point "t+1".

Usage

```
cumulative_count_union(
  x,
  association_file = NULL,
  timepoint_column = "TimePoint",
  key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  include_tp_zero = FALSE,
  zero = "0000",
  aggregate = FALSE,
  ...
)
```

Arguments

x	A simple integration matrix or an aggregated matrix (see details)
association_file	NULL or the association file for x if aggregate is set to TRUE
timepoint_column	What is the name of the time point column?
key	The aggregation key - must always contain the timepoint_column
include_tp_zero	Include timepoint 0?
zero	How is 0 coded in the data frame?
aggregate	Should x be aggregated?
...	Additional parameters to pass to aggregate_values_by_key

Details

Input data frame:

The user can provide as input for the x parameter both a simple integration matrix AND setting the aggregate parameter to TRUE, or provide an already aggregated matrix via aggregate_values_by_key. If the user supplies a matrix to be aggregated the association_file parameter must not be NULL: aggregation will be done by an internal call to the aggregation function. If the user supplies an already aggregated matrix, the key parameter is the key used for aggregation - **NOTE: for this operation is mandatory that the time point column is included in the key.**

Assumptions on time point format:

By using the functions provided by this package, when imported, an association file will be correctly formatted for future usage. In the formatting process there is also a padding operation performed on time points: this means the functions expects the time point column to be of type character and to be correctly padded with 0s. If the chosen column for time point is detected as numeric the function will attempt the conversion to character and automatic padding. If you choose to import the association file not using the import_association_file function, be sure to check the format of the chosen column to avoid undesired results.

Value

A data frame

See Also

Other Analysis functions: CIS_grubbs(), comparison_matrix(), compute_abundance(), cumulative_is(), is_sharing(), iss_source(), purity_filter(), sample_statistics(), separate_quant_matrices(), threshold_filter(), top_integrations()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
cumulative_count <- cumulative_count_union(aggreg)
cumulative_count
```

---

cumulative_is *Expands integration matrix with the cumulative is union over time.*

Description

[Experimental] Given an input integration matrix that can be grouped over time, this function adds integrations in groups assuming that if an integration is observed at time point "t" then it is also observed in time point "t+1".

Usage

```
cumulative_is(
  x,
  key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  timepoint_col = "TimePoint",
  include_tp_zero = FALSE,
  keep_og_is = TRUE,
  expand = FALSE
)
```

Arguments

x	An integration matrix, ideally aggregated via aggregate_values_by_key()
key	The aggregation key used
timepoint_col	The name of the time point column
include_tp_zero	Should time point 0 be included?
keep_og_is	Keep original set of integrations as a separate column?
expand	If FALSE, for each group, the set of integration sites is returned in a separate column as a nested table, otherwise the resulting column is unnested.

Value

A data frame

See Also

Other Analysis functions: CIS_grubbs(), comparison_matrix(), compute_abundance(), cumulative_count_union(), is_sharing(), iss_source(), purity_filter(), sample_statistics(), separate_quant_matrices(), threshold_filter(), top_integrations()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
cumulated_is <- cumulative_is(aggreg)
cumulated_is
```

---

date_columns_coll *Possible choices for* date_col *parameter.*

Description

Possible choices for date_col parameter.

Usage

```
date_columns_coll()
```

Value

A character vector of column names

See Also

remove_collisions

Examples

```
dates <- date_columns_coll()
```

date_formats	*Possible choices for the* dates_format *parameter in* import_association_file, import_parallel_vispa2Matrices_interactive *and* import_parallel_vispa2Matrices_auto.

Description

All options correspond to lubridate functions:

- ymd: year, month, date
- ydm: year, day, month
- mdy: month, day, year
- myd: month, year, day
- dmy: day, month, year
- dym: day, year, month
- yq: year quantile

Usage

```
date_formats()
```

Details

NOTE: use the same date format across the association file.

Value

A character vector

See Also

import_association_file, import_parallel_Vispa2Matrices_auto

Examples

```
date_formats()
```

default_iss_file_prefixes *Default regex prefixes for Vispa2 stats files.*

Description

Note that each element is a regular expression.

Usage

```
default_iss_file_prefixes()
```

Value

A character vector of regexes

Examples

```
default_iss_file_prefixes()
```

default_meta_agg *Default metadata aggregation function table*

Description

A default columns-function specifications for aggregate_metadata

Usage

```
default_meta_agg()
```

Details

This data frame contains four columns:

- `Column`: holds the name of the column in the association file that should be processed
- `Function`: contains either the name of a function (e.g. mean) or a purrr-style lambda (e.g. `~ mean(.x,na.rm = TRUE)`). This function will be applied to the corresponding column specified in `Column`
- `Args`: optional additional arguments to pass to the corresponding function. This is relevant ONLY if the corresponding `Function` is a simple function and not a purrr-style lambda.
- `Output_colname`: a `glue` specification that will be used to determine a unique output column name. See glue for more details.

Value

A data frame

See Also

Other Aggregate functions: `aggregate_metadata()`, `aggregate_values_by_key()`

Examples

```
default_meta_agg()
```

`default_report_path` *Default folder for saving ISAnalytics reports. Supplied as default argument for several functions.*

Description

Default folder for saving ISAnalytics reports. Supplied as default argument for several functions.

Usage

```
default_report_path()
```

Value

A path

Examples

```
default_report_path()
```

`default_stats` *A set of pre-defined functions for* `sample_statistics`.

Description

A set of pre-defined functions for `sample_statistics`.

Usage

```
default_stats()
```

Value

A named list of functions/purrr-style lambdas

Examples

```
default_stats()
```

generate_blank_association_file

Creates a blank association file.

Description

This function is useful if you want a blank association file to start using both Vispa2 and this package or simply if you want a correct framework to fix a malformed association file you have already.

Usage

```
generate_blank_association_file(path)
```

Arguments

path	The path on disk where the file should be written

Value

returns NULL

See Also

Other Utility functions: as_sparse_matrix(), generate_Vispa2_launch_AF(), unzip_file_system()

Examples

```
temp <- tempfile()
generate_blank_association_file(temp)
```

generate_Vispa2_launch_AF

Creates a reduced association file for Vispa2 run, given project and pool

Description

The function selects the appropriate columns and prepares a file for the launch of Vispa2 pipeline for each project/pool pair specified.

Usage

```
generate_Vispa2_launch_AF(association_file, project, pool, path)
```

Arguments

`association_file`	The imported association file (via `import_association_file`)
`project`	A vector of characters containing project names
`pool`	A vector of characters containing pool names. **NOTE: the names should refer to the values contained in the PoolID column of the association file and NOT the concatenatePoolIDSeqRun column!**
`path`	A single string representing the path to the folder where files should be written. If the folder doesn't exist it will be created.

Details

Note: the function is vectorized, meaning you can specify more than one project and more than one pool as vectors of characters, but you must ensure that:

- Both `project` and `pool` vectors have the same length
- You correclty type names in corresponding positions, for example c("CLOEXP", "PROJECT1100", "PROJECT1100") - c("POOL6", "ABX-LR-PL5-POOL14-1", "ABX-LR-PL6-POOL15-1"). If you type a pool in the position of a corresponding project that doesn't match no file will be produced since that pool doesn't exist in the corresponding project.

Value

returns NULL

See Also

Other Utility functions: `as_sparse_matrix()`, `generate_blank_association_file()`, `unzip_file_system()`

Examples

```
temp <- tempdir()
data("association_file", package = "ISAnalytics")
generate_Vispa2_launch_AF(association_file, "PJ01", "POOL01", temp)
```

HSC_population_plot *Plot of the estimated HSC population size for each patient.*

Description

Plot of the estimated HSC population size for each patient.

Usage

```
HSC_population_plot(
  estimates,
  project_name,
  timepoints = "Consecutive",
  models = "Mth Chao (LB)"
)
```

Arguments

estimates	The estimates data frame, obtained via HSC_population_size_estimate
project_name	The project name, will be included in the plot title
timepoints	Which time points to plot? One between "All", "Stable" and "Consecutive"
models	Name of the models to plot (as they appear in the column of the estimates)

Value

A plot

See Also

Other Plotting functions: CIS_volcano_plot(), circos_genomic_density(), integration_alluvial_plot(), sharing_heatmap(), sharing_venn(), top_abund_tableGrob()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
aggreg_meta <- aggregate_metadata(
    association_file = association_file
)
estimate <- HSC_population_size_estimate(
    x = aggreg,
    metadata = aggreg_meta,
    stable_timepoints = c(90, 180, 360),
    cell_type = "Other"
)
p <- HSC_population_plot(estimate, "PJ01")
p
```

HSC_population_size_estimate
Hematopoietic stem cells population size estimate.

Description

[Experimental] Hematopoietic stem cells population size estimate with capture-recapture models.

Usage

```
HSC_population_size_estimate(
  x,
  metadata,
  stable_timepoints = NULL,
  aggregation_key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  blood_lineages = blood_lineages_default(),
  timepoint_column = "TimePoint",
  seqCount_column = "seqCount_sum",
  seqCount_threshold = 3,
  nIS_threshold = 5,
  cell_type = "MYELOID",
  tissue_type = "PB"
)
```

Arguments

x	An aggregated integration matrix. See details.
metadata	An aggregated association file. See details.
stable_timepoints	A numeric vector or NULL if there are no stable time points.
aggregation_key	A character vector indicating the key used for aggregating x and metadata. Note that x and metadata should always be aggregated with the same key.
blood_lineages	A data frame containing information on the blood lineages. Users can supply their own, provided the columns `CellMarker` and `CellType` are present.
timepoint_column	What is the name of the time point column to use? Note that this column must be present in the key.
seqCount_column	What is the name of the column in x holding the values of sequence count quantification?
seqCount_threshold	A single numeric value. After re-aggregating `x`, rows with a value greater or equal will be kept, the others will be discarded.

nIS_threshold	A single numeric value. If a group (row) in the metadata data frame has a count of distinct integration sites strictly greater than this number it will be kept, otherwise discarded.
cell_type	The cell types to include in the models. Note that the matching is case-insensitive.
tissue_type	The tissue types to include in the models. Note that the matching is case-insensitive.

Value

A data frame with the results of the estimates

Input formats

Both x and metadata should be supplied to the function in aggregated format (ideally through the use of aggregate_metadata and aggregate_values_by_key). Note that the aggregation_key, aka the vector of column names used for aggregation, must contain at least the columns SubjectID, CellMarker, Tissue and a time point column (the user can specify the name of the column in the argument timepoint_column).

On time points

If stable_timepoints is a vector with length > 1, the function will look for the first available stable time point and slice the data from that time point onward. If NULL is supplied instead, it means there are no stable time points available. Note that 0 time points are ALWAYS discarded. Also, to be included in the analysis, a group must have at least 2 distinct non-zero time points.

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
aggreg_meta <- aggregate_metadata(association_file = association_file)
estimate <- HSC_population_size_estimate(
    x = aggreg,
    metadata = aggreg_meta,
    stable_timepoints = c(90, 180, 360),
    cell_type = "Other"
)
```

`import_association_file` *Import the association file from disk*

Description

[Stable] Imports the association file and immediately performs a check on the file system starting from the root to assess the alignment between the two.

Usage

```
import_association_file(
  path,
  root = NULL,
  tp_padding = 4,
  dates_format = "ymd",
  separator = "\t",
  filter_for = NULL,
  import_iss = FALSE,
  convert_tp = TRUE,
  report_path = default_report_path(),
  ...
)
```

Arguments

`path`	The path on disk to the association file.
`root`	The path on disk of the root folder of Vispa2 output or NULL. See details.
`tp_padding`	Timepoint padding, indicates the number of digits of the "TimePoint" column once imported. Fills the content with 0s up to the length specified (ex: 1 becomes 0001 with a tp_padding of 4)
`dates_format`	A single string indicating how dates should be parsed. Must be a value in: `date_formats()`
`separator`	The column separator used in the file
`filter_for`	A named list where names represent column names that must be filtered. For example: list(ProjectID = c("PROJECT1", "PROJECT2)) will filter the association file so that it contains only those rows for which the value of the column "ProjectID" is one of the specified values. If multiple columns are present in the list all filtering conditions are applied as a logical AND.
`import_iss`	Import Vispa2 stats and merge them with the association file?
`convert_tp`	Should be time points be converted into months and years?
`report_path`	The path where the report file should be saved. Can be a folder, a file or NULL if no report should be produced. Defaults to `{user_home}/ISAnalytics_reports`.
`...`	Additional arguments to pass to `import_Vispa2_stats`

Details

If the root argument is set to NULL no file system alignment is performed. This allows to import the basic file but it won't be possible to perfom automated matrix and stats import. For more details see the "How to use import functions" vignette: vignette("import_functions_howto",package = "ISAnalytics")

Value

The data frame holding metadata

See Also

date_formats

Other Import functions: import_Vispa2_stats(), import_parallel_Vispa2Matrices(), import_single_Vispa2Matri

Examples

```
fs_path <- system.file("extdata", "fs.zip", package = "ISAnalytics")
fs <- unzip_file_system(fs_path, "fs")
af_path <- system.file("extdata", "asso.file.tsv.gz", package = "ISAnalytics")
af <- import_association_file(af_path, root = fs, report_path = NULL)
head(af)
```

---

import_parallel_Vispa2Matrices

Import integration matrices from paths in the association file.

Description

[Stable] The function offers a convenient way of importing multiple integration matrices in an automated or semi-automated way. For more details see the "How to use import functions" vignette: vignette("import_functions_howto",package = "ISAnalytics")

Usage

```
import_parallel_Vispa2Matrices(
  association_file,
  quantification_type,
  matrix_type = "annotated",
  workers = 2,
  multi_quant_matrix = TRUE,
  report_path = default_report_path(),
  patterns = NULL,
  matching_opt = matching_options(),
  mode = c("AUTO", "INTERACTIVE"),
  ...
)
```

Arguments

association_file	Data frame imported via import_association_file (with file system alignment) or a string containing the path to the association file on disk.
quantification_type	A vector of requested quantification_types. Possible choices are quantification_types
matrix_type	A single string representing the type of matrices to be imported. Can only be one in "annotated" or "not_annotated".
workers	A single integer representing the number of parallel workers to use for the import
multi_quant_matrix	If set to TRUE will produce a multi-quantification matrix through comparison_matrix instead of a list.
report_path	The path where the report file should be saved. Can be a folder, a file or NULL if no report should be produced. Defaults to {user_home}/ISAnalytics_reports.
patterns	Relevant only if argument mode is set to AUTO. A character vector of additional patterns to match on file names. Please note that patterns must be regular expressions. Can be NULL if no patterns need to be matched.
matching_opt	Relevant only if argument mode is set to AUTO. A single value between matching_options
mode	A single value between AUTO and INTERACTIVE. If INTERACTIVE, the function will ask for input from the user on console, otherwise the process is fully automated (with limitations, see vignette).
...	<dynamic-dots> Additional named arguments to pass to import_association_file and comparison_matrix

Value

Either a multi-quantification matrix or a list of integration matrices

See Also

Other Import functions: import_Vispa2_stats(), import_association_file(), import_single_Vispa2Matrix()

Examples

```
fs_path <- system.file("extdata", "fs.zip", package = "ISAnalytics")
fs <- unzip_file_system(fs_path, "fs")
af_path <- system.file("extdata", "asso.file.tsv.gz",
    package = "ISAnalytics"
)
af <- import_association_file(af_path,
    root = fs,
    import_iss = FALSE,
    report_path = NULL
)
matrices <- import_parallel_Vispa2Matrices(af,
```

```
    c("seqCount", "fragmentEstimate"),
    mode = "AUTO", report_path = NULL
)
head(matrices)
```

`import_single_Vispa2Matrix` *Import a single integration matrix from file*

Description

[Stable] This function allows to read and import an integration matrix produced as the output of Vispa2 pipeline and converts it to a tidy format.

Usage

```
import_single_Vispa2Matrix(
  path,
  to_exclude = NULL,
  keep_excluded = FALSE,
  separator = "\t"
)
```

Arguments

`path`	The path to the file on disk
`to_exclude`	Either NULL or a character vector of column names that should be ignored when importing
`keep_excluded`	Keep the columns in `to_exclude` as additional id columns?
`separator`	The column delimiter used, defaults to \t

Details

For more details see the "How to use import functions" vignette: `vignette("import_functions_howto",package = "ISAnalytics")`

Value

A data.table object in tidy format

See Also

Other Import functions: `import_Vispa2_stats()`, `import_association_file()`, `import_parallel_Vispa2Matrices()`

Examples

```
fs_path <- system.file("extdata", "fs.zip", package = "ISAnalytics")
fs <- unzip_file_system(fs_path, "fs")
matrix_path <- fs::path(
    fs,
    "PJ01",
    "quantification",
    "POOL01-1",
    "PJ01_POOL01-1_seqCount_matrix.no0.annotated.tsv.gz"
)
matrix <- import_single_Vispa2Matrix(matrix_path)
head(matrix)
```

---

import_Vispa2_stats *Import Vispa2 stats given the aligned association file.*

Description

[Stable] Imports all the Vispa2 stats files for each pool provided the association file has been aligned with the file system (see import_association_file).

Usage

```
import_Vispa2_stats(
  association_file,
  file_prefixes = default_iss_file_prefixes(),
  join_with_af = TRUE,
  pool_col = "concatenatePoolIDSeqRun",
  report_path = default_report_path()
)
```

Arguments

association_file	The file system aligned association file (contains columns with absolute paths to the 'iss' folder)
file_prefixes	A character vector with known file prefixes to match on file names. NOTE: the elements represent regular expressions. For defaults see default_iss_file_prefixes.
join_with_af	Logical, if TRUE the imported stats files will be merged with the association file, if false a single data frame holding only the stats will be returned.
pool_col	A single string. What is the name of the pool column used in the Vispa2 run? This will be used as a key to perform a join operation with the stats files POOL column.
report_path	The path where the report file should be saved. Can be a folder, a file or NULL if no report should be produced. Defaults to {user_home}/ISAnalytics_reports.

Value

A data frame

See Also

Other Import functions: import_association_file(), import_parallel_Vispa2Matrices(), import_single_Vispa2Matrix()

Examples

```
fs_path <- system.file("extdata", "fs.zip", package = "ISAnalytics")
fs <- unzip_file_system(fs_path, "fs")
af_path <- system.file("extdata", "asso.file.tsv.gz",
    package = "ISAnalytics"
)
af <- import_association_file(af_path,
    root = fs,
    import_iss = FALSE,
    report_path = NULL
)
stats_files <- import_Vispa2_stats(af,
    join_with_af = FALSE,
    report_path = NULL
)
head(stats_files)
```

---

integration_alluvial_plot

Alluvial plots for IS distribution in time.

Description

[Experimental] Alluvial plots allow the visualization of integration sites distribution in different points in time in the same group. This functionality requires the suggested package ggalluvial.

Usage

```
integration_alluvial_plot(
  x,
  group = c("SubjectID", "CellMarker", "Tissue"),
  plot_x = "TimePoint",
  plot_y = "fragmentEstimate_sum_PercAbundance",
  alluvia = mandatory_IS_vars(),
  alluvia_plot_y_threshold = 1,
  top_abundant_tbl = TRUE,
  ...
)
```

Arguments

x	A data frame. See details.
group	Character vector containing the column names that identify unique groups.
plot_x	Column name to plot on the x axis
plot_y	Column name to plot on the y axis
alluvia	Character vector of column names that uniquely identify alluvia
alluvia_plot_y_threshold	Numeric value. Everything below this threshold on y will be plotted in grey and aggregated. See details.
top_abundant_tbl	Logical. Produce the summary top abundant tables via top_abund_tableGrob?
...	Additional arguments to pass on to top_abund_tableGrob

Details

Input data frame:

The input data frame must contain all the columns specified in the arguments `group`, `plot_x`, `plot_y` and `alluvia`. The standard input for this function is the data frame obtained via the compute_abundance function.

Plotting threshold on y:

The plotting threshold on the quantification on the y axis has the function to highlight only relevant information on the plot and reduce computation time. The default value is 1, that acts on the default column plotted on the y axis which holds a percentage value. This translates in natural language roughly as "highlight with colors only those integrations (alluvia) that at least in 1 point in time have an abundance value >= 1 %". The remaining integrations will be plotted as transparent in the strata.

Value

For each group a list with the associated plot and optionally the summary tableGrob

See Also

Other Plotting functions: `CIS_volcano_plot()`, `HSC_population_plot()`, `circos_genomic_density()`, `sharing_heatmap()`, `sharing_venn()`, `top_abund_tableGrob()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
abund <- compute_abundance(x = aggreg)
```

```
alluvial_plots <- integration_alluvial_plot(abund,
    alluvia_plot_y_threshold = 0.5
)
ex_plot <- alluvial_plots[[1]]$plot +
    ggplot2::labs(
        title = "IS distribution over time",
        subtitle = "Patient 1, MNC BM",
        y = "Abundance (%)",
        x = "Time point (days after GT)"
    )
print(ex_plot)
```

`integration_matrices` *Example of imported multi-quantification integration matrices.*

Description

The data was obtained manually by simulating real research data.

Usage

```
data("integration_matrices")
```

Format

Data frame with 1689 rows and 8 columns

chr The chromosome number (as character)

integration_locus Number of the base at which the viral insertion occurred

strand Strand of the integration

GeneName Symbol of the closest gene

GeneStrand Strand of the closest gene

CompleteAmplificationID Unique sample identifier

seqCount Value of the sequence count quantification

fragmentEstimate Value of the fragment estimate quantification

iss_source *Find the source of IS by evaluating sharing.*

Description

[Experimental] The function computes the sharing between a reference group of interest for each time point and a selection of groups of interest. In this way it is possible to observe the percentage of shared integration sites between reference and each group and identify in which time point a certain IS was observed for the first time.

Usage

```
iss_source(
  reference,
  selection,
  ref_group_key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  selection_group_key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  timepoint_column = "TimePoint",
  by_subject = TRUE,
  subject_column = "SubjectID"
)
```

Arguments

reference	A data frame containing one or more groups of reference. Groups are identified by ref_group_key
selection	A data frame containing one or more groups of interest to compare. Groups are identified by selection_group_key
ref_group_key	Character vector of column names that identify a unique group in the reference data frame
selection_group_key	Character vector of column names that identify a unique group in the selection data frame
timepoint_column	Name of the column holding time point info?
by_subject	Should calculations be performed for each subject separately?
subject_column	Name of the column holding subjects information. Relevant only if by_subject = TRUE

Value

A list of data frames or a data frame

See Also

Other Analysis functions: CIS_grubbs(), comparison_matrix(), compute_abundance(), cumulative_count_union(), cumulative_is(), is_sharing(), purity_filter(), sample_statistics(), separate_quant_matrices(), threshold_filter(), top_integrations()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
df1 <- aggreg %>%
    dplyr::filter(.data$Tissue == "BM")
df2 <- aggreg %>%
    dplyr::filter(.data$Tissue == "PB")
source <- iss_source(df1, df2)
source
ggplot2::ggplot(source$PT001, ggplot2::aes(x = as.factor(g2_TimePoint),
                                           y = sharing_perc, fill = g1)) +
    ggplot2::geom_col() +
    ggplot2::labs(x = "Time point", y = "Shared IS % with MNC BM",
                  title = "Source of is MNC BM vs MNC PB")
```

`is_sharing` *Sharing of integration sites between given groups.*

Description

[Experimental] Computes the amount of integration sites shared between the groups identified in the input data.

Usage

```
is_sharing(
  ...,
  group_key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  group_keys = NULL,
  n_comp = 2,
  is_count = TRUE,
  relative_is_sharing = TRUE,
  minimal = TRUE,
  include_self_comp = FALSE,
  keep_genomic_coord = FALSE,
  table_for_venn = FALSE
)
```

Arguments

`...`	One or more integration matrices
`group_key`	Character vector of column names which identify a single group. An associated group id will be derived by concatenating the values of these fields, separated by "_"

group_keys	A list of keys for asymmetric grouping. If not NULL the argument group_key is ignored
n_comp	Number of comparisons to compute. This argument is relevant only if provided a single data frame and a single key.
is_count	Logical, if TRUE returns also the count of IS for each group and the count for the union set
relative_is_sharing	Logical, if TRUE also returns the relative sharing.
minimal	Compute only combinations instead of all possible permutations? If TRUE saves time and excludes redundant comparisons.
include_self_comp	Include comparisons with the same group?
keep_genomic_coord	If TRUE keeps the genomic coordinates of the shared integration sites in a dedicated column (as a nested table)
table_for_venn	Add column with truth tables for venn plots?

Details

An integration site is always identified by the triple (chr, integration_locus, strand), thus these columns must be present in the input(s).

The function accepts multiple inputs for different scenarios, please refer to the vignette `vignette("sharing_analyses",pac = "ISAnalytics")` for a more in-depth explanation.

Output:

The function outputs a single data frame containing all requested comparisons and optionally individual group counts, genomic coordinates of the shared integration sites and truth tables for plotting venn diagrams.

Plotting sharing:

The sharing data obtained can be easily plotted in a heatmap via the function `sharing_heatmap` or via the function `sharing_venn`

Value

A data frame

See Also

Other Analysis functions: `CIS_grubbs()`, `comparison_matrix()`, `compute_abundance()`, `cumulative_count_union()`, `cumulative_is()`, `iss_source()`, `purity_filter()`, `sample_statistics()`, `separate_quant_matrices()`, `threshold_filter()`, `top_integrations()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
sharing <- is_sharing(aggreg)
sharing
```

---

known_clinical_oncogenes

Known clinical oncogenes (for mouse and human).

Description

Known clinical oncogenes (for mouse and human).

Usage

```
known_clinical_oncogenes()
```

Value

A data frame

See Also

Other Plotting function helpers: `clinical_relevant_suspicious_genes()`

Examples

```
known_clinical_oncogenes()
```

---

mandatory_IS_vars

Names of mandatory variables for an integration matrix.

Description

Contains the names of the columns that need to be present in order for a tibble to be considered an integration matrix.

Usage

```
mandatory_IS_vars()
```

Value

A character vector

Examples

```
mandatory_IS_vars()
```

`matching_options` *Possible choices for the* `matching_opt` *parameter.*

Description

These are all the possible values for the `matching_opt` parameter in `import_parallel_vispa2Matrices_auto`.

Usage

```
matching_options()
```

Details

The values "ANY", "ALL" and "OPTIONAL", represent how the patterns should be matched, more specifically

- ANY = look only for files that match AT LEAST one of the patterns specified
- ALL = look only for files that match ALL of the patterns specified
- OPTIONAL = look preferentially for files that match, in order, all patterns or any pattern and if no match is found return what is found (keep in mind that duplicates are discarded in automatic mode)

Value

A vector of characters for matching_opt

See Also

`import_parallel_Vispa2Matrices_auto`

Other Import functions helpers: `quantification_types()`

Examples

```
opts <- matching_options()
```

`outliers_by_pool_fragments` *Identify and flag outliers based on pool fragments.*

Description

[Experimental] Identify and flag outliers

Usage

```
outliers_by_pool_fragments(
  metadata,
  key = "BARCODE_MUX",
  outlier_p_value_threshold = 0.01,
  normality_test = FALSE,
  normality_p_value_threshold = 0.05,
  transform_log2 = TRUE,
  per_pool_test = TRUE,
  pool_col = "PoolID",
  min_samples_per_pool = 5,
  flag_logic = "AND",
  keep_calc_cols = TRUE,
  report_path = default_report_path()
)
```

Arguments

`metadata`	The metadata data frame
`key`	A character vector of numeric column names
`outlier_p_value_threshold`	The p value threshold for a read to be considered an outlier
`normality_test`	Perform normality test? Normality is assessed for each column in the key using Shapiro-Wilk test and if the values do not follow a normal distribution, other calculations are skipped
`normality_p_value_threshold`	Normality threshold
`transform_log2`	Perform a log2 trasformation on values prior the actual calculations?
`per_pool_test`	Perform the test for each pool?
`pool_col`	A character vector of the names of the columns that uniquely identify a pool
`min_samples_per_pool`	The minimum number of samples that a pool needs to contain in order to be processed - relevant only if `per_pool_test = TRUE`
`flag_logic`	A character vector of logic operators to obtain a global flag formula - only relevant if the key is longer than one. All operators must be chosen between: AND, OR, XOR, NAND, NOR, XNOR

keep_calc_cols	Keep the calculation columns in the output data frame?
report_path	The path where the report file should be saved. Can be a folder, a file or NULL if no report should be produced. Defaults to {user_home}/ISAnalytics_reports.

Details

This particular test calculates for each column in the key

- The zscore of the values
- The tstudent of the values
- The the distribution of the tstudent values

Optionally the test can be performed for each pool and a normality test can be run prior the actual calculations. Samples are flagged if this condition is respected:

- tdist < outlier_p_value_threshold & zscore < 0

If the key contains more than one column an additional flag logic can be specified for combining the results. Example: let's suppose the key contains the names of two columns, X and Y key = c("X","Y") if we specify the the argument flag_logic = "AND" then the reads will be flagged based on this global condition: (tdist_X < outlier_p_value_threshold & zscore_X < 0) AND (tdist_Y < outlier_p_value_threshold & zscore_Y < 0)

The user can specify one or more logical operators that will be applied in sequence.

Value

A data frame of metadata with the column to_remove

See Also

Other Outlier tests: available_outlier_tests()

Examples

```
data("association_file", package = "ISAnalytics")
flagged <- outliers_by_pool_fragments(association_file,
    report_path = NULL
)
head(flagged)
```

`outlier_filter` *Filter out outliers in metadata, identified by the chosen outlier test.*

Description

[Experimental] Filter out outliers in metadata.

Usage

```
outlier_filter(
  metadata,
  outlier_test = "outliers_by_pool_fragments",
  negate = FALSE,
  ...
)
```

Arguments

`metadata`	The metadata data frame
`outlier_test`	A string representing a function name. The name must be one of the available outlier tests, see available_outlier_tests.
`negate`	If TRUE will return only the metadata that was flagged to be removed. If FALSE will return only the metadata that wasn't flagged to be removed.
`...`	Additional named arguments passed to `outliers_test`

Value

A data frame of metadata which has less or the same amount of rows

Examples

```
data("association_file", package = "ISAnalytics")
filtered_af <- outlier_filter(association_file,
    key = "BARCODE_MUX",
    report_path = NULL
)
head(filtered_af)
```

proto_oncogenes *Data frames for proto-oncogenes (human and mouse) amd tumor-suppressor genes from UniProt.*

Description

The file is simply a result of a research with the keywords "proto-oncogenes" and "tumor suppressor" for the target genomes on UniProt database.

Usage

```
data("proto_oncogenes")

data("tumor_suppressors")
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 569 rows and 13 columns.

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 523 rows and 13 columns.

Functions

- `tumor_suppressors`: Data frame for tumor suppressor genes

purity_filter *Filter integration sites based on purity.*

Description

[Experimental] Filter that targets possible contamination between cell lines based on a numeric quantification (likely abundance or sequence count).

Usage

```
purity_filter(
  x,
  lineages = blood_lineages_default(),
  aggregation_key = c("SubjectID", "CellMarker", "Tissue", "TimePoint"),
  group_key = c("CellMarker", "Tissue"),
  selected_groups = NULL,
  join_on = "CellMarker",
  min_value = 3,
  impurity_threshold = 10,
  by_timepoint = TRUE,
  timepoint_column = "TimePoint",
  value_column = "seqCount_sum"
)
```

Arguments

x	An aggregated integration matrix, obtained via aggregate_values_by_key()
lineages	A data frame containing cell lineages information
aggregation_key	The key used for aggregating x
group_key	A character vector of column names for re-aggregation. Column names must be either in x or in lineages. See details.
selected_groups	Either NULL, a character vector or a data frame for group selection. See details.
join_on	Common columns to perform a join operation on
min_value	A minimum value to filter the input matrix. Integrations with a value strictly lower than min_value are excluded (dropped) from the output.
impurity_threshold	The ratio threshold for impurity in groups
by_timepoint	Should filtering be applied on each time point? If FALSE, all time points are merged together
timepoint_column	Column in x containing the time point
value_column	Column in x containing the numeric quantification of interest

Details

Setting input arguments:

The input matrix can be re-aggregated with the provided group_key argument. This key contains the names of the columns to group on (besides the columns holding genomic coordinates of the integration sites) and must be contained in at least one of x or lineages data frames. If the key is not found only in x, then a join operation with the lineages data frame is performed on the common column(s) join_on.

Group selection:

It is possible for the user to specify on which groups the logic of the filter should be applied to. For example: if we have group_key = c("HematoLineage") and we set selected_groups = c("CD34","Myeloid","Lymphoid") it means that a single integration will be evaluated for the filter only for groups that have the values of "CD34", "Myeloid" and "Lymphoid" in the "HematoLineage" column. If the same integration is present in other groups it is kept as it is. selected_groups can be set to NULL if we want the logic to apply to every group present in the data frame, it can be set as a simple character vector as the example above if the group key has length 1 (and there is no need to filter on time point). If the group key is longer than 1 then the filter is applied only on the first element of the key.

If a more refined selection on groups is needed, a data frame can be provided instead:

```
group_key = c("CellMarker", "Tissue")
selected_groups = tibble::tribble(
~ CellMarker, ~ Tissue,
"CD34", "BM",
"CD14", "BM",
```

```
"CD14", "PB"
)
```

Columns in the data frame should be the same as group key (plus, eventually, the time point column). In this example only those groups identified by the rows in the provided data frame are processed.

Value

A data frame

See Also

Other Analysis functions: `CIS_grubbs()`, `comparison_matrix()`, `compute_abundance()`, `cumulative_count_union()`, `cumulative_is()`, `is_sharing()`, `iss_source()`, `sample_statistics()`, `separate_quant_matrices()`, `threshold_filter()`, `top_integrations()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
filtered_by_purity <- purity_filter(
    x = aggreg,
    value_column = "seqCount_sum"
)
head(filtered_by_purity)
```

---

quantification_types *Possible choices for the* quantification_type *parameter.*

Description

These are all the possible values for the `quantification_type` parameter in `import_parallel_vispa2Matrices_interac` and `import_parallel_vispa2Matrices_auto`.

Usage

```
quantification_types()
```

Details

The possible values are:

- fragmentEstimate
- seqCount
- barcodeCount
- cellCount
- ShsCount

Value

A vector of characters for quantification types

See Also

import_parallel_Vispa2Matrices_interactive, import_parallel_Vispa2Matrices_auto

Other Import functions helpers: matching_options()

Examples

```
quant_types <- quantification_types()
```

---

realign_after_collisions

Re-aligns matrices of other quantification types based on the processed sequence count matrix.

Description

[Stable] This function should be used to keep data consistent among the same analysis: if for some reason you removed the collisions by passing only the sequence count matrix to remove_collisions(), you should call this function afterwards, providing a list of other quantification matrices. NOTE: if you provided a list of several quantification types to remove_collisions() before, there is no need to call this function.

Usage

```
realign_after_collisions(sc_matrix, other_matrices)
```

Arguments

sc_matrix	The sequence count matrix already processed for collisions via remove_collisions()
other_matrices	A named list of matrices to re-align. Names in the list must be quantification types (quantification_types()) except "seqCount".

Details

For more details on how to use collision removal functionality: `vignette("collision_removal",package = "ISAnalytics")`

Value

A named list with re-aligned matrices

See Also

`remove_collisions`

Other Collision removal: `remove_collisions()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
separated <- separate_quant_matrices(
    integration_matrices
)
no_coll <- remove_collisions(
    x = separated$seqCount,
    association_file = association_file,
    quant_cols = c(seqCount = "Value"),
    report_path = NULL
)
realigned <- realign_after_collisions(
    sc_matrix = no_coll,
    other_matrices = list(fragmentEstimate = separated$fragmentEstimate)
)
realigned
```

---

reduced_AF_columns *Names of the columns of the association file to consider for Vispa2 launch.*

Description

Selection of column names from the association file to be considered for Vispa2 launch. NOTE: the `TagID` column appears only once but needs to be repeated twice for generating the launch file. Use the appropriate function to generate the file automatically.

Usage

```
reduced_AF_columns()
```

Value

A character vector

Examples

```
reduced_AF_columns()
```

---

refGenes_hg19 *Gene annotation files for hg19, mm9 and mm10.*

Description

This file was obtained following this steps:

1. Download from http://hgdownload.soe.ucsc.edu/goldenPath/hg19/database/ the refGene.sql, knownGene.sql, knownToRefSeq.sql, kgXref.sql tables
2. Import everything it in mysql
3. Generate views for annotation:

```
SELECT kg.`chrom`, min(kg.cdsStart) as CDS_minStart,
max(kg.`cdsEnd`) as CDS_maxEnd, k2a.geneSymbol,
kg.`strand` as GeneStrand, min(kg.txStart) as TSS_minStart,
max(kg.txEnd) as TSS_maxStart,
kg.proteinID as ProteinID, k2a.protAcc as ProteinAcc, k2a.spDisplayID
FROM `knownGene` AS kg JOIN kgXref AS k2a
ON BINARY kg.name = k2a.kgID COLLATE latin1_bin
-- latin1_swedish_ci
-- WHERE k2a.spDisplayID IS NOT NULL and (k2a.`geneSymbol` LIKE 'Tcra%' or
k2a.`geneSymbol` LIKE 'TCRA%')
WHERE (k2a.spDisplayID IS NOT NULL or k2a.spDisplayID NOT LIKE '')
and k2a.`geneSymbol` LIKE 'Tcra%'
group by kg.`chrom`, k2a.geneSymbol
ORDER BY kg.chrom ASC , kg.txStart ASC
```

Usage

```
data("refGenes_hg19")

data("refGenes_mm9")
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 27275 rows and 12 columns.

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 24487 rows and 12 columns.

Functions

- `refGenes_mm9`: Data frame for murine mm9 genome

refGene_table_cols *Required columns for refGene file.*

Description

Required columns for refGene file.

Usage

```
refGene_table_cols()
```

Value

Character vector of column names

Examples

```
refGene_table_cols()
```

remove_collisions *Identifies and removes collisions.*

Description

[Stable] A collision is an integration (aka a unique combination of `chr`, `integration_locus` and `strand`) which is observed in more than one independent sample (a unique pair of `ProjectID` and `SubjectID`). The function tries to decide to which subject an integration should be assigned to and, if no decision can be taken, the integration is completely removed from the data frame. For more details refer to the vignette "Collision removal functionality": `vignette("collision_removal",package = "ISAnalytics")`

Usage

```
remove_collisions(
  x,
  association_file,
  date_col = "SequencingDate",
  reads_ratio = 10,
  quant_cols = c(seqCount = "seqCount", fragmentEstimate = "fragmentEstimate"),
  report_path = default_report_path()
)
```

Arguments

x	Either a multi-quantification matrix or a named list of matrices (names must be quantification types)
association_file	The association file imported via import_association_file()
date_col	The date column that should be considered. Must be one value in date_columns_coll()
reads_ratio	A single numeric value that represents the ratio that has to be considered when deciding between seqCount value.
quant_cols	A named character vector where names are quantification types and values are the names of the corresponding columns. The quantification seqCount MUST be included in the vector.
report_path	The path where the report file should be saved. Can be a folder, a file or NULL if no report should be produced. Defaults to {user_home}/ISAnalytics_reports.

Value

Either a multi-quantification matrix or a list of data frames

See Also

date_columns_coll

Other Collision removal: realign_after_collisions()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
no_coll <- remove_collisions(
    x = integration_matrices,
    association_file = association_file,
    report_path = NULL
)
head(no_coll)
```

---

sample_statistics *Computes user specified functions on numerical columns and updates the metadata data frame accordingly.*

Description

[Experimental] The function operates on a data frame by grouping the content by the sample key and computing every function specified on every column in the value_columns parameter. After that the metadata data frame is updated by including the computed results as columns for the corresponding key. For this reason it's required that both x and metadata have the same sample key, and it's particularly important if the user is working with previously aggregated data. For example:

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
 x = integration_matrices,
 association_file = association_file,
 value_cols = c("seqCount", "fragmentEstimate")
)
aggreg_meta <- aggregate_metadata(association_file = association_file)

sample_stats <- sample_statistics(x = aggreg,
metadata = aggreg_meta,
value_columns = c("seqCount", "fragmentEstimate"),
sample_key = c("SubjectID", "CellMarker","Tissue", "TimePoint"))
```

Usage

```
sample_statistics(
  x,
  metadata,
  sample_key = "CompleteAmplificationID",
  value_columns = "Value",
  functions = default_stats(),
  add_integrations_count = TRUE
)
```

Arguments

x	A data frame
metadata	The metadata data frame
sample_key	Character vector representing the key for identifying a sample
value_columns	The name of the columns to be computed, must be numeric or integer
functions	A named list of function or purrr-style lambdas
add_integrations_count	Add the count of distinct integration sites for each group? Can be computed only if x contains the mandatory columns chr, integration_locus, strand

Value

A list with modified x and metadata data frames

See Also

Other Analysis functions: CIS_grubbs(), comparison_matrix(), compute_abundance(), cumulative_count_union(), cumulative_is(), is_sharing(), iss_source(), purity_filter(), separate_quant_matrices(), threshold_filter(), top_integrations()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
stats <- sample_statistics(
    x = integration_matrices,
    metadata = association_file,
    value_columns = c("seqCount", "fragmentEstimate")
)
stats
```

`separate_quant_matrices` *Separate a multiple-quantification matrix into single quantification matrices.*

Description

[Stable] The function separates a single multi-quantification integration matrix, obtained via comparison_matrix, into single quantification matrices as a named list of tibbles.

Usage

```
separate_quant_matrices(
  x,
  fragmentEstimate = "fragmentEstimate",
  seqCount = "seqCount",
  barcodeCount = "barcodeCount",
  cellCount = "cellCount",
  ShsCount = "ShsCount",
  key = c(mandatory_IS_vars(), annotation_IS_vars(), "CompleteAmplificationID")
)
```

Arguments

`x`	Single integration matrix with multiple quantification value columns, likely obtained via comparison_matrix.
`fragmentEstimate`	Name of the fragment estimate values column in input
`seqCount`	Name of the sequence count values column in input
`barcodeCount`	Name of the barcode count values column in input
`cellCount`	Name of the cell count values column in input
`ShsCount`	Name of the shs count values column in input
`key`	Key columns to perform the joining operation

Value

A named list of tibbles, where names are quantification types

See Also

quantification_types

Other Analysis functions: CIS_grubbs(), comparison_matrix(), compute_abundance(), cumulative_count_union(), cumulative_is(), is_sharing(), iss_source(), purity_filter(), sample_statistics(), threshold_filter(), top_integrations()

Examples

```
data("integration_matrices", package = "ISAnalytics")
separated <- separate_quant_matrices(
    integration_matrices
)
separated
```

---

sharing_heatmap *Plot IS sharing heatmaps.*

Description

[Experimental] Displays the IS sharing calculated via is_sharing as heatmaps.

Usage

```
sharing_heatmap(
  sharing_df,
  show_on_x = "g1",
  show_on_y = "g2",
  absolute_sharing_col = "shared",
  title_annot = NULL,
  plot_relative_sharing = TRUE,
  rel_sharing_col = c("on_g1", "on_union"),
  show_perc_symbol_rel = TRUE,
  interactive = FALSE
)
```

Arguments

sharing_df	The data frame containing the IS sharing data
show_on_x	Name of the column to plot on the x axis
show_on_y	Name of the column to plot on the y axis
absolute_sharing_col	Name of the column that contains the absolute values of IS sharing
title_annot	Additional text to display in the title
plot_relative_sharing	Logical. Compute heatmaps also for relative sharing?

`rel_sharing_col`
: Names of the columns to consider as relative sharing. The function is going to plot one heatmap per column in this argument.

`show_perc_symbol_rel`
: Logical. Only relevant if `plot_relative_sharing` is set to TRUE, should the percentage symbol be displayed in relative heatmaps?

`interactive`
: Logical. Requires the package plotly is required for this functionality. Returns the heatmaps as interactive HTML widgets.

Value

A list of plots or widgets

See Also

is_sharing

Other Plotting functions: `CIS_volcano_plot()`, `HSC_population_plot()`, `circos_genomic_density()`, `integration_alluvial_plot()`, `sharing_venn()`, `top_abund_tableGrob()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
sharing <- is_sharing(aggreg,
    minimal = FALSE,
    include_self_comp = TRUE
)
sharing_heatmaps <- sharing_heatmap(sharing_df = sharing)
sharing_heatmaps$absolute
sharing_heatmaps$on_g1
sharing_heatmaps$on_union
```

---

sharing_venn *Produce tables to plot sharing venn or euler diagrams.*

Description

[Experimental] This function processes a sharing data frame obtained via `is_sharing()` with the option `table_for_venn = TRUE` to obtain a list of objects that can be plotted as venn or euler diagrams.

Usage

```
sharing_venn(sharing_df, row_range = NULL, euler = TRUE)
```

Arguments

sharing_df	The sharing data frame
row_range	Either NULL or a numeric vector of row indexes (e.g. c(1,4,5) will produce tables only for rows 1, 4 and 5)
euler	If TRUE will produce tables for euler diagrams, otherwise will produce tables for venn diagrams

Details

The functions requires the package eulerr. Each row of the input data frame is representable as a venn/euler diagram. The function allows to specify a range of row indexes to obtain a list of plottable objects all at once, leave it to NULL to process all rows.

To actually plot the data it is sufficient to call the function `plot()` and specify optional customization arguments. See eulerr docs for more detail on this.

Value

A list of data frames

See Also

Other Plotting functions: `CIS_volcano_plot()`, `HSC_population_plot()`, `circos_genomic_density()`, `integration_alluvial_plot()`, `sharing_heatmap()`, `top_abund_tableGrob()`

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
sharing <- is_sharing(aggreg, n_comp = 3, table_for_venn = TRUE)
venn_tbls <- sharing_venn(sharing, row_range = 1:3, euler = FALSE)
venn_tbls
plot(venn_tbls[[1]])
```

---

threshold_filter *Filter data frames with custom predicates*

Description

[Experimental] Filter a single data frame or a list of data frames with custom predicates assembled from the function parameters.

Usage

```
threshold_filter(x, threshold, cols_to_compare = "Value", comparators = ">")
```

Arguments

`x`	A data frame or a list of data frames
`threshold`	A numeric/integer vector or a named list of numeric/integer vectors
`cols_to_compare`	A character vector or a named list of character vectors
`comparators`	A character vector or a named list of character vectors. Must be one of the allowed values between `c("<",">","==","!=",">=","<=")`

Details

A single data frame as input:

If the user chooses to operate on a single data frame, the other parameters should only be vectors: numeric vector for `threshold` and character vectors for both `cols_to_compare` and `comparators`. A filtering condition is obtained by combining element by element `cols_to_compare` + `comparators` + `threshold` (similarly to the `paste` function). For example:
threshold = c(20, 35, 50)
cols_to_compare = c("a", "b", "c")
comparators = "<"
given these vectors, the input data frame will be filtered by checking which values in column "a" are less than 20 **AND** which values in column "b" are less than 35 **AND** which values in column "c" are less than 50. Things the user should keep in mind are:

- The vectors of length 1 are going to be recycled if one or more parameters are longer (in the example, the `comparators` value)
- If vectors are not of length 1 they must have the same length
- Columns to compare, of course, need to be included in the input data frame and need to be numeric/integer
- The filtering will perform a logical "AND" on all the conditions, only rows that satisfy ALL the conditions are preserved

A list of data frames as input:

The input for the function may also be a list of data frames, either named or unnamed.

Unnamed list:
If the input is a simple unnamed list, the other parameters should be simple vectors (as for data frames). All the predicates will simply be applied to every data frame in the list: this is useful if it's desirable to filter for the same conditions different data frames that have the same structure but different data.

Named list:
It is also possible to filter different data frames with different sets of conditions. Besides having the possibility of defining the other parameters as simple vector, which has the same results as operating on an unnamed list, the user can define the parameters as named lists containing vectors. For example:

```
example_df <- tibble::tibble(a = c(20, 30, 40),
                             b = c(40, 50, 60),
                             c = c("a", "b", "c"),
                             d = c(3L, 4L, 5L))
example_list <- list(first = example_df,
                     second = example_df,
                     third = example_df)
print(example_list)
```

```
## $first
## # A tibble: 3 × 4
##       a     b c         d
##   <dbl> <dbl> <chr> <int>
## 1    20    40 a         3
## 2    30    50 b         4
## 3    40    60 c         5
##
## $second
## # A tibble: 3 × 4
##       a     b c         d
##   <dbl> <dbl> <chr> <int>
## 1    20    40 a         3
## 2    30    50 b         4
## 3    40    60 c         5
##
## $third
## # A tibble: 3 × 4
##       a     b c         d
##   <dbl> <dbl> <chr> <int>
## 1    20    40 a         3
## 2    30    50 b         4
## 3    40    60 c         5
```

```
filtered <- threshold_filter(example_list,
threshold = list(first = c(20, 60),
third = c(25)),
cols_to_compare = list(first = c("a", "b"),
third = c("a")),
comparators = list(first = c(">", "<"),
third = c(">=")))
print(filtered)
```

```
## $first
## # A tibble: 1 × 4
##       a     b c         d
##   <dbl> <dbl> <chr> <int>
## 1    30    50 b         4
##
## $second
## # A tibble: 3 × 4
##       a     b c         d
```

```
##   <dbl> <dbl> <chr> <int>
## 1    20    40 a         3
## 2    30    50 b         4
## 3    40    60 c         5
##
## $third
## # A tibble: 2 × 4
##       a     b c         d
##   <dbl> <dbl> <chr> <int>
## 1    30    50 b         4
## 2    40    60 c         5
```

The above signature will roughly be translated as:

- Filter the element "first" in the list by checking that values in column "a" are bigger than 20 AND values in column "b" are less than 60
- Don't apply any filter to the element "second" (returns the data frame as is)
- Filter the element "third" by checking that values in column "a" are equal or bigger than 25.

It is also possible to use some parameters as vectors and some as lists: vectors will be recycled for every element filtered.

```
filtered <- threshold_filter(example_list,
threshold = list(first = c(20, 60),
third = c(25, 65)),
cols_to_compare = c("a", "b"),
comparators = list(first = c(">", "<"),
third = c(">=", "<=")))
```

In this example, different threshold and comparators will be applied to the same columns in all data frames.

Things the user should keep in mind are:

- Names for the list parameters must be the same names in the input list
- Only elements explicited in list parameters as names will be filtered
- Lengths of both vectors and lists must be consistent

Value

A data frame or a list of data frames

See Also

Other Analysis functions: `CIS_grubbs()`, `comparison_matrix()`, `compute_abundance()`, `cumulative_count_union()`, `cumulative_is()`, `is_sharing()`, `iss_source()`, `purity_filter()`, `sample_statistics()`, `separate_quant_matrices()`, `top_integrations()`

Examples

```
example_df <- tibble::tibble(
    a = c(20, 30, 40),
    b = c(40, 50, 60),
    c = c("a", "b", "c"),
    d = c(3L, 4L, 5L)
```

```
)
example_list <- list(
    first = example_df,
    second = example_df,
    third = example_df
)

filtered <- threshold_filter(example_list,
    threshold = list(
        first = c(20, 60),
        third = c(25)
    ),
    cols_to_compare = list(
        first = c("a", "b"),
        third = c("a")
    ),
    comparators = list(
        first = c(">", "<"),
        third = c(">=")
    )
)
filtered
```

`top_abund_tableGrob` *Summary top abundant tableGrobs for plots.*

Description

Produce summary tableGrobs as R graphics. For this functionality the suggested package gridExtra is required. To visualize the resulting object:

```
gridExtra::grid.arrange(tableGrob)
```

Usage

```
top_abund_tableGrob(
  df,
  id_cols = mandatory_IS_vars(),
  quant_col = "fragmentEstimate_sum_PercAbundance",
  by = "TimePoint",
  alluvial_plot = NULL,
  top_n = 10,
  tbl_cols = "GeneName",
  include_id_cols = FALSE,
  digits = 2,
  perc_symbol = TRUE
)
```

Arguments

df	A data frame
id_cols	Character vector of id column names. To plot after alluvial, these columns must be the same as the alluvia argument of integration_alluvial_plot.
quant_col	Column name holding the quantification value. To plot after alluvial, these columns must be the same as the plot_y argument of integration_alluvial_plot.
by	The column name to subdivide tables for. The function will produce one table for each distinct value in by. To plot after alluvial, these columns must be the same as the plot_x argument of integration_alluvial_plot.
alluvial_plot	Either NULL or an alluvial plot for color mapping between values of y.
top_n	Integer. How many rows should the table contain at most?
tbl_cols	Table columns to show in the final output besides quant_col.
include_id_cols	Logical. Include id_cols in the output?
digits	Integer. Digits to show for the quantification column
perc_symbol	Logical. Show percentage symbol in the quantification column?

Value

A tableGrob object

See Also

Other Plotting functions: CIS_volcano_plot(), HSC_population_plot(), circos_genomic_density(), integration_alluvial_plot(), sharing_heatmap(), sharing_venn()

Examples

```
data("integration_matrices", package = "ISAnalytics")
data("association_file", package = "ISAnalytics")
aggreg <- aggregate_values_by_key(
    x = integration_matrices,
    association_file = association_file,
    value_cols = c("seqCount", "fragmentEstimate")
)
abund <- compute_abundance(x = aggreg)
grob <- top_abund_tableGrob(abund)
gridExtra::grid.arrange(grob)
```

top_integrations *Sorts and keeps the top n integration sites based on the values in a given column.*

Description

[Experimental] The input data frame will be sorted by the highest values in the columns specified and the top n rows will be returned as output. The user can choose to keep additional columns in the output by passing a vector of column names or passing 2 "shortcuts":

- `keep = "everything"` keeps all columns in the original data frame
- `keep = "nothing"` only keeps the mandatory columns (`mandatory_IS_vars()`) plus the columns in the `columns` parameter.

Usage

```
top_integrations(
  x,
  n = 20,
  columns = "fragmentEstimate_sum_RelAbundance",
  keep = "everything",
  key = NULL
)
```

Arguments

`x`	An integration matrix (data frame containing `mandatory_IS_vars()`)
`n`	How many integrations should be sliced (in total or for each group)? Must be numeric or integer and greater than 0
`columns`	Columns to use for the sorting. If more than a column is supplied primary ordering is done on the first column, secondary ordering on all other columns
`keep`	Names of the columns to keep besides `mandatory_IS_vars()` and `columns`
`key`	Either `NULL` or a character vector of column names to group by. If not `NULL` the input will be grouped and the top fraction will be extracted from each group.

Value

Either a data frame with at most n rows or a data frames with at most n*(number of groups) rows.

See Also

Other Analysis functions: `CIS_grubbs()`, `comparison_matrix()`, `compute_abundance()`, `cumulative_count_union()`, `cumulative_is()`, `is_sharing()`, `iss_source()`, `purity_filter()`, `sample_statistics()`, `separate_quant_matrices()`, `threshold_filter()`

Examples

```
smpl <- tibble::tibble(
    chr = c("1", "2", "3", "4", "5", "6"),
    integration_locus = c(14536, 14544, 14512, 14236, 14522, 14566),
    strand = c("+", "+", "-", "+", "-", "+"),
    CompleteAmplificationID = c("ID1", "ID2", "ID1", "ID1", "ID3", "ID2"),
    Value = c(3, 10, 40, 2, 15, 150),
    Value2 = c(456, 87, 87, 9, 64, 96),
    Value3 = c("a", "b", "c", "d", "e", "f")
)
top <- top_integrations(smpl,
    n = 3,
    columns = c("Value", "Value2"),
    keep = "nothing"
)
top_key <- top_integrations(smpl,
    n = 3,
    columns = "Value",
    keep = "Value2",
    key = "CompleteAmplificationID"
)
```

---

unzip_file_system *A utility function to unzip and use example file systems included in the package*

Description

This utility function is a simple shortcut to create a temporary directory, unzip and reference the examples file systems included in the package for testing purposes.

Usage

```
unzip_file_system(zipfile, name)
```

Arguments

zipfile	The zipped file to decompress
name	The name of the folder in the zipped archive ("fs" or "fserr")

Value

A path to reference

See Also

Other Utility functions: as_sparse_matrix(), generate_Vispa2_launch_AF(), generate_blank_association_file()

Examples

```
root_pth <- system.file("extdata", "fs.zip", package = "ISAnalytics")
root <- unzip_file_system(root_pth, "fs")
```

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