Package ‘RnBeads’

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Title RnBeads

Description RnBeads facilitates comprehensive analysis of various types of DNA methylation data at the genome scale.

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Collate 'CNV.R' 'Report-class.R' 'Report-methods.R'
    'ReportPlot-class.R' 'ReportPlot-methods.R'
    'RnBDiffMeth-class.R' 'bigFl.R' 'RnBSet-class.R'
    'RnBeadSet-class.R' 'RnBeadRawSet-class.R' 'RnBeads-package.R'
    'RnBiseqSet-class.R' 'agePrediction.R' 'annotations.R'
    'batch.R' 'batch.quality.R' 'bmiq.R' 'cellTypeAdjustment.R'
    'clusterArchitecture.R' 'clusterArchitectureSGE.R'
    'clustering.R' 'combining.R' 'computeCluster.R'
    'controlPlots.R' 'controlPlotsBiSeq.R' 'dataExport.R'
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    'differentialVariability.R' 'enmix.R' 'enrichment.R'
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    'genomewide.R' 'greedycut.R' 'immune.R' 'loading.R' 'logger.R'
    'lolaUtils.R' 'main.R' 'normalization.R' 'options.R'
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'parallelProcessing.R' 'plottingUtils.R' 'profiles.R'
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'wbcInference.R'

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The values of options in RnBeads are stored in dedicated R objects accompanying the package. These objects are named `infos`, `accepted`, `current` and `previous`. They should not be loaded or otherwise operated on by users. Please refer to the documentation of `rnb.options` for accessing and modifying option values in RnBeads.
Format

ijats is a data.frame containing information about all options in RnBeads. Row names in this table are the option names; the column names are "Type", "Named", "Null", "Max", "Min", "MaxInclusive" and "MinInclusive". accepted is a list containing the sets of accepted values for some of the options. current is a list with current values for all options. previous is a list with previous values for the affected options; this list is only temporarily used while setting option values through rnb.options or rnb.xml2options.

Author(s)

Yassen Assenov

Description

Adds a differential methylation table

Usage

## S4 method for signature 'RnBDiffMeth'
addDiffMethTable(object, dmt, comparison, region.type, grp.labs = c("group1", "group2"))

Arguments

object RnBDiffMeth object
dmt Differential methylation table to add
comparison character or index of the comparison of the table to retrieve
region.type character or index of the region type of the table to retrieve
grp.labs character vector of length 2 specifying the names of the groups being compared

Value

the updated RnBDiffMeth object

Note

Caveat: if disk dumping is enabled the resulting object tables will be stored in the initial location of the object.

Author(s)

Fabian Mueller
Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,"Sample_Group",c("genes","tiling"))
s.groups <- rnb.sample.groups(rnb.set.example,"Sample_Group")[[1]]
dmt.sites <- computeDiffTab.extended.site(meth(rnb.set.example),s.groups[[1]],s.groups[[2]])
map.regions.to.sites <- regionMapping(rnb.set.example,"promoters")
dmt.promoters <- computeDiffTab.default.region(dmt.sites,map.regions.to.sites)
cmp.name <- get.comparisons(dm)[1]
grp.labs <- get.comparison.grouplabels(dm)[,1]
#add the promoter level differential methylation table
dm.add <- addDiffMethTable(dm,dmt.promoters,cmp.name,"promoters",grp.labs)
get.region.types(dm.add)
```

addPheno,RnBSet-method

**addPheno**

Description

Adds phenotypic or processing information to the sample annotation table of the given RnBSet object.

Usage

```r
## S4 method for signature 'RnBSet'
addPheno(object, trait, header)
```

Arguments

- **object**: RnBSet of interest.
- **trait**: Trait as a non-empty vector or factor. The length of this vector must be equal to the number of samples in object, the i-th element storing the value for the i-th sample. Note that names, if present, are ignored.
- **header**: Trait name given as a one-element character. This is the heading to be used for the sample annotation table. This method fails if such a trait already exists; in other words, if header %in% names(phenotype(object)).

Value

The modified dataset as an object of type RnBSet.

Author(s)

Fabian Mueller
addRegionSubsegments

Examples

```
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
is.hiPSC <- pheno(rnb.set.example)[, "Sample_Group"] == "hiPSC"
rnb.set.mod <- addPheno(rnb.set.example, is.hiPSC, "is_hiPSC")
pheno(rnb.set.mod)
```

Description

For the region annotation of a given RnBSet object. Subdivide each region into subsegments by hierarchical clustering on the site distances in a particular region and then splitting the region into subregions consisting of these site clusters. The number of clusters is determined in such way that the mean number of sites per cluster is given by the ns parameter.

Usage

```
addRegionSubsegments(rnb.set, annotation.dir, region.types = NULL,
                      add.region.types.to.options = FALSE, ns = 10)
```

Arguments

- **rnb.set**: an RnBSet object
- **annotation.dir**: a directory to save the annotation to for later reloading. (binary RData format.)
- **region.types**: the region types to which subsegmentation should be applied. Must be a non-empty subset of `summarized.regions(rnb.set)`. Defaults (NULL) to all region types in rnb.set
- **add.region.types.to.options**: Flag indicating whether to add the newly created subregions to the package’s `region.types` option
- **ns**: the mean number of sites per cluster.

Value

the modified RnBSet object

Author(s)

Fabian Mueller
Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.set.mod <- addRegionSubsegments(rnb.set.example,tempdir(),region.types=c("tiling","genes"))
summary(meth(rnb.set.mod,type="tiling.subsegments"))

annotation,RnBSet-method

annotation-methods

Description

Genomic annotation of the methylation sites or regions covered in the supplied dataset.

Usage

## S4 method for signature 'RnBSet'
annotation(object, type = "sites", add.names = FALSE,
include.regions = FALSE)

Arguments

doct
dataset as an object of type inheriting RnBSet.
type
loci or regions for which the annotation should be obtained. If the value of this
parameter is "sites" (default), individual methylation sites are annotated. Oth-
nerwise, this must be one of the available region types, as returned by rnb.region.types.
add.names
flag specifying whether the unique site identifiers should be used as row names
of the resulting data frame
include.regions
if TRUE one additional column is added to the returned annotation data frame for
each of the available region types, giving the indices of the

Value

Annotation table in the form of a data.frame.

Author(s)

Pavlo Lutsik

Examples

library(RnBeads.hg19)
data(small.example.object)
## show present sites
head((annotation(rnb.set.example, add.names=TRUE))
## show promoters
ann.prom<-annotation(rnb.set.example, type="promoters", add.names=TRUE)
apply.iEVORA

Description
This routine applies the iEVORA method created by Teschendorff et.al. to the supplied methylation matrix in a similar way as the diffVar method.

Usage
apply.iEVORA(meth.matrix, inds.g1, inds.g2)

Arguments
meth.matrix Matrix containing the methylation information used to calculate differentially variable sites between the two groups
inds.g1 Indices in the phenotypic table corresponding to the first group.
inds.g2 Indices in the phenotypic table corresponding to the second group.

Value
Q-values as the result of applying the iEVORA method and then correct for multiple testing.

Author(s)
Michael Scherer

Conversion to/from RnBeadRawSet

Description
The “as” method can be used for the following conversions:

- MethyLumiSet (in package methylumi) to RnBeadRawSet
- RnBeadRawSet to MethyLumiSet
- RGChannelSet (in package minfi) to RnBeadRawSet
assembly,RnBSet-method

Description

Extracts information about assembly

Usage

```r
## S4 method for signature 'RnBSet'
assembly(object)
```

Arguments

- `object`: Dataset of interest.

Value

Sample annotation information available for the dataset in the form of a `data.frame`.

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
assembly(rnb.set.example) # "hg19"
```

auto.select.rank.cut

Description

Automatically select a rank cutoff for given ranks and p-values. Current implementation: sort the p-values according to rank, select as rank cutoff the rank for which the worst (i.e., max) p-value in the top list is still smaller than the best (i.e., min) p-value of the group of worst-ranking p-values of equal size as the top-list.

Usage

```r
auto.select.rank.cut(p, r, alpha = 0.1)
```

Arguments

- `p`: Vector of p-values
- `r`: Vector of ranks
- `alpha`: The percentile to select the top and bottom part of the list.
Value

the maximum rank fulfilling the criterion

Author(s)

Fabian Mueller

Description

This function makes 3 independent attempts to fit a 3-state beta mixture model on the provided type I probes. An attempt is successful if at least 4 probes are assigned to each level. In case all attempts fail, the return value is NULL.

Usage

BMIQ(beta.v, design.v, doH = TRUE, nfit = 50000, th1.v = c(0.2, 0.75), th2.v = NULL, niter = 5, tol = 0.001)

Arguments

beta.v double vector consisting of beta values. Missing values (NAs) cannot be handled, so these must be removed or imputed prior to running BMIQ. Before normalization, beta values that are exactly 0 and exactly 1 are replaced by the minimum positive and maximum value below 1, respectively.

design.v integer vector of length length(beta.v), containing the values 1 and 2 only. These values specify probe design type.

doH Flag indicating if normalization for hemimethylated type II probes is to be performed.

nfit Number of probes of a given design to use for the fitting. Smaller values will make BMIQ faster at the expense of accuracy. Values between 10000 and 50000 seem to work well.

th1.v Thresholds "type 1" to use for the initialization of the EM algorithm. These values should represent best guesses for calling type I probes hemi-methylated and methylated, and are refined in further steps by the algorithm.

th2.v Thresholds "type 2" to use for the initialization of the EM algorithm. These values should represent best guesses for calling type II probes hemi-methylated and methylated, and are refined in further steps by the EM algorithm. If this is NULL (default), the thresholds are estimated based on th1.v and a modified PBC correction method.

niter Maximum number of EM iterations to be performed.

tol Tolerance threshold for EM algorithm.

Details

Performs Beta-mixture quantile normalization, adjusting for type II bias in Infinium 450K data.
Value

List with the following elements:

"all" The normalised beta-profile for the sample.
"class1" Methylation state assigned to the type I probes.
"class2" Methylation state assigned to the type II probes.
"av1" Mean beta values for the nL classes for type I probes.
"av2" Mean beta values for the nL classes for type II probes.
"hf" Hubble dilation factor.
"th1" Estimated thresholds used for type I probes.
"th2" Estimated thresholds used for type II probes.

Author(s)

Andrew Teschendorff and Steve Horvath; with minor modifications by Yassen Assenov

ClusterArchitecture-class

ClusterArchitecture Class

Description

A virtual class for storing specifications of architectures for different compute clusters. It is designed to let other classes inherit from it

Details

For a concrete child class for a sun grid architecture specification see ClusterArchitectureSGE If you want to implement your own child class be sure to at least implement the following functions: getSubCmdTokens,ClusterArchitecture-method.

Slots

name A name or identifier
executables A NAMED character vector of executables that can be used by the cluster. For instance, the R executable is important
getSubCmdTokens.optional.args character vector containing the valid optional arguments to the getSubCmdTokens,ClusterArchitecture-method function.

Methods

getSubCmdTokens,ClusterArchitecture-method Returns a vector of command line tokens corresponding to submitting a job with the given command to the cluster
getSubCmdStr,ClusterArchitecture-method Returns a string for the of command line corresponding to submitting a job with the given command to the cluster
setExecutable,ClusterArchitecture,character,character-method Tells the cluster architecture about an executable that can be submitted as job
getExecutable,ClusterArchitecture,character-method Gets the location of an executable associated with a name
ClusterArchitectureSGE-class

*ClusterArchitectureSGE Class*

**Description**

A child class of *ClusterArchitecture* implementing specifications of Sun Grid Engine (SGE) architectures.

**Details**

Follow this template if you want to create your own ClusterArchitecture class.

**Slots**

see *ClusterArchitecture*

**Methods**

getSubCmdTokens,ClusterArchitectureSGE-method Returns a vector of command line tokens corresponding to submitting a job with the given command to the cluster

**Author(s)**

Fabian Mueller

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**coercion-methods**

*as("RnBeadSet", "MethyLumiSet")*

**Description**

Convert a *RnBeadSet* object to *MethyLumiSet*

Convert a *RnBeadSet* object to a "mock" *RnBiseqSet* object (used in the combine method)
cols.to.rank.site
cols.to.rank.site
cols.to.rank.site
cols.to.rank.site

description

Return a matrix containing the negative absolute values of the information used to rank the sites. Those are currently: the variance difference, the log ratio in variances and the p-value from the statistical test.

Usage

cols.to.rank.site(diff.var)
cols.to.rank.region(diff.var)

Arguments

diff.var A differential variability table.

Value

A matrix with the absolute values of the relevant columns

Author(s)

Michael Scherer

combine,RnBSet,RnBSet-method
combine-methods

description

Combine two objects inheriting from RnBSet class

Usage

## S4 method for signature 'RnBSet,RnBSet'
combine(x, y, type = "all")

Arguments

x, y RnBeadSet, RnBeadRawSet or RnBiseqSet object
type character singleton defining the set operation applied to the two site sets, one of "all", "all.x", "all.y" or "common"

Details

The sample sets of x and y should be unique. Sample annotation information is merged only for columns which have identical names in both objects. CpG sites of the new object are a union of those present in both objects.
Value

combined `RnBeadSet`, `RnBeadRawSet` or `RnBiseqSet` object

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
r1 <- rnb.set.example
r1 <- remove.samples(r1,samples(rnb.set.example)[1:5])
i <- which(r1@sites[,2] == 15 | r1@sites[,2] == 21)
sites.rem.r1 <- union(sample(1:nrow(meth(rnb.set.example)),500),i)
r1 <- remove.sites(r1@sites, sites.rem.r1)
r2 <- rnb.set.example
r2 <- remove.samples(r2,samples(rnb.set.example)[6:12])
sites.rem.r2 <- sample(1:nrow(meth(rnb.set.example)),800)
r2 <- remove.sites(r2@sites, sites.rem.r2)
rc <- combine(r1,r2)
#assertion: check the number of sites
sites.rem.c <- intersect(sites.rem.r1, sites.rem.r2)
(nrow(meth(rnb.set.example))-length(sites.rem.c)) == nrow(meth(rc))
```

Description

combine differential methylation objects (output from `rnb.run.differential`). To be more precise, the `diffmeth` and `dm.go.enrich` are merged. Individual objects that are merged are assumed to belong to the same analysis and vary only in their indexing of region types and comparisons.

Usage

`combine.diffMeth.objs(obj.list)`

Arguments

- `obj.list`: a list containing outputs from `rnb.run.differential`

Author(s)

Fabian Mueller
Description


Usage

combineTestPvalsMeth(pvalues, testWeights = NULL, correlated = FALSE, methExpectedTestCorrelation = 0.8)

Arguments

pvalues p-values to combine
testWeights weights for the individual tests
correlated are the individual tests correlated
methExpectedTestCorrelation expected correlation. Empirically approximated to the default value of 0.8 for DNA-methylation

Value

the combined p-value

Author(s)

Fabian Mueller, Christoph Bock

Examples

p.vals <- 10^-c(0,1,5)
combineTestPvalsMeth(p.vals)

computeDiffTab.default.region

computes a difference table containing multiple difference measures. In the simple version the mean of the difference in means, the mean quotient in means and a combination of p-values on the site level are computed. This is computed for each row of the input table. The extended version contains additional columns.
computeDiffTab.default.region

Usage

computeDiffTab.default.region(dmtp, regions2sites, includeCovg = FALSE)

Arguments

dmtp differential methylation table on the site level (as obtained from computeDiffTab.default.site)
regions2sites a list containing for each region the indices of the corresponding sites in the site differential methylation table
includeCovg flag indicating whether to include coverage information

Value

da dataframe containing the following variables for a given genomic region:

- mean.mean.g1, mean.mean.g2
  mean of mean methylation levels for group 1 and 2 across all sites in a region

- mean.mean.diff
  Mean difference in means across all sites in a region

- mean.mean.quot.log2
  Mean quotient in means across all sites in a region

- comb.p.val
  Combined p-value using a generalization of Fisher's method. See combineTestPvalsMeth for details.

- comb.p.adj.fdr
  FDR adjusted combined p-value

- num.sites
  number of sites that were considered for a region

- mean.num.na.g1/2
  mean number (across all considered sites) of samples that contained an NA for group 1 and 2 respectively

- mean.mean.covg.g1/2
  Mean value of mean coverage values (across all samples in a group) across all sites in a region

- mean.nsamples.covg.thresh.g1/2
  mean number (across all considered sites) of samples that have a coverage larger than the specified threshold (see computeDiffTab.default.site for details) for group 1 and 2 respectively

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
sample.groups <- rnb.sample.groups(rnb.set.example)[[1]]
dm.sites <- computeDiffTab.extended.site(meth.mat,sample.groups[[1]],sample.groups[[2]])
map.regions.to.sites <- regionMapping(rnb.set.example,"promoters")
dm.promoters <- computeDiffTab.default.region(dm.sites,map.regions.to.sites)
**computeDiffTab.default.site**

**Description**

computes a difference table containing multiple difference measures. In the simple version the difference in means, quotients in means and a p-value for the comparison of two groups in a table are computed. This is computed for each row of the input table. The extended version contains additional columns.

**Usage**

```r
computeDiffTab.default.site(X, inds.g1, inds.g2,
   diff.method = rnb.getOption("differential.site.test.method"),
   variability.method = rnb.getOption("differential.variability.method"),
   paired = FALSE, adjustment.table = NULL, eps = 0.01, imputed = FALSE)
```

```r
computeDiffTab.extended.site(X, inds.g1, inds.g2,
   diff.method = rnb.getOption("differential.site.test.method"),
   variability.method = rnb.getOption("differential.variability.method"),
   paired = FALSE, adjustment.table = NULL, eps = 0.01, covg = NULL,
   covg.thres = rnb.getOption("filtering.coverage.threshold"),
   imputed = FALSE)
```

**Arguments**

- **X**  
  Matrix on which the difference measures are calculated for every row

- **inds.g1**  
  Column indices of group 1 members

- **inds.g2**  
  Column indices of group 2 members

- **diff.method**  
  Method to determine p-values for differential methylation. Currently supported are "ttest" for a two-sided Welch t-test, "refFreeEWAS" for adjusting for cell mixtures, and "limma" for p-values resulting from linear modeling of the transformed beta values (M-values) and using techniques from expression microarray analysis employed in the limma package.

- **variability.method**  
  Method to determine p-values for differential variability. Currently supported are "diffVar" for the diffVar method implemented in the missMethyl bioconductor package, and "iEVORA".

- **paired**  
  Should a paired analysis be performed. If TRUE then inds.g1 and inds.g2 should have exactly the same length and should be order, such that the first element of inds.g1 corresponds to the first element of inds.g2 and so on.

- **adjustment.table**  
  A table of variables to be adjusted for in the differential methylation test. Currently this is only supported for diff.method="limma"

- **eps**  
  Epsilon for computing quotients (avoid division by 0 by adding this value to denominator and enumerator before calculating the quotient)

- **imputed**  
  Flag indicating if methylation matrix was already imputed
covg coverage information (should be NULL for disabled or of equal dimensions as \( X \))
covg.thres a coverage threshold

Value

a dataframe containing the following variables:

mean.g1 Mean of group 1
mean.g2 Mean of group 2
mean.diff Difference in means
mean.quot.log2 log2 of the quotient of means
diffmeth.p.val P-value (as determined by diff.method)
max.g1/max.g2 [extended version only] Group maxima
min.g1/min.g2 [extended version only] Group minima
sd.g1/sd.g2 [extended version only] Group standard deviations
min.diff [extended version only] Minimum of 0 and single linkage difference between the groups
diffmeth.p.adj.fdr [extended version only] FDR adjusted p-values
num.na.g1/num.na.g2 [extended version only] number of NA methylation values for groups 1 and 2 respectively
mean.covg.g1/mean.covg.g2 [extended version with coverage information only] mean coverage of groups 1 and 2 respectively
min.covg.g1/min.covg.g2 [extended version with coverage information only] minimum coverage of groups 1 and 2 respectively
max.covg.g1/max.covg.g2 [extended version with coverage information only] maximum coverage of groups 1 and 2 respectively
covg.thresh.nsamples.g1/2 [extended version with coverage information only] number of samples in group 1 and 2 respectively exceeding the coverage threshold for this site.

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
sample.groups <- rnb.sample.groups(rnb.set.example)[[1]]
dm <- computeDiffTab.extended.site(meth.mat,sample.groups[[1]],sample.groups[[2]])
summary(dm)
```
Description

Extract coverage information from an object of RnBSet class.

Usage

## S4 method for signature 'RnBSet'
covg(object, type = "sites", row.names = FALSE,
i = NULL, j = NULL)

Arguments

- **object**: Dataset of interest.
- **type**: character singleton. If sites DNA methylation information per each available site is returned. Otherwise should be one of region types for for which the summarized coverage information is available.
- **row.names**: Flag indicating of row names are to be generated in the result.
- **i**: indices of sites/regions to be retrieved. By default (NULL), all will be retrieved.
- **j**: indices of samples to be retrieved. By default (NULL), all will be retrieved.

Value

coverage information available for the dataset in the form of a matrix.

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
## per-site beta-value matrix
cvg<-covg(rnb.set.example, row.names=TRUE)
head(cvg)
```

create.densityScatter

Description

Creates a density scatterplot highlighting points in sparsely populated plot regions as well as points marked as special in a separate color

Usage

```r
create.densityScatter(df2p, is.special = NULL, dens.subsample = FALSE,
dens.special = TRUE, sparse.points = 0.01, dens.n = 100,
add.text.cor = FALSE)
```
Arguments

df2p  
data.frame to be plotted. Only the first two columns are taken into account as x and y coordinates respectively
is.special  
boolean vector of length equal to the number of rows in df2p. Specifies which points should be highlighted separately in a different color
dens.subsample  
if the number of points exceeds this number, subsample the number of points for the density estimation to that number. Any non-numeric value disables subsampling.
dens.special  
Flag indicating whether the points of the special population should be colored according to their density
sparse.points  
Either percentage (<1,>=0) or the absolute number of points in the sparsely populated area that should be drawn separately. A value of 0 means that these points will not be drawn.
dens.n  
passed on to ggplot2::stat_density2d: argument: n
add.text.cor  
flag indicating whether a text token with the correlation coefficient should be included in the lower right corner of the plot

Value

ggplot object

Author(s)

Fabian Mueller

Examples

d <- data.frame(x=rnorm(1000),y=rnorm(1000))
s <- rep(FALSE,1000)
s[sample(1:length(s),100)] <- TRUE
create.densityScatter(d,s)

Description

Creates a summary plot binning the data given by a certain quantity in heagonal bins

Usage

create.hex.summary.plot(df2p, x = colnames(df2p)[1], y = colnames(df2p)[2],
q = colnames(df2p)[3], bins = 128, fun = median, ...)

create.hex.summary.plot
  create.hex.summary.plot
create.scatter.dens.points

Arguments

- `df2p` data.frame to be plotted.
- `x` name of the variable in `df2p` considered as x-axis
- `y` name of the variable in `df2p` considered as y-axis
- `q` name of the variable in `df2p` considered as quantity to be summarized over bins
- `bins`, `fun`, `...` arguments to be passed on to `stat_summary_hex`

Value

- `ggplot` object

Author(s)

- Fabian Mueller

Description

Creates a scatterplot containing all points in a given data.frame. Points are colored according to point density. Optionally, a selection of points are shown in a different color

Usage

create.scatter.dens.points(df2p, is.special = NULL, dens.special = TRUE, mock = FALSE)

Arguments

- `df2p` data.frame to be plotted. Only the first two columns are taken into account as x and y coordinates respectively
- `is.special` boolean vector of length equal to the number of rows in `df2p`. Specifies which points should be highlighted separately in a different color
- `dens.special` Flag indicating whether the points of the special population should be colored according to their density
- `mock` Should only the axis be plotted? useful when exporting scatterplots with lots of points as image and the corresponding axis as vector graphics.

Value

- `ggplot` object

Author(s)

- Fabian Mueller
createReport

Examples

d <- data.frame(x=rnorm(1000), y=rnorm(1000))
s <- rep(FALSE, 1000)
s[sample(1:length(s), 100)] <- TRUE
create.scatter.dens.points(d, s)

description

Description

Creates a new report object.

Usage

createReport(fname, title, page.title = "RnBeads report", authors = NULL,
dirs = NULL, init.configuration = FALSE)

Arguments

fname        Single-element character vector denoting the name of the file to contain the
            HTML report. If this file already exists, it will be overwritten.

            title    Title of the report in the form of a single-element character vector.

            page.title Web page title. This usually appears in the web browser’s window title when
            the report is open. If specified, this must be a vector. Note that only the first
            element is used.

            authors  Optional list of authors in the form of a character vector. This list is included
            in the header of the generated HTML file. Note that author names can contain
            only Latin letters, space, dash (\textendash{}), comma (,), or dot (.)

            dirs     Location of the supporting directories, that is, paths that are expected to contain
            additional files linked to from the HTML report. See the Details section for a
            list of these directories.

            init.configuration Flag indicating if the report configuration data should be initialized. If this pa-
            rameter is TRUE, the method creates the respective directory and copies config-
            uration files that define cascading style sheet (CSS) definitions and Javascript
            functions used by the HTML report. If such configuration files already exist,
            they will be overwritten. Since the aforementioned files can be shared by mul-
            tiple reports, it is recommended that the configuration is initialized using the
            method rnb.initialize.reports, instead of setting this flag to TRUE.

Details

If specified, the parameter dirs must be a character vector. The following names are read:

- "configuration" Directory that contains the auxiliary configuration files, such as style
  sheets and Javascript files. If missing or NA, the default value used is "configuration".

```r
createReport(simple.rnBeads)
```
• "data" Directory to contain the tables, lists and other generated data files that are linked to in the HTML report. If missing or NA, the value used is formed from the file name fname (without the extension) and the suffix "_data".

• "pngs" Directory to contain the low resolution PNG images shown in the HTML report. If missing or NA, the value used is formed from the file name fname (without the extension) and the suffix "_images".

• "pdfs" Directory to contain the PDF images (if such are created). If not missing or NA, the value used is formed from the file name fname (without the extension) and the suffix "_pdf".

• "high" Directory to contain the high resolution PNG images (if such are created). If missing or NA, the value used is the same as the pngs directory.

Any other elements, if present, are ignored. Note that these directories are not required to point to different locations. In particular, if the directories for low and for high resolution images are identical, the high-resolution image files are assumed to be the ones with suffix "_high_resolution.png". See createReportPlot for creating image files. In order to ensure independence of the operating system, there are strong restrictions on the names of the file and directories. The name of the report’s HTML file can consist of the following symbols only: Latin letters, digits, dot (.), dash (-) and underline (_). The extension of the report’s HTML file must be one of htm, html, xhtml or xml. The supporting directories must be given as relative paths; the restrictions on the path names are identical to the ones for file name. Forward slash (/) is to be used as path separator. Path names cannot start or end with a slash. None of the directory names can be an empty string, use "." instead. A value in the form "mypath/.html" for fname is invalid. Upon initialization, the report attempts to create or overwrite the specified fname. If the path to it does not exist, or if the current process does not have permissions to write to the file, report initialization will fail. The report object visits each supporting directory (except configuration) and attempts to create it, unless it is an existing empty directory. Report initialization will fail if any of the visited directories does not meet the criteria and could not be created. Hidden files (file names starting with "." on Unix platforms) are ignored. Thus, all supporting directories that already exist and contain hidden files only are considered valid.

Value

Newly created Report object.

Author(s)

Yassen Assenov

See Also

Report for functions adding contents to an HTML report

Examples

report <- createReport("example.html", "Example", init.configuration = TRUE)
createReportGgPlot

Description

creates a report plot containing a ggplot object. Except for the ggp parameter, the signature and behavior is identical to createReportPlot.

Usage

createReportGgPlot(ggp, fname, report = NULL, width = 7, height = 7, 
create.pdf = TRUE, low.png = as.integer(100), high.png = as.integer(0))

Arguments

ggp ggplot object to be plotted
fname character vector with one element storing the name of the output file, without the extension. The initialized object appends .pdf and/or .png to this name.
report Report (object of type Report) to which this plot is going to be added. This is used to set the directories for PDF and/or PNG files generated for these plots. If this parameter is NULL, the current working directory is used to host all generated images.
width numeric storing the width of the device in inches. The length of this vector must be 1.
height numeric storing the height of the device in inches. The length of this vector must be 1.
create.pdf Flag indicating if a PDF image is to be created. The length of this vector must be 1.
low.png Resolution, in dots per inch, used for the figure image. Set this to 0 or a negative value to disable the creation of a low resolution image. The length of this vector must be 1.
high.png Resolution, in dots per inch, used for a dedicated image. Set this to 0 or a negative value to disable the creation of a high resolution image. The length of this vector must be 1.

Value

Newly created ReportGgPlot object.

Author(s)

Fabian Mueller
createReportPlot

Description

Initializes a report plot and opens a device to create it. The type of the device created depends on the parameters `create.pdf`, `low.png` and `high.png`. If `create.pdf` is TRUE, a PDF device is opened and its contents are later copied to PNG device(s) if needed. Otherwise, a PNG device is opened. Note that at least one of the following conditions must be met:

- `create.pdf` == TRUE
- `low.png` > 0
- `high.png` > 0

Usage

```
createReportPlot(fname, report = NULL, width = 7, height = 7,
                 create.pdf = TRUE, low.png = 100L, high.png = 0L)
```

Arguments

- **fname** character vector with one element storing the name of the output file, without the extension. The initialized object appends `.pdf` and/or `.png` to this name.
- **report** Report (object of type `Report`) to which this plot is going to be added. This is used to set the directories for PDF and/or PNG files generated for these plots. If this parameter is `NULL`, the current working directory is used to host all generated images.
- **width** numeric storing the width of the device in inches. The length of this vector must be 1.
- **height** numeric storing the height of the device in inches. The length of this vector must be 1.
- **create.pdf** Flag indicating if a PDF image is to be created. The length of this vector must be 1.
- **low.png** Resolution, in dots per inch, used for the figure image. Set this to 0 or a negative value to disable the creation of a low resolution image. The length of this vector must be 1.
- **high.png** Resolution, in dots per inch, used for a dedicated image. Set this to 0 or a negative value to disable the creation of a high resolution image. The length of this vector must be 1.

Details

In order to ensure independence of the operating system, there are strong restrictions on the name of the file. It can consist of the following symbols only: Latin letters, digits, dot (.), dash (-) and underline (_). The name must not include paths, that is, slash (/) or backslash (\) cannot be used.

Value

Newly created `ReportPlot` object.
Author(s)
Yassen Assenov

See Also
pdf for manually initializing a graphics device; Report for other functions adding contents to an HTML report

Examples

plot.image <- createReportPlot('scatterplot_tumors')
plot(x = c(0.4, 1), y = c(9, 3), type = 'p', main = NA, xlab = expression(beta), ylab = 'Measure')
off(plot.image)

Description

Converts a data.frame that defines genomic regions to object of type GRanges.

Usage
data.frame2GRanges(dframe, ids = rownames(dframe),
                chrom.column = "chromosome", start.column = "start", end.column = "end",
                strand.column = NULL, assembly = "hg19", sort.result = TRUE)

Arguments
dframe Table defining genomic regions.
ids Region names (identifiers) as a character vector, or NULL if no names are present.
chrom.column Column name or index that lists the chromosome names.
start.column Column name or index that lists the start positions of the regions.
end.column Column name or index that lists the end positions of the regions.
strand.column Column name or index that lists the strands on which the regions are located. Set this to NULL if this region set is not strand-specific.
assembly Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.
sort.result Should the resulting table be sorted

Value

GRanges object encapsulating all well defined regions on supported chromosomes, contained in dframe. Columns other that the ones listed as parameters in this function are included as metadata.

Author(s)
Yassen Assenov
densRanks

Description
Rank the points according to density of the region they fall in. Densities are computed as Kernel Density estimates. The method and parameters are implemented in analogy to grDevices::densCols.

Usage
densRanks(x, y = NULL, nbin = 128, bandwidth)

Arguments
x x-coordinate
y y-coordinate
nbin number of bins
bandwidth bandwidth

Author(s)
Fabian Mueller

destroy, RnBDiffMeth-method

Description
remove tables stored to disk from the file system. Useful for cleaning up disk dumped objects. CAUTION: currently only works with reloaded objects.

Usage
## S4 method for signature 'RnBDiffMeth'
destroy(object)

Arguments
object RnBDiffMeth object

Value
Nothing of particular interest

Author(s)
Fabian Mueller
**deviation.plot.beta**

deviation.plot.beta

**Description**

Creates a deviation plot based on the methylation beta values of a population.

**Usage**

```r
deviation.plot.beta(betas, c.values = NULL, c.legend = NULL)
```

**Arguments**

- `betas` Non-empty numeric matrix of methylation beta values. Rows in this matrix must denote sites or regions, and columns - samples. If a locus (row in the matrix) contains missing values only, it is not included in the plot.
- `c.values` Vector (usually a factor) storing category or quantitative values for each site or region. The length of this vector must be equal to nrow(betas), the i-th element storing the property values for the i-th locus in betas. Note that this vector’s names, if present, are ignored.

**Value**

Nothing of particular interest
c.legend

If c.values stores categories, this parameter specifies the mapping from property values to colors. The mapping is in the form of a named character vector. All values that appear in c.values must be present among the names of this vector. The order of the values in this mapping determines in which order the colors are stacked (when the number of loci is large). If c.values denotes a quantitative measure, this parameter is a singleton integer, specifying the color scheme for visualizing the values. Currently, the only supported values are 2 and 3. See rnb.options for more details.

Value

Methylation variability as a number between 0 and 1, invisibly. This number denotes the relative area of variation in the generated plot.

Author(s)

Yassen Assenov

diffVar

diffVar

Description

This routine applies the diffVar method from the missMethyl package that determines sites exhibiting differential variability between two sample groups.

Usage

diffVar(meth.matrix, inds.g1, inds.g2, adjustment.table = NULL, paired = FALSE)

Arguments

meth.matrix Matrix containing the methylation information used to calculate differentially variable sites between the two groups
inds.g1 Indices in the phenotypic table corresponding to the first group.
inds.g2 Indices in the phenotypic table corresponding to the second group.
adjustment.table A data.frame containing variables to adjust for in the testing
paired Should the analysis be performed in a paired fashion. If yes, the first index in inds.g1 must correspond to the first in inds.g2 and so on.

Value

P-values as the result of the diffVar method not adjusted for multiple hypothesis testing.

Author(s)

Michael Scherer
References


dim, BigFfMat-method

Description

Dimensions of BigFfMat

Usage

## S4 method for signature 'BigFfMat'
dim(x)

Arguments

x BigFfMat object

downloadLolaDbs

Description

Downloading prepared LOLA DBs from server

Usage

downloadLolaDbs(dest, dbs = c("LOLACore"))

Arguments

dest destination directory
dbs vector of names of LOLA DBs to be downloaded. Currently 'LOLACore' and 'LOLAExt' are supported

Details

Requires a stable internet connection. Could take a while depending on the size of the database and the internet connection

Value

a list containing vectors of directory names for each available genome assembly

Author(s)

Fabian Mueller
Examples

lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")

dpval.RnBeadSet-method
dpval-methods

Description

Extract detection p-values from an object of RnBeadSet class.

Usage

## S4 method for signature 'RnBeadSet'
dpval(object, type = "sites", row.names = FALSE,
i = NULL, j = NULL)

Arguments

object  RnBeadSet or RnBeadRawSet object
type  character singleton. If sites detection p-values per each available site is returned. Otherwise should be one of region types for which the summarized p-values are available
row.names  Flag indicating of row names are to be generated in the result.
i  Indices of sites/regions to be retrieved. By default (NULL), all will be retrieved.
j  Indices of samples to be retrieved. By default (NULL), all will be retrieved.

Value

detection p-values available for the dataset in the form of a matrix.

Examples

library(RnBeads.hg19)
data(small.example.object)
dp<-dpval(rnb.set.example, row.names=TRUE)
head(dp)
**estimateProportionsCP**

**Description**
Estimates cell type proportions using the constrained projection method from Houseman et al. [1]

**Usage**
estimateProportionsCP(rnb.set, cell.type.column, n.most.variable = NA,
                         n.markers = 500L, constrained = TRUE, full.output = FALSE)

**Arguments**
- rnb.set: RnBSet object
- cell.type.column: integer index or character identifier of a column in the RnBSet object sample annotation table which gives the mapping to reference cell type samples
- n.most.variable: Singleton integer specifying how many top variable CpGs should be used for marker selection. If this option is set to NA or NULL, all sites are considered. Please take into account the extended computation time in such a case.
- n.markers: singleton integer specifying how many CpGs should be used as markers for fitting the projection model
- constrained: if TRUE the returned cell type proportion estimates are non-negative
- full.output: if TRUE not only the estimated proportions but also the intermediate analysis results are returned

**Details**
The column specified by cell.type.column should give assignment of each reference sample to a cell type and missing values for all the target samples. First the marker selection model is fit to estimate association of each CpG with the given reference cell types (first expression in eq. (1) of [1]). The strength of association is expressed as an F-statistic. Since fitting the marker selection model to all CpGs can take a lot of time, one can limit the marker search only to variable CpG positions by setting n.most.variable to non-NA positive integer. The CpGs will be ranked by decreasing across-sample variance in the reference data set and n.most.variable will be taken to fit the marker selection model. Coefficients of the fit together with the F-statistic value for each CpG are returned in case full.output is TRUE. Thereafter, n.markers are selected as true quantitative markers and the projection model (eq. [2]) is fit to estimate contributions of each cell type. Depending on the value of constrained the returned coefficients can be either raw or enforced to attain values between 0 and 1 with within-sample sum less or equal to 1.

**Value**
a matrix of estimated cell type contributions (samples times cell types) or a list with results of the intermetidate steps (see details).

**Note**
Requires the package nlme.
exportDMRs2regionFile

Author(s)
Pavlo Lutsik

References

Description
export differentially methylated regions to region file (standard bed). The output is in BED6 format where the score corresponds to the combined rank (rank==1 would receive a score of 1000 and a combined rank equal to the number of regions a score of 0)

Usage
exportDMRs2regionFile(rnbSet, diffmeth, dest, comp.name, region.type, rank.cut = NULL, rerank = FALSE)

Arguments
rnbSet the RnBSet object for which the DMRs were computed.
diffmeth DiffMeth object. See rnb.execute.computeDiffMeth for details.
dest destination file name
comp.name name of the comparison
region.type region type.
rank.cut rank cutoff. If NULL (default), all regions are processed.
rerank flag indicating whether the ranks should be reranked or whether rank.cut refers to the absolute rank

Value
NULL

Author(s)
Fabian Mueller

Examples
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
exportDMRs2regionFile(rnb.set.example, dm, tempfile(), get.comparisons(dm)[1], "promoters")
Description

Given indices for two groups of samples for comparison, this function retrieves data.frame containing the variables to be adjusted for.

Usage

```r
get.adjustment.variables(rnbSet, inds.g1, inds.g2 = -inds.g1,
                        colnames.adj = c(), colname.target = "",
                        adjust.sva = FALSE,
                        adjust.celltype = FALSE)
```

Arguments

- `rnbSet`: RnBSet object
- `inds.g1`: sample indices in `rnbSet` of group 1 members
- `inds.g2`: sample indices in `rnbSet` of group 2 members
- `colnames.adj`: column names in `pheno(rnbSet)` to retrieve
- `colname.target`: column names in `pheno(rnbSet)` of the target variable. Only important if `adjust.sva==TRUE`
- `adjust.sva`: flag indicating whether the resulting table should also contain surrogate variables (SVs) for the given target variable.
- `adjust.celltype`: flag indicating whether the resulting table should also contain estimated celltype contributions. See `rnb.execute.ct.estimation` for details.

Value

A data.frame containing one column for each selected variable from the phenotypic data each row corresponds to a sample in the union of samples of the two groups with the first `length(inds.g1)` rows corresponding to group 1 and the remaining rows corresponding to group 2.

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
sample.groups <- rnb.sample.groups(rnb.set.example)[[1]]
get.adjustment.variables(rnb.set.example, sample.groups[[1]], sample.groups[[2]], "Cell_Line")
```
Description

Gets all comparison grouplabels represented in the object as character matrix of dimension n.comparisons x 2 where the columns specify group names 1 and 2 respectively

Usage

## S4 method for signature 'RnBDiffMeth'
get.comparison.grouplabels(object)

Arguments

object RnBDiffMeth object

Value

character matrix containing comparison group names

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
get.comparison.grouplabels(dm)

Description

Gets all comparison group sizes represented in the object as character matrix of dimension n.comparisons x 2 where the columns specify sizes of groups 1 and 2 respectively

Usage

## S4 method for signature 'RnBDiffMeth'
get.comparison.groupsizes(object)
get.comparison.info

Arguments

object \text{RnBDiffMeth object}

Value

character matrix containing comparison group sizes

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
get.comparison.groupsizes(dm)

Description

retrieve the comparison information for an RnBSet object

Usage

get.comparison.info(x,
  pheno.cols = rnb.getOption("differential.comparison.columns"),
  region.types = rnb.region.types.for.analysis(x),
  pheno.cols.all.pairwise = rnb.getOption("differential.comparison.columns.all.pairwise"),
  columns.pairs = rnb.getOption("columns.pairing"),
  columns.adj = rnb.getOption("covariate.adjustment.columns"),
  adjust.sva = rnb.getOption("differential.adjustment.sva"),
  pheno.cols.adjust.sva = rnb.getOption("inference.targets.sva"),
  adjust.celltype = rnb.getOption("differential.adjustment.celltype"),
  adjust.na.rm = TRUE)

Arguments

x \text{RnBSet object}

pheno.cols column names of the pheno slot in x on which the dataset should be partitioned. Those columns are required to be factors or logical. In case of factors, each group in turn will be compared to all other groups

region.types which region types should be processed for differential methylation

pheno.cols.all.pairwise integer or character vector specifying the columns of pheno(x) on which all pairwise comparisons should be conducted. A value of NULL indicates no columns.
get.comparison.info

- **columns.pairs**: argument passed on to `rnb.sample.groups`. See its documentation for details.
- **columns.adj**: Column names or indices in the table of phenotypic information to be used for confounder adjustment in the differential methylation analysis.
- **adjust.sva**: flag indicating whether the adjustment table should also contain surrogate variables (SVs) for the given target variable.
- **pheno.cols.adjust.sva**: Target variables for SVA adjustment. Only important if `adjust.sva==TRUE`. Only the intersection of `pheno.cols` and `pheno.cols.adjust.sva` is considered for SVA adjustment.
- **adjust.celltype**: flag indicating whether the resulting table should also contain estimated celltype contributions. See `rnb.execute.ct.estimation` for details.
- **adjust.na.rm**: Flag indicating whether NAs in the adjustment table should be removed.

### Value

a list containing one element for each comparison to be conducted. Each element is again a list containing:

- **comparison**: the name of the comparison
- **pheno.colname**: the column name of the sample annotation table the comparison is derived from
- **group.names**: the names of the two groups being compared
- **group.inds**: the sample indices of the samples belonging to the two groups
- **paired**: flag indicating whether paired analysis is conducted
- **adj.sva**: flag indicating whether adjustment for SVA is conducted
- **adj.celltype**: flag indicating whether adjustment for cell type is conducted
- **adjustment.table**: the covariate adjustment table. `NULL` if the comparison is not adjusted
- **region.types**: the region types applicable to the analysis

### Author(s)

Fabian Mueller

### Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
cmp.info <- get.comparison.info(rnb.set.example, pheno.cols=c("Sample_Group","Treatment"))
cmp.info[[1]]
```
get.comparisons,RnBDiffMeth-method

Description
Gets all comparisons represented in the object as character vector

Usage
```r
## S4 method for signature 'RnBDiffMeth'
get.comparisons(object)
```

Arguments

- `object` \texttt{RnBDiffMeth} object

Value
character vector containing comparisons

Author(s)
Fabian Mueller

Examples
```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
get.comparisons(dm)
```

get.covariates.ct

description
Retrieves an N x K matrix of cell type contributions stored in an RnBSet for a given target variable

Usage
```r
getcovariates.ct(rnb.set)
```

Arguments

- `rnb.set` \texttt{RnBSet} object
get.covariates.sva

Value

an NxK matrix of K cell types contributions for N samples of the rnb.set. NULL if the components have not been computed or added to rnb.set.

Description

Retrieves an NxK table of Surrogate variables stored in an RnBSet for a given target variable

Usage

get.covariates.sva(rnb.set, target)

Arguments

rnb.set RnBSet object
target target variable. Must be in pheno(rnb.set) and belong to target variables for which the SVs have already been computed and stored in the RnBSet.

Value

an NxK table of K Surrogate variables stored for N samples of the rnb.set. NULL if the components have not been computed or added to rnb.set.

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
sva.obj <- rnb.execute.sva(rnb.set.example,c("Sample_Group","Treatment"),numSVmethod="be")
sva.obj$sva.performed
sva.obj$num.components
rnb.set.mod <- set.covariates.sva(rnb.set.example, sva.obj)
get.covariates.sva(rnb.set.mod,"Sample_Group")
Description

Gets the coverage threshold employed for obtaining statistics in the differential methylation tables.

Usage

```r
## S4 method for signature 'RnBDiffMeth'
get.covg.thres(object)
```

Arguments

- `object` RnBDiffMeth object

Value

integer coverage threshold

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
get.covg.thres(dm)
```

Description

Computes CpG-related statistics for the specified regions.

Usage

```r
get.cpg.stats(chrom.sequence, starts, ends)
```

Arguments

- `chrom.sequence` Chromosome sequence, usually obtained from the assembly’s genome definition. This must be an object of type MaskedDNAString.
- `starts` integer vector of start positions for the regions of interest.
- `ends` integer vector of end positions for the regions of interest.
Value

Table of statistics for the regions in the form of a matrix with the following columns: "CpG" and "GC". The columns contain the number of CpG dinucleotides and the number of C and G bases in each region.

Author(s)

Yassen Assenov

get.files

Description

Gets the list of all files that are planned to be generated, or were already generated by the given report plot.

Usage

get.files(report.plot)

Arguments

report.plot Report plot of interest. This must be an object of type ReportPlot.

Value

Non-empty character vector of absolute file names.

Author(s)

Yassen Assenov

Examples

plot.image <- createReportPlot('scatterplot', high.png = 200)
get.files(plot.image)
get.region.types,RnBDiffMeth-method

get.region.types-methods

Description

Gets all region types represented in the object as character vector

Usage

```r
## S4 method for signature 'RnBDiffMeth'
get.region.types(object)
```

Arguments

- `object`: RnBDiffMeth object

Value

character vector containing region types

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example, pheno.cols=c("Sample_Group","Treatment"))
get.region.types(dm)
```

get.site.test.method,RnBDiffMeth-method

get.site.test.method-methods

Description

Gets the site testing method used to obtain the p-values in the differential methylation tables

Usage

```r
## S4 method for signature 'RnBDiffMeth'
get.site.test.method(object)
```

Arguments

- `object`: RnBDiffMeth object
get.table,RnBDiffMeth-method

Value

character describing the site test method

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
get.site.test.method(dm)

description

get.table,RnBDiffMeth-method

get.table-methods

Description

Gets a differential methylation table

Usage

## S4 method for signature 'RnBDiffMeth'
get.table(object, comparison, region.type,
undump = TRUE, return.data.frame = FALSE)

Arguments

object RnBDiffMeth object
comparision character or index of the comparison of the table to retrieve
region.type character or index of the region type of the table to retrieve
undump Flag indicating whether to convert the table into a matrix instead of using the
descriptor. Only meaningful if the if the object’s disk.dump slot is true.
return.data.frame should a data.frame be returned instead of a matrix?

Value

differential methylation table. See computeDiffMeth.bin.site and computeDiffMeth.bin.region
for details.

Author(s)

Fabian Mueller
Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
dm.promoters <- get.table(dm,get.comparisons(dm)[1],"promoters",return.data.frame=TRUE)
summary(dm.promoters)
```

get.table.ids

Returns the column names of the differential variability table.

Description

Returns the column names of the differential variability table.

Usage

```r
get.table.ids(includeCovg = FALSE)
```

Arguments

- `includeCovg`: Flag indicating if dataset contains coverage information

Value

Column names of the differential variability table

get.variability.method,RnBDiffMeth-method

Description

Gets the variability testing method used to obtain the p-values in the differential variability tables

Usage

```r
## S4 method for signature 'RnBDiffMeth'
get.variability.method(object)
```

Arguments

- `object`: RnBDiffMeth object

Value

character describing the variability method

Author(s)

Michael Scherer
getCellTypesFromLolaDb

Description
retrieve or guess cell types from a LOLA DB object

Usage
getCellTypesFromLolaDb(lolaDb)

Arguments
lolaDb LOLA DB object as returned by LOLA::loadRegionDB or loadLolaDbs

Value
character vector with cell types

Author(s)
Fabian Mueller

Examples

# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
lolaDb <- loadLolaDbs(lolaDirs[["hg19"]])
getCellTypesFromLolaDb(lolaDb)

getExecutable,ClusterArchitecture,character-method

description
Retrieves the executable associated with a name/identifier

Usage
## S4 method for signature 'ClusterArchitecture,character'
getExecutable(object, exec.name)
getModuleNumCores,RnBClusterRun-method

Arguments

object: ClusterArchitecture object
exec.name: The executable’s name/identifier

Value

The executable. If the name is not associated with any executable, the names will be returned and a warning will be raised

Author(s)

Fabian Mueller

description

Retrieves the number of cores used by each module

Usage

## S4 method for signature 'RnBClusterRun'
getModuleNumCores(object)

Arguments

object: RnBClusterRun object

Value

A named vector containing the number of cores for each module

Author(s)

Fabian Mueller
**getNamesFromLolaDb**

**Description**
get human readable names from a LOLA DB object

**Usage**
```
getNamesFromLolaDb(lolaDb, addCollectionNames = FALSE, addDbId = TRUE)
```

**Arguments**
- `lolaDb` LOLA DB object as returned by `LOLA::loadRegionDB` or `loadLolaDbs`
- `addCollectionNames` attach the name of the collection to the name
- `addDbId` attach the index of the item in the LOLA DB object to the name

**Value**
character vector with human readable names

**Author(s)**
Fabian Mueller

**Examples**
```
# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
lolaDb <- loadLolaDbs(lolaDirs[["hg19"]])
getNamesFromLolaDb(lolaDb)
```

**getNumNaMeth,RnBSet-method**

**Description**
for each site/region, the getNumNaMeth retrieves the number of NA values across all samples. Does this efficiently by breaking down the methylation matrix into submatrices

**Usage**
```
## S4 method for signature 'RnBSet'
getNumNaMeth(object, type = "sites", chunkSize = 1e+05,
              mask = NULL)
```
getSubCmdStr,ClusterArchitecture-method

Arguments

object  object inheriting from RnBSet

type    "sites" or region type

chunkSize  size of each submatrix (performance tuning parameter)

mask    logical matrix. its entries will also be considered NAs in counting

Value

vector containing the number of NAs per site/region

Description

Returns a string for the of command line corresponding to submitting a job with the given command to the cluster.

Usage

## S4 method for signature 'ClusterArchitecture'
getSubCmdStr(object, ...)

Arguments

object    ClusterArchitecture object

...    arguments passed on to getSubCmdTokens,ClusterArchitecture-method

Value

A string containing the submission command

Author(s)

Fabian Mueller
getSubCmdTokens, ClusterArchitecture-method

Description
Returns a string for the command line corresponding to submitting a job with the given command to the cluster.

Usage
## S4 method for signature 'ClusterArchitecture'
getSubCmdTokens(object, cmd.tokens, log, 
job.name = '"", res.req = character(0), depend.jobs = character(0))

Arguments

object
ClusterArchitecture object
cmd.tokens
a character vector specifying the executable command that should be wrapped in the cluster submission command
log
file name and path of the log file that the submitted job writes to
job.name
name of the submitted job
res.req
character vector specifying required resources. The resource requirements should be the values of the vector, the names should specify the resource name
depend.jobs
character vector containing names or ids of jobs the submitted job will depend on.

Details
For a concrete child class implementation for a sun grid architecture specification see getSubCmdTokens, ClusterArchitectureSGE-method

Value
A character vector containing the submission command tokens

Author(s)
Fabian Mueller
getTargetFromLolaDb

Usage

## S4 method for signature 'ClusterArchitectureSGE'
getSubCmdTokens(object, cmd.tokens, log,
job.name = "", res.req = character(0), depend.jobs = character(0),
sub.binary = TRUE, quote.cmd = TRUE)

Arguments

object  
ClusterArchitectureSGE object

cmd.tokens  
a character vector specifying the executable command that should be wrapped in the cluster submission command

log  
file name and path of the log file that the submitted job writes to

job.name  
name of the submitted job

res.req  
character vector specifying required resources. The resource requirements should be the values of the vector, the names should specify the resource name

derepend.jobs  
character vector containing names or ids of jobs the submitted job will depend on.

sub.binary  
treat the command as binary (see -b flag of qsub of the SGE documentation)

quote.cmd  
Flag indicating whether the submitted command should also be wrapped in quotes

Details

For a concrete child class implementation for a sun grid architecture specification see ClusterArchitectureSGE

Value

A character vector containing the submission command tokens

Author(s)

Fabian Mueller

Examples

```
arch <- new("ClusterArchitectureSGE",
name="my_sge_architecture"
)
getSubCmdTokens(arch,c("Rscript","my_great_script.R"),"my_logfile.log")
```

getTargetFromLolaDb  
getTargetFromLolaDb

Description

retrieve or guess the target from a LOLA DB object. Here, target typically refers to antibodies for ChIP-seq experiments, but could also refer to other annotations (e.g. motifs in TF motif databases, annotation according to UCSC features etc.)
getTargetFromLolaDb(lolaDb)

Arguments

lolaDb  LOLA DB object as returned by LOLA::loadRegionDB or loadLolaDbs

Value

character vector with targets

Author(s)

Fabian Mueller

Examples

# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
lolaDb <- loadLolaDbs(lolaDirs[['hg19']])
getTargetFromLolaDb(lolaDb)

greedycut.filter.matrix

Usage

greedycut.filter.matrix(mm, rows2ignore = integer(), rc.ties = "row")

Arguments

mm  Numeric matrix to filter.
rows2ignore  integer vector containing indices of rows in mm to be ignored by this function.
rc.ties  Flag indicating what the behaviour of the algorithm should be in case of ties between values of rows and columns. The value of this parameter must be one of "row", "column" or "any" (the last one indicating random choice).

Value

Table summarizing the iterations of the algorithm in the form of a data.frame with the following columns: Index, Type, Score, Normalized score, Rows, Columns.
Author(s)
Yassen Assenov

See Also

greedy.cut.get.submatrix for extracting the resulting matrix after filtering

greedy.cut.get.statistics

description
Calculates various statistics on the iterations of Greedycut.

Usage

greedy.cut.get.statistics(filterinfo)

Arguments

filterinfo Information on the filtering iterations as a data.frame returned by greedy.cut.filter.matrix.

Value

Additional statistics on the iterations in the form of a data.frame with the following columns: "Elements retained", "Elements removed", "Mismatches retained", "Mismatches removed", "False Positive Rate", "Sensitivity", "D". The last column signifies distance from the diagonal in a ROC curve.

Author(s)
Yassen Assenov

Description
Filters a data matrix executing the given number of iterations of Greedycut.

Usage

greedy.cut.get.submatrix(mm, filter.info, it.num = nrow(filter.info) - as.integer(1))
has.covariates.ct

Arguments

mm Data matrix to be filtered.
filter.info Information on the filtering iterations as a data.frame returned by `greedycut.filter.matrix`.
it.num Number of iterations to execute. Defaults to all iterations.

Value

Data matrix containing subsets of the rows and columns of mm.

Author(s)

Yassen Assenov

Description

Checks whether the given RnBSet object contains cell type contribution estimates

Usage

has.covariates.ct(rnb.set)

Arguments

rnb.set RnBSet object

Value

TRUE if the supplied object contains the cell type covariates information and FALSE otherwise

has.covariates.sva

Description

Returns whether Surrogate Variables have been computed and added to the rnb.set for a given target variable

Usage

has.covariates.sva(rnb.set, target)

Arguments

rnb.set RnBSet object
target target variable. Must be in pheno(rnb.set) and belong to target variables for which the SVs have already been computed and stored in the RnBSet.
Value

logical(1)

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
sva.obj <- rnb.execute.sva(rnb.set.example,c("Sample_Group","Treatment"),numSVmethod="be")
sva.obj$sva.performed
sva.obj$num.components
rnb.set.mod <- set.covariates.sva(rnb.set.example, sva.obj)
has.covariates.sva(rnb.set.example,"Sample_Group")
has.covariates.sva(rnb.set.mod,"Sample_Group")
has.covariates.sva(rnb.set.mod,"Treatment")
Description

Returns TRUE if the differential methylation object contains site-level information

Usage

```r
## S4 method for signature 'RnBDiffMeth'
includes.sites(object)
```

Arguments

- `object`: RnBDiffMeth object

Value

TRUE if the differential methylation object contains site-level information. FALSE otherwise

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example, pheno.cols=c("Sample_Group","Treatment"))
includes.sites(dm)
```

Description

Initialize an ClusterArchitecture object

Usage

```r
## S4 method for signature 'ClusterArchitecture'
initialize(.Object,
          name = "ClusterArchitecture")
```
**initialize,RnBClusterRun-method**

**Argument**

- **Object**: New instance of `ClusterArchitecture`
- **name**: A name or identifier

**Author(s)**

Fabian Mueller

---

**initialize,ClusterArchitectureSGE-method**

`initialize.ClusterArchitectureSGE`

**Description**

Initialize an `ClusterArchitecture` object for a Sun Grid Engine (SGE)

**Usage**

```r
## S4 method for signature 'ClusterArchitectureSGE'
initialize(.Object,
    name = "ClusterArchitectureSGE", ...)
```

**Arguments**

- **Object**: New instance of `ClusterArchitectureSGE`
- **name**: A name or identifier
- ... arguments passed on to the constructor of `ClusterArchitecture` (the parent class)

**Author(s)**

Fabian Mueller

---

**initialize,RnBClusterRun-method**

`initialize.RnBClusterRun`

**Description**

Initialize an `RnBClusterRun` object

**Usage**

```r
## S4 method for signature 'RnBClusterRun'
initialize(.Object, architecture)
```
Arguments


architecture A ClusterArchitecture object managing the settings for a scientific compute cluster.

Author(s)

Fabian Mueller

Description

Initialize an RnBDiffMeth object

Usage

## S4 method for signature 'RnBDiffMeth'
initialize(.Object,
    site.test.method = rnb.getOption("differential.site.test.method"),
    variability.method = rnb.getOption("differential.variability.method"),
    covg.thres = rnb.getOption("filtering.coverage.threshold"),
    disk.dump = FALSE, disk.path = NULL)

Arguments

.Object New instance of RnBDiffMeth.

site.test.method method which was applied to obtain the site-level p-values.

variability.method method to be used to calculate differentially variable sites. Has to be one of: ‘diffVar’ or ‘iEVORA’.

covg.thres coverage threshold. Important for certain columns of the differential methylation tables. See computeDiffMeth.bin.site and computeDiffMeth.bin.region for details.

disk.dump Flag indicating whether the tables should be stored on disk rather than in the main memory

disk.path Path on the disk for DMTs. Only meaningful if disk.dump is TRUE

Author(s)

Fabian Mueller
intensities.by.color  intensities.by.color

Description
Rearranges information from "M" and "U" slots of a RnBeadsRawSet object by color channel.

Usage
intensities.by.color(raw.set, address.rownames = TRUE,
  add.oob = all(!is.null(M0(raw.set)), !is.null(U0(raw.set))),
  add.controls = !is.null(qc(raw.set)), add.missing = TRUE)

Arguments
raw.set Methylation dataset as an instance of RnBeadRawSet object.
address.rownames if TRUE the rows of the returned matrices are named with the corresponding Illumina probe addresses
add.oob if TRUE the "out-of-band" intensities are included
add.controls if TRUE the control probe intensities are included
add.missing if TRUE the rows for the probes missing in raw.set is imputed with NA values

Value
a list with elements Cy3 and Cy5 containing average bead intensities measured for each each probe in the green and red channels, respectively.

Author(s)
Pavlo Lutsik

is.valid,RnBDiffMeth-method
is.valid-methods

Description
Validate an RnBDiffMeth object, i.e. verify that all differential methylation tables are specified and accounted for

Usage
## S4 method for signature 'RnBDiffMeth'
is.valid(object, verbose = FALSE)

Arguments
object RnBDiffMeth object
verbose print more info to the logger
Value

TRUE iff all differential methylation tables are present and accounted for

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm1 <- rnb.execute.computeDiffMeth(rnb.set.example,"Sample_Group",c("genes","tiling"))
dm2 <- rnb.execute.computeDiffMeth(rnb.set.example,c("Sample_Group","Treatment"),"promoters")
dm.join1 <- join.diffMeth(dm1,dm2)
#The following joint object is invalid due to missing region type - comparison combinations
is.valid(dm.join1)
dm3 <- rnb.execute.computeDiffMeth(rnb.set.example,c("Treatment"),c("genes","tiling"))
dm.join2 <- join.diffMeth(dm.join1,dm3)
#After joining the missing information, the new object is valid
is.valid(dm.join2)
```

Description

Getter for the imputation field. Return TRUE, if the object has been imputed and FALSE otherwise.

Usage

```r
## S4 method for signature 'RnBSet'
isImputed(object)
```

Arguments

object Object for which the information should be returned

Value

TRUE, if the object has been imputed and FALSE otherwise.

Author(s)

Michael Scherer
join.diffMeth, RnBDiffMeth, RnBDiffMeth-method

join.diffMeth-methods

Description
Merges two disjoint RnBDiffMeth objects into one. Disjoint here means, that no differential methylation table is specified in both objects.

Usage
```r
## S4 method for signature 'RnBDiffMeth,RnBDiffMeth'
join.diffMeth(obj1, obj2)
```

Arguments
- `obj1`  
  `RnBDiffMeth` object. Its base properties will be used to create the joint object this is particularly imported for disk dumped objects as its path will be used and tables from the second object will be copied there
- `obj2`  
  `RnBDiffMeth` object

Value
the merged `RnBDiffMeth` object

Note
Caveat: if disk dumping is enabled the resulting object tables will be stored in the initial location of the first object to be joined I.e. deleting the first object will lead to a broken joined object and deleting the joined object will lead to an broken first object.

Author(s)
Fabian Mueller

Examples
```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm1 <- rnb.execute.computeDiffMeth(rnb.set.example,"Sample_Group",c("genes","tiling"))
dm2 <- rnb.execute.computeDiffMeth(rnb.set.example,c("Sample_Group","Treatment"),"promoters")
dm.join1 <- join.diffMeth(dm1,dm2)
#The following joint object is invalid due to missing region type - comparison combinations
is.valid(dm.join1)
dm3 <- rnb.execute.computeDiffMeth(rnb.set.example,"Treatment",c("genes","tiling"))
dm.join2 <- join.diffMeth(dm.join1,dm3)
#After joining the missing information, the new object is valid
is.valid(dm.join2)
```
Description

applies hierarchical modeling analogous to differential expression employed in the limma package and returns p-values for differential methylation

Usage

limmaP(X, inds.g1, inds.g2 = -inds.g1, adjustment.table = NULL, fun.conversion = rnb.beta2mval, paired = FALSE)

Arguments

X
Matrix on which the test is performed for every row
inds.g1
column indices of group 1 members
inds.g2
column indices of group 2 members
adjustment.table
a data.frame containing variables to adjust for in the testing
fun.conversion
conversion function to transform the beta values into M values. By default, it is the logit function with adjustment for infinity values. See rnb.beta2mval for details.
paired
should a paired analysis model be used. If so, the first index in inds.g1 must correspond to the first index in inds.g2 and so on.

Value

vector of p-values resulting from limma's differential analysis

Note

Requires limma package

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
sample.groups <- rnb.sample.groups(rnb.set.example)[[1]]
p.vals <- limmaP(meth.mat,sample.groups[[1]],sample.groups[[2]])
load.region.subsegment.annotation

Description
For the region annotation of a given RnBSet object. Subdivide each region into subsegments by hierarchical clustering on the site distances in a particular region and then splitting the region into subregions consisting of these site clusters. The number of clusters is determined in such way that the mean number of sites per cluster is given by the ns parameter.

Usage
load.region.subsegment.annotation(rnb.set, annotation.dir)

Arguments
rnb.set The RnBSet object with subsegments specified in the regions
annotation.dir a directory to load the annotation from. (binary RData format.)

Value
invisible TRUE

Author(s)
Fabian Mueller

load.rnb.diffmeth

Description
load a saved RnBDiffMeth object from disk

Usage
load.rnb.diffmeth(path)

Arguments
path path of the saved object (a directory containing a corresponding rnbDiffMeth.RData file and possibly rnbDiffMeth_tables files)

Value
the loaded RnBDiffMeth object

Author(s)
Fabian Mueller
Description

Loading of the RnBSet objects with large matrices of type ff.

Usage

load.rnb.set(path, temp.dir = tempdir())

Arguments

path full path of the file or directory. If archive is FALSE) without an extension.
temp.dir character singleton which specifies temporary directory, used while loading

Value

Loaded object

Author(s)

Pavlo Lutsik

----------------------------------------------------------------------------------------

loadLolaDbs

Description

Load LOLA databases from disk and merge them

Usage

loadLolaDbs(lolaDbPaths)

Arguments

lolaDbPaths vector of names of LOLA DB paths to be loaded

Value

LOLA DB list as returned by LOLA::loadRegionDB

Author(s)

Fabian Mueller
Examples

# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
lolaDb <- loadLolaDbs(lolaDirs[["hg19"]])

Description

Reads a command-line argument supplied to a script.

Usage

logger.argument(arg.names, full.name, arg.type = "character",
accepted.values = NULL, default = NULL, arg.list = commandArgs())

Arguments

arg.names character vector of acceptable argument names. This function scans the pro-
vided arguments and performs a case insensitive match.

full.name One-element character vector giving the argument’s full name or description.
This is used in a log message in case of an error.

arg.type Variable type of the argument. Must be one of "character", "logical", "integer",
"double", "numeric" or "real". The last three types are all synonyms.

accepted.values Vector of accepted values for the argument. This must be of the type given in
arg.type. Set this to NULL if there are no restrictions on the argument values.

default Default value for the argument in case it is not specified. Setting this to NULL
makes the argument required, that is, an error is generated if the argument is not
specified. Set this to NA if is not a required argument and it shouldn’t default to
a specific value. Otherwise, if accepted.values is provided, this must be one
of its elements.

arg.list Vector of arguments provided at the execution of the script. The arguments
should be provided as name=value pairs.

Details

This is convenience function for reading parameters supplied to the script in the form name=value.
It expects that logging is enabled (see rnb.options). The function fails if this condition is not met.

Value

Argument’s value, or NULL if such is not provided.
**Description**

Gets the files currently used by the logger.

**Usage**

```r
logger.getfiles()
```

**Value**

Vector storing the full names of the files that are being used by the logger. This vector contains `NA` as an element if the logger is (also) using the console for its output. If logging functionality is disabled (see `rnb.options`) or the logger is not initialized, this function returns `NULL`.

**Author(s)**

Yassen Assenov

**See Also**

- `logger.isinitialized` to check if logging is activated; `logger.start` for initializing a logger or starting a section

**Examples**

```r
if (NA %in% logger.getfiles())
  cat("Console logger is enabled\n")
```
### logger.isinitialized

**Description**
Checks if the logger is initialized.

**Usage**
```
logger.isinitialized()
```

**Value**
TRUE if the logger was initialized and is in use; FALSE otherwise.

**Author(s)**
Yassen Assenov

**See Also**
- `logger.start` for initializing a logger or starting a section

**Examples**
```
if (!logger.isinitialized())
  logger.start(fname = NA)
```

### logger.machine.name

**Description**
Log the machine name the analysis is run on

**Usage**
```
logger.machine.name()
```

**Value**
None (invisible NULL).

**Author(s)**
Fabian Mueller
Description

Functions for logger management.

Usage

logger.start(txt = character(0), fname = NULL)

logger.completed()

logger.close()

Arguments

txt Description to add to the log file. The words STARTED and COMPLETED are prepended to the message upon initialization and completion of the section, respectively.

fname Name of the log file and/or console. Note that at most one file name can be specified. The function logger.start normalizes the given name, that is, it converts it to an absolute name. If this parameter is NA, logger messages are printed to the console. If it is a two-element vector containing one file name and NA, the logger is (re)initialized to print messages both to the given file name and the console. A value of NULL (default) indicates the logger should continue using the previously specified file.

Value

None (invisible NULL).

Details

logger.start initializes the logger and/or starts a new section. logger.completed completes the last (innermost) open section in the log. logger.close deinitializes the logger. Note that after reinitialization or deinitialization, the information about the current output file, as well as any open sections, is deleted.

Author(s)

Yassen Assenov

See Also

logger.isinitialized
Examples

```r
if (!logger.isinitialized())
  logger.start(fname = NA)
logger.start("Tests for Significance")
logger.completed()
logger.close()
```

Description

Appends a single-line status message to the log text file. The message is prepended by its type, which is one of STATUS, INFO, WARNING or ERROR.

Usage

```r
logger.status(txt)
logger.info(txt)
logger.warning(txt)
logger.error(txt, terminate = rnb.getOption("logging.exit.on.error"))
```

Arguments

- `txt`: Text to add to the log file. This must be a character vector; its elements are concatenated using a single space (" ") as a separator.
- `terminate`: Flag indicating if the execution is to be terminated after this error message is added to the log.

Value

None (invisible NULL).

Author(s)

Yassen Assenov

See Also

- `logger.isinitialized` to check if logging is activated; `logger.start` for initializing a logger or starting a section
Examples

if (!logger.isinitialized())
    logger.start(fname = NA)
logger.status(c("Reached step", 2))
logger.info(c("Provided email:", rnb.getOption("email")))

Description

Validates the specified file or directory exists. Prints an error or a warning message to the log if it does not exist, it is not of the accepted type or is not accessible.

Usage

logger.validate.file(file, is.file = TRUE, terminate = TRUE)

Arguments

- **file**: Name of file or directory to validate.
- **is.file**: Flag indicating if the given name must denote an existing file. If this is FALSE, the given name must denote a directory. Set this to NA if both types are an acceptable scenario.
- **terminate**: Flag indicating if the execution is to be terminated in case the validation fails. This parameter determines if an error message (terminate is TRUE) or a warning message (terminate is FALSE) is to be sent to the log when the specified file or directory does not exist, is not of the accepted type or is not accessible.

Value

Whether the validation succeeded or not, invisibly. Note that when terminate is TRUE and the validation fails, the R session is closed and thus no value is returned.

Author(s)

Yassen Assenov

Examples

if (!logger.isinitialized())
    logger.start(fname = NA)
# Validate the current working directory exists
logger.validate.file(getwd(), FALSE)
Description

plot a barplot of LOLA enrichment results

Usage

lolaBarPlot(lolaDb, lolaRes, scoreCol = "pValueLog", orderCol = scoreCol, signifCol = "qValue", includedCollections = c(), pvalCut = 0.01, maxTerms = 50, colorpanel = sample(rainbow(maxTerms, v = 0.5)), groupByCollection = TRUE, orderDecreasing = NULL)

Arguments

lolaDb
LOLA DB object as returned by LOLA::loadRegionDB or loadLolaDbs

lolaRes
LOLA enrichment result as returned by the runLOLA function from the LOLA package

scoreCol
column name in lolaRes to be plotted

orderCol
column name in lolaRes which is used for sorting the results

signifCol
column name of the significance score in lolaRes. Should be one of c("pValueLog", "qValue")

includedCollections
vector of collection names to be included in the plot. If empty (default), all collections are used

pvalCut
p-value cutoff to be employed for filtering the results

maxTerms
maximum number of items to be included in the plot

colorpanel
colors to be used for coloring the bars according to "target" (see getTargetFromLolaDb). An empty vector indicates that black will be used for all bars.

groupByCollection
facet the plot by collection

orderDecreasing
flag indicating whether the value in orderCol should be considered as decreasing (as opposed to increasing). NULL (default) for automatic determination.

Value

ggplot object containing the plot

Author(s)

Fabian Mueller
Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
# compute differential methylation
dm <- rnb.execute.computeDiffMeth(rnb.set.example, pheno.cols=c("Sample_Group","Treatment"))
# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
# perform enrichment analysis
res <- performLolaEnrichment.diffMeth(rnb.set.example, dm, lolaDirs["hg19"])
# select the 500 most hypermethylated tiling regions in ESCs compared to iPSCs
# in the example dataset
lolaRes <- res$region["hESC vs. hiPSC (based on Sample_Group)"][]["tiling"]
lolaRes <- lolaRes[lolaRes$userSet=="rankCut_500_hyper",]
# plot
lolaBarPlot(res$lolaDb, lolaRes, scoreCol="oddsRatio", orderCol="maxRnk", pvalCut=0.05)

lolaBoxPlotPerTarget  lolaBoxPlotPerTarget

Description

plot a boxplot showing LOLA enrichment results per "target" group (see getTargetFromLolaDb
for an explanation of "target").

Usage

lolaBoxPlotPerTarget(lolaDb, lolaRes, scoreCol = "pValueLog", 
orderCol = scoreCol, signifCol = "qValue", includedCollections = c(),
pvalCut = 0.01, maxTerms = 50, colorpanel = c(),
groupByCollection = TRUE, orderDecreasing = NULL,
scoreDecreasing = NULL)

Arguments

lolaDb  LOLA DB object as returned by LOLA::loadRegionDB or loadLolaDbs
lolaRes  LOLA enrichment result as returned by the runLOLA function from the LOLA package
scoreCol  column name in lolaRes to be plotted
orderCol  column name in lolaRes which is used for sorting the results
signifCol  column name of the significance score in lolaRes. Should be one of c("pValueLog", "qValue")
includedCollections  vector of collection names to be included in the plot. If empty (default), all collections are used
pvalCut  p-value cutoff to be employed for filtering the results
maxTerms  maximum number of items to be included in the plot
lolaVolcanoPlot

colorpanel colors to be used for coloring the bars according to "target" (see `getTargetFromLolaDb`). An empty vector indicates that black will be used for all bars.

groupByCollection facet the plot by collection

orderDecreasing flag indicating whether the value in `orderCol` should be considered as decreasing (as opposed to increasing). NULL (default) for automatic determination.

scoreDecreasing flag indicating whether the value in `scoreCol` should be considered as decreasing (as opposed to increasing). NULL (default) for automatic determination.

Value

- ggplot object containing the plot

Author(s)

- Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
# compute differential methylation
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
# perform enrichment analysis
res <- performLolaEnrichment.diffMeth(rnb.set.example, dm, lolaDirs["hg19"])
# select the 500 most hypermethylated tiling regions in ESCs compared to iPSCs in the example dataset
lolaRes <- res$region[["hESC vs. hiPSC (based on Sample_Group)"]][["tiling"]]
lolaRes <- lolaRes[lolaRes$userSet=="rankCut_500_hyper",]
# plot
lolaBoxPlotPerTarget(res$lolaDb, lolaRes, scoreCol="oddsRatio", orderCol="maxRnk", pvalCut=0.05)
```

Description

- plot a volcano plot showing LOLA enrichment results: LOLA p-value against the log-odds score. Colored by rank

Usage

```r
lolaVolcanoPlot(lolaDb, lolaRes, includedCollections = c(),
    signifCol = "qValue", colorBy = "maxRnk", colorpanel = c())
```
**lump.hg19**

**Arguments**

- **lolaDb**: LOLA DB object as returned by LOLA::loadRegionDB or `loadLolaDbs`
- **lolaRes**: LOLA enrichment result as returned by the `runLOLA` function from the LOLA package
- **includedCollections**: vector of collection names to be included in the plot. If empty (default), all collections are used
- **signifCol**: column name of the significance score in `lolaRes`. Should be one of `c("pValueLog", "qValue")`.
- **colorBy**: annotation/column in the the LOLA DB that should be used for point coloring
- **colorpanel**: colors to be used for coloring the points

**Value**

`ggplot` object containing the plot

**Author(s)**

Fabian Mueller

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
# compute differential methylation
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
# perform enrichment analysis
res <- performLolaEnrichment.diffMeth(rnb.set.example, dm, lolaDirs["hg19"])
# select the 500 most hypermethylated tiling regions in ESCs compared to iPSCs
# in the example dataset
lolaRes <- res$region["hESC vs. hiPSC (based on Sample_Group)"][["tiling"]]
lolaRes <- lolaRes[lolaRes$userSet=="rankCut_500_hyper",]
# plot
lolaVolcanoPlot(res$lolaDb, lolaRes, signifCol="qValue")
```

---

**lump.hg19**

**LUMP Support**

**Description**

The sites used by the LUMP algorithm for estimating immune cell content are stored in an object named `lump.hg19`. This object should not be loaded or otherwise operated on by users. Please refer to the documentation of `rnb.execute.lump` for information on the algorithm and its implementation in `RnBeads`. 
Format

lump.* is a list of non-empty integer matrices, one per supported platform. Every matrix contains exactly two columns, denoting chromosome index and chromosome-based index, respectively. These indices refer to positions within the probe/site annotation table employed by \texttt{RnBeads} for the corresponding platform.

Author(s)

Yassen Assenov

Description

Extract raw methylated probe intensity from an object of \texttt{RnBeadRawSet} class.

Usage

\begin{verbatim}
## S4 method for signature 'RnBeadRawSet'
M(object, row.names = FALSE)
\end{verbatim}

Arguments

- \textbf{object} Dataset of interest.
- \textbf{row.names} Flag indicating whether the resulting matrix will be assigned row names

Value

matrix of the methylated probe intensities

Examples

\begin{verbatim}
library(RnBeads.hg19)
data(small.example.object)
M.intensity<-M(rnb.set.example)
head(M.intensity)
\end{verbatim}
**mask.sites.meth,RnBSet-method**

**Description**
Given a logical matrix, sets corresponding entries in the methylation table to NA (masking). Low memory footprint.

**Usage**

```r
## S4 method for signature 'RnBSet'
mask.sites.meth(object, mask, verbose = FALSE)
```

**Arguments**

- **object**: Dataset of interest.
- **mask**: logical matrix indicating which sites should be masked
- **verbose**: if TRUE additional diagnostic output is generated

**Value**

The modified dataset.

**mergeSamples,RnBSet-method**

**Description**
Take an RnBSet object and merge methylation and phenotype information given a grouping column in the pheno table coverage is combined by taking the sum of coverages pheno is combined by concatenating entries from all samples.

**Usage**

```r
## S4 method for signature 'RnBSet'
mergeSamples(object, grp.col)
```

**Arguments**

- **object**: input RnBSet object
- **grp.col**: a column name (string) of pheno(rnb.set) that contains unique identifiers for sample groups/replicates to be combined

**Details**

combines phenotype information, coverage information and methylation information methylation is combined by taking the average. Detection p-values are combined using Fisher’s method. For methylation arrays, bead counts are currently not taken into account. objects of class RnBeadRawSet are automatically converted to RnBeadSet.
**Value**

the modified RnBSet object

**Note**

Requires the packages **foreach** and **doParallel**.

**Author(s)**

Fabian Mueller

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.set.example
rnb.set.merged <- mergeSamples(rnb.set.example,"Cell_Line")
rnb.set.merged
pheno(rnb.set.merged)
```

**meth,RnBSet-method**

**meth-methods**

**Description**

Extracts DNA methylation information (beta values) for a specified set of genomic features.

**Usage**

```r
## S4 method for signature 'RnBSet'
meth(object, type = "sites", row.names = FALSE,
   i = NULL, j = NULL)
```

**Arguments**

- **object**
  - dataset of interest.
- **type**
  - character singleton. If this is set to "sites" (default), DNA methylation information for each available site is returned. Otherwise, this should be one of region types for which summarized DNA methylation information is computed in the given dataset.
- **row.names**
  - flag indicating if row names are to be generated in the result.
- **i**
  - indices of sites/regions to be retrieved. By default (NULL), all will be retrieved.
- **j**
  - indices of samples to be retrieved. By default (NULL), all will be retrieved.

**Value**

matrix with methylation beta values.
See Also

`mval` for calculating M values

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
## per-site beta-value matrix
mm<-meth(rnb.set.example, row.names=TRUE)
head(mm)
## beta-values for each covered gene
gmm<-meth(rnb.set.example, type="gene", row.names=TRUE)
head(gmm)
```

Description

Extracts DNA methylation information (M values) for a specified set of genomic features.

Usage

```r
## S4 method for signature 'RnBSet'
mval(object, type = "sites", row.names = FALSE,
    epsilon = 0)
```

Arguments

- `object`: dataset of interest.
- `type`: character singleton. If this is set to "sites" (default), DNA methylation information for each available site is returned. Otherwise, this should be one of region types for which summarized DNA methylation information is computed in the given dataset.
- `row.names`: Flag indicating of row names are to be generated in the result.
- `epsilon`: Threshold of beta values to use when adjusting for potential M values close to +infinity or -infinity. See `rnb.beta2mval` for more details.

Value

matrix with methylation M values.

See Also

`meth` for extracting methylation beta values
Examples

library(RnBeads.hg19)
data(small.example.object)
## per-site M-value matrix
mm<-mval(rnb.set.example, row.names=TRUE)
head(mm)
## M-values for each covered gene
gmm<-mval(rnb.set.example, type="gene", row.names=TRUE)
head(gmm)

nsites,RnBSet-method  nsites-methods

Description

Returns the number of sites/regions for a given RnBSet object

Usage

## S4 method for signature 'RnBSet'
nsites(object, type = "sites")

Arguments

object  RnBSet of interest.
type character singleton. If this is set to "sites" (default), the number of sites is returned. Otherwise, this should be one of region types for for which the number of regions is returned.

Value

integer stating the number of sites/regions. NA if the regions have not been summarized yet.

See Also

meth Retrieving the matrix of methylation values

Examples

library(RnBeads.hg19)
data(small.example.object)
nsites(rnb.set.example)
Description

Performs cleanup and/or other finishing activities and closes the specified device, connection, or document.

Usage

```r
## S4 method for signature 'Report'
off(.Object)

## S4 method for signature 'ReportPlot'
off(.Object)

## S4 method for signature 'ReportGgPlot'
off(.Object, handle.errors = FALSE)
```

Arguments

- `.Object` Object to be closed.
- `handle.errors` Flag indicating if the method should attempt to catch and process errors (e.g., I/O errors) internally. Setting this to `TRUE` does not guarantee that the method never stops with an error.

Value

The closed object, invisibly.

Description

Gets the number of workers used for parallel processing.

Usage

```r
parallel.getNumWorkers()
```

Value

Number of workers used for parallel processing; -1 if parallel processing is not enabled.

Author(s)

Fabian Mueller
Examples

parallel.getNumWorkers()
parallel.setup(2)
parallel.getNumWorkers()
parallel.teardown()
parallel.getNumWorkers()

parallel.isEnabled

Description
Checks if whether parallel processing is enabled.

Usage
parallel.isEnabled()

Value
TRUE if multicore processing is enabled, FALSE otherwise.

Author(s)
Fabian Mueller

Examples

parallel.isEnabled()
parallel.setup(2)
parallel.isEnabled()
parallel.teardown()
parallel.isEnabled()

parallel.setup

Description
Sets up parallel processing. Requires the foreach and doParallel packages

Usage
parallel.setup(...)
Arguments

Parameters for registerDoParallel from the \texttt{doParallel} package. This allows, for instance, for specifying the number of workers.

Value

\texttt{TRUE} (invisible) to indicate that parallelization is set up.

Note

Requires the packages \texttt{foreach} and \texttt{doParallel}.

Author(s)

Fabian Mueller

Examples

\begin{verbatim}
parallel.setup(2)
parallel.teardown()
\end{verbatim}

\begin{verbatim}
parallel.teardown
\end{verbatim}

Description

Disables parallel processing.

Usage

\begin{verbatim}
parallel.teardown()
\end{verbatim}

Value

\texttt{TRUE}, invisibly.

Author(s)

Fabian Mueller

Examples

\begin{verbatim}
parallel.getNumWorkers()
parallel.setup(2)
parallel.getNumWorkers()
parallel.teardown()
parallel.getNumWorkers()
\end{verbatim}
performGoEnrichment.diffMeth

Description
performs Geno Ontology (GO) enrichment analysis for a given differential methylation table.

Usage
performGoEnrichment.diffMeth(rnbSet, diffmeth, ontologies = c("BP", "MF"),
rank.cuts.region = c(100, 500, 1000), add.auto.rank.cut = TRUE,
rerank = TRUE, verbose = TRUE, ...)

Arguments
rnbSet RnBSet object for which differential methylation was computed
diffmeth RnBDiffMeth object. See RnBDiffMeth-class for details.
ontologies GO ontologies to use for enrichment analysis
rank.cuts.region Cutoffs for combined ranking that are used to determine differentially methylated regions
add.auto.rank.cut flag indicating whether an automatically computed cut-off should also be considered.
rerank For determining differential methylation: should the ranks be ranked again or should the absolute ranks be used.
verbose Enable for detailed status report
...
arguments passed on to the parameters of GOHyperGParams from the GOstats package

Value
a DiffMeth.go.enrich object (S3) containing the following attributes
region Enrichment information for differential methylation on the region level. See GOHyperGresult from the GOstats package for further details

Author(s)
Fabian Mueller

Examples
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example, pheno.cols=c("Sample_Group","Treatment"))
res <- performGoEnrichment.diffMeth(rnb.set.example, dm)
Description

performs Gene Ontology (GO) enrichment analysis for a list of Entrez identifiers

Usage

performGOenrichment.diffMeth.entrez(gids, uids, ontology, assembly = "hg19", ...)

Arguments

gids                      gene ids to test (entrez IDs)
uids                      ids to test against (universe)
ontology                  which ontology should be used (see GOHyperGParams from the GOstats package for details)
assembly                  Genome to be used. One of the following: hg19, mm9, mm10 or rn5
...                       arguments passed on to the parameters of GOHyperGParams from the GOstats package

Value

a GOHyperGresult object (see the GOstats package for further details)

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
dmt <- get.table(dm,get.comparisons(dm)[1],"promoters")
annot <- annotation(rnb.set.example,"promoters")
all.promoters <- annot$entrezID
#get the hypermethylated promoters
hyper.promoters <- annot$entrezID[dmt[,"mean.mean.diff"]>0]
result <- performGOenrichment.diffMeth.entrez(hyper.promoters,all.promoters,"BP",assembly="hg19")
performGOEnrichment.diffVar

Description
performs Geno Ontology (GO) enrichment analysis for a given differential variability table.

Usage
performGOEnrichment.diffVar(rnbSet, diffmeth, enrich.diffMeth = NULL,
ontologies = c("BP", "MF"), rank.cuts.region = c(100, 500, 1000),
add.auto.rank.cut = TRUE, rerank = TRUE, verbose = TRUE, ...)

Arguments
rnbSet RnBSet object for which differential variability was computed
diffmeth RnBDiffMeth object. See RnBDiffMeth-class for details.
enrich.diffMeth Result of performGOEnrichment.diffMeth. NULL, if enrichment should only be performed for differential variability.
ontologies GO ontologies to use for enrichment analysis
rank.cuts.region Cutoffs for combined ranking that are used to determine differentially variable regions
add.auto.rank.cut flag indicating whether an automatically computed cut-off should also be considered.
rerank For determining differential variability: should the ranks be ranked again or should the absolute ranks be used.
verbose Enable for detailed status report
...
arguments passed on to the parameters of GOHyperGParams from the GOstats package

Value
a DiffMeth.enrich object (S3) containing the following attributes

region Enrichment information for differential variability on the region level. See GOHyperGresult from the GOstats package for further details

Author(s)
Fabian Mueller and Michael Scherer
Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.diffVar(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
res <- performEnrichment.diffVar(rnb.set.example, dm)

Description

performs LOLA enrichment analysis for a given differential methylation table.

Usage

performLolaEnrichment.diffMeth(rnbSet, diffmeth, lolaDbPaths, 
rank.cuts.region = c(100, 500, 1000), add.auto.rank.cut = TRUE, 
rerank = TRUE, verbose = TRUE)

Arguments

rnbSet  
RnBSet object for which differential methylation was computed
diffmeth  
RnBDiffMeth object. See RnBDiffMeth-class for details.
lolaDbPaths  
LOLA database paths
rank.cuts.region  
Cutoffs for combined ranking that are used to determine differentially methylated regions
add.auto.rank.cut  
flag indicating whether an automatically computed cut-off should also be considered.
rerank  
For determining differential methylation: should the ranks be ranked again or should the absolute ranks be used.
verbose  
Enable for detailed status report

Value

a DiffMeth.lola.enrich object (S3) containing the following attributes

region  
Enrichment information for differential methylation on the region level. A data.table object as returned by the runLOLA function from the LOLA package for further details. Each element will contain different user sets for different rank cutoffs and hyper/hypomethylation events(userSet column)
lolaDb  
The loaded lolaDb object containing the merged databases as returned by loadLolaDbs

Author(s)

Fabian Mueller
**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
# compute differential methylation
dm <- rnb.execute.computeDiffMeth(rnb.set.example, pheno.cols=c("Sample_Group","Treatment"))
# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDb(lolaDest, dbs="LOLACore")
# perform enrichment analysis
res <- performLolaEnrichment.diffMeth(rnb.set.example, dm, lolaDirs[["hg19"]])
```

**Description**

performs LOLA enrichment analysis for a given differential variability table.

**Usage**

```r
performLolaEnrichment.diffVar(rnbSet, diffmeth, enrich.diffMeth = NULL, lolaDbPaths, rank.cuts.region = c(100, 500, 1000), add.auto.rank.cut = TRUE, rerank = TRUE, verbose = TRUE)
```

**Arguments**

- `rnbSet`: RnBSet object for which differential variability was computed.
- `diffmeth`: RnBDiffMeth object. See `RnBDiffMeth-class` for details.
- `enrich.diffMeth`: Enrichment object as obtained from `performLolaEnrichment.diffMeth`. If it is not provided a new object is created.
- `lolaDbPaths`: LOLA database paths.
- `rank.cuts.region`: Cutoffs for combined ranking that are used to determine differentially variable regions.
- `add.auto.rank.cut`: flag indicating whether an automatically computed cut-off should also be considered.
- `rerank`: For determining differential variability: should the ranks be ranked again or should the absolute ranks be used.
- `verbose`: Enable for detailed status report.
Value

a DiffMeth.lola.enrich object (S3) containing the following attributes

region  Enrichment information for differential variability on the region level. A data.table object as returned by the runLOLA function from the LOLA package for further details. Each element will contain different user sets for different rank cutoffs and hyper/hypomethylation events (userSet column)

lolaDb  The loaded lolaDb object containing the merged databases as returned by loadLolaDb

Author(s)

Michael Scherer and Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
# compute differential methylation
dm <- rnb.execute.diffVar(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
# download LOLA DB
lolaDest <- tempfile()
dir.create(lolaDest)
lolaDirs <- downloadLolaDbs(lolaDest, dbs="LOLACore")
# perform enrichment analysis
res <- performLolaEnrichment.diffVar(rnb.set.example,dm,lolaDirs[["hg19"]])
Examples

library(RnBeads.hg19)
data(small.example.object)
pheno(rnb.set.example)

prepareSOFTfileForGEO

Description

Starting from an RnBeadSet object generates a batch submission file for Gene Expression Omnibus series in SOFT format

Usage

prepareSOFTfileForGEO(rnb.set, filename, sample.source.col = NULL, sample.description.col = NULL, sample.title.col = NULL, export.cols = seq(ncol(pheno(rnb.set))), rnb.set.raw = NULL, sample.extra.info = NULL, series.info = NULL)

Arguments

rnb.set Object inheriting from class RnBeadSet with "GSE".
filename Absolute path or a name of a SOFT file to be generated
sample.source.col integer singleton specifying a column in the pheno slot of rnb.set containing information which will be written into the field Sample_source_name_ch1 of each sample record
sample.description.col integer singleton specifying a column in the pheno slot of rnb.set containing information which will be written into the field Sample_description of each sample record
sample.title.col integer singleton specifying a column in the pheno slot of rnb.set containing information which will be written into the field Sample_title of each sample record
export.cols integer vector specifying columns in the pheno slot of rnb.set containing information which will be written into the fields Sample_characteristics_ch1 of each sample record
rnb.set.raw Object inheriting from class RnBeadSet
sample.extra.info Optionally, a list with elements to be written to all series record. Elements should be character singletons named with valid SOFT labels of a SAMPLE section, e.g. Sample_extract_protocol, Sample_hyb_protocol, Sample_label_protocol_ch1, Sample_data_processing, Sample_contact_name, Sample_contact_email etc.
series.info A list with elements to be written to the series record. Elements should be character singletons named SERIES (contains a valid GSE identifier for updating an existing series) Series_title, Series_summary, Series_type, Series_overall_design, Series_contributor, Series_sample_id

Details

The code was largely adapted from a similar function in package lumi which is due to Pan Du.

Value

TRUE on success.

Author(s)

Pavlo Lutsik

Description

Extracts HumanMethylation quality control information

Usage

## S4 method for signature 'RnBeadSet'
qc(object)

Arguments

object Dataset of interest.

Value

Quality control information available for the dataset in the form of a list with two elements: Cy3 and Cy5.

Examples

library(RnBeads.hg19)
data(small.example.object)
qcinf<-dpval(rnb.set.example, row.names=TRUE)
head(qcinf$Cy3)
head(qcinf$Cy5)
**Description**

Reads a reduced-representation/whole-genome bisulfite sequencing data set from a set of BED files

**Usage**

```r
read.bed.files(base.dir = NULL, file.names = NULL, sample.sheet = NULL,
file.names.col = 0, assembly = rnb.getOption("assembly"),
region.types = rnb.region.types.for.analysis(assembly),
pos.coord.shift = 1L, skip.lines = 1,
sep.samples = rnb.getOption("import.table.separator"),
merge.bed.files = TRUE, useff = rnb.getOption("disk.dump.big.matrices"),
usebigff = rnb.getOption("disk.dump.bigff"), verbose = TRUE, ...)
```

**Arguments**

- `base.dir`: Directory with BED files containing processed methylation data
- `file.names`: Optional non-empty character vector listing the names of the files that should be loaded relative to `base.dir`. If supplied, this vector must not contain NA among its elements.
- `sample.sheet`: Optional file name containing a table of sample annotation data, or the table itself in the form of a `data.frame` or matrix. Only (and all) samples defined in this table will be loaded. The table is expected to contain a column named "barcode" that lists the samples' Sentrix barcodes. If such a column is not present, this function searches for columns "Sentrix_ID" and "Sentrix_Position" (or similar) that build a barcode.
- `file.names.col`: Column of the sample sheet which contains the file names (integer singleton). If NA an attempt will be made to find a suitting column automatically.
- `assembly`: Genome assembly. Defaults to human ("hg19")
- `region.types`: Character vector storing the types of regions for which the methylation information is to be summarized. The function `rnb.region.types` provides the list of all supported regions. Setting this to NULL or an empty vector restricts the dataset to site methylation only.
- `pos.coord.shift`: The frame shift between the the CpG annotation (1-based) and the coordinates in the loaded BEDs. If BEDs have 0-based coordinates, pos.coord.shift=1 (default).
- `skip.lines`: The number of top lines to skip while reading the BED files
- `sep.samples`: Character singleton used as field separator in the sample sheet file. Default value is taken by the call to `rnb.getOption("import.table.separator")`
- `merge.bed.files`: In case multiple BED files are specified for each sample, the flag indicates whether the methylation calls should be merged after reading
- `useff`: If TRUE, functionality provided by the `ff` package will be used to read the data efficiently.
read.data.dir

usebigff  flag specifying whether the extended ff functionality should be used (large matrix support for ff)
verbose  Flag indicating if the messages to the logger should be sent. Note that the logger must be initialized prior to calling this function. Logging is useful for keeping a record of the downloaded and processed samples. Also, informative messages are stored in case of an error.

Details
To control the BED column assignment, one should also supply arguments to read.single.bed.

Value
an object of class RnBiseqSet

Author(s)
Pavlo Lutsik

Description
Reads in a directory with Illumina Infinium HumanMethylation450 data. The files should be stored as data

Usage
read.data.dir(dir, pheno, betas, p.values, bead.counts, sep = rnb.getOption("import.table.separator"), verbose = TRUE)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dir</td>
<td>directory containing the table files</td>
</tr>
<tr>
<td>pheno</td>
<td>a file containing data sample annotations and phenotypic information</td>
</tr>
<tr>
<td>betas</td>
<td>a file containing the beta values. If not supplied, the routine will look in dir for a file containing &quot;beta&quot; token in the filename</td>
</tr>
<tr>
<td>p.values</td>
<td>a file containing the detection p values. If not supplied, the routine will look in dir for a file containing &quot;pval&quot; token in the filename</td>
</tr>
<tr>
<td>bead.counts</td>
<td>a file containing the bead counts (optional). If not supplied, the routine will look in dir for a file containing &quot;bead&quot; token in the filename</td>
</tr>
<tr>
<td>sep</td>
<td>character used as field separator in the tables files. Default value is taken by the call to rnb.getOption(&quot;import.table.separator&quot;)</td>
</tr>
<tr>
<td>verbose</td>
<td>Flag indicating if the messages to the logger should be sent. Note that the logger must be initialized prior to calling this function. Logging is useful for keeping a record of the downloaded and processed samples. Also, informative messages are stored in case of an error.</td>
</tr>
</tbody>
</table>
**Details**

Colnames in all files should match. They will be returned as the samples element of the list.

**Value**

Object of type `RnBeadSet`.

**Author(s)**

Pavlo Lutsik

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**read.GS.report**

**read.GS.report**

**Description**

Reads in a Genome Studio report, exported as a single file.

**Usage**

```r
read.GS.report(gsReportFile, pd = NULL, 
sep = rnb.getOption("import.table.separator"), keep.methylumi = FALSE, 
verbose = TRUE)
```

**Arguments**

- `gsReportFile` location of the GS report file
- `pd` alternative sample annotation, if the `gsReportFile` is missing the sample section as `data.frame` of character singleton with the file name
- `sep` character used as field separator in the sample sheet file and in the GS report file (should be identical). Default value is taken by the call to `rnb.getOption("import.table.separator")`
- `keep.methylumi` a flag indicating whether the a `MethylumiSet` object should be returned instead of a `RnBeadRawSet`
- `verbose` Flag indicating if the messages to the logger should be sent. Note that the logger must be initialized prior to calling this function. Logging is useful for keeping a record of the downloaded and processed samples. Also, informative messages are stored in case of an error.

**Value**

`MethylumiSet` object with the data from the report
**read.idat.files**

**Description**

Reads a directory of .idat files and initializes an object of type `MethyLumiSet`.

**Usage**

```r
read.idat.files(base.dir, barcodes = NULL, sample.sheet = NULL,
                 sep.samples = rnb.getOption("import.table.separator"), useff = FALSE,
                 verbose = TRUE)
```

**Arguments**

- `base.dir` Directory that contains the .idat files to be read; or a character vector of such directories.
- `barcodes` Optional non-empty character vector listing the barcodes of the samples that should be loaded. If supplied, this vector must not contain NA among its elements.
- `sample.sheet` Optional file name containing a table of sample annotation data, or the table itself in the form of a `data.frame` or `matrix`. Only (and all) samples defined in this table will be loaded. The table is expected to contain a column named "barcode" that lists the samples' Sentrix barcodes. If such a column is not present, this function searches for columns "Sentrix_ID" and "Sentrix_Position" (or similar) that build a barcode.
- `sep.samples` character string used as field separator in the sample sheet file. Default value is taken by the call to rnb.getOption("import.table.separator")
- `useff` If TRUE ff package is used to store large matrices on the hard disk
- `verbose` Flag specifying whether the messages to the logger should be sent. Note that the logger must be initialized prior to calling this function. Logging is useful for keeping a record of the downloaded and processed samples. Also, informative messages are stored in case of an error.

**Details**

If neither barcodes, nor sample.sheet are specified, the function attempts to locate a file in `base.dir` containing sample annotation information. It fails if such a file cannot be (unambiguously) identified. If both barcodes and sample.sheet are supplied, only sample.sheet is used in loading methylation data. The value of barcodes is tested for validity but it is not used as a filter.

**Value**

Loaded dataset of HumanMethylation450K samples, encapsulated in an object of type `MethyLumiSet`.

**Author(s)**

Pavlo Lutsik
See Also

methylumIDAT in package methylumi

read.idat.files2...read.idat.files2

Description

Reads a directory of .idat files and initializes an object of type MethyLumiSet.

Usage

read.idat.files2(base.dir, barcodes = NULL, sample.sheet = NULL, sep.samples = rnb.getOption("import.table.separator"), load.chunk = NULL, keep.methylumi = FALSE, verbose = TRUE)

Arguments

base.dir Directory that contains the .idat files to be read; or a character vector of such directories.
barcodes Optional non-empty character vector listing the barcodes of the samples that should be loaded. If supplied, this vector must not contain NA among its elements.
sample.sheet Optional file name containing a table of sample annotation data, or the table itself in the form of a data.frame or matrix. Only (and all) samples defined in this table will be loaded. The table is expected to contain a column named "barcode" that lists the samples’ Sentrix barcodes. If such a column is not present, this function searches for columns "Sentrix_ID" and "Sentrix_Position" (or similar) that build a barcode.
sep.samples character used as field separator in the sample sheet file. Default value is taken by the call to rnb.getOption("import.table.separator")
load.chunk integer of size one, giving the number of IDAT files which should be loaded in one loading cycle or NULL, in which case an attempt will be made to load all files in one go. Should be assigned in case the number of IDATs is more than one thousand.
keep.methylumi a flag indicating whether the a MethyLumiSet object should be returned instead of a RnBeadRawSet.
verbose Flag indicating if the messages to the logger should be sent. Note that the logger must be initialized prior to calling this function. Logging is useful for keeping a record of the downloaded and processed samples. Also, informative messages are stored in case of an error.

Details

If neither barcodes, nor sample.sheet are specified, the function attempts to locate a file in base.dir containing sample annotation information. It fails if such a file cannot be (unambiguously) identified. If both barcodes and sample.sheet are supplied, only sample.sheet is used in loading methylation data. The value of barcodes is tested for validity but it is not used as a filter.
Value

Loaded dataset of HumanMethylation450K samples, encapsulated in an object of type MethyLumiSet.

Author(s)

Pavlo Lutsik

See Also

methylumIDAT in package methylumi

Description

Reads Illumina Infinium sample annotation.

Usage

read.sample.annotation(fname, sep = rnb.getOption("import.table.separator"))

Arguments

fname Name of text file that contains a sample annotation table with a header. This method handles a variety of file formats, including comma-separated values file exported from Genome Studio.

sep One-element character used as field separator in the tables file.

Value

Sample annotation table in the form of a data.frame, in which every row corresponds to a sample, and every column - to a trait.

Author(s)

Pavlo Lutsik

Examples

annotation.file<-system.file("")
sa<-read.sample.annotation(annotation.file)
sa
read.single.bed

Description

reads a BED file with methylation information

Usage

read.single.bed(file, chr.col = 1L, start.col = 2L, end.col = 3L,
strand.col = 6L, mean.meth.col = 7L, coverage.col = 8L, c.col = NA,
t.col = NA, is.epp.style = FALSE, coord.shift = 0L, ffread = FALSE,
context = "cg", ...) 

Arguments

file the input BED file
chr.col chromosome column index
start.col start column index
end.col end column index
strand.col strand column index
mean.meth.col mean methylation column index
coverage.col column with coverage information
c.col converted C counts column index
t.col unconverted C counts column index
is.epp.style Flag for custom Broad Epigenome Pipeline (EPP) bed style (columns "chrom",
"start","end","methylated_count/total_count","meth_score_scaled_0_1000"
and "strand" in this order). Setting this to TRUE overwrites all other parameters
except file, and also neglects ....
coord.shift An integer specifying the coordinate adjustment applied to the start and end
coordinates.
ffread Use ff package functionality
context prefix for the output rownames
... further arguments to read.table or read.table.ffdf

Details

Missing columns should be assigned with NA. In case mean.meth.col is absent at least coverage.col
and one of c.col or t.col should be specified.

Value

a data.frame or ff.data.frame object with DNA methylation and coverage information. The row
names are formed by the following conversion: context\read.delim(file,...)[,chr.col]\read.delim(file,...)

Author(s)

Pavlo Lutsik
**Description**

Applies the reference-free cell-type heterogeneity adjustment model from [1] and returns corrected p-values

**Usage**

```r
defreeEWASP(X, inds.g1, inds.g2 = -inds.g1, adjustment.table = NULL, paired = FALSE, nboot = 100, ignore.na = TRUE, rescale.residual = TRUE)
```

**Arguments**

- **X**
  - Matrix on which the test is performed for every row
- **inds.g1**
  - column indices of group 1 members
- **inds.g2**
  - column indices of group 2 members
- **adjustment.table**
  - a data.frame containing variables to adjust for in the testing
- **paired**
  - should a paired analysis model be used. If so, the first index in `inds.g1` must correspond to the first index in `inds.g2` and so on.
- **nboot**
  - The number of bootstrapping resamples
- **ignore.na**
  - in this case all NA containing rows are removed
- **rescale.residual**
  - rescale the residual matrix as z-scores

**Value**

vector of p-values for the "adjusted" regression coefficients from the Reference-free EWAS model

**Note**

Requires the package `RefFreeEWAS`.

**Author(s)**

Pavlo Lutsik

**References**

Description
get the mapping of regions in the RnBSet object to methylation site indices in the RnBSet object

Usage
```r
## S4 method for signature 'RnBSet'
regionMapping(object, region.type)
```

Arguments
- `object`: Dataset as an object of type inheriting `RnBSet`
- `region.type`: region type. see `rnb.region.types` for possible values

Value
A list containing for each region the indices (as integers) of sites that belong to that region

Author(s)
Fabian Mueller

Examples
```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
promoter.probe.list <- regionMapping(rnb.set.example,"promoters")
# get the number of CpGs per promoter in the dataset:
sapply(promoter.probe.list,length)
```

Description
Methylation regions, information for which is present in the RnBSet object.

Usage
```r
## S4 method for signature 'RnBSet'
regions(object, type = NULL)
```
Arguments

object  Dataset of interest.

type  Region type(s) of interest as a character vector. If this is set to NULL, all region types summarized in the object are returned.

Value

Methylation site and region assignment. If type is singleton, a matrix is returned. The first column corresponds to the methylation context index. The second column is the index of the chromosome in the genome, and the third is the index of the region in the GRanges object of the region type annotation. When length(type)>1, a list of such matrices is returned for each element of type. If type is NULL, matrices for all summarized region types are returned.

Note

Methylation context index is an integer number denoting the sequence context of the cytosine of interest. Index 1 corresponds to CpG, the only supported index in bisulfite sequencing datasets.

Author(s)

Pavlo Lutsik

See Also

summarized.regions for all summarized region types in a dataset; rnb.get.chromosomes listing all supported chromosomes for a given genome assembly

Examples

library(RnBeads.hg19)
data(small.example.object)
head(regions(rnb.set.example))
remove.regions,RnBSet-method

Arguments

object  RnBDiffMeth object
save.file  location of the ff data saved to disk (i.e. save in save.RData and save.ffData)
disk.path  path on the disk for DMTs. can be new or be the same as in the original object

Value

the updated RnBDiffMeth object

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
#compute differential methylation
pcols <- c("Sample_Group","Treatment")
tdir <- tempfile(pattern="working")
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pcols,disk.dump=TRUE,disk.dump.dir=tdir)
#get temporary file names
fn.save.tabs <- tempfile(pattern="saveTables")
fn.save.obj <- tempfile(pattern="saveObject")
#save the object and the tables to disk
save(dm,file=fn.save.obj)
save.tables(dm,fn.save.tabs)
#delete the object from the workspace
destroy(dm)
rm(dm)
#reload the object and tables
load(fn.save.obj)
dm.new <- reload(dm,fn.save.tabs)

---

remove.regions,RnBSet-method

remove.regions-methods

Description

Remove the summarized methylation information for a given region type from an RnBSet object.

Usage

## S4 method for signature 'RnBSet'
remove.regions(object, region.type)
remove.samples,RnBSet-method

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>Dataset of interest.</td>
</tr>
<tr>
<td>region.type</td>
<td>Type of the region annotation for which the summarization should be removed</td>
</tr>
</tbody>
</table>

Value

object of the same class as the supplied one without the summarized methylation information for the specified region type

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
summarized.regions(rnb.set.example)
rnb.set.reduced<-remove.regions(rnb.set.example, "genes")
summarized.regions(rnb.set.reduced)
```

remove.samples,RnBSet-method

Description

Removes the specified samples from the dataset.

Usage

```r
## S4 method for signature 'RnBSet'
remove.samples(object, samplelist)
```

```r
## S4 method for signature 'RnBeadSet'
remove.samples(object, samplelist)
```

```r
## S4 method for signature 'RnBeadRawSet'
remove.samples(object, samplelist)
```

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>Dataset of interest.</td>
</tr>
<tr>
<td>samplelist</td>
<td>List of samples to be removed in the form of a logical, integer or character vector. If this parameter is logical, it is not recycled; its length must be equal to the number of samples in object. If it is integer or character, it must list only samples that exist in the dataset. Specifying sample indices larger than the number of samples, or non-existent sample identifiers results in an error.</td>
</tr>
</tbody>
</table>

Value

The modified dataset.
See Also

remove.sites for removing sites or probes from a methylation dataset

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
samples(rnb.set.example)
## remove 3 random samples
s2r<-sample.int(length(samples(rnb.set.example)), 3)
rmn.set.f<-remove.samples(rnb.set.example, s2r)
samples(rmn.set.f)
```

Description

Removes the specified probes from the dataset.

Usage

```r
## S4 method for signature 'RnBSet'
remove.sites(object, probelist, verbose = FALSE)
## S4 method for signature 'RnBeadSet'
remove.sites(object, probelist, verbose = TRUE)
## S4 method for signature 'RnBeadRawSet'
remove.sites(object, probelist, verbose = TRUE)
```

Arguments

- `object` Dataset of interest.
- `probelist` List of probes to be removed in the form of a logical, integer or character vector. If this parameter is logical, it is not recycled; its length must be equal to the number of probes in object. If it is integer or character, it must list only probes that exist in the dataset. Specifying probe indices larger than the number of probes, or non-existent probe identifiers results in an error.
- `verbose` if TRUE additional diagnostic output is generated

Value

The modified dataset.

See Also

remove.samples for removing samples from a methylation dataset
Examples

```r
library(RnBeads.hg19)
data(small.example.object)
print(rnb.set.example)
## remove 100 random sites
s2r<-sample.int(nrow(sites(rnb.set.example)), 100)
rnb.set.f<-remove.sites(rnb.set.example, s2r)
print(rnb.set.f)
```

Description

Handler of a generated HTML report. Reports are initialized using the function `createReport`.

Slots

- `fname` Name of the file that contains the HTML report.
- `dir.conf` Directory that contains configuration files; usually shared between reports.
- `dir.data` Directory that contains the generated external lists and tables.
- `dir.pnms` Directory that contains the generated figure image files.
- `dir.pdfs` Directory that contains the generated figure PDF files.
- `dir.high` Directory that contains the generated high-resolution image file.
- `sections` Number of sections and subsections currently added to the report.
- `opensections` Indices of currently active section and subsections.
- `figures` Number of figures currently added to the report.
- `tables` Number of selectable tables added to the report.
- `references` List of references to be added at the end of the report.

Methods and Functions

- `rnb.get.directory` Gets the location of a given report-specific directory.
- `rnb.add.section` Generates HTML code for a new section in the report.
- `rnb.add.paragraph` Generates HTML code for a new paragraph in the report.
- `rnb.add.list` Generates HTML code for a list in the report.
- `rnb.add.table` Generates HTML code for a table in the report.
- `rnb.add.tables` Generates HTML code for a listing of tables in the report.
- `rnb.add.figure` Generates HTML code for a figure in the report.
- `rnb.add.reference` Adds a reference item to the report.
- `off` Completes the HTML report by adding a reference section (if needed), a footer notice and closing the `<body>` and `<html>` tags.

Author(s)

Yassen Assenov
ReportGgPlot-class

Description
Information about the files created to store one generated plot in a report. Report plots are initialized using the function `createReportGgPlot`. It inherits from the `ReportPlot` class and handling is analogous, except that it contains an additional slot to store a `ggplot` object.

Slots
- `ggp` ggplot object to be printed

Notes
No device is being opened until `off(reportGgPlot)` is called.

Author(s)
Fabian Mueller

ReportPlot-class

Description
Information about the files created to store one generated plot in a report. Report plots are initialized using the function `createReportPlot`.

Slots
- `fname` Relative file name. It does not include path or extension.
- `width` Width of the image in inches.
- `height` Height of the image in inches.
- `create.pdf` Flag indicating if a PDF image is created.
- `low.png` Resolution, in dots per inch, used for the figure image.
- `high.png` Resolution, in dots per inch, used for the high-resolution image.
- `dir.pdf` Directory that contains the generated PDF file.
- `dir.png.low` Directory that contains the generated figure image file.
- `dir.png.high` Directory that contains the generated high-resolution image file.

Methods and Functions
- `get.files` Gets the list of all files that are planned to be generated, or were already generated by the report plot.
- `off` Copies the figure to a PNG file (if needed) and closes the device associated with the report plot.
Description

Generates HTML code for a figure in the specified report. A figure is a collection of images (plots), of which only one is visible at any given moment.

Usage

```r
rnb.add.figure(report, description, report.plots, setting.names = list(),
               selected.image = as.integer(1))
```

Arguments

- `report`: Report to write the text to.
- `description`: Human-readable description of the figure. This must be a non-empty character vector. The elements of this vector are concatenated without a separator to form the full description.
- `report.plots`: Object of type `ReportPlot`, or a list of such objects.
- `setting.names`: List of plot file element descriptors. Every variable elements in the plot file names must be included in this list. Set this to empty list if no variable elements are present, that is, if the figure should present a single report plot.
- `selected.image`: Index of plot to be initially selected in the figure.

Value

The modified report.

Author(s)

Yassen Assenov

See Also

- `rnb.add.tables` for adding a listing of tables; `Report` for other functions adding contents to an HTML report
Description
Generates HTML code for a list in the specified report.

Usage
rnb.add.list(report, txt, type = "u")

Arguments
- report: Report to write the text to.
- txt: Non-empty list of items to be written. An attribute named type, if it exists, specifies the type of the list. See the Details section for more information. Every item must be either a nested list, denoting a sublist, or a character vector (or array), storing the text to be written. Any other objects are coerced to a character type. Elements are concatenated without a separator to form the text for a list item.
- type: List type to be used for the list and/or its sublists in case the attribute type is not specified.

Details
There are two ways to specify a list type: (1) setting a value for the attribute type of the list, or (2) using the function’s parameter type. The value of the function’s parameter is used only for lists and sublists that do not contain an attribute named type. The following types are supported:

- "o": Ordered list using arabic numbers - 1, 2, 3, etc.
- "u": Unordered list using bullet points.

Note that every list type must be a one-element character vector containing one of the codes listed above. Specifying any other value for list type results in an error.

Value
The modified report, invisibly.

Author(s)
Yassen Assenov

See Also
Report for other functions adding contents to an HTML report

Examples
```r
report <- createReport("example.html", "Example", init.configuration = TRUE)
recipe <- list("Sift flour in a bowl", "Add sugar and mix", "Add milk and mix")
rnb.add.list(report, recipe, type="o")
```
Description

Generates HTML code for a new paragraph in the specified report.

Usage

\[
\text{rnb.add.paragraph}(\text{report, txt, paragraph.class = NULL})
\]

Arguments

- \text{report} \quad \text{Report to write the text to.}
- \text{txt} \quad \text{character vector (or array) storing the text to be written. The elements of this vector are concatenated without a separator.}
- \text{paragraph.class} \quad \text{CSS class definition of the paragraph. This must be either NULL (default) or one of:}
  - "centered" This paragraph gives a formula or a short statement. Text is horizontally centered.
  - "note" This paragraph describes a note. Text is italic.
  - "task" This paragraph describes a task. Text is bold and bright red.

Value

The modified report, invisibly.

Author(s)

Yassen Assenov

See Also

Report for other functions adding contents to an HTML report

Examples

```r
report <- createReport("example.html", "Example", init.configuration = TRUE)
txt <- "A pessimist is a person who has had to listen to too many optimists."
txt <- c(txt, " <i>Don Marquis</i>")
rnb.add.paragraph(report, txt)
```
Description

Adds a reference item to the given report.

Usage

rnb.add.reference(report, txt)

Arguments

- report: Report to add a reference item to.
- txt: Text of the reference in the form of a non-empty character vector. The elements of this vector are concatenated without a separator.

Value

The modified report.

Author(s)

Yassen Assenov

See Also

rnb.get.reference for adding citations in the report’s text; Report for other functions adding contents to an HTML report

Examples

```r
report <- createReport("example.html", "Example", init.configuration = TRUE)
report <- rnb.add.reference(report, txt.reference)
txt <- c("This was shown in ", rnb.get.reference(report, txt.reference), ", .")
rnb.add.paragraph(report, txt)
```

Description

Generates HTML code for a new section in the specified report.

Usage

rnb.add.section(report, title, description, level = 1L, collapsed = FALSE)
rnb.add.table

Arguments

report  Report to write the text to.
title   Section header. This must be a single-element character vector.
description  Human-readable paragraph text of the section in the form of a character vector. Elements of this vector are concatenated without a separator to form the full description. Set this to NULL if the section does not (yet) contain text.
level    Section level as a single integer. It must be one of 1, 2 or 3, denoting section, subsection and sub-subsection, respectively.
collapsed Flag indicating if the contents of this section is to be initially collapsed. Possible values are TRUE (the section is not visible), FALSE (default, the section is expanded) and "never" (the section cannot be collapsed or expanded).

Value

The modified report.

Author(s)

Yassen Assenov

See Also

Report for other functions adding contents to an HTML report

Examples

report <- createReport("example.html", "Example", init.configuration = TRUE)
report <- rnb.add.section(report, "Introduction", "This is how it's done.")

rnb.add.table

Description

Generates HTML code for a table in the specified report.

Usage

rnb.add.table(report, tdata, row.names = TRUE, first.col.header = FALSE, indent = 0, tag.attrs = c(class = "tabdata"), thead = NULL, tcaption = NULL, na = "<span class="disabled">n/a</span>")
Arguments

report  | Report to write the text to.
tdata   | Matrix or data frame to be presented in HTML form. Column names, if present, are used to define table columns. If this table contains 0 (zero) rows or 0 columns, calling this function has no effect.
row.names | Flag indicating if row names should also be printed. If this parameter is TRUE and tdata defines row names, these are printed in the left-most column and are displayed as header cells. Keep in mind that data.frames always define row names.
first.col.header | Flag indicating if all cells in the first column must be displayed as header cells. Note that, if both this parameter and row.names are TRUE, and tdata contains row names, the constructed HTML table will have 2 columns of header cells.
indent  | Default indentation, in number of tabulation characters, to apply to HTML tags. This indentation is also applied to thead.
tag.attrs | Named character vector specifying the list of attributes to be set to the <table> element. Setting this to NULL or an empty character vector disables attributes.
thead | character vector storing a table header to include. This can, for example, be a character that defines column widths. Every element in this vector is written on a separate line, applying the indentation given by indent.
tcaption | Text to include as a caption below the table, or NULL if the table does not contain caption.
na | character to be used for printing NA values in the table. This parameter is not considered when printing thead or the table’s column names.

Value

The modified report, invisibly.

Author(s)

Yassen Assenov

See Also

rnb.add.tables for adding a listing of tables; Report for other functions adding contents to an HTML report

Description

Generates HTML code for a listing of tables (of which only one is visible at any moment) in the specified report.

Usage

rnb.add.tables(report, tables, setting.names, selected.table = 1L, indent = 2L, ...)
rnb.annotation.size

Arguments

```r
report
    Report to write the text to.

tables
    Non-empty list of tables, each one represented by a data.frame or matrix. The names of this list are used as table identifiers; each one consists of elements separated by underscore character (_).

setting.names
    List of table name element descriptors. Every variable elements in the table names must be included in this list.

selected.table
    Index of the table to be initially selected in this listing.

indent
    Default indentation, in number of tabulation characters, to apply to every table.

...
    Other parameters passed to rnb.add.table.
```

Value

The modified report.

Author(s)

Yassen Assenov

See Also

rnb.add.table for adding a single table to a report; Report for other functions adding contents to an HTML report

rnb.annotation.size  rnb.annotation.size

Description

Gets the size, in number of genomic elements, of the specified annotation.

Usage

```r
rnb.annotation.size(type = "CpG", assembly = "hg19")
```

Arguments

```r

type
    Name of annotation. Control probe annotations are not accepted.

assembly
    Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.
```

Value

integer vector showing the number of elements the specified annotation contains per chromosome. The names of the vector are the names of rnb.get.chromosomes for the given genome assembly. Chromosomes that are not covered by the annotation have their respective value set to 0 (zero).

Author(s)

Yassen Assenov
See Also

- `rnb.region.types` for a list of supported region annotations

Examples

```r
library(RnBeads.hg19)
rnb.annotation.size("probes450")
```

Description

Transform the specified site, probe or region annotation to `data.frame`.

Usage

```r
rnb.annotation2data.frame(annotation.table, add.names = TRUE)
```

Arguments

- `annotation.table` - Annotation in the form of non-empty `GRangesList` object, as returned by `rnb.get.annotation`.
- `add.names` - Flag indicating if element names should be extracted and returned also as a column named "ID" in the resulting `data.frame`. Note that element names, if present, are set to be the row names of the table.

Value

Annotation in the form of a single `data.frame`. The columns in this table include, among other, "Chromosome", "Start" and "End".

Author(s)

Yassen Assenov

Examples

```r
library(RnBeads.hg19)
head(rnb.annotation2data.frame(rnb.get.annotation("probes450")))
```
Description

Transforms beta values to M values, adjusting for +infinity and -infinity.

Usage

```r
rnb.beta2mval(betas, epsilon = 1e-05)
```

Arguments

- `betas`: numeric vector or matrix of beta values to be transformed.
- `epsilon`: Single numeric in the range [0, 0.5], giving the threshold of beta values to use when adjusting for potential M values close to +infinity or -infinity. Setting this parameter to 0 (zero) disables stabilization; in which case M values of -infinity or +infinity could be returned.

Value

The calculated and adjusted M values.

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
mvals <- rnb.beta2mval(meth(rnb.set.example))
summary(mvals)
```

Description

Creates an HTML index file that contains listing of all available RnBeads reports. If no known reports are found in the specified directory, no index is created.

Usage

```r
rnb.build.index(dir.reports, fname = "index.html",
                 dir.configuration = "configuration", open.index = TRUE)
```
Arguments

**dir.reports**  Directory that contains HTML reports generated by **RnBeads** modules. If this directory does not exist, is a regular file, is inaccessible, or does not contain any recognizable HTML report files, this function does not generate an HTML index file and produces an error or a warning message.

**fname**  One-element character vector specifying the name of the index file to be generated. See the *Details* section for restrictions on the name. The file will be created in **dir.reports**. If such a file already exists, it will be overwritten.

**dir.configuration**  Subdirectory that hosts configuration files shared by the reports. This must be a character vector of length one that gives location as a path relative to **dir.reports**. Strong restrictions apply to the path name. See the description of the **createReport** function for more details.

**open.index**  Flag indicating if the index should be displayed after it is created. If this is TRUE, **rnb.show.report** is called to open the generated HTML file.

Details

In order to ensure independence of the operating system, there are strong restrictions on the name of the index file. It can consist of the following symbols only: Latin letters, digits, dot (.), dash (-) and underline (_). The extension of the file must be one of htm, html, xhtml or xml. The name must not include paths, that is, slash (/) or backslash (\) cannot be used. In addition, it cannot be any of the recognized **RnBeads** report file names.

Value

Names of all HTML report files that were referenced in the newly generated index, invisibly. The order of the file names is the same as the one they are listed in the index. If no known reports are found in the given directory, the returned value is an empty character vector.

Author(s)

Yassen Assenov

See Also

**rnb.run.analysis**, **rnb.initialize.reports**

Description

calls the destructor of an RnBSet, RnBeadSet or RnBeadRawSet object conditionally on whether the enforce.destroy.disk.dumps option is enabled.

Usage

**rnb.call.destructor**(object, ...)

---

**rnb.call.destructor**  **rnb.call.destructor**

---

**Description**

calls the destructor of an RnBSet, RnBeadSet or RnBeadRawSet object conditionally on whether the enforce.destroy.disk.dumps option is enabled.

**Usage**

**rnb.call.destructor**(object, ...)

Arguments

object          object to be destroyed
...
     further arguments to the method destroy

Value

invisible TRUE

Author(s)

Fabian Mueller

Description

Creates a figure in the given report that contains one or more color legends.

Usage

rnb.color.legends(report, legends, fprefix = ifelse(is.character(legends),
"legend", "legend_"), description = "Color legend.", setting.names = NULL,
size.factor = 3)

Arguments

report          Report to contain the legend figure. This must be an object of type Report.
legends         Color legend in the form of a non-empty character vector. Element names denote legend labels, and the elements themselves specify colors. This parameter can also be a list of color legends. Special restrictions apply to the names of the list elements, see Details.
fprefix          File name or prefix for the plot files.
description     Text of the figure description. See the corresponding parameter in rnb.add.figure for more details.
setting.names   One-element list containing a plot file descriptor, when legends is a list. See the corresponding parameter in rnb.add.figure for more details. If this is set to NULL (default), the list is automatically created using names(legends) (when legends is a list), or as an empty list (when legends is a vector).
size.factor     Relative size, in inches of the plots. Legends are displayed in columns of up to 10 items; each column is effectively a square with the specified size.

Details

In case legends specifies multiple legends in the form of a list, names(legends) are appended to fprefix to generate file names. In order to ensure independence of the operating system, there are strong restrictions on these names. They can consist of the following symbols only: Latin letters, digits, dot (.), dash (–) and underline (\_).
Value

The modified report.

Author(s)

Yassen Assenov

---

**rnb.combine.arrays**

Combine array-based datasets

---

**Description**

Concatenates two array-based datasets focusing on the common probes.

**Usage**

```r
rnb.combine.arrays(dataset1, dataset2, type = "common")
```

**Arguments**

- `dataset1`: First input dataset as an object of type inheriting `RnBeadSet`.
- `dataset2`: Second input dataset as an object of type inheriting `RnBeadSet`.
- `type`: Type of the combine operation as a character singleton, one of "common", "all.x", "all.y" and "all".

**Details**

- **Sample annotation tables**  This method expects that the sample annotation tables of the two datasets have identical structures.
- **Genome assembly**  This method expects that the two datasets target the same genome assembly.
- **Platform**  The platform of the combined dataset is the most recent among the platforms of the input datasets.
- **Intensity values**  The combined dataset is of type `RnBeadRawSet` only when both input datasets are of this type. Otherwise, any intensity value data is ignored.
- **Probes**  Only the common probes are included in the resulting dataset.
- **Regions**  Regions summarized in any of the input datasets are ignored. In the resulting dataset, regions are summarized as specified in the analysis option "region.types".
- **Quality control data**  QC data in the input datasets is ignored. The combined dataset includes no data on QC probe intensities.
- **Inferred covariates**  Inferred covariates in the input datasets are ignored. The combined dataset includes no data on inferred covariates.
- **Disk dumping**  The combined dataset stores big tables on disk when the analysis option "disk.dump.big.matrices" is enabled.

**Value**

Combined dataset as an object of type inheriting `RnBeadSet`.

**Author(s)**

Yassen Assenov
rnb.execute.age.prediction

Description
Performs age prediction by either the specified predictor in the option inference.age.prediction.predictor or by the corresponding predefined predictor.

Usage
rnb.execute.age.prediction(object)

Arguments
- object: a RnBSet object for which age prediction should be performed

Value
modified RnBSet object

Author(s)
Michael Scherer

rnb.execute.batch.qc

Description
Computation of correlations and permutation-based p-values for detecting quality-associated batch effects.

Usage
rnb.execute.batch.qc(rnb.set, pcoordinates, permutations = NULL)

Arguments
- rnb.set: HumanMethylation450K dataset as an object of type RnBeadSet.
- pcoordinates: Coordinates of the samples of rnb.set in the principal components space, as returned by rnb.execute.dreduction.
- permutations: Matrix of sample index permutations, as returned by rnb.execute.batcheffects. If this parameter is NULL, permutation-based p-values are not calculated.
Value

NULL if no principal components for batch analysis are specified (`rnb.getOption("exploratory.principal.components") == 0`); otherwise, a hierarchical structure of matrices in the form of a nested list. The root branches are represented by the elements "correlations" and "pvalues". Every element is a list of control probe types; each type is in turn a list of up to two matrices of correlations between probe values and principal components - one for the probes on the green channel and one for the red channel. Note that the "pvalues" branch is not returned when `permutations` is NULL.

Author(s)

Pavlo Lutsik

---

**rnb.execute.batcheffects**

**rnb.execute.batcheffects**

Description

Performs tests for association between traits and principal components.

Usage

```r
rnb.execute.batcheffects(rnb.set, pcoordinates = NULL)
```

Arguments

- `rnb.set`: Methylation dataset as an object of type inheriting `RnBSet`.
- `pcoordinates`: Coordinates of the samples of `rnb.set` in the principal components space, as returned by `rnb.execute.dreduction`.

Value

Results of attempted tests for associations in the form of a list with up to three elements:

- "permutations" integer matrix of index permutations. The number of rows in the matrix is \( N \) - the number of samples in `rnb.set`. Every column in this matrix denotes a sample permutation; the first column is the sequence 1 to \( N \). This element is included only when `rnb.getOption("exploratory.correlation.permutations")` is non-zero and there are numeric traits to be tested.

- "pc" List of four matrices named "failures", "tests", "correlations" and "pvalues". The rows in each of these matrices correspond to the first several principal components, and the columns - to selected traits. This element is not included in the returned list when `pcoordinates` is NULL.

- "traits" List of four square symmetric matrices named "failures", "tests", "correlations" and "pvalues", containing information about the performed tests for pairwise trait association. This element is included only if two or more traits were tested.

Author(s)

Yassen Assenov
**rnb.execute.clustering**

See Also

*rnb.run.exploratory* for running the whole exploratory analysis module

Examples

library(RnBeads.hg19)
data(small.example.object)
regs <- c("sites", summarized.regions(rnb.set.example))
dreduction <- function(x) rnb.execute.dreduction(rnb.set.example, x)
pcoordinates <- lapply(regs, dreduction)
names(pcoordinates) <- regs
result <- rnb.execute.batcheffects(rnb.set.example, pcoordinates)

**Description**

Performs hierarchical clustering on the samples of the given dataset using multiple distance metrics and agglomeration methods for a single given region type.

Usage

rnb.execute.clustering(rnb.set, region.type = "sites")

Arguments

- **rnb.set**: Methylation dataset as an object of type inheriting RnBSet.
- **region.type**: the clustering is performed on methylation levels from regions of that type. see *rnb.region.types* for possible values.

Value

List of clustering results, whereby each element is an object of type RnBeadClustering. In case clustering cannot be performed, the return value is NULL. Reasons for a failure include, among others, the case when *rnb.set* contains less than 3 samples, or undefined distances between a pair of samples due to (too many) missing values in the respective methylation matrix.

Author(s)

Yassen Assenov
Examples

library(RnBeads.hg19)
data(small.example.object)
results <- rnb.execute.clustering(rnb.set.example, "promoters")
  # List applied dissimilarity metrics
  sapply(results, slot, "dissimilarity")
  # List applied clustering algorithms
  str(lapply(results, slot, "algorithm"))

Description

Performs hierarchical clustering on the samples of the given dataset using multiple distance metrics and agglomeration methods for all suggested site and region types.

Usage

rnb.execute.clustering.all(rnb.set)

Arguments

rnb.set	Methylation dataset as an object of type inheriting RnBSet.

Value

List of list of clustering results; each element corresponds to one region type and is a list of objects of type RnBeadClustering.

Author(s)

Fabian Mueller

See Also

rnb.execute.clustering for performing clustering using a single site or region type.
Description

computes differential methylation

Usage

```r
rnb.execute.computeDiffMeth(x, pheno.cols,
  region.types = rnb.region.types.for.analysis(x),
  covg.thres = rnb.getOption("filtering.coverage.threshold"),
  pheno.cols.all.pairwise = rnb.getOption("differential.comparison.columns.all.pairwise"),
  columns.pairs = rnb.getOption("columns.pairing"),
  columns.adj = rnb.getOption("covariate.adjustment.columns"),
  adjust.sva = rnb.getOption("differential.adjustment.sva"),
  pheno.cols.adjust.sva = rnb.getOption("inference.targets.sva"),
  adjust.celltype = rnb.getOption("differential.adjustment.celltype"),
  skip.sites = !rnb.getOption("analyze.sites"),
  disk.dump = rnb.getOption("disk.dump.big.matrices"),
  disk.dump.dir = tempfile(pattern = "diffMethTables_"), ...)
```

Arguments

- `x` RnBSet object
- `pheno.cols` column names of the pheno slot in `x` on which the dataset should be partitioned. Those columns are required to be factors or logical. In case of factors, each group in turn will be compared to all other groups
- `region.types` which region types should be processed for differential methylation
- `covg.thres` coverage threshold for computing the summary statistics. See `computeDiffTab.extended.site` for details.
- `pheno.cols.all.pairwise` integer or character vector specifying the columns of `pheno(x)` on which all pairwise comparisons should be conducted. A value of NULL (default) indicates no columns.
- `columns.pairs` argument passed on to `rnb.sample.groups`. See its documentation for details.
- `columns.adj` Column names or indices in the table of phenotypic information to be used for confounder adjustment in the differential methylation analysis.
- `adjust.sva` flag indicating whether the adjustment table should also contain surrogate variables (SVs) for the given target variable.
- `pheno.cols.adjust.sva` Column names or indices in the table of phenotypic information to be used for SVA adjustment in the differential methylation analysis.
- `adjust.celltype` flag indicating whether the resulting table should also contain estimated celltype contributions. See `rnb.execute.ct.estimation` for details.
skip.sites flag indicating whether differential methylation in regions should be computed directly and not from sites. This leads to skipping of site-specific differential methylation

disk.dump Flag indicating whether the resulting differential methylation object should be file backed, i.e. the matrices dumped to disk

disk.dump.dir disk location for file backing of the resulting differential methylation object. Only meaningful if disk.dump=TRUE. must be a character specifying a NON-EXISTING valid directory.

... arguments passed on to binary differential methylation calling. See computeDiffTab.extended.site for details.

Value

an RnBDiffMeth object. See class description for details.

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))
get.comparisons(dm)
Value

List of three or four elements:

"dataset.before" Copy of rnb.set.
"dataset" The (possibly modified) RnBeadSet object after performing the missing value removal.
"filtered" integer vector storing the indices of all removed probes in dataset.before.
"contexts" The value of the parameter contexts.

Author(s)

Yassen Assenov

Examples

library(RnBeads.hg19)
data(small.example.object)
contexts.to.ignore <- c("CC", "CAG", "CAH")
rnb.set.filtered <- rnb.execute.context.removal(rnb.set.example, contexts.to.ignore)$dataset
identical(rnb.set.example, rnb.set.filtered) # FALSE

Description

Removes all probes defined as cross-reactive from the given dataset.

Usage

rnb.execute.cross.reactive.removal(rnb.set)

Arguments

rnb.set Methylation dataset as an object of type inheriting RnBeadSet.

Value

list of four elements:

"dataset.before" Copy of rnb.set.
"dataset" The (possibly modified) dataset object after removing probes that have a high likelihood of cross-hybridization.
"filtered" integer vector storing the indices (in beta matrix of the unfiltered dataset) of all removed probes.

Author(s)

Yassen Assenov
Examples

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.set.filtered <- rnb.execute.cross.reactive.removal(rnb.set.example)$dataset
identical(meth(rnb.set.example), meth(rnb.set.filtered)) # FALSE
```

Description

Perform the estimation of the cell type contributions in each analyzed sample.

Usage

```r
rnb.execute.ct.estimation(rnb.set, cell.type.column = NA,
                          test.max.markers = NA, top.markers = 500, method = "houseman1",
                          verbose = TRUE)
```

Arguments

- `rnb.set`: object of class `RnBSet`
- `cell.type.column`: integer index or character identifier of a column in sample annotation table of `rnb.set` which gives the mapping of samples to reference cell types
- `test.max.markers`: Maximal amount of CpG positions to use for marker selection. If this option is set to NA or NULL, all sites are considered. Please take into account the extended computation time in such a case.
- `top.markers`: the number of markers to select
- `method`: algorithm used for estimation of the cell type contributions
- `verbose`: flag specifying whether diagnostic output should be written to the console or to the RnBeads logger in case the latter is initialized

Details

The only supported method is the one from Houseman et al BMC Bioinformatics 2012

Value

object of class `CellTypeInferenceResult`

Author(s)

Pavlo Lutsik
Description

This routine computes sites that are differentially variable between two sample groups specified as the column name in the phenotypic table.

Usage

```r
rnb.execute.diffVar(rnb.set, 
    pheno.cols = rnb.getOption("differential.comparison.columns"), 
    region.types = rnb.region.types.for.analysis(rnb.set), 
    columns.adj = rnb.getOption("covariate.adjustment.columns"), 
    adjust.celltype = rnb.getOption("differential.adjustment.celltype"), 
    disk.dump = rnb.getOption("disk.dump.big.matrices"), 
    disk.dump.dir = tempfile(pattern = "diffMethTables_")
)```

Arguments

- **rnb.set**: Object of type `RnBSet` on which differential variability analysis should be conducted.
- **pheno.cols**: Column names used to define the classes, whose methylation variability should be compared with each other.
- **region.types**: Regions types to be used for the analysis. Defaults to the results given by `rnb.region.types.for.analysis` of the given `RnBSet`.
- **columns.adj**: Column names or indices in the table of phenotypic information to be used for confounder adjustment in the differential variability analysis.
- **adjust.celltype**: Flag indicating whether the resulting table should also contain estimated celltype contributions. See `rnb.execute.ct.estimation` for details.
- **disk.dump**: Flag indicating whether the resulting differential methylation object should be file backed, i.e. the matrices dumped to disk.
- **disk.dump.dir**: Disk location for file backing of the resulting differential methylation object. Only meaningful if disk.dump=TRUE.

Value

Object of type `RnBDiffMeth` containing information about the differential variability analysis.

Author(s)

Michael Scherer
Description

Performs principal component analysis (PCA) and multi-dimensional scaling (MDS) of the samples in the given methylation dataset.

Usage

rnb.execute.dreduction(rnb.set, target = "sites")

Arguments

- **rnb.set**: Methylation dataset as an object of type inheriting `RnBSet`. This dataset must contain at least four samples.
- **target**: character singleton specifying the level of DNA methylation information. If this is "sites", the DNA methylation information for the individual sites or probes is analyzed. Otherwise, this should be one of the supported region types, as returned by `rnb.region.types`.

Details

Row names in the returned matrices are sample identifiers, determined based on the package option "identifiers.column". See `RnBeads Options` for more information on this option.

Value

Results of the dimension reduction in the form of a list with the following elements:

- **pca**: Results of the PCA as returned by the function `prcomp`.
- **mds**: List of two elements - "manhattan" and "euclidean", each of which is a two-column matrix storing the coordinates of the samples in a two-dimensional space. The matrices are computed using the function `isoMDS`.

Author(s)

Yassen Assenov

See Also

`rnb.run.exploratory` for running the whole exploratory analysis module

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
regs <- c("sites", summarized.regions(rnb.set.example))
dreduction <- function(x) rnb.execute.dreduction(rnb.set.example, x)
pcoordinates <- lapply(regs, dreduction)
```
Description

Exports (selected) methylation tables of the given dataset to comma-separated value files.

Usage

rnb.execute.export.csv(rnb.set, output.location, region.types = rnb.getOption("export.types"))

Arguments

rnb.set Methylation dataset as an object of type inheriting RnBSet.
output.location character or Report specifying the output directory. If this is a report, the output directory is set to be a subdirectory named csv of the report’s data directory. Set this parameter to the empty string (""") or NA to use the current working directory. If the given path does not exist, this function attempts to create it.
region.types character vector indicating region types to be exported.

Details

The names of the generated output files are formed by the prefix "betas_", followed by a number between 1 and length(region.types). The extension is .csv or .csv.gz, depending on the value of the RnBeads option "gz.large.files". Any such files that already exist in the output directory, are overwritten.

There are several reasons why a certain output file cannot be (fully) generated. Examples for failures are listed below:

- The corresponding region type is invalid.
- The corresponding region type is not supported by the dataset. If the type is loaded in RnBeads, use the summarize.regions method prior to calling this function, in order to include the support of this region type in the dataset.
- Due to security restrictions, the creation of files in the output directory is not allowed.
- A file or directory with the same name exists and cannot be overwritten.
- The disk is full or the user quota is exceeded.

Value

character vector containing the names of the files to which data were exported; prepended by output.location. In case a certain region type could not be exported (see the Details section), the corresponding element of this vector is NA.
Author(s)

Yassen Assenov

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.execute.export.csv(rnb.set.example, "", summarized.regions(rnb.set.example))
```

Description

Calculates a table summarizing the effect of the applied filtering procedures.

Usage

```r
rnb.execute.filter.summary(old.set, new.set)
```

Arguments

- `old.set`: Methylation dataset before filtering as an object of type inheriting `RnBSet`.
- `new.set`: Methylation dataset after filtering as an object of type inheriting `RnBSet`.

Details

This function expects that the sites and samples in `new.set` are subsets of the sites and samples in `old.set`, respectively. If this is not the case, it exists with an error.

Value

`matrix` summarizing the number of removed and retained sites, samples, and (optionally) reliable and unreliable measurements.

Author(s)

Yassen Assenov

See Also

`rnb.run.preprocessing` for running the whole preprocessing module
**rnb.execute.gender.prediction**

**Description**

Infers the gender of every sample in the given dataset, based on average signal intensity values on the autosomes and the sex chromosomes.

**Usage**

```r
rnb.execute.gender.prediction(rnb.set)
```

**Arguments**

- `rnb.set` Methylation dataset as an object of type `RnBeadRawSet`.

**Value**

The possibly modified dataset. If gender could be predicted, the sample annotation table is enriched with two more columns - "Predicted Male Probability" and "Predicted Gender".

**Author(s)**

Yassen Assenov

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.set.example <- rnb.execute.gender.prediction(rnb.set.example)
table(rnb.set.example[, "Predicted Gender"])
```

---

**rnb.execute.genomewide**

*Genome-wide methylation level*

**Description**

Computes genome-wide methylation levels per sample.

**Usage**

```r
rnb.execute.genomewide(dataset)
```

**Arguments**

- `dataset` Methylation dataset to study, provided as an object of type inheriting `RnBSet`.
Value

vector of values in the range $[0, 1]$, storing the average beta values per sample.

Author(s)

Yassen Assenov

Description

Executes the Greedycut procedure for probe and sample filtering based on the detection p-values, and calculates statistics on its iterations.

Usage

```r
rnb.execute.greedycut(rnb.set,
   rc.ties = rnb.getOption("filtering.greedycut.rc.ties"))
```

Arguments

- `rnb.set`: HumanMethylation450K dataset as an object of type `RnBeadSet`.
- `rc.ties`: Flag indicating what the behaviour of the algorithm should be in case of ties between values of rows (probes) and columns (samples). See the corresponding parameter in `greedycut.filter.matrix` for more details.

Value

NULL if `rnb.set` does not contain a matrix of detection p-values, or if all p-values denote reliable measurements. Otherwise, a list of the following elements:

- "infos": Table summarizing the iterations of the algorithm, as returned by `greedycut.filter.matrix`.
- "statistics": Additional statistics on all iterations, as returned by `greedycut.get.statistics`.
- "iteration": Number of Greedycut iterations + 1 applied to the dataset, that is, a value of 1 indicates that the dataset was not modified.
- "sites": Indices of all sites to be removed.
- "samples": Indices of all samples to be removed.

Author(s)

Yassen Assenov

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
greedy.result <- rnb.execute.greedycut(rnb.set.example)
# Number of applied iterations
greedy.result$iteration
```
rnb.execute.high.coverage.removal

Description
Removes methylation sites with a coverage larger than 100 times the 95-percentile of coverage in each sample.

Usage
rnb.execute.high.coverage.removal(rnb.set)

Arguments
rnb.set Methylation dataset as an object of type inheriting RnBiseqSet.

Value
list of two elements:
"dataset" The (possibly) modified dataset after retaining sites on autosomes only.
"filtered" integer vector storing the indices of all removed sites.

Author(s)
Fabian Mueller

rnb.execute.import

Description
Loads the data from the specified type and encapsulates it in either an RnBSet-inheriting object

Usage
rnb.execute.import(data.source,
 data.type = rnb.getOption("import.default.data.type"),
 dry.run = FALSE,
 verbose = TRUE)

Arguments
data.source non-empty character vector or list specifying the location of the data items. The expected format depends on the data.type that is given. See the Details section.
data.type type of the input data; must be one of "idat.dir", "data.dir", "data.files", "GS.report", "GEO" or "rnb.set".
dry.run if TRUE and data.type is "bs.bed.dir", only a test data import is performed and first 10,000 lines are read from each BED file
verbose flag specifying whether diagnostic output should be written to the console or to the RnBeads logger in case the latter is initialized
Details

The interpretation of data.source depends on the value of data.type and is summarized in the following table:

<table>
<thead>
<tr>
<th>data.type</th>
<th>Type of data.source</th>
<th>Maximal length of data.source</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;infinium.idat.dir&quot;</td>
<td>list or character</td>
<td>2</td>
<td>(1) Directory containing IDAT files</td>
</tr>
<tr>
<td>&quot;infinium.data.dir&quot;</td>
<td>character</td>
<td>1</td>
<td>Directory containing data table</td>
</tr>
<tr>
<td>&quot;infinium.data.files&quot;</td>
<td>character</td>
<td>2..4</td>
<td>The character vector should contain sample annotations</td>
</tr>
<tr>
<td>&quot;infinium.GS.report&quot;</td>
<td>character</td>
<td>1</td>
<td>Genome Studio report file</td>
</tr>
<tr>
<td>&quot;infinium.GEO&quot;</td>
<td>character</td>
<td>1</td>
<td>GEO identifier or downloaded series matrix</td>
</tr>
<tr>
<td>&quot;bs.bed.dir&quot;</td>
<td>list or character</td>
<td>1..3</td>
<td>(1) Directory with BED files each giving a DNA methylation profile</td>
</tr>
<tr>
<td>&quot;rnb.set&quot;</td>
<td>RnBSet</td>
<td>1</td>
<td>object of class inheriting from RnBSet</td>
</tr>
</tbody>
</table>

Value

Loaded data as an object of type RnBSet (when the input data type is "data.dir", "data.files" or "GEO") or of type MethylumiSet (when the data type is "idat.dir" or "GS.report").

Author(s)

Pavlo Lutsik

See Also

read.data.dir, read.idat.files, read.GS.report, rnb.read.geo, read.bed.files

Examples

# Directory where your data is located
data.dir <- "~/RnBeads/data/Ziller2011_PLoSGen_450K"
idat.dir <- file.path(data.dir, "idat")
sample.annotation <- file.path(data.dir, "sample_annotation.csv")
data.source <- c(idat.dir, sample.annotation)
rnb.set <- rnb.execute.import(data.source = data.source, data.type = "idat.dir")

rnb.execute.imputation

Description

Removes missing methylation values in the methylation matrix of the given object

Usage

rnb.execute.imputation(rnb.set, method = rnb.getOption("imputation.method"), update.ff = TRUE, ...)
Arguments

- **rnb.set**: Dataset object inheriting from `RnBSet`.
- **method**: Imputation method to be used, must be one of "mean.cpgs", "mean.samples", "random", "knn", "median.cpgs", "median.samples", or "none".
- **update.ff**: Flag indicating if the disk based matrices should be updated. Should be set to FALSE if methylation matrix should only temporarily be changed. If this value is FALSE, the region level methylation values are not updated and only the site-wise matrix is changed temporarily.

Details

Imputes missing values by applying on the following methods:

- **mean.cpgs**: missing values are inferred as the average methylation value from all other (non-missing) CpGs in this sample
- **mean.samples**: missing values are inferred as the average methylation value from all other (non-missing) values at this CpG sites in all other samples
- **random**: missing values are inferred by randomly selecting a (non-missing) methylation value from any other sample at this CpG site
- **knn**: missing values are inferred by k-nearest neighbors imputation (see `impute`)
- **median.cpgs**: missing values are inferred as the median methylation value from all other (non-missing) CpGs in this sample
- **median.samples**: missing values are inferred as the median methylation value from all other (non-missing) values at this CpG sites in all other samples
- **none**: imputation should not be performed

Value

The modified rnb.set object without missing methylation values.

Author(s)

- Michael Scherer

Usage

```r
rnb.execute.low.coverage.masking(rnb.set, 
covg.threshold = rnb.getOption("filtering.coverage.threshold"))
```
rnb.execute.lump

Arguments

rnb.set Methylation dataset as an object of type inheriting RnBSet.
covg.threshold Threshold for minimal acceptable coverage, given as a non-negative integer value. All methylation measurements with lower coverage than this threshold are set to NA. If this parameter is 0, calling this method has no effect.

Value

List of three elements:

"dataset.before" Copy of rnb.set.
"dataset" The (possibly) modified dataset after retaining sites on autosomes only.
"mask" A logical matrix of dimension meth(rnb.set,type="sites") indicating which methylation values have been masked

Author(s)

Fabian Mueller

---

rnb.execute.lump Leukocytes unmethylation for purity

Description

Implementation of the LUMP (Leukocytes UnMethylation for Purity) algorithm for purity estimation on methylation datasets.

Usage

rnb.execute.lump(dataset)

Arguments

dataset Methylation dataset to study, provided as an object of type inheriting RnBSet.

Details

The LUMP algorithm is developed by Dvir Aran, Marina Sirota and Atul J. Buttea.

Value

Purity estimates provided as a vector of values in the range [0, 1]. The attribute "sites" contains the number of sites used in estimating the immune cell proportions. In case the dataset does not contain measurements for any of the sites on which LUMP focuses, the return values is NULL.

Author(s)

Yassen Assenov
Description

Removes all probes with missing value (if such exists) from the given dataset.

Usage

```r
rnb.execute.na.removal(rnb.set,
    threshold = rnb.getOption("filtering.missing.value.quantile"))
```

Arguments

- `rnb.set`: Methylation dataset as an object of type inheriting `RnBSet`.
- `threshold`: Maximum quantile of NAs allowed per site. This must be a value between 0 and 1.

Value

List of four or five elements:

- "dataset.before" Copy of `rnb.set`.
- "dataset" The (possibly modified) dataset after performing the missing value removal.
- "filtered" integer vector storing the indices (in beta matrix of the unfiltered dataset) of all removed sites.
- "threshold" Copy of `threshold`.
- "naCounts" Vector storing the number of NAs per site

Author(s)

Yassen Assenov

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.set.filtered <- rnb.execute.na.removal(rnb.set.example, 0)$dataset
identical(meth(rnb.set.example), meth(rnb.set.filtered)) # TRUE
```
rnb.execute.normalization

Description

Performs normalization of the provided HumanMethylation450 data set.

Usage

```r
rnb.execute.normalization(object,
  method = rnb.getOption("normalization.method"),
  bgcorr.method = rnb.getOption("normalization.background.method"),
  verbose = TRUE)
```

Arguments

- **object**: Methylation dataset as an object of type `MethyLumiSet` or `RnBSet`.
- **method**: Normalization method, must be one of "none", "illumina", "swan", "minfi.funnorm", "bmiq", or `wm.*` where `*` stands for one of the methods implemented in `watermelon` package. Note that the execution of methods SWAN and minfi.funnorm requires packages `minfi` and `IlluminaHumanMethylation450kmanifest`. The BMIQ method requires the package `RPMM`. The `wm.*` methods naturally require `watermelon`.
- **bgcorr.method**: Character singleton specifying which background subtraction should be used. Only methods implemented in the `methylumi` package are supported at the moment, namely methylumi.noob, methylumi.goob and methylumi.doob. See Triche et al. for detailed description of the methods.
- **verbose**: Flag specifying whether diagnostic output should be written to the console or to the RnBeads logger in case the latter is initialized.

Value

Normalized dataset as an object of type `RnBeadSet`.

Author(s)

Pavlo Lutsik

References


Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
```
rnb.execute.normalization(rnb.set.example, method="illumina", bgcorr.method="none")

rnb.execute.quality

Description
Performs quality control calculations on the loaded DNA methylation data set.

Usage
rnb.execute.quality(object, type = "sites",
qc.coverage.plots = rnb.getOption("qc.coverage.plots"), verbose = TRUE)

Arguments
- object: Methylation dataset as an object of class RnBeadSet, RnBeadRawSet or RnBiseqSet.
- type: character vector of length 1 giving the type of genomic regions for which the quality control information is summarized.
- qc.coverage.plots: Flag indicating if sequencing coverage information is summarized and returned. This parameter is considered only when object is of type RnBiseqSet.
- verbose: Flag specifying whether diagnostic output should be written to the console or to the RnBeads logger in case the latter is initialized.

Details
Currently, summarizing coverage for RnBiseqSet object is the only available function.

Value
- RnBeadSet object with imputed quality control information

Author(s)
Pavlo Lutsik
Description

Removes all sites in sex chromosomes from the given dataset.

Usage

rnb.execute.sex.removal(rnb.set)

Arguments

rnb.set  Methylation dataset as an object of type inheriting RnBSet.

Value

List of three elements:
"dataset.before"  Copy of rnb.set.
"dataset"  The (possibly) modified dataset after retaining sites on autosomes only.
"filtered"  integer vector storing the indices (in beta matrix of the unfiltered dataset) of all removed probes.

Author(s)

Yassen Assenov

Examples

library(RnBeads.hg19)
data(small.example.object)
rnb.set.filtered <- rnb.execute.sex.removal(rnb.set.example)$dataset
identical(meth(rnb.set.example), meth(rnb.set.filtered)) # FALSE

Description

Removes all probes overlapping with single nucleotide polymorphisms (SNPs) from the given dataset.

Usage

rnb.execute.snp.removal(rnb.set, snp = rnb.getOption("filtering.snp"))
**Arguments**

- **rnb.set**: Methylation dataset as an object of type inheriting `RnBSet`.
- **snp**: Criterion for the removal of sites or probes based on overlap with SNPs. Possible values are "no", "3", "5", "any" or "yes". See the documentation of `rnb.options` for a detailed explanation of the procedures these values encode.

**Value**

- list of four elements:
  - "dataset.before" Copy of `rnb.set`.
  - "dataset" The (possibly) modified dataset object after removing probes that overlap with SNPs.
  - "filtered" integer vector storing the indices (in beta matrix of the unfiltered dataset) of all removed sites or probes.
  - "snp" The value of the `snp` parameter.

**Author(s)**

Yassen Assenov

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.set.filtered <- rnb.execute.snp.removal(rnb.set.example, "any")$dataset
identical(meth(rnb.set.example), meth(rnb.set.filtered)) # FALSE
```

**Description**

Conduct Surrogate Variable Analysis (SVA) on the beta values of an RnBSet for given target variables.

**Usage**

```r
rnb.execute.sva(rnb.set, cmp.cols = rnb.getOption("inference.targets.sva"),
                 columns.adj = rnb.getOption("covariate.adjustment.columns"), assoc = TRUE,
                 numSVmethod = rnb.getOption("inference.sva.num.method"))
```

**Arguments**

- **rnb.set**: The RnBSet object on which the SVA should be conducted.
- **cmp.cols**: a vector of sample annotation column names which will be the targets of the SVA.
- **columns.adj**: Column names in the table of phenotypic information to be used for confounder adjustment.
- **assoc**: a flag indicating whether association information with principal components and other sample annotation should be returned.
- **numSVmethod**: method to estimate the number of surrogate variables. Passed to `sva`.
Value

An object of class SvaResult: basically a list containing the following elements:

- num.components  a vector storing the number of detected SVs for each target variable
- sva.performed  a vector storing whether SVA was performed on a target variable and whether more than 0 SVs were found
- targets  a vector storing the names of the target variables
- components  a list storing for each target variable a matrix containing the sample-wise SVs as rows
- assoc  a special object containing association information of SVs with principal components and sample annotations typically only used in rnb.section.sva.

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
sva.obj <- rnb.execute.sva(rnb.set.example,c("Sample_Group","Treatment"),numSVmethod="be")
sva.obj$sva.performed
sva.obj$num.components
rnb.set.mod <- set.covariates.sva(rnb.set.example, sva.obj)
has.covariates.sva(rnb.set.example,"Sample_Group")
has.covariates.sva(rnb.set.mod,"Sample_Group")
has.covariates.sva(rnb.set.mod,"Treatment")
```

Description

export RnBSet to various output data formats

Usage

```r
rnb.execute.tnt(rnb.set, out.dir, exp.bed = rnb.getOption("export.to.bed"),
exp.trackhub = rnb.getOption("export.to.trackhub"),
region.types = rnb.getOption("export.types"), ...)
```

Arguments

- **rnb.set** RnBSet object
- **out.dir** output directory.
- **exp.bed** A character vector indicating which data types should be exported to UCSC. Possible values in the vector are bigBed and bigWig. If NULL, UCSC export is disabled
- **exp.trackhub** file types which should be exported to a trackhub structure.
- **region.types** a character vector indicating region types to be exported
- **...** Arguments passed to rnb.export.to.trackhub
Value

a list containing information on the export

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.execute.train(rnb.set.example,tempdir())
```

Description

Trains a new age predictor on the specified data set and writes it to the given path. Elastic net regression is to fit the input ages to the methylation values.

Usage

```r
rnb.execute.training(object, path = "", alpha = 0.8)
```

Arguments

- **object**
  - a `RnBSet` object on which a new predictor should be created
- **path**
  - path to which the predictor should be written out
- **alpha**
  - alpha parameter used in the elastic net regression

Author(s)

Michael Scherer
Description

Removes all sites or probes with low variability from the given dataset.

Usage

```r
rnb.execute.variability.removal(rnb.set,  
  min.deviation = rnb.getOption("filtering.deviation.threshold"))
```

Arguments

- `rnb.set`: Methylation dataset as an object of type inheriting `RnBSet`.
- `min.deviation`: Threshold for standard deviation per site. This must be a scalar between 0 and 1. All sites, for which the standard deviation of methylation values (for all samples in `rnb.set`) is lower than this threshold, will be filtered out.

Value

List of four elements:

- "dataset.before" Copy of `rnb.set`.
- "dataset" The (possibly modified) dataset after removing sites with low variability.
- "filtered" integer vector storing the indices (in beta matrix of the unfiltered dataset) of all removed sites.
- "threshold" The value of the given parameter `min.deviation`.

Author(s)

Yassen Assenov

Examples

```r
library(RnBeads.hg19)  
data(small.example.object)  
rnb.set.filtered <- rnb.execute.variability.removal(rnb.set.example, 0.01)
```
rnb.export.all.annotation

Description
Wrapper for exporting all annotation sets

Usage
rnb.export.all.annotation(out.dir, types = c("CpG", rnb.region.types(assembly)), assembly = "hg19", format = "bed")

Arguments
- out.dir: The directory to write the files to
- types: One-element character vector giving the name of the region annotation.
- assembly: Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.
- format: output format. currently only "bed" is supported.

Value
TRUE, invisibly.

Author(s)
Fabian Mueller

Examples
logger.start(fname=NA)
 rnb.export.all.annotation(tempdir(),c("genes","promoters"))

rnb.export.annotation

Description
Export the annotation to a defined format (currently only bed is supported

Usage
rnb.export.annotation(fname, type, assembly = "hg19", format = "bed")
Arguments

fname
One-element character vector giving the name of the file to contain the annotation data. If this file already exists, it will be overwritten.

type
One-element character vector giving the name of the region annotation.

assembly
Genome assembly of interest. See `rnb.get.assemblies` for the list of supported genomes.

format
Output format. currently only "bed" is supported.

Value

TRUE, invisibly.

Author(s)

Fabian Mueller

Examples

    rnb.export.annotation(tempfile(pattern="promoters",fileext=".bed"),"promoters")

rnb.export.to.ewasher

Description

Data exported to a format compatible with the FaST-LMM-EWASher tool for cell-mixture adjustment. see Zou, J., et al., Nature Methods, 2014 for further details on the tool.

Usage

    rnb.export.to.ewasher(rnb.set, out.dir, reg.type = "sites", ...)

Arguments

rnb.set
Object of class `RnBSet`

out.dir
output directory. If not existing, it will be created and all exported files will be placed here. If existing, this functions results in an error.

reg.type
region type to be exported

Value

a list containing information on the export

Author(s)

Fabian Mueller
Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.export.to.ewasher(rnb.set.example,tempfile(pattern="forEwasher"))
```

Description

convert an `RnBSet` object to a UCSC-style track hub.

Usage

```r
rnb.export.to.trackhub(rnb.set, out.dir, reg.type = "sites",
data.type = "bigBed", ...)
```

Arguments

- `rnb.set`: Object of class `RnBSet`
- `out.dir`: output directory. If not existing, it will be created. otherwise files in that directory are overwritten.
- `reg.type`: region type to be converted
- `data.type`: either "bigBed" or "bigWig"
- `...`: parameters passed on to the track hub generating procedure

Details

During execution the RnBSet is converted to bed files. If the operating system is supported (currently Unix and MacOS only) these are automatically converted to bigBed files. If your operating system is not supported, you need to create them manually (see the UCSC Genome Browser documentation for details). For details on UCSC track hubs see the UCSC tracks help page.

Value

a list containing information on the export

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.export.to.trackhub(rnb.set.example,tempdir())
```
rnb.find.relative.site.coord

Description
given a region types, assigns sites to regions and determines relative positions of sites in the assigned region

Usage
rnb.find.relative.site.coord(rnb.set, region.type, extend.by = 0.33)

Arguments
- rnb.set: RnBSet object
- region.type: Region type for which the coordinates are computed
- extend.by: A number between 0 and 1 specifying the percentage by which a region is extended in order to capture methylation information before region start and after region end

Value
a data frame containing the site index, the assigned region index and the relative coordinate The relative coordinate is 0 if the site’s coordinate is identical to the region start coordinate and 1 if identical to the regions end coordinate and scaled inbetween. Coordinates can be less than 0 or larger than 1 if a site is in the upstream or downstream flanking region respectively

Author(s)
Fabian Mueller

rnb.get.annotation

Description
Extracts the requested annotation for the given genome.

Usage
rnb.get.annotation(type = "CpG", assembly = "hg19")

Arguments
- type: Name of annotation.
- assembly: Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.
Details

When the returned value is of type GRangesList, it defines the genomic positions of the requested sites, probes or regions. Identifiers, if present, can be obtained using the names method. Strand information is also included when applicable. Any additional annotation is stored as metadata in the respective GRanges objects.

Value

Probe, site or region annotation table. If the specified type refers to control probes, the returned value is a data.frame listing all respective control probes. Otherwise, this function returns an object of type GRangesList - a list of consistent GRanges objects, one per chromosome.

Author(s)

Fabian Mueller

See Also

rnb.set.annotation for adding annotation; rnb.region.types for all loaded region types in a genome assembly

Examples

rnb.get.annotation("promoters")

Description

Gets the supported genome assemblies.

Usage

rnb.get.assemblies()

Value

All supported genome assemblies in the form of a character vector. These are "hg19", "mm10", "mm9" and "rn5".

Author(s)

Yassen Assenov

Examples

"hg19" %in% rnb.get.assemblies()
rnb.get.chromosomes

Description

Gets the chromosome names supported for the specified assembly.

Usage

rnb.get.chromosomes(assembly = "hg19")

Arguments

assembly Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.

Value

character vector of supported chromosomes for the specified genome assembly. The elements of the vector follow the Ensembl convention ("1", "2", ...), and the names of this vector - the convention of the UCSC Genome Browser ("chr1", "chr2", ...).

Author(s)

Pavlo Lutsik

Examples

"chrX" %in% names(rnb.get.chromosomes())

rnb.get.directory

Description

Gets the location of the given report-specific directory.

Usage

rnb.get.directory(report, dir = c("data", "images", "images-high", "pdfs"), absolute = FALSE)

Arguments

report Report of interest.

dir Type of directory to get. Must be one of "data", "images", "images-high" or "pdfs".

absolute Flag indicating if the absolute path of the directory is to be returned. If this is FALSE, the directory name is returned relative to the report’s HTML file location.
rnb.get.mapping

Value
Path of the requested directory as a single-element character vector.

Author(s)
Yassen Assenov

See Also
Report for functions adding contents to an HTML report

Examples
report <- createReport("example.html", "Example", init.configuration = TRUE)
rnb.get.directory(report, "data")

rnb.get.mapping  rnb.get.mapping

Description
Gets the mapping information used for a region type. These are structures used to map regions to
the genomic loci (or Infinium probes) that target them.

Usage
rnb.get.mapping(region.type, target.type, assembly = "hg19")

Arguments
region.type Region type. The built-in types are "cpgislands", "genes", "promoters" and "tiling".
target.type Target type for sites.
assembly Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.

Value
list of mapping structures, one per chromosome. Every mapping structure is an object of type
IRanges and stores the range of indices of all sites contained in the respective region. Regions that
do not contain sites are left out of the mapping.

Author(s)
Yassen Assenov

Examples
promoters2probes <- rnb.get.mapping("promoters", "probes450")
promoters2probes[["chr21"]]
Description

Creates a string that points to the given reference item in the specified report.

Usage

\[
\text{rnb.get.reference}(\text{report, txt})
\]

Arguments

- **report**: Report that contains the reference to be cited.
- **txt**: Text of the reference in the form of a non-empty character vector. This reference must already added to the report.

Value

Citation of the reference item (including a link) in the form of a one-element character vector. If the specified reference item is not found in the report, this method returns an empty string.

Author(s)

Yassen Assenov

See Also

- `rnb.add.reference` for adding a reference item to a report; `Report` for other functions adding contents to an HTML report

Examples

```r
report <- createReport("example.html", "Example", init.configuration = TRUE)
report <- rnb.add.reference(report, txt.reference)
txt <- c("This was shown in ", rnb.get.reference(report, txt.reference), ",."
rb.add.paragraph(report, txt)
```
rnb.get.reliability.matrix

Description

Gets a matrix of reliability indications for every measurement in the given dataset.

Usage

rnb.get.reliability.matrix(rnb.set, row.names = FALSE)

Arguments

- **rnb.set**: Methylation dataset as an object of type inheriting `RnBSet`.
- **row.names**: Flag indicating if row names are to be generated in the result.

Value

A logical matrix in which every row corresponds to a CpG site or probe and every column - to a patient. If the dataset does not contain coverage or detection p-value information, the returned value is `NULL`.

Author(s)

Yassen Assenov

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.options(identifiers.column = "Sample_ID")
str(rnb.get.reliability.matrix(rnb.set.example))
```

rnb.infinium.control.targets

Description

Extracts all control probe types in the HumanMethylation450 assay.

Usage

rnb.infinium.control.targets(target = "probes450")
Arguments

target

A singleton of type character, specifying the microarray platform. "probesEPIC", "probes450", and "probes27" correspond to MethylationEPIC, HumanMethylation450, and HumanMethylation27 microarrays respectively.

Value

character vector of control targets.

Author(s)

Pavlo Lutsik

Examples

"NEGATIVE" %in% rnb.infinium.control.targets()

Description

Creates a new directory to host HTML reports and copies the shared configuration files.

Usage

rnb.initialize.reports(dir.reports, dir.configuration = "configuration")

Arguments

dir.reports

Directory to host report files. This must be a character of length one that specifies a non-existent path, as this method attempts to create it.

dir.configuration

Subdirectory to host configuration files shared by the reports. This must be a character of length one that gives location as a path relative to dir.reports. Also, strong restrictions apply to the path name. See the description of the createReport function for more details. This method creates the directory and copies configuration files that define cascading style sheet (CSS) definitions and Javascript functions used by the HTML reports.

Value

TRUE if the report directory was successfully created and the configuration files were copied to the specified location; FALSE otherwise.

Author(s)

Yassen Assenov
See Also

createReport for initializing an HTML report

Examples

dir.reports <- "~/infinium_studies/cancer_study/reports"
if (!rnb.initialize.reports(dir.reports)) {
  cat("ERROR: Could not initialize configuration in ", dir.reports, 
       \n", sep = "")
}

rnb.is.option(rnb.is.option)

rnb.is.option(rnb.is.option)

Description

Checks if the specified text is an option name.

Usage

rnb.is.option(txt)

Arguments

txt Potential option name. This should be a one-element character vector.

Value

TRUE if the specified parameter is a valid analysis option name; FALSE otherwise.

Author(s)

Yassen Assenov

See Also

rnb.options for getting and setting option values

Examples

rnb.is.option("logging") # TRUE
rnb.is.option("Logging") # FALSE
**rnb.load.annotation**

**Description**

Loads a previously saved custom region annotation from a binary (RData) file.

**Usage**

```r
rnb.load.annotation(fname, type)
```

**Arguments**

- **fname**: One-element character vector giving the name of the file that contains the annotation data.
- **type**: One-element character vector giving the name of the region annotation. If this annotation is already available, it will be overwritten for the current session.

**Details**

If the region annotation cannot be loaded from the specified location, this function exits with an error message in the form "unable to load object from ...". This could happen, for example, when `fname` does not refer to a valid RData file, or the file cannot be accessed due to security restrictions.

If the file is loaded in the current session, but no annotation was added, the function returns invisibly one of the following short failure messages:

- "invalid format" The RData file does not store exactly the following three objects - assembly, regions, and mapping, or they are not of the expected type.
- "unsupported assembly" The specified assembly is unknown.
- "invalid format of regions" The specified region annotation table is invalid.
- "invalid format of mappings" The specified region mapping tables are invalid.

**Value**

Invisibly, TRUE if the annotation was loaded successfully; an error message if the objects in the given file do not encode an annotation.

**Author(s)**

Yassen Assenov

**See Also**

- `rnb.save.annotation` for saving annotation to a binary file; `rnb.set.annotation` for loading an annotation from a BED file.
rnb.load.annotation.from.db

Description

Loads a previously region annotation from the RnBeads resource database

Usage

```r
rnb.load.annotation.from.db(types, assembly = "hg19")
```

Arguments

- `types`:
  - One-element character vector giving the name of the region annotation. If this annotation is already available, it will be overwritten for the current session.

- `assembly`:
  - Genome assembly of interest. See `rnb.get.assemblies` for the list of supported genomes.

Details

This function checks whether a region annotation is present in the RnBeads resources, downloads the corresponding annotation file(s) from the and then runs `rnb.load.annotation` to import the annotation.

Value

Invisibly, `TRUE` if the annotation was loaded successfully; an error message if the objects in the given file do not encode an annotation.

Author(s)

Fabian Mueller

See Also

- `rnb.load.annotation` for loading annotation from a binary file

Examples

```r
rnb.region.types()
rnb.load.annotation.from.db(c("tiling1kb", "dynamicMethZiller2013"))
rnb.region.types()
```
rnb.load.sitelist rnb.load.sitelist

Description

Loads a list of probe or site identifiers. This function is used in the preprocessing module for loading a whitelist and/or a blacklist of identifiers.

Usage

rnb.load.sitelist(fname, verbose = FALSE)

Arguments

fname  File listing the identifiers, one per line.
verbose  Flag indicating if messages are to be printed. If the values is TRUE and a logger is initialized, this function adds a message to the log.

Value

The loaded list of identifiers, or NULL if fname could not be open.

Author(s)

Yassen Assenov

See Also

logger.start for initializing a logger

rnb.message.plot rnb.message.plot

Description

Creates a plot, using ggplot2, with a single text message.

Usage

rnb.message.plot(txt)

Arguments

txt  Text to be plotted.

Value

The newly initialized ggplot instance.
rnb.mval2beta

Author(s)
Yassen Assenov

Examples

```r
x11(width = 5, height = 5)
rnb.message.plot("Missing data")
```

rnb.mval2beta rnb.mval2beta

Description
Transforms M values to beta values.

Usage

```r
rnb.mval2beta(mvals)
```

Arguments

mvals numeric vector or matrix of M values to be transformed.

Value
The calculated beta values.

Author(s)
Pavlo Lutsik

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
mvals <- rnb.beta2mval(meth(rnb.set.example))
bvals <- rnb.mval2beta(mvals)
all((bvals-meth(rnb.set.example))<1e-10)
```
rnb.options  

RnBeads Options

Description

Allows the user to set and examine a variety of RnBeads global options. They affect the way in which the package computes and displays its results.

Usage

rnb.options(...)  
rnb.getOption(x)

Arguments

...  
Option names as characters, or new option values given in the form name = value.

x  
Option name in the form of a character vector of length 1.

Details

Invoking rnb.options() with no arguments returns a list with the current values of the options. To access the value of a single option, one should use, e.g., rnb.getOption("filtering.greedyCut"), rather than rnb.options("filtering.greedyCut") which is a list of length one. Also, only a limited set of options is available (see below). Attempting to get or set the value of a non-existing option results in an error.

Value

For rnb.getOption, the current value for x. For rnb.options(), a list of all RnBeads options and their current values. If option names are given, a list of all requested options and their values. If option values are set, rnb.options returns the previous values of the modified options, invisibly.

Options used in RnBeads

analysis.name = NULL  
One-element character vector storing a short title of the analysis. If specified, this name appears at the page title of every report.

logging = TRUE  
Flag indicating if logging functionality is enabled in the automatic runs of the pipeline.

eemail = NULL  
Email address associated with the analyses.

assembly = "hg19"  
Genome assembly to be used. Currently only important for bisulfite mode. The supported genomes returned by the function rnb.get.assemblies.

analyze.sites = TRUE  
Flag indicating if analysis on site or probe level is to be conducted. Note that the preprocessing module always operates on the site level (only), regardless of the value of this option.

region.types = NULL  
Region types to carry out analysis on, in the form of a character vector. NULL (default value) signifies that all available region annotations (as returned by rnb.region.types) are summarized upon loading and normalization, and the other modules analyze all regions summarized in the dataset. If this option is set to an empty vector, analysis on the region level is skipped.
region.aggregation = "mean" Aggregation function to apply when calculating the methylation value for a region based on the values of the CpGs associated with that region. Accepted values for this function are "min", "max", "mean" (default), "median", "sum", "coverage.weighted".

The last method is applicable only for sequencing-based methylation datasets. It computes the weighted average of the values of the associated CpGs, whereby weights are calculated based on the coverages of the respective sites.

region.subsegments = 0 If a number larger than 1 is specified, RnBeads will subdivide each region specified in the region.types option into subsegments containing on average region.subsegments sites per subsegment. This is done by clustering the sites within each regions according to their genomic coordinates. These subsegments are then used for subsequent analysis. Use cautiously as this will significantly increase the runtime of the pipeline.

region.subsegments.types = NULL The region types to which subsegmentation will be applied. Defaults to region.types when set to NULL.

identifiers.column = NULL Column name or index in the table of phenotypic information to be used when plotting sample identifiers. If this option is NULL, it points to a non-existing column or a column that does not list IDs, the default identifiers are used. These are the row names of the sample phenotype table (and the column names of the beta value matrix).

colors.category = c("#1B9E77","#D95F02",...) character vector of length 2 or more giving the color scheme for displaying categorical trait values in plots. RnBeads denotes missing values (NA) by grey, therefore, it is not recommended to include shades of grey in this vector. The default value of this option is the result of the "Dark2" palette of RColorBrewer with 8 values.

colors.gradient = c("#132B43","#56B1F7") character vector of length 2 or more giving the color scheme for displaying continuous (gradient) trait values in plots. RnBeads interpolates between the color values.

min.group.size = 2 Minimum number of samples each subgroup defined by a trait, in order for this trait to be considered in the methylation profiles and in the differential methylation modules. This must be a positive integer.

max.group.count = NULL Maximum number of subgroups defined by a trait, in order for this trait to be considered in the methylation profiles and in the differential methylation modules. This must be an integer of value 2 or more. As a special case, a value of NULL (default) indicates that the maximum number of subgroups is the number of samples in an analysis minus 1, i.e. traits with all unique values will be ignored.

replicate.id.column = NULL Column name in the sample annotation table that indicates sample replicates. Replicates are expected to contain the same value. Samples without replicates should contain unique or missing values. If this option is NULL (default), replicate handling is disabled.

gz.large.files = FALSE Flag indicating whether large output files should be compressed (in .gz format).

import = TRUE Flag controlling whether data import report should be generated. This option be set to FALSE only when the provided data source is an object of type RnBSet, i.e. the data has been previously loaded by RnBeads.

import.default.data.type = "infinium.idat.dir" Type of data assumed to be supplied by default (Infinium 450k microarray). For sequencing data set this to bs.bed.dir and save the options. See rnb.execute.import for further details.

import.table.separator = "," Separator used in the plain text data tables. See rnb.execute.import for details.

import.bed.style = "BisSNP" Preset for bed-like formats. "BisSNP", "Encode", "EPP", "bismarkCytosine", "bismarkCov" are currently supported. See the RnBeads vignette and the FAQ section on the website for more details.
import.bed.columns Column indices in the supplied BED file with DNA methylation information. These are represented by a named integer vector, in which the names are: "chr", "start", "end", "strand", "meth", "coverage", "c" and "t". These names correspond to the columns for chromosome, start position, end position, strand, methylation degree, read coverage, number of reads with C and number of reads with T, respectively. Methylation degree and/or read coverage, if not specified, are inferred from the values in the columns "c" and "t". Further details and examples of BED files can be found in Section 4.1 of the RnBeads vignette.

import.bed.frame.shift = 1 Singleton of type integer specifying the frame shift between the coordinates in the input BED file and the corresponding genomic reference. This (integer) value is added to the coordinates from the BED file before matching the methylation sites to the annotated ones.

import.bed.test = TRUE Perform a small loading test, by reading 1000 rows from each BED file, after which normal loading is performed. See RnBeads vignette and the FAQ section on the website for more details.

import.bed.test.only = FALSE Perform only the small loading test, and skip loading all the data.

import.skip.object.check = FALSE Skip the check of the loaded RnBSet object after loading. Helps with keeping the memory profile down.

import.gender.prediction = TRUE Flag indicating if gender prediction is to be performed. Gender prediction is supported for Infinium 450k, EPIC and bisulfite sequencing datasets with signal intensity or coverage information. The value of this option is ignored for 27k datasets.

qc = TRUE Flag indicating if the quality control module is to be executed.

qc.boxplots = TRUE [Microarrays] Add boxplots for all types of quality control probes to the quality control report. The boxplots give signal distribution across samples.

qc.barplots = TRUE [Microarrays] Add barplots for each quality control probes to the quality control report.

qc.negative.boxplot = TRUE [Microarrays] Add boxplot of negative control probe intensities for all samples.

qc.snp.heatmap = TRUE [Microarrays] Flag indicating if a heatmap of the beta values for all SNP probes is to be generated.

qc.snp.barplot = FALSE [Microarrays] Add bar plots of the beta-values observed for each SNP-calling probe.


qc.snp.distances = TRUE [Microarrays] Flag indicating if intersample distances based on the beta values of SNP probes are to be displayed. This can help identify genetically similar or identical samples.

qc.snp.purity = FALSE [Microarrays] Flag indicating if genetic purity should be estimated based on the beta values of SNP probes.

qc.sample.batch.size = 50 [Microarrays] Maximal number of samples included in a single quality control barplot and negative control boxplot.

qc.coverage.plots = FALSE [Bisulfite sequencing] Add genome-wide sequencing coverage plot for each sample.

qc.coverage.threshold.plot = 1:10 [Bisulfite sequencing] Values for coverage cutoffs to be shown in a coverage thresholds plot. This must be an integer vector of positive values. Setting this to an empty vector disables the coverage thresholds plot.

qc.coverage.histograms = FALSE [Bisulfite sequencing] Add sequencing coverage histogram for each sample.
qc.coverage.violins = FALSE  [Bisulfite sequencing] Add sequencing coverage violin plot for each sample.

preprocessing = TRUE  Flag controlling whether the data should be preprocessed (whether quality filtering and in case of Infinium microarray data normalization should be applied).

normalization = NULL  Flag controlling whether the data should be normalized and normalization report generated. Setting this to NULL (default) enables this step for analysis on Infinium datasets, but disables it in case of sequencing-based datasets. Note that normalization is never applied in sequencing datasets; if this flag is enabled, it will lead to a warning message.

normalization.method = "swan"  Normalization method to be applied, or "none". Multiple normalization methods are supported: "illumina" - methylumi-implemented Illumina scaling normalization; "swan" (default) - SWAN-normalization by Gordon et al., as implemented in minfi; "bmiq" - beta-mixture quantile normalization method by Teschendorff et al; as well as "wm.dansen", "wm.nasen", "wm.betaqnn", "wm.naten", "wm.nanes", "wm.danes", "wm.danet", "wm.daten1", "wm.daten2", "wm.tost", "wm.fuks" and "wm.swan" - all normalization methods implemented in the wateRmelon package. When setting this option to a specific algorithm, make sure its dedicated package is installed.

normalization.background.method = "methylumi.noob"  A character singleton specifying which background subtraction is to be performed during normalization. The following values are accepted: "none", "methylumi.noob", "methylumi.goob", "methylumi.lumi" and "enmix.oob".

normalization.plot.shifts = TRUE  Flag indicating if the report on normalization should include plots of shifts (degrees of beta value correction).

filtering.whitelist = NULL  Name of a file specifying site or probe identifiers to be whitelisted. Every line in this file must contain exactly one identifier. The whitelisted sites are always retained in the analysed datasets, even if filtering criteria or blacklisting requires their removal. For Infinium studies, the file must contain Infinium probe identifiers. For bisulfite sequencing studies, the file must contain CpG positions in the form "chromosome:coordinate" (1-based coordinate of the cytosine), e.g. chr2:48607772. Unknown identifiers are silently ignored.

filtering.blacklist = NULL  Name of a file specifying site or probe identifiers to be blacklisted. Every line in this file must contain exactly one identifier. The blacklisted sites are removed from the analysed datasets as a first step in the preprocessing module. For Infinium studies, the file must contain Infinium probe identifiers. For bisulfite sequencing studies, the file must contain CpG positions in the form "chromosome:coordinate" (1-based coordinate of the cytosine), e.g. chr2:48607772. Unknown identifiers are silently ignored.

filtering.context.removal = c("CC", "CAG", ...)  character vector giving the list of probe context types to be removed as a filtering step. Possible context values are "CC", "CG", "CAG", "CAH", "CTG", "CTH" and "Other". Probes in the second context measure CpG methylation; the last context denotes probes dedicated to SNP detection. Setting this option to NULL or an empty vector effectively disables the step of context-specific probe removal.

filtering.snp = "3"  Removal of sites or probes based on overlap with SNPs. The accepted values for this option are:

"no"  no SNP-based filtering;
"3"  filter out a probe when the last 3 bases in its target sequence overlap with SNP;
"5"  filter out a probe when the last 5 bases in its target sequence overlap with SNP;
"any" or "yes"  filter out a CpG site or probe when any base in its target sequence overlaps with SNP.

Bisulfite sequencing datasets operate on sites instead of probes, therefore, the values "3" and "5" are treated as "yes".

filtering.cross.reactive = FALSE  Flag indicating if the removal of potentially cross-reactive probes should be performed as a filtering step in the preprocessing module. A probes whose sequence maps to multiple genomic locations (allowing up to 3 mismatches) is cross-reactive.
filtering.greedy.cut = NULL  Flag indicating if the Greedycut procedure should be run as a filtering step in the preprocessing module. NULL (default) indicates that Greedycut will be run for array-based datasets, but not for sequencing-based datasets.

filtering.greedy.cut.p.value.threshold = 0.05 Threshold for the detection p-value to be used in Greedycut. This is a value between 0 and 1. This option has effect only when filtering.greedy.cut is TRUE.

filtering.greedy.cut.rc.ties = "row" Indicator of what the behaviour of Greedycut should be in case of ties between the scores of rows (probes) and columns (samples). The value of this option must be one of "row", "column" or "any"; the last one indicating random choice. This option has effect only when filtering.greedy.cut is TRUE.

filtering.sex.chromosomes.removal = FALSE Flag indicating if the removal of probes located on sex chromosomes should be performed as a filtering step.

filtering.missing.value.quantile = 1 Number between 0 and 1, indicating the fraction of allowed missing values per site. A site is filtered out when its methylation beta values are NAs in a larger fraction of samples than this threshold. Setting this option to 1 (default) retains all sites, and thus effectively disabling the missing value filtering step in the preprocessing module. If this is set to 0, all sites that contain missing values are filtered out.

filtering.coverage.threshold = 5 Threshold for minimal acceptable coverage. This must be a non-negative value. Setting this option to 0 (zero) effectively considers any known or unknown read coverage for sufficiently deep.

filtering.low.coverage.masking = FALSE Flag indicating whether methylation values for low coverage sites should be set to missing. In combination with filtering.missing.value.quantile this can lead to the removal of sites.

filtering.high.coverage.outliers = FALSE (Bisulfite sequencing mode) Flag indicating whether methylation sites with a coverage of more than 10 times the 95-percentile of coverage should be removed.

filtering.deviation.threshold = 0 Threshold used to filter probes based on the variability of their assigned beta values. This must be a real value between 0 and 1, denoting minimum standard deviation of the beta values in one site across all samples. Any sites that have standard deviation lower than this threshold are filtered out. Note that sites with undetermined variability, that is, sites for which there are no measurements (all beta values are NAs), are retained. Setting this option to 0 (default) disables filtering based on methylation variability.

imputation.method = "none" Character indicating which imputation method should be used to replace missing values. This option has to be one of the following values "none", "mean.cpps", "mean.samples", "random", "median.cpps", "median.samples" or "knn". Setting this option to "none" inactivates imputation (default).

inference = FALSE Flag indicating if the covariate inference analysis module is to be executed.

inference.genome.methylation = "Genome-wide methylation" Name of the column to add to the sample annotation, storing the genome-wide methylation level. If such a column already exists, its values will be overwritten. Setting this option to NULL or an empty character disables computing and adding genome-wide methylation levels.

inference.targets.sva = character() Column names in the sample annotation table for which surrogate variable analysis (SVA) should be conducted. An empty vector (default) means that SVA is skipped.

inference.reference.methylome.column = character() Column name in the sample annotation table giving the assignment of samples to reference methylomes. The target samples should have NA values in this column.
rnb.options

\texttt{inference.max.cell.type.markers = 50000} Number of most variable CpGs which are tested for association with the reference cell types. Setting this option to NULL forces the algorithm to use all available sites in the dataset, and may greatly increase the running time for cell type composition estimation.

\texttt{inference.top.cell.type.markers = 500} Number of top cell type markers used for determining cell type contributions to the target DNA methylation profiles using the projection method of Houseman et al.

\texttt{inference.sva.num.method = "leek"} Name of the method to be used for estimating the number of surrogate variables. must be either 'leek' or 'be', See sva function for details.

\texttt{inference.age.column = "age"} Name of the column in which the ages of the donors are annotated. This function can be of numeric, string or factor format.

\texttt{inference.age.prediction = TRUE} Flag indicating if the epigenetic age prediction within the inference module is to be executed.

\texttt{inference.age.prediction.training = FALSE} Flag indicating if a new predictor should be created based on the provided data set.

\texttt{inference.age.prediction.cv = FALSE} Flag indicating if predictive power of a predictor that was trained in that run of the age prediction should be assessed by cross-validation. This option only has an influence if inference.age.prediction.training = TRUE.

\texttt{inference.immune.cells = TRUE} Flag indicating if immune cell content estimation is to be performed. Immune cell content prediction is based on the LUMP algorithm and is currently supported for the hg19 assembly only.

\texttt{exploratory = TRUE} Flag indicating if the exploratory analysis module is to be executed.

\texttt{exploratory.columns = NULL} Traits, given as column names or indices in the sample annotation table, to be used in the exploratory analysis. These traits are used in multiple steps in the module: they are visualized using point types and colors in the dimension reduction plots; tested for strong correlations and associations with principal components in a methylation space; used to define groups when plotting beta distributions and/or inter-sample methylation variability. The default value of this parameter - NULL - indicates that columns should be automatically selected; see \texttt{rnb.sample.groups} for how this is done.

\texttt{exploratory.top.dimensions = 0} Number of most variable probes, sites or regions to select prior to performing dimension reduction techniques and tests for associations. Preselection can significantly reduce the running time and memory usage in the exploratory analysis module. Setting this number to zero (default) disables preselection.

\texttt{exploratory.principal.components = 8} Maximum number of principal components to be tested for associations with other factors, such as control probe states and sample traits. This must be an integer value between 0 and 10. Setting this option to 0 disables such tests.

\texttt{exploratory.correlation.pvalue.threshold = 0.01} Significance threshold for a \textit{p}-value resulting from applying a test for association. This is a value between 0 and 1.

\texttt{exploratory.correlation.permutations = 10000} Number of permutations in tests performed to check for associations between traits, and between control probe intensities and coordinates in the principal component space. This must be a non-negative integer. Setting this option to 0 disables permutation tests.

\texttt{exploratory.correlation.qc = TRUE} [Infinium 450k] Flag indicating if quality-associated batch effects should be studied. This amounts to testing for associations between intensities of quality control probes and principal components. This option has effect only when exploratory.principal.components is non-zero.

\texttt{exploratory.beta.distribution = TRUE} Flag indicating whether beta value distributions for sample groups and probe or site categories should be computed.
exploratory.intersample = TRUE  Flag indicating if methylation variability in sample groups should be computed as part of the exploratory analysis module.

exploratory.deviation.plots = NULL  Flag indicating if the inter-sample methylation variability step in the exploratory analysis module should include deviation plots. Deviation plots show intra-group methylation variability at the covered sites and regions. Setting this option to NULL (default) enables deviation plots on Infinium datasets, but disables them in case of sequencing-based datasets, because their generation can be very computationally intensive. This option has effect only when exploratory.intersample is TRUE.

exploratory.clustering = "all"  Which sites should be used by clustering algorithms in the exploratory analysis module. RnBeads performs several algorithms that cluster the samples in the dataset. If this option is set to "all" (default), clustering is performed using all sites; a value of "top" indicates that only the most variable sites are used (see the option exploratory.clustering.top.sites); and "none" disables clustering.

exploratory.clustering.top.sites = 1000  Number of most variable sites to use when visualizing heatmaps. This must be a non-empty integer vector containing positive values. This option is ignored when exploratory.clustering is "none".

exploratory.clustering.heatmaps.pdf = FALSE  Flag indicating if the generated methylation value heatmaps in the clustering section of the exploratory analysis module should be saved as PDF files. Enabling this option is not recommended for large values of exploratory.clustering.top.sites (more than 200), because heatmaps might generate very large PDF files.

exploratory.region.profiles = NULL  Region types for generating regional methylation profiles. If NULL (default), regional methylation profiles are created only for the region types that are available for the targeted assembly and summarized in the dataset of interest. Setting this option to an empty vector disables the region profiles step in the exploratory analysis module.

exploratory.gene.symbols = NULL  A list of gene symbols to be used for custom locus profiling. Locus views will be generated for these genes.

differential = TRUE  Flag indicating if the differential methylation module is to be executed.

differential.site.test.method = "limma"  Method to be used for calculating p-values on the site level. Currently supported options are "ttest" for a (paired) t-test and "limma" for a linear modeling approach implemented in the limma package for differential expression in microarrays.

differential.variability = FALSE  Flag indicating if differential variability analysis is to be conducted. If TRUE, the method specified in differential.variability.method is applied to detect sites that show differential variability between the groups that are specified.

differential.variability.method = "diffVar"  Method to be used for calculating p-values on the differential variable sites. Currently supported options are "diffVar" implemented in the missMethyl package and "iEVORA".

differential.permutations = 0  Number of permutation tests performed to compute the p-value of rank permutation tests in the differential methylation analysis. This must be a non-negative integer. Setting this option to 0 (default) disables permutation tests for rank permutations. Note that p-values for differential methylation are computed and also considered for the ranking in any case.

differential.comparison.columns = NULL  Column names or indices in the table of the sample annotation table to be used for group definition in the differential methylation analysis. The default value - NULL - indicates that columns should be automatically selected. See rnb.sample.groups for how this is done. By default, the comparisons are done in a one vs. all manner if there are multiple groups defined in a column.
differential.comparison.columns.all.pairwise = NULL Column names or indices in the table of sample annotation table to be used for group definition in the differential methylation analysis in which all pairwise comparisons between groups should be conducted (the default is one vs all if multiple groups are specified in a column). Caution: for large numbers of sample groups this can lead to combinatorial explosion and thus to huge runtimes. A value of NULL (default) indicates that no column is selected for all pairwise comparisons explicitly. If specified, the selected columns must be a subset of the columns that will be selected according to the differential.comparison.columns option.

covariate.adjustment.columns = NULL Column names or indices in the table of phenotypic information to be used for confounder adjustment in the differential methylation analysis. Currently this is only supported for differential.site.test.method="limma".

columns.pairing = NULL A NAMED vector containing for each column name for which paired analysis should be performed (say columnA) the name or index of another column (say columnB) in which same values indicate the same pairing. columnA should be the name of the value columnB in this vector. For more details see rnb.sample.groups

differential.adjustment.sva = TRUE Flag indicating if the differential methylation analysis should account for Surrogate Variables. If TRUE, RnBeads looks for overlaps between the differential.comparison.columns and inference.targets.sva options and include the surrogate variables as confounding factors only for these columns. In other words, it will only have an effect if the corresponding inference option (see inference.targets.sva option for details) is enabled. Currently this is only supported for differential.site.test.method="limma".

differential.adjustment.celltype = TRUE Should the differential methylation analysis account for celltype using the reference based Houseman method. It will only have an effect if the corresponding inference option is enabled (see inference.reference.methylome.column option for details). Currently this is only supported for differential.site.test.method="limma".

differential.enrichment.go = FALSE Flag indicating whether Gene Ontology (GO)-enrichment analysis is to be conducted on the identified differentially methylated regions.

differential.enrichment.lola = FALSE Flag indicating whether LOLA-enrichment analysis is to be conducted on the identified differentially methylated regions.

differential.enrichment.lola.dbs = c("${LOLACore}\" Vector of directories containing LOLA databases. The following placeholders are allowed which will automatically download corresponding databases from the internet: "$\{LOLACore\}" and "$\{LOLAExt\}" for the Core and Extended LOLA Databases respectively.

differential.report.sites = TRUE Flag indicating whether a section corresponding to differential site methylation should be added to the report. Has no effect on the actual analysis, just the report. To disable differential site methylation analysis entirely use the analyze.sites option.

export.to.bed = TRUE Flag indicating whether the data should be exported to bed files.

export.to.trackhub = c("bigBed","bigWig\") character vector specifying which data types should be exported to Track hub directories. Possible values in the vector are "bigBed" and "bigWig". When this options is set to NULL, track hub export is disabled. Note that if "bigBed" is contained in this option, bed files are created automatically.

export.to.csv = FALSE Flag indicating whether methylation value matrices are to be exported to comma-separated value (CSV) files.

export.to.ewasher = FALSE Flag indicating whether methylation values and differential methylation analysis settings should be exported to a format compatible with FaST-LMM-EWASher, a tool for adjusting for cell-type compositions. See Zou, J., et al., Nature Methods, 2014 for further details on the tool.
export.types = "sites" character vector of sites and region names to be exported. If NULL, no region methylation values are exported.

disk.dump.big.matrices = TRUE Flag indicating whether big tables should be stored on disk rather than in main memory in order to keep memory requirements down. May slow down analysis!

logging.exit.on.error = FALSE Flag indicating if the active R session should be terminated when an error is encountered during execution.

distribution.subsample = 1000000 When plotting methylation value distributions, this threshold specifies the number of observations drawn per group. Distributions are estimated and plotted based on these random subsamples. This approach can significantly reduce the memory requirements of the preprocessing and exploratory analysis modules, where methylation value distributions are plotted. Setting this to 0 disables subsampling. More information is presented the Details section of rnb.step.betadistribution.

enforce.memory.management = FALSE Flag indicating whether in some places of the code memory management should actively being enforced in order to achieve a better memory profile. I.e. garbage collection, variable removal is conducted actively. May slow down analysis.

enforce.destroy.disk.dumps = FALSE Flag indicating whether disked dumped big matrices (see disk.dump.big.matrices option) should actively be deleted when RnBSets are modified. You should switch it to TRUE when disk.dump.big.matrices is TRUE and the amount of hard drive space is also limited.

Author(s)

Yassen Assenov

Examples

str(rnb.options())

rnb.getOption("filtering.greedyCut")

Description

Exports all option values to an XML document.

Usage

rnb.options2xml(pretty = TRUE)

Arguments

pretty Flag indicating if the document should be formatted to be easily readable. For example, if this is set to TRUE (default), every element is located on separate line. Formatting does not affect the validity of the generated XML tree.
**rnb.performance.profile**

**Value**

XML document in the form of a character that encodes all options and their current values.

**Author(s)**

Yassen Assenov

**Examples**

```r
cat(rnb.options2xml(), file = "rnbeads_options.xml")
```

**Description**

Enables one of the pre-installed analysis option profiles.

**Usage**

```r
rnb.performance.profile(data.type = "450k", profile)
```

**Arguments**

- `data.type` Type of dataset targeted; this must be one of "450k" (default) or "bs".
- `profile` Option profile; this must be one of "minimal", "moderate" or "full".

**Value**

Invisibly, a list containing the previous values of all modified options.

**Author(s)**

Pavlo Lutsik
rnb.plot.beta.comparison

Description

Draws plots that compare two distributions of beta values.

Usage

rnb.plot.beta.comparison(beta.values, fprefix, report = NULL,
qq.length = 501L,
points.per.group = rnb.getOption("distribution.subsample"))

Arguments

beta.values Two beta value sequences in the form of a named list of two non-empty vectors of type double. If any of the vectors contains NAs, this method may exit with an error.
fprefix File name prefix for the plots. This function appends the suffixes ",_density", ",_histogram" and ",_qq" to this prefix.
report Report to which the plots are to be added.
qq.length Positive integer value showing the number of quantiles to be calculated and presented in the generated Q-Q plot.
points.per.group Maximum number of values to use in plotting a group’s distribution. Groups that contain more observations than this threshold are subsampled. Setting this parameter to a value less than 2 disables subsampling.

Value

List of all generated plots, each being an object of type ReportPlot.

Author(s)

Yassen Assenov

rnb.plot.betadistribution.probeCategories

Description

plot beta value distributions given probe categories

Usage

rnb.plot.betadistribution.probeCategories(beta.matrix, probe.cat,
annotation = "Group", color.legend = NULL, log.str = NULL,
points.per.group = rnb.getOption("distribution.subsample"))
Arguments

beta.matrix  
Beta values in the form of a non-empty matrix of type double. Rows in this matrix must correspond to Infinium probes, and columns to samples.

probe.cat  
Factor vector of length nrow(beta.matrix) corresponding to the probe categories.

annotation  
Name of the annotation being visualized, in the form of a character vector of length 1.

color.legend  
Color legend to use in the form of a character vector with element names. The values in this vector should encode colors. All values in probe.cat must be present in the names of this color legend. If this parameter is NULL, a default color legend is be constructed.

log.str  
String specifying more details for the log file

points.per.group  
The targeted number of points per group. Set this to a value < 1 to disable subsampling. More information in the Details section of rnb.step.betadistribution

Value

The plot as a ggplot2 object.

Author(s)

Fabian Mueller

See Also

rnb.plot.betadistribution.sampleGroups

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
probe.types <- annotation(rnb.set.example)[, "Design"]
rnb.plot.betadistribution.probeCategories(meth.mat,probe.types,annotation="Infinium probe type")

rnb.plot.betadistribution.sampleGroups

rnb.plot.betadistribution.sampleGroups

rnb.plot.betadistribution.sampleGroups

Description

Plots beta value distributions given a sample grouping.

Usage

rnb.plot.betadistribution.sampleGroups(beta.matrix, sample.group.inds, annotation = "Group", log.str = NULL, points.per.group = rnb.getOption("distribution.subsample"))
Arguments

- **beta.matrix**: Beta values in the form of a non-empty matrix of type double. Rows in this matrix must correspond to Infinium probes, and columns to samples.

- **sample.group.inds**: Named list that contains indices for the samples contained in the groups in `beta.matrix`. The number of groups is determined by the length of the list, and its names are used as group names.

- **annotation**: Name of the annotation being visualized, in the form of a character vector of length 1.

- **log.str**: String specifying more details for the log file.

- **points.per.group**: The targeted number of points per group. Set this to a value < 1 to disable subsampling. More information in the Details section of `rnb.step.betadistribution`.

Value

The plot as a ggplot2 object.

Author(s)

Fabian Mueller

See Also

- `rnb.plot.betadistribution.probeCategories`

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
sample.groups <- rnb.sample.groups(rnb.set.example)[[1]]
rnb.plot.betadistribution.sampleGroups(meth.mat, sample.groups)
```

Description

Plots the sequencing coverage of the RnBiseqSet object across the genomic coordinate.

Usage

```r
rnb.plot.biseq.coverage(rnbs.set, sample, type = "sites",
                        writeToFile = FALSE, numeric.names = FALSE, covg.lists = NULL, ...)
```
Arguments

rnbs.set RnBiseqSet object
sample unique sample identifier. In case rnb.getOption("identifiers.column") is not NULL, sample should attain values from the corresponding column, or colnames(meth(rnb.set)) otherwise
type character singleton. If site the coverage information is plotted for each methylation site. Otherwise should be one of the regions returned by rnb.region.types
writeToFile flag specifying whether the output should be saved as ReportPlot
numeric.names if TRUE and writeToFile is TRUE substitute the plot options in the plot file name with digits
covg.lists if available, the output of rnb.execute.quality
... other arguments to createReportPlot

Value
plot as an object of type ReportPlot if writeToFile is TRUE and of class ggplot otherwise.

Author(s)
Pavlo Lutsik

Description
Plots the histograms of the coverage

Usage
rnb.plot.biseq.coverage.hist(rnbs.set, sample, type = "sites",
writeToFile = FALSE, numeric.names = FALSE, covg.max.percentile = 1,
...)

Arguments
rnbs.set RnBiseqSet object
sample unique sample identifier. In case rnb.getOption("identifiers.column") is not NULL, sample should attain values from the corresponding column, or colnames(meth(rnb.set)) otherwise
type character singleton. If site the coverage information is plotted for each methylation site. Otherwise should be one of the regions returned by rnb.region.types
writeToFile a flag specifying whether the output should be saved as ReportPlot
numeric.names if TRUE and writeToFile is TRUE substitute the plot options in the plot file name with digits
covg.max.percentile the maximum percentile of the coverage to be plotted
... other arguments to createReportPlot
rnb.plot.biseq.coverage.violin

**Value**

plot as an object of type `ReportPlot` if `writeToFile` is `TRUE` and of class `ggplot` otherwise.

**Author(s)**

Pavlo Lutsik

---

**rnb.plot.biseq.coverage.violin**

**Description**

Plots the violin plots of the coverage distribution

**Usage**

```r
rnb.plot.biseq.coverage.violin(rnbs.set, samples, fname = NULL, 
type = "sites", covg.range = NULL, ...)
```

**Arguments**

- `rnbs.set` RnBiseqSet object
- `samples` unique sample identifiers. In case `rnb.getOption("identifiers.column")` is not `NULL`, samples should attain values from the corresponding column, or `colnames(meth(rnb.set))` otherwise
- `fname` base filename for the files to be plotted. If `NULL`, the plot will not be written to file
- `type` character singleton. If `site` the coverage information is plotted for each methylation site. Otherwise should be one of the regions returned by `rnb.region.types`
- `covg.range` Vector of length 2 specifying the range of coverage to be plotted. If `NULL` (default) the entire range will be plotted
- `...` other arguments to `createReportPlot`

**Value**

plot as an object of type `ReportPlot` if `writeToFile` is `TRUE` and of class `ggplot` otherwise.

**Author(s)**

Fabian Mueller
Description
Per-sample bar plots of Illumina HumanMethylation control probes

Usage

```r
rnb.plot.control.barplot(rnb.set, probe,
    sample.subset = 1:length(samples(rnb.set)), writeToFile = FALSE,
    numeric.names = FALSE, name.prefix = NULL, verbose = FALSE, ...)
```

Arguments

- `rnb.set` RnBeadRawSet or RnBeadSet object with valid quality control information
- `probe` exact id of the control probe consisting of the control probe type (see `rnb.plot.control.boxplot`)
- `sample.subset` an integer vector specifying the subset of samples for which the plotting should be performed
- `writeToFile` flag specifying whether the output should be saved as `ReportPlot`
- `numeric.names` if TRUE and writeToFile is TRUE substitute the plot options in the plot file name with digits
- `name.prefix` in case writeToFile is TRUE, a character singleton specifying a prefix to the variable part of the image file names
- `verbose` if TRUE additional diagnostic output is generated
- `...` other arguments to `createReportPlot`

Value

plot as an object of type `ReportPlot` if writeToFile is TRUE and of class `ggplot` otherwise.

Author(s)

Pavlo Lutsik

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
control.meta.data <- rnb.get.annotation("controls450")
ctrl.probe <- paste0(unique(control.meta.data["Target"])[4], ".3")
print(ctrl.probe) # EXTENSION.3
rnb.plot.control.barplot(rnb.set.example, ctrl.probe)
```
**Description**

Box plots of various control probes

**Usage**

```r
rnb.plot.control.boxplot(rnb.set,
    type = rnb.infinium.control.targets(rnb.set@target)[1],
    writeToFile = FALSE, numeric.names = FALSE, ...)
```

**Arguments**

- `rnb.set` \(\text{RnBeadRawSet or RnBeadSet object with valid quality control information.}\)
- `type` \(\text{type of the control probe; must be one of the "BISULFITE CONVERSION I", "BISULFITE CONVERSION II", "EXTENSION", "HYBRIDIZATION", "NEGATIVE", "NON-POLYMORPHIC", "NORM_A", "NORM_C", "NORM_G", "NORM_T", "SPECIFICITY I", "SPECIFICITY II", "STAINING", "TARGET REMOVAL".}\)
- `writeToFile` \(\text{flag specifying whether the output should be saved as ReportPlot}\)
- `numeric.names` \(\text{if TRUE and writeToFile is TRUE substitute the plot options in the plot file name with digits}\)
- `...` \(\text{other arguments to createReportPlot}\)

**Value**

plot as an object of type `ReportPlot` if `writeToFile` is `TRUE` and of class `ggplot` otherwise.

**Author(s)**

Pavlo Lutsik

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.plot.control.boxplot(rnb.set.example)
```
Description

Plots the number of remaining CpGs after applying different thresholds for coverage and support.

Usage

```r
rnb.plot.coverage.thresholds(rnb.set, min.coverages, fname = NA, ...)
```

Arguments

- `rnb.set`: Methylation dataset as an object of type `RnBiseqSet`.
- `min.coverages`: Non-empty integer vector storing the unique positive cutoff values to be applied for minimal coverage. Names, if present, are interpreted as colors that must be used to denote the corresponding values.
- `fname`: File name to save the generated plot to. See the Details section for restrictions.
- `...`: Additional named parameters related to saving the plot to files. These can include: `report`, `width`, `height`, `create.pdf`, `low.png` and `high.png`. These parameters are ignored when `fname` is `NULL` or `NA`.

Details

If `fname` is specified, this function calls `createReportPlot` to save the plot to PDF and/or PNG files. See its documentation for information on acceptable file names. Additional parameters `-report`, `width`, `height`, etc. - can also be given. If image width is not specified, it is set to a value between 4.7 and 9.2 (inches), depending on the number of samples in the dataset. The default image height is fixed to 7.2.

Value

If `fname` is `NULL` or `NA` (default), the generated plot as an object of type `ggplot2`; otherwise, the initialized and closed `ReportPlot` object, invisibly.

Author(s)

Yassen Assenov
Description

Plot contributions of the cell types.

Usage

rnb.plot.ct.heatmap(ct.obj, type = "nonnegative", writeToFile = FALSE, ...)

Arguments

ct.obj Object of class CellTypeInferenceResult as returned by rnb.execute.ct.estimation.
type Type of cell type contributions to plot.
writeToFile If TRUE, the plot will be written to a file.
... Other arguments passed to createReportPlot.

Details

The cell type contributions are visualized as a heatmap.

Value

if writeToFile=TRUE an object of class ReportPlot, or the protted matrix otherwise.

Author(s)

Pavlo Lutsik

Description

Creates a dimension reduction plot based on the methylation values of the given dataset.

Usage

rnb.plot.dreduction(rnb.set, plot.type = "pca", dimensions = 1:2, distance.metric = "euclidean", target = "sites", point.types = 0L, point.colors = 0L, legend.space = 2)
Arguments

- **rnb.set**: Methylation dataset as an object of type inheriting `RnBSet`. This dataset must contain at least four samples.
- **plot.type**: Type of plot to be created. This must be one of "pca" (projection to two principal components), "mds" (multidimensional scaling to two dimensions) or "tsne" (t-distributed stochastic neighbor embedding to two dimensions). The section Details provides more details on how the dimension reduction techniques are applied.
- **dimensions**: Vector of two positive integer values giving the principle components to be shown in the horizontal and vertical axis of the plot. This parameter is considered only when plot.type is "pca".
- **distance.metric**: Distance metric to be applied when reducing the dimensionality of the methylation data. This must be one of "euclidean" or "manhattan". The second metric is not supported by principal component analysis.
- **target**: Site or region type to be used in the dimension reduction technique. This must be either "sites" (individual CpGs) or one of the region types summarized in `rnb.set`.
- **point.types**: Trait, specified as column name or index in the sample annotation table of `rnb.set`, to be used to define point types in the plot. Setting this parameter to zero (default) or to a trait that does not define categories results in all samples being displayed as filled circles. If this parameter specifies a column that can be used as sample identifiers, the plot displays the samples as identifiers instead of points.
- **point.colors**: Trait, specified as column name or index in the sample annotation table of `rnb.set`, to be used to define sample colors in the plot. Setting this parameter to zero (default) or to a trait that does not define numerical values or categories results in all samples being displayed in black.
- **legend.space**: Width, in inches, of the space dedicated for legends that will be assigned on the right side of the plot. This parameter is considered only if legends are actually included, that is, if sample traits are mapped to point types and/or colors.

Details

The analysis option "exploratory.top.dimensions" controls whether dimension reduction is applied on all probes, sites or regions available in the given dataset, or only on the most variable ones. In case a trait is mapped to point types, the shapes to use are taken from the option "points.category". Similarly, the option "colors.category" determines which colors are used when mapping sample categories to color. In cases when numerical values are mapped to color, the option "colors.3.gradient" is used. If the set of value contains both positive and negative numbers, the middle point in the color legend is set to zero. See `RnBeads Options` for more information on the options mentioned above.

Value

The generated plot as an object of type `ggplot`. The object also contains an attribute "info", which is a list with the following elements:

- "Target": Targeted sites or regions; the value of the parameter target.
- "Technique": Dimension reduction technique applied; one of "PCA" or "MDS".
"All"  Total number of sites or regions defining the high dimensional methylation space.
"Missing" Number of dimensions ignored because they contain (only) missing values.
"Selected"  Number of dimensions used when applying a dimension reduction technique.
"Explained"  Value between 0 and 1 showing the variance explained by the selected dimensions,
as a fraction of the total variance of all dimensions.

Author(s)
Yassen Assenov

See Also
summarized.regions for listing all region types summarized in a dataset

Examples

library(RnBeads.hg19)
data(small.example.object)
pdf("PCA.pdf", width = 7.2, height = 5.2)
print(rnb.plot.dreduction(rnb.set.example, point.colors="Sample_Group"))
dev.off()

rnb.plot.locus.profile

Description
Computes methylation distributions for various region types and sample groups

Usage
rnb.plot.locus.profile(rnbSet, chrom, start, end, grps = NULL,
plot.m.regions = NULL, plot.m.heatmap = TRUE, plot.m.smooth = TRUE,
cvals.grps = rnb.getOption("colors.category"),
cvals.meth = rnb.getOption("colors.meth"), smooth.profile = "wide")

Arguments
rnbSet  RnBSet object
chrom  chromosome of window to plot
start  start coordinate of window to plot
end  end coordinate of window to plot
grps  a list of indices for each group to be compared or NULL if no sample grouping
       information should be displayed
plot.m.regions  character vector of region types whose methylation values should be displayed
   If grps is not NULL the methylation values will be separated by sample groups.
plot.m.heatmap flag indicating whether sites methylation values should be displayed in a heatmap. If grps is not NULL the heatmaps will be separated by sample groups.

plot.m.smooth flag indicating whether a scatterplot with smoothing curves should be displayed. If grps is not NULL the colors will be used to separate sample groups.

cvals.grps colors to be used for the different groups

cvals.meth colors to be used for methylation values and heatmaps

smooth.profile profile to be used for the smoothing curves. Allowed values include wide (default) which yields smoother curves and narrow which yields more "wiggly" curves

Value

a ggplot2 plot object containing the plot

Author(s)

Fabian Mueller

Examples

#see RnBeads vignette (section: 'Generating Locus Profile Plots') for examples

Value

if writeToFile=TRUE an object of class ReportPlot, and the plotted reordered F-statistics vector otherwise

Description

Plot the the cell type marker selection based on the reference methylome data

Usage

rnb.plot.marker.fstat(ct.object, writeToFile = FALSE, ...)

Arguments

c.object Object of class CellTypeInferenceResult as returned by rnb.execute.ct.estimation.
writeToFile If TRUE, the plot will be written to a file.
... Other arguments to createReportPlot.

Details

The F-statistic values from the cell type association model (first part of eqn. (1) in [1]) are plotted in decreasing order for all tested CpG positions. A vertical line gives a cut-off for the number of selected cell type markers.

Value

if writeToFile=TRUE an object of class ReportPlot, and the plotted reordered F-statistics vector otherwise
Author(s)

Pavlo Lutsik

References


Description

Box plots of negative control probes

Usage

rnb.plot.negative.boxplot(rnb.set, sample.subset = 1:length(samples(rnb.set)), writeToFile = FALSE, name.prefix = NULL, ...)

Arguments

- `rnb.set` RnBeadSet object with valid quality control information
- `sample.subset` an integer vector specifying the subset of samples for which the plotting should be performed
- `writeToFile` flag specifying whether the output should be saved as ReportPlot
- `name.prefix` in case writeToFile is TRUE, a character singleton specifying a prefix to the variable part of the image file names
- `...` other arguments to createReportPlot

Value

plot as an object of type ReportPlot if writeToFile is TRUE and of class ggplot otherwise.

Author(s)

Pavlo Lutsik

Examples

library(RnBeads.hg19)
data(small.example.object)
 rnb.plot.negative.boxplot(rnb.set.example)
**Description**

plot the number of sites vs median and other percentiles of coverage

**Usage**

```r
rnb.plot.num.sites.covg(rnbs, addSampleNames = (length(samples(rnbs)) < 100),
bar.percentiles = c(0.25, 0.75))
```

**Arguments**

- `rnbs`: RnBiseqSet object
- `addSampleNames`: should the sample names be added to the plot
- `bar.percentiles`: the percentiles to be used for the error bars. Must be a vector of length 2 of which the first two elements will be used

**Value**

plot as an object of type `ggplot`

**Author(s)**

Fabian Mueller

---

**rnb.plot.pheno.categories**

**Description**

Generates bar charts summarizing the categorical traits in a sample annotation table.

**Usage**

```r
rnb.plot.pheno.categories(annotations, columns = NULL,
fileprefix = "barchart_pheno", report = NULL,
color.values = rnb.getOption("colors.category"))
```
rnb.plot.region.profile.density

Arguments

annotations  Methylation dataset as an object of type inheriting RnBSet, or its sample annotations in the form of a data.frame. If this parameter is a dataset, the annotation information is extracted using the method pheno.

columns  Optional; predefined column names (in the form of a character vector) or indices (an integer vector) to consider. All other columns in the annotation table will be ignored.

fileprefix  character vector with one element storing the file name prefix of the output files, without the extension. Only a limited set of symbols is allowed to be used in this prefix.

report  Report to contain the generated plots. If specified, this must be an object of type Report.

color.values  Non-empty character vector containing the color scheme to be mapped to the categories defined in the annotation table. Colors are recycled if necessary, that is, if the length of this vector is smaller than the number of categories in a trait.

Details

This function identifies the traits that define sample subgroups and then generates one report plot per trait. Every report plot consists of two files. File names are formed by appending an index and file extension to fileprefix. Thus, the suffixes appended are ".1.pdf", ".1.png", ".2.pdf", ".2.png", ... Existing files with the generated filenames are overwritten.

Value

List of report plots. The names in this list are the column names in the annotation table that were selected for visualization. In case no suitable categorical traits are found among the provided annotations, this function returns an empty list.

Author(s)

Yassen Assenov

See Also

rnb.sample.groups for identifying traits in the annotation table that define sample subgroups; createReportPlot for the allowed symbols to be used in fileprefix

rnb.plot.region.profile.density

rnb.plot.region.profiles

Description

Plots the density of methylation levels across all regions of the specified type

Usage

rnb.plot.region.profile.density(rnb.set, sample, region.type = "", region.profile = NULL, extend.by = 0.33)
Arguments

rnb.set RnBSet object
sample Index or name of the sample for which the plot should be generated
region.type Region type for which the plot should be generated
region.profile Alternative to specifying region.type, the function can accept a region profile generated by the rnb.find.relative.site.coord function
extend.by A number between 0 and 1 specifying the percentage by which a region is extended in order to capture methylation information before region start and after region end

Value

a ggplot2 object for plotting the plot shows the density of methylation levels of sites across the specified region type for all regions of that type from 0 (region start) to 1 (region end). Sites in the flanking areas are also shown (coordinates <0 and >1).

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.plot.region.profile.density(rnb.set.example,1,"genes")
```

Description

Creates a composite plot showing the sample and groupwise smoothed estimates of methylation values across all regions of the specified type

Usage

```r
ernb.plot.region.profiles(rnb.set, group.index.list, region.type = ",
region.profile = NULL, extend.by = 0.33,
cvalues = rnbgetOption("colors.category"))
```
Arguments

- **rnb.set**: RnBSet object
- **group.index.list**: a list (preferably named) containing sample indices for each group; a list of such lists is for instance generated by the `rnb.sample.groups` function.
- **region.type**: Region type for which the plot should be generated
- **region.profile**: Alternative to specifying `region.type`, the function can accept a region profile generated by the `rnb.find.relative.site.coord` function
- **extend.by**: A number between 0 and 1 specifying the percentage by which a region is extended in order to capture methylation information before region start and after region end
- **cvalues**: Color values that will be assigned to sample groups

Value

A ggplot2 object for plotting the plot shows the smoothed methylation levels of sites across the specified region type for all regions of that type from 0 (region start) to 1 (region end). Sites in the flanking areas are also shown (coordinates <0 and >1). Smoothing is stratified by sample (dashed lines) and sample group (thick solid lines). Cubic splines are used for smoothing.

Author(s)

Fabian Mueller

Examples

```r
# Careful: this might take a while
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.plot.region.profiles(rnb.set.example,rnb.sample.groups(rnb.set.example)[[1]],"genes")
```

Description

Plots the density of sites across the specified region type

Usage

```r
rnb.plot.region.site.density(rnb.set, region.type, extend.by = 0.33)
```
Arguments

rnb.set        RnBSet object
region.type   Region type for which the plot should be generated
extend.by     A number between 0 and 1 specifying the percentage by which a region is extended in order to capture methylation information before region start and after region end

Value

a ggplot2 object for plotting the plot shows the density of sites across the specified region type for all regions of that type from 0 (region start) to 1 (region end). Sites in the flanking areas are also shown (coordinates <0 and >1).

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.plot.region.site.density(rnb.set.example,"genes")

Description

Creates a point-and-whisker plots showing beta value distributions at Sentrix positions for the given slide.

Usage

rnb.plot.sentrix.distribution(rnb.set, sentrix.id)

Arguments

rnb.set        HumanMethylation450K dataset as an object of type RnBeadSet.
sentrix.id     Slide number (Sentrix ID) as an integer or character singleton.

Value

Generated point-and-whisker plot (an instance of ggplot) of mean methylations for the samples on the specified slide, or FALSE if the dataset is non-empty but does not contain samples on the given slide. If the provided dataset does not contain valid Sentrix ID and position information (or is an empty dataset), this method returns NULL.
Author(s)
Yassen Assenov

Examples

library(RnBeads.hg19)
data(small.example.object)
sid<-as.character(pheno(rnb.set.example)[["Sentrix_ID"]][1])
rnb.plot.sentrix.distribution(rnb.set.example,sid)

Description

Creates one or more point-and-whisker plots showing beta value distributions at Sentrix positions.

Usage

rnb.plot.sentrix.distributions(rnb.set, fprefix = "sentrix_whisker", ...)

Arguments

rnb.set HumanMethylation450K dataset as an object of type RnBeadSet.
fprefix File name prefix to be used in the generated plots. In order to ensure independence of the operating system, there are strong restrictions on the name of the file. See the documentation of createReportPlot for more information.
...
Other arguments passed to createReportPlot. These can include the named parameters report, width, height, and others.

Details

If no additional parameters are specified, this function creates one PDF and one low-resolution PNG file for every generated plot.

Value

Point-and-whisker plot (an instance of ReportPlot), or a list of such plots - one per slide. If the provided dataset does not contain valid Sentrix ID and position information (or is an empty dataset), this method returns NULL.

Author(s)
Yassen Assenov

See Also

rnb.plot.sentrix.distribution for creating a single plot for a specified slide number
**Description**

Bar plots of beta-values from the genotyping probes

**Usage**

```
rnb.plot.snp.barplot(dataset, probeID, writeToFile = FALSE, numeric.names = FALSE, ...)
```

**Arguments**

- `dataset`: Dataset as an instance of `RnBeadRawSet` or `RnBeadSet`. Alternatively, the dataset can be specified as a non-empty matrix containing the computed beta values on the SNP probes.
- `probeID`: Probe identifier. This must be one of `rownames(meth(dataset))`.
- `writeToFile`: Flag specifying whether the output should be saved as `ReportPlot`.
- `numeric.names`: if `TRUE` and `writeToFile` is `TRUE` substitute the plot options in the plot file name with digits.
- `...`: Additional named arguments passed to `createReportPlot`.

**Value**

Plot as an object of type `ReportPlot` if `writeToFile` is `TRUE` and of class `ggplot` otherwise.

**Author(s)**

Pavlo Lutsik

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
samp <- samples(rnb.set.example)[1]
rnb.plot.snp.barplot(rnb.set.example, samp)
```
Description

Box plots of beta-values from the genotyping probes

Usage

\[
\text{rnb.plot.snp.boxplot}(\text{dataset}, \text{writeToFile} = \text{FALSE}, \ldots)
\]

Arguments

- \text{dataset}: Dataset as an object of type inheriting \text{RnBeadSet}, or a matrix of methylation beta values.
- \text{writeToFile}: Flag specifying whether the output should be saved as \text{ReportPlot}.
- \ldots: Additional named arguments passed to \text{createReportPlot}.

Value

If \text{writeToFile} is \text{TRUE}: plot as an object of type \text{ReportPlot}. Otherwise: plot as an object of type \text{ggplot}.

Author(s)

Pavlo Lutsik

Examples

\[
\text{library(RnBeads.hg19)}
\text{data(small.example.object)}
\text{rnb.plot.snp.boxplot(rnb.set.example)}
\]

Description

Heatmap of beta values from genotyping probes.

Usage

\[
\text{rnb.plot.snp.heatmap}(\text{dataset}, \text{writeToFile} = \text{FALSE}, \ldots)
\]
**rnb.read.geo**

**Arguments**

- **dataset**: Dataset as an object of type inheriting `RnBeadSet`, or a matrix of methylation beta values.
- **writeToFile**: Flag specifying whether the output should be saved as `ReportPlot`.
- **...**: Additional named arguments passed to `createReportPlot`. These are used only if `writeToFile` is TRUE.

**Value**

If `writeToFile` is TRUE, plot as an object of type `ReportPlot`. Otherwise, there is no value returned (invisible NULL).

**Author(s)**

Pavlo Lutsik

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
rnb.plot.snp.heatmap(rnb.set.example)
```

---

**rnb.read.geo**

*Import methylation data from GEO*

**Description**

Imports Infinium 450K or MethylationEPIC data series from the Gene Expression Omnibus. This function uses the series matrix file.

**Usage**

```r
rnb.read.geo(accession = NULL, verbose = logger.isinitialized(),
             destdir = tempdir())
```

**Arguments**

- **accession**: Character string, starting with "GSE", representing the GEO series for download and parsing. Alternatively, this parameter can specify the file name of a previously downloaded GEO series matrix file or its gzipped representation (in which case the filename must end in " .gz"). Other file formats, such as SOFT files, are not supported.
- **verbose**: Flag indicating if messages should be created informing about the progress. If the logger is initialized prior to calling this function, the informative messages are sent to the logger. Warnings and errors are not affected by this parameters, the function always outputs them.
- **destdir**: The destination directory for any downloads. Defaults to the (architecture-dependent) temporary directory. Keep in mind that GEO series can be demanding in terms of storage space.
**Value**

*RnBeadSet* object with phenotypic and beta value information.

**Author(s)**

Yassen Assenov

---

**Description**

Gets the supported region annotations for a given genome assembly.

**Usage**

```r
rnb.region.types(assembly = "hg19")
```

**Arguments**

- `assembly`: Genome assembly of interest. See `rnb.get.assemblies` for the list of supported genomes.

**Value**

Region types supported by *RnBeads* in the form of a character vector. The built-in ones are "cpgislands", "genes", "promoters" and "tiling". The names of all custom region definitions are also included in the returned vector.

**Author(s)**

Yassen Assenov

**See Also**

- `rnb.get.annotation`, `rnb.set.annotation`

**Examples**

```r
"promoters" %in% rnb.region.types() # TRUE
```
Description

Identifies the region types that are summarized by the given dataset and pointed to for analysis.

Usage

```r
rnb.region.types.for.analysis(rnb.set)
```

Arguments

- `rnb.set`: Methylation dataset as an object of type inheriting `RnBSet`.

Details

This function intersects the value of the analysis option "region.types" with the region types that are summarized in the provided dataset. In case the option’s value is NULL, this function returns all summarized region types in `rnb.set`.

Value

List of all region types to be analyzed in the current dataset in the form of a character vector.

Author(s)

Yassen Assenov

See Also

- `rnb.getOption` for checking the value of the "region.types" option; `summarized.regions` for obtaining the region types summarized in a dataset

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
"promoters" %in% rnb.region.types.for.analysis(rnb.set.example)
```
rnb.remove.annotation

Description

Deletes a region annotation table. Use this function with caution; its operation cannot be undone.

Usage

rnb.remove.annotation(type, assembly = "hg19")

Arguments

type
One-element character vector giving the name of the region annotation.

assembly
Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.

Value

Invisibly, TRUE if the annotation has been successfully deleted, or FALSE if the specified region type is not supported.

Author(s)

Fabian Mueller

See Also

rnb.get.annotation, rnb.region.types

Examples

t.regions <- rnb.get.annotation("tiling")
rnb.remove.annotation("tiling")

rnb.RnBSet.to.bed

Export to BED files

Description

Exports the beta values from a methylation dataset to BED files.

Usage

rnb.RnBSet.to.bed(rnb.set, out.dir, reg.type = "sites",
                 names.quant.meth = TRUE, add.track.line = TRUE, lexicographic = FALSE,
                 verbose = TRUE)
rnb.RnBSet.to.bedGraph

Arguments

- `rnb.set`: Methylation dataset as an object of type inheriting RnBSet.
- `out.dir`: Output directory. If not existing, it will be created. otherwise files in that directory are overwritten.
- `reg.type`: Region type to be extracted.
- `names.quant.meth`: should the names of the bed regions contain information on the methylation level. If TRUE the following format is applied: meth_percent covg(rnb.set) is not NULL
- `add.track.line`: Add a track line to the bed file to enable browsers like IGV to display the data better
- `lexicographic`: Should lexicographic ordering be used for chromosome names
- `verbose`: More detailed logger output

Details

Details on the BED file format can be found in the UCSC Genome Browser documentation. Each methylation site is an entry in the resulting bed file. The Score column corresponds to a site's methylation value in the interval [0,1].

Value

(invisibly) a summary list containing information on the conversion step. elements are filenames (a table containing information on which sample has been written to what filename) and assembly (a string indicating the assembly used by rnb.set).

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.RnBSet.to.bed(rnb.set.example,tempdir())
```

rnb.RnBSet.to.bedGraph

Description

Exports the methylation data of an RnBSet object to *.bedGraph files.

Usage

```r
rnb.RnBSet.to.bedGraph(rnb.set, out.dir = ".", reg.type = "sites",
parameters = character(), digits = NULL)
```
Arguments

rnb.set Dataset as an instance of class RnBSet.
out.dir One-element character vector signifying the output directory in which to create bedGraph files. Setting this to "." (default) uses the current working directory. If the output directory does not exist, this function attempts to create it. Any existing files in this directory could be overwritten.
reg.type Site or region type to be exported.
parameters Named character vector storing parameters (other than "type" and "name") to include in the track definition line. The names of this vector must be the parameter names, and its elements - the corresponding values; missing values (NAs) are allowed neither for names, nor for values. This function does not test if all provided parameter names and values conform to the BedGraph track specification.
digits Optionally, number of significant digits after the decimal point to round methylation values to. If specified, this parameter must be an integer between 0 and 10.

Details

The description of the BedGraph track format can be found here. Each methylation site is an entry in the resulting bedGraph file. The Score column corresponds to a site’s methylation value in the interval \([0,1]\).

Value

(invisibly) a summary list containing information on the conversion step. elements are filenames (a table containing information on which sample has been written to what filename) and assembly (a string indicating the assembly used by rnb.set).

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.RnBSet.to.bedGraph(rnb.set.example,tempdir())

rnb.RnBSet.to.GRangesList

Description

convert an RnBSet object to a GRangesList object
**Usage**

```r
rnb.RnBSet.to.GRangesList(rnb.set, reg.type = "sites", return.regular.list = FALSE)
```

**Arguments**

- `rnb.set` Object of class `RnBSet`
- `reg.type` region type to be converted
- `return.regular.list` flag indicating whether a regular list object should be returned instead of a `GRangesList`. Might improve performance in some cases

**Value**

a `GRangesList` or `list` object with one list element (`GRanges`) for each sample in `rnb.set`

**Author(s)**

Fabian Mueller

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
result <- rnb.RnBSet.to.GRangesList(rnb.set.example)
```

---

**rnb.run.analysis**

**RnBeads Analysis Pipeline**

**Description**

Starts the RnBeads analysis pipeline on the given dataset. It loads the dataset if it is specified as a location.

**Usage**

```r
rnb.run.analysis(dir.reports, data.source = NULL, sample.sheet = NULL, data.dir = NULL, GS.report = NULL, GEO.acc = NULL, data.type = rnb.getOption("import.default.data.type"), initialize.reports = TRUE, build.index = TRUE, save.rdata = TRUE)
```

**Arguments**

- `dir.reports` Directory to host the generated report files. This must be a character of length one that specifies either a non-existent path (when `initialize.reports` is `TRUE`), or an existing directory (when `initialize.reports` is `FALSE`). In the latter case, a call to `rnb.initialize.reports` might be required before viewing the reports.
### data.source
Methylation dataset as an object of type inheriting RnBSet, or a character vector specifying the location of the data items on disk. The expected length of the vector differs for different values of data.type; see `rnb.execute.import` for a more detailed description. If set, the parameters sample.sheet, data.dir, GS.report, GEO.acc will be ignored.

### sample.sheet
A spreadsheet-like text file with sample annotations. The required columns are different for different values of data.type.

### data.dir
For data.type %in% c("data.dir", "idat.dir", "bed.dir") a character singleton specifying the location of the directory with data files. The directory should have zero depth, i.e. should contain no subdirectories.

### GS.report
GenomeStudio report file. data.type will be automatically set to "GS.report".

### GEO.acc
Gene Expression Omnibus accession of the data series with HumanMethylation450 data. data.type will be automatically set to "GEO".

### data.type
character vector of length one specifying the type of the input data. The value must be one of "data.dir", "idat.dir", "GS.report", "GEO" or "rnb.set". See `rnb.execute.import` for a more detailed description.

### initialize.reports
Flag indicating if the report’s directory must be initialized. If this parameter is set to TRUE, this function attempts to create the path specified by dir.reports. Otherwise, dir.reports is expected to signify an existing directory.

### build.index
Flag indicating if a report index file (named "index.html") should be created after all modules in the pipeline complete their analyses. If this is TRUE, the index file is also displayed using the function `rnb.show.report`.

### save.rdata
Flag indicating whether important data objects (the filtered and unfiltered RnBSets, differential methylation) should be saved to an RData file in the reports folder.

### Value
Invisibly, the loaded, normalized and/or possibly filtered dataset as an object of type inheriting RnBSet.

### Author(s)
Yassen Assenov

### See Also
RnBeads modules

---

**Description**

Starts the RnBeads Data Juggler (RnBeadsDJ) for configuring and running RnBeads analyses from the web browser.
**rnb.run.example**

**Usage**

```r
rnb.run.dj()
```

**Details**

A Shiny app is launched in the web browser

**Value**

Nothing of particular interest

**Author(s)**

Fabian Mueller

**See Also**

- `rnb.run.analysis` for starting an analysis pipeline

---

**Description**

Executes the analysis pipeline for an example from the RnBeads web site.

**Usage**

```r
rnb.run.example(index = 4L, dir.output = "example")
```

**Arguments**

- `index`  
  Example to start. This must be one of 1, 2, 3 or 4.

- `dir.output`  
  One-element character vector specifying the directory to contain the downloaded data files and generated reports. This must be a non-existent path, as this function attempts to create it.

**Details**

For more information about the examples, please visit the dedicated page on the RnBeads web site.

**Value**

Invisibly, the loaded, normalized and/or possibly filtered dataset as an object of type inheriting `RnBSet`.

**Author(s)**

Yassen Assenov

**See Also**

- `rnb.run.analysis` for starting the analysis pipeline from a local data source
Examples

rnb.run.example()

rnb.run.import data.source, data.type = rnb.getOption("import.default.data.type"), dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE

rnb.run.qc(rnb.set, dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE)

rnb.run.preprocessing(rnb.set, dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE)

rnb.run.inference(rnb.set, dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE)

rnb.run.tnt(rnb.set, dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE)

rnb.run.exploratory(rnb.set, dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE)

rnb.run.differential(rnb.set, dir.reports, init.configuration = !file.exists(file.path(dir.reports, "configuration")), close.report = TRUE, show.report = FALSE)

Arguments

data.source character vector specifying the location of the data items on disk. The expected length of the vector differs for different values of data.type; see rnb.execute.import for a more detailed description.
data.type character vector of length one specifying the type of the input data. The value of this parameter must be one of "idat.dir", "data.dir", "data.files", "GS.report", "GEO" or "rnb.set". See rnb.execute.import for a more detailed description.

dir.reports Directory to host the generated report file. Note that if this directory contains files, they may be overwritten.

init.configuration Flag indicating if the configuration directory (usually shared among reports) should also be created.

close.report Flag indicating if the created report is to be closed using the `off` method.

show.report Flag indicating if the report is to be displayed after it is created. If this is, TRUE `rnb.show.report` is called to open the generated HTML file.

rnb.set Methylation dataset as an object of type inheriting RnBSet.

Details

The functions start the import, quality control, preprocessing, covariate inference, tracks and tables, exploratory analysis and differential methylation modules, respectively.

Value

For `rnb.run.import`, `rnb.run.preprocessing` and `rnb.run.inference`, the returned value is a list of two elements - the initialized or modified dataset and the created report. All other functions return the created report, invisibly.

Author(s)

Yassen Assenov

See Also

`rnb.run.analysis` which executes these modules in the order given above

Examples

### Running the modules step by step

```r
# Directory where your data is located
data.dir <- "~/RnBeads/data/Ziller2011_PLoSGen_450K"
idat.dir <- file.path(data.dir, "idat")sample.annotation <- file.path(data.dir, "sample_annotation.csv")

# Directory where the output should be written to
analysis.dir <- "~/RnBeads/analysis"
report.dir <- file.path(analysis.dir, "reports_details")
rnb.initialize.reports(report.dir)

# Set some analysis options
rnb.options(filtering.sex.chromosomes.removal = TRUE, identifiers.column = "Sample_ID")

## Restrict logging to the console only
logger.start(fname = NA)

## Data import
```
rnb.run.xml

data.source <- c(idat.dir, sample.annotation)
result <- rnb.run.import(data.source=data.source, data.type="idat.dir", dir.reports=report.dir)
rnb.set <- result$rnb.set

## Quality Control
rnb.run.qc(rnb.set, report.dir)

## Preprocessing
rnb.set <- rnb.run.preprocessing(rnb.set, dir.reports=report.dir)$rnb.set

## Data export
rnb.options(export.to.csv = TRUE)
rnb.run.tnt(rnb.set, report.dir)

## Exploratory analysis
rnb.run.exploratory(rnb.set, report.dir)

## Differential methylation
rnb.run.differential(rnb.set, report.dir)

---

rnb.run.xml

Description

Starts the analysis pipeline from an XML configuration file. This function uses the XML package to parse the configuration file.

Usage

rnb.run.xml(fname, create.r.command = FALSE)

Arguments

fname
XML configuration file to read.

create.r.command
Flag indicating if the R command(s) that correspond to the given XML configuration should be generated. If this is set to TRUE, a file named "analysis.R" is created in the reports directory.

Details

Two values are required to be specified (as tags) in the configuration file - data.source and dir.reports. They define the input and output directory, respectively. In addition, the file may define analysis option values. The vignette Comprehensive DNA Methylation Analysis with RnBeads describes in detail the syntax of the XML configuration file.

The sample annotation table must be stored as a file in data.source. For more information about the required parameters, see the documentation of rnb.run.analysis, which is called by this function.
Description

Identifies sample subgroups defined in the given annotation information.

Usage

\[
\text{rnb.sample.groups}(\text{annotations}, \text{columns} = \text{NULL}, \text{columns.pairs} = \text{NULL}, \\
\text{min.group.size} = \text{rnb.getOption("min.group.size")}, \\
\text{max.group.count} = \text{rnb.getOption("max.group.count")})
\]

Arguments

- **annotations**: Methylation dataset as an object of type inheriting \textit{RnBSet}, or its sample annotations in the form of a \texttt{data.frame}. If this parameter is a dataset, the annotation information is extracted using the method \textit{pheno}.

- **columns**: Optional; predefined column names (in the form of a \texttt{character} vector) or indices (an \texttt{integer} vector) to consider. All other columns in the annotation table will be ignored.

- **columns.pairs**: Optional; a \texttt{NAMED} vector containing for each column name for which paired comparisons should be performed (say columnA) the name or index of another column (say columnB) in which same values indicate the same pairing. columnA should be the name of the value columnB in this vector.

- **min.group.size**: Minimum number of samples in each subgroup. This must be a positive integer.

- **max.group.count**: Maximum number of subgroups defined by a trait. This must be an integer greater than 1.

Value

List of traits that define subgroups in the dataset. For each trait, the defined subgroups are represented by a list of \texttt{integer} vectors storing the corresponding sample indices.

Author(s)

Yassen Assenov
Examples

library(RnBeads.hg19)
data(small.example.object)
str(rnb.sample.groups(rnb.set.example))

rnb.sample.replicates  rnb.sample.replicates

Description
Identifies sample replicates defined in the given sample annotation table.

Usage
rnb.sample.replicates(rnb.set, replicate.id.col)

Arguments

  rnb.set Methylation dataset as an object of type inheriting RnBSet.
  replicate.id.col Trait (column name in the sample annotation table) that indicates sample replicates. Replicates should have the same value for this trait, while samples without replicates are expected to have unique values or missing values.

Value
List of length of the number of replicates in the dataset. Each element is an integer vector storing the corresponding sample indices.

Author(s)
Fabian Mueller

rnb.sample.summary.table  rnb.sample.summary.table

Description
Creates a sample summary table from an RnBSet object

Usage
rnb.sample.summary.table(rnbSet)

Arguments

  rnbSet RnBSet of interest.
Value

A summary table (as data.frame) with the following variables for each sample (rows):

- **sampleName**: Name of the sample
- ***_num** (* can be 'sites' or a region type): Number of sites or regions with coverage in the sample
- ***_covgMean** (RnBiseqSet only): Mean coverage of sites or regions in the sample
- ***_covgMedian** (RnBiseqSet only): Median coverage of sites or regions in the sample
- ***_covgPerc25** (RnBiseqSet only): 25 percentile of coverage of sites or regions in the sample
- ***_covgPerc75** (RnBiseqSet only): 75 percentile of coverage of sites or regions in the sample
- ***_numCovg5,10,30,60** (RnBiseqSet only): Number of sites or regions with coverage greater or equal to 5,10,30,60
- **sites_numDPval5x10^-2,1x10^-6,1x10^-3** (RnBeadSet only): Number of sites with a detection p-value smaller than 0.05, 0.01, 0.001
- ****_numSitesMean** (** is any region type): Mean number of sites in a region
- ****_numSitesMedian**: Median number of sites in a region
- ****_numSites2,5,10,20**: Number of regions with at least 2,5,10,20 sites with valid methylation measurements

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
rnb.sample.summary.table(rnb.set.example)
```

Description

Saves the specified region annotation table and its accompanying data structures to a binary file.

Usage

```r
rnb.save.annotation(fname, type, assembly = "hg19")
```
Arguments

fname  One-element character vector giving the name of the file to contain the annotation data. If this file already exists, it will be overwritten.

type One-element character vector giving the name of the region annotation.

assembly Genome assembly of interest. See `rnb.get.assemblies` for the list of supported genomes.

Details

This function is used in combination with `rnb.load.annotation` to enable fast reloading of custom region annotations. It can also be used to save a build-in region annotation (e.g. before overwriting it) but not site or control probe annotations.

Value

TRUE, invisibly.

Author(s)

Yassen Assenov

See Also

`rnb.load.annotation` for loading a saved annotation

Description

Adds information for differentially variable regions to the report.

Usage

`rnb.section.diffVar.region(rnb.set, diff.meth, report, gzTable = FALSE, level = 1)`

Arguments

rnb.set Object of type `RnBSet` containing methylation information
diff.meth RnBDiffMeth object. See `RnBDiffMeth-class` for details.
report Report object to which the content is added
gzTable Flag indicating if tables should be gzipped
level Which level of section should be created. See `rnb.add.section`.

Value

The modified report object


rnb.set.annotation

Description

Adds or replaces a region annotation table.

Usage

rnb.set.annotation(type, regions, description = NULL, assembly = "hg19")

Arguments

type One-element character vector giving the name of the annotation. If this region type is already available, it will be overwritten for the current session. The type cannot be one of "CpG", "probes450" or "controls450", because these names are reserved for the annotation tables of CpG dinucleotides, and Infinium methylation and control probes, respectively.

regions BED file defining regions (see Details). Alternatively, the value of this parameter can be a table of genomic regions in the form of a data.frame, containing at least the following three columns - "chromosome", "start" and "end" (notice the lower case). The "chromosome" column must be a character or factor vector that lists chromosome names. The "start" and "end" columns are expected to contain genomic positions as integers. The row names of this data.frame are used as region identifiers.

description Optional; short description in the form of a non-empty character vector. The elements in this vector are concatenated without a separator to form the description of the annotation.

assembly Genome assembly of interest. See rnb.get.assemblies for the list of supported genomes.

Details

In case the parameter regions specifies an existing BED file, regions are loaded from this file. The number of columns defined must be at least 3. Columns after the sixth one, if present, are dropped. The columns are given the following names: "chromosome", "start", "end", "id", "score" and "strand".

The annotation tables in RnBeads focus on chromosomes "chr1", "chr2", ..., "chr22", "chrX" and "chrY". Regions on other chromosomes are ignored. This function also recognizes the convention of chromosome names such as "1", adopted, for example, by Ensembl. Apart from this, the region definition table is not examined in details by this function; therefore, regions located on unsupported chromosomes or having invalid (e.g. negative) genomic coordinates are simply not mapped to any sites or probes.

Value

Invisibly, TRUE if an existing annotation was replaced and FALSE otherwise.
Author(s)
Yassen Assenov

See Also

rnb.get.annotation for extracting annotation; rnb.region.types for all loaded region types in a genome assembly

Examples

my.regions <- data.frame(
  chromosome = c("chr1", "chr1"),
  start = c(49242278L, 49242372L),
  end = c(49242590L, 49242810L),
  rownames = c("BEND5E1", "CpG:38")
)

txt <- "First exon of the BEND5 gene and an overlapping CpG island."

rnb.set.annotation("my regions", my.regions, txt)

rnb.set.annotation.and.cpg.stats

Description

wrapper for rnb.set.annotation to accept the region format as output by annotation(rnb.set). Additionally, CpG statistics are added to the annotation.

Usage

rnb.set.annotation.and.cpg.stats(type, regions, description = NULL, assembly = "hg19")

Arguments

type, description, assembly
Parameters handled exactly as in rnb.set.annotation

regions
a data.frame handled similarly as by rnb.set.annotation with the exception that the genomic location columns should be specified using upper case first letters

Value

Invisibly, TRUE if an existing annotation was replaced and FALSE otherwise.

Author(s)
Fabian Mueller

See Also

rnb.set.annotation
Description

Opens the given HTML report file in the browser.

Usage

rnb.show.report(report)

Arguments

report Report object to open.

Value

None (invisible NULL).

Author(s)

Pavlo Lutsik

rnb.step.betadistribution

Description

Computes the distributions of beta values across various sample groups and adds a corresponding section to the report.

Usage

rnb.step.betadistribution(rnb.set, report, columns = rnb.getOption("exploratory.columns"), points.per.group = rnb.getOption("distribution.subsample"))

Arguments

rnb.set HumanMethylation450K dataset as an object of type RnBSet.
report Report to contain the methylation deviation section. This must be an object of type Report.
columns Optional; predefined column names (in the form of a character vector) or indices (an integer vector) in the sample annotation table. Only these columns are considered for grouping samples and defining profiles. All other columns in the phenotype table are ignored.
points.per.group the targeted number of points (T) per group. Set this to a value < 1 to disable subsampling. More information in the Details section.
Value

The modified report.

Details

If subsampling is enabled (i.e. points.per.group>0), observations per group are subsampled according to the following procedure: Given K groups and numbers of observed beta values per group N_1,...,N_K, and the target number of points per group T: the total number of points N = sum(N_1,...,N_K) is computed. Afterwards the proportions p_k = N_k/N is computed and from each group, S_k = p_k*(K*T) observations are randomly selected from all observations belonging to group k.

Author(s)

Fabian Mueller
rnb.xml2options

See Also
write.table

Examples

data(mtcars)
  rnb.write.table(mtcars,tempfile(pattern="cars",fileext=".csv"))

Description
Parses and partially validates parameters and RnBeads options from an XML tree.

Usage
rnb.xml2options(fname, return.full.structure = FALSE)

Arguments
fname           File name containing the XML analysis option values. The name of the root node in this document must be "rnb.xml".
return.full.structure
                if enabled, return the full structure instead of just the option list

Value
List of two sublists - "analysis.params" and "options", storing the specified analysis parameters and previous values of the RnBeads options, respectively.

Author(s)
Yassen Assenov

Examples
fname <- paste0("extdata/optionProfiles/",profile,".xml")
  rnb.xml2options(system.file(fname,package="RnBeads"))
RnBClusterRun-class  
**RnBClusterRun Class**

**Description**

A class for configuring and running RnBeads on a scientific compute cluster.

**Slots**

- **architecture**  
  A `ClusterArchitecture` object managing the settings for a scientific compute cluster
- **modules**  
  A vector of pipeline modules
- **module.res.req**  
  Stores the resource requirements for each module. A list containing named vectors for the resources
- **module.num.cores**  
  Stores the number of cores for each module

**Methods**

- **setModuleResourceRequirements,RnBClusterRun,character,character-method**  
  Sets the resource requirements for the different pipeline modules
- **setModuleNumCores,RnBClusterRun,integer,character-method**  
  Sets the number of cores used by the different pipeline modules
- **getModuleNumCores,RnBClusterRun-method**  
  Gets the number of cores used by the different pipeline modules
- **run,RnBClusterRun-method**  
  Submit the pipeline modules to the cluster

**Author(s)**

Fabian Mueller

---

RnBDiffMeth-class  
**RnBDiffMeth Class**

**Description**

A class for storing differential methylation data.

**Details**

Contains differential methylation tables (DMT) for multiple comparisons and region types. DMTs can be stored in memory as R objects or on disk
Slots

sites List of differential methylation tables on site level (see computeDiffMeth.bin.site for
details). Indexed by comparison.

regions List of lists of differential methylation tables on region levels (see computeDiffMeth.bin.region
for details). Indexed by region type on the top level and comparison on the lower level.

comparisons character vector of all comparisons stored in the objects. Vector indices correspond
to indices in the sites and regions list slots.

region.types character vector of all region types stored in the objects. Vector indices correspond
to indices in the regions list slot.

comparison.grouplabels A character matrix with 2 columns containing group labels of all com-
parisons in the object

comparison.info A list containing comparison information for each comparison. See get.comparison.info
for details.

includesSites Logical indicating whether the object contains site-level differential methylation
information.

site.test.method method which was applied to obtain the site-level p-values.

variability.method method to be used to detect differentially variable sites.

covg.thres coverage threshold. Important for certain columns of the differential methylation ta-
bles.

disk.dump Flag indicating whether the tables should be stored on disk rather than in the main
memory

disk.path path on the disk for DMTs. Only meaningful if disk.dump is TRUE

Methods

destroy,RnBDiffMeth-method remove tables stored to disk from the file system

get.region.types,RnBDiffMeth-method Gets all region types represented in the object as char-
acter vector

get.comparisons,RnBDiffMeth-method Gets all comparisons represented in the object as char-
acter vector

get.comparison.grouplabels,RnBDiffMeth-method Gets all comparison group names as a ma-
trix

get.covg.thres,RnBDiffMeth-method Gets the coverage threshold employed for obtaining statis-
tics in the differential methylation tables

get.table,RnBDiffMeth-method Gets a differential methylation table

addDiffMethTable,RnBDiffMeth-method Adds a differential methylation table

reload,RnBDiffMeth-method relink disk dumped tables. Useful if the files are manually copied
or if the object is loaded again

save.tables,RnBDiffMeth-method save disk dumped tables as binaries and zip them. Useful if
the files are copied or shared.

join.diffMeth Merges two disjoint RnBDiffMeth objects into one

Author(s)

Fabian Mueller
### RnBeadClustering-class

**RnBeadClustering Class**

**Description**

Storage class for the results of a clustering algorithm applied on an RnBSet dataset.

**Slots**

- **dissimilarity** Dissimilarity metric used in the form of a one-element character vector.
- **dimensionality** Dimensionality of the clustered points in the form of a one-element integer vector.
- **algorithm** Clustering algorithm (and optionally, type) as a character vector of length 1 or 2.
- **result** Resulting object after applying the clustering algorithm on a dataset.
- **assignments** Cluster assignments for the samples in the dataset as a matrix. Row names in this matrix are sample identifiers, and each column is dedicated to partitioning into \( k \) clusters for a fixed \( k \).
- **silhouettes** numeric vector of mean silhouette values for each tested value of \( k \).

**Methods and Functions**

- **samples** Gets the identifiers of all samples used in the clustering.

**Author(s)**

Yassen Assenov

---

### RnBeadRawSet-class

**RnBeadRawSet-class**

**Description**

Main class for storing HumanMethylation micorarray data which includes intensity information

Wrapper function RnBeadRawSet

**Usage**

```r
RnBeadRawSet(pheno, probes, M, U, M0 = NULL, U0 = NULL, 
bead.counts.M = NULL, bead.counts.U = NULL, p.values = NULL, 
qc = NULL, platform = "450k", beta.offset = 100, 
summarize.bead.counts = TRUE, summarize.regions = TRUE, 
region.types = rnb.region.types.for.analysis("hg19"), 
useff = rnb.getOption("disk.dump.big.matrices"), ffcleanup = FALSE)
```
Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pheno</td>
<td>Phenotypic data.</td>
</tr>
<tr>
<td>probes</td>
<td>character vector of Infinium(R) probe identifiers</td>
</tr>
<tr>
<td>M</td>
<td>Matrix of intensities for the probes measuring the abundance of methylated molecules</td>
</tr>
<tr>
<td>U</td>
<td>Matrix of intensities for the probes measuring the abundance of unmethylated molecules</td>
</tr>
<tr>
<td>M0</td>
<td>Matrix of &quot;out-of-band&quot; intensities for the probes measuring the abundance of methylated molecules</td>
</tr>
<tr>
<td>U0</td>
<td>Matrix of &quot;out-of-band&quot; intensities for the probes measuring the abundance of unmethylated molecules</td>
</tr>
<tr>
<td>bead.counts.M</td>
<td>Matrix of bead counts per probe.</td>
</tr>
<tr>
<td>bead.counts.U</td>
<td>Matrix of bead counts per probe.</td>
</tr>
<tr>
<td>p.values</td>
<td>Matrix of detection p-values.</td>
</tr>
<tr>
<td>qc</td>
<td>…</td>
</tr>
<tr>
<td>platform</td>
<td>character singleton specifying the microarray platform: &quot;450k&quot; corresponds to HumanMethylation450 microarray, and “27k” stands for HumanMethylation27.</td>
</tr>
<tr>
<td>beta.offset</td>
<td>A regularization constant which is added to the denominator at beta-value calculation</td>
</tr>
<tr>
<td>summarize.bead.counts</td>
<td>If TRUE the coverage slot is filled by summarizing the bead.counts.M and bead.counts.U matrices. For type I probes the summarization is done using min operation, while for type II probes the bead counts should be identical in both supplied matrices</td>
</tr>
<tr>
<td>summarize.regions</td>
<td>...</td>
</tr>
<tr>
<td>region.types</td>
<td>A character vector specifying the region types, for which the methylation information will be summarized.</td>
</tr>
<tr>
<td>useff</td>
<td>If TRUE the data matrices will be stored as ff objects</td>
</tr>
<tr>
<td>ff.cleanup</td>
<td>If TRUE and disk dumping has been enabled the data of the input ff objects will be deleted</td>
</tr>
</tbody>
</table>

Value

an object of class RnBeadRawSet

Slots

<table>
<thead>
<tr>
<th>Slot</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pheno</td>
<td>Phenotypic data.</td>
</tr>
<tr>
<td>M</td>
<td>matrix of intensities for the probes measuring the abundance of methylated molecules</td>
</tr>
<tr>
<td>U</td>
<td>matrix of intensities for the probes measuring the abundance of unmethylated molecules</td>
</tr>
<tr>
<td>M0</td>
<td>matrix of &quot;out-of-band&quot; intensities for the probes measuring the abundance of methylated molecules</td>
</tr>
<tr>
<td>U0</td>
<td>matrix of &quot;out-of-band&quot; intensities for the probes measuring the abundance of unmethylated molecules</td>
</tr>
<tr>
<td>bead.counts.M</td>
<td>matrix of bead counts per probe.</td>
</tr>
<tr>
<td>bead.counts.U</td>
<td>matrix of bead counts per probe.</td>
</tr>
</tbody>
</table>
Methods and Functions

samples  Gets the identifiers of all samples in the dataset.
M     Get the matrix of intensities for the probes measuring the abundance of methylated molecules.
U     Get the matrix of intensities for the probes measuring the abundance of unmethylated molecules.
intensities.by.color  Get probe intensities in each color channel.

Author(s)

Pavlo Lutsik

Description

RnBeads facilitates comprehensive analysis of various types of DNA methylation data at the genome scale. It extends previous approaches for such analysis by high throughput capabilities, as well as presenting results in a comprehensive, highly interpretable fashion.

Details

The complete analysis can be performed by calling the function `rnb.run.analysis`.

References


Description

RnBeads uses sets of annotation tables and mappings (from regions to sites) for each of the supported genomes. The structures for one assembly are stored in a separate dedicated annotation package. The following annotation packages are available in Bioconductor:

* RnBeads.hg19  for "hg19"
* RnBeads.mm10  for "mm10"
* RnBeads.mm9   for "mm9"
* RnBeads.rn5   for "rn5"
**Format**

- "regions" list of NULLs; the names of the elements correspond to the built-in region annotation tables. Once the default annotations are loaded, the attribute "builtin" is a logical vector storing, for each region annotation, whether it is the default (built-in) or custom.
- "sites" list of NULLs; the names of the elements correspond to the site and probe annotation tables.
- "controls" list of NULLs; the names of the elements correspond to the control probe annotation tables. The attribute "sites" is a character vector pointing to the site annotation that encompasses the respective control probes.
- "mappings" list of NULLs; the names of the elements correspond to the built-in region annotation tables.

**Details**

An assembly-specific scaffold is automatically loaded upon initialization of its annotation, that is, by the first valid call to any of the following functions: `rnb.get.chromosomes`, `rnb.get.annotation`, `rnb.set.annotation`, `rnb.get.mapping`, `rnb.annotation.size`. Adding an annotation amounts to attaching its table(s) and mapping structures to the scaffold.

**Author(s)**

Yassen Assenov

---

**Description**

Stores the preprocessed information from HumanMethylation experiments

Wrapper function RnBeadSet

**Usage**

```r
RnBeadSet(pheno, probes, betas, p.values = NULL, bead.counts = NULL, 
            qc = NULL, platform = "450k", summarize.regions = TRUE, 
            region.types = rnb.region.types.for.analysis("hg19"), 
            useff = rnb.getOption("disk.dump.big.matrices"))
```

**Arguments**

- **pheno** Phenotypic data.
- **probes** character vector of Infinium(R) probe identifiers
- **betas** matrix or `ff_matrix` of beta values. If probes are missing should contain Infinium probe identifiers as row names.
- **p.values** matrix or `ff_matrix` of detection p-values.
- **bead.counts** ...
RnBeadSet-class

qc  
platform  character singleton specifying the microarray platform: "450k" corresponds to HumanMethylation450 microarray, and "27k" stands for HumanMethylation27.
summarize.regions  ...
region.types  A character vector specifying the region types, for which the methylation information will be summarized.
useff  If TRUE the data matrices will be stored as ff objects

Details

There are multiple ways to create an object of type RnBeadSet:

Loading from files  Dataset can be loaded from text or binary files. See the function `rnb.execute.import` for more details.

Downloading from GEO  See the function `rnb.read.geo` for details.
Converting from MethyLumiSet ...

Value

an object of class RnBeadSet

Slots

pval.sites  matrix of detection p-values with the same dimensions as betas, or NULL if the detection p-values are not available.
pval.regions  list of methylation matrix objects, one per available region type. Every row in a matrix corresponds to a methylation site, and every column - to a sample.
covg.sites  matrix of bead counts per probe with the same dimensions as betas, or NULL if this data are not available.
qc  Quality control probe information in the form of a list of two elements - "Cy3" and "Cy5", storing intensities of probes on the green and red channels, respectively. This slot’s value is NULL if no control probe information is available.

Methods and Functions

samples  Gets the identifiers of all samples in the dataset.
pheno  Gets the phenotypic and processing data of the dataset.
meth  Gets the matrix of methylation beta-values of the dataset.
dpval  Gets the matrix of detection p-values of the dataset.
covg  Gets the matrix of bead counts of the dataset.
qc  Gets the intensities of the quality control probes.
remove.sites  Removes probes from the dataset.
remove.samples  Removes samples from the dataset.
combine  Combines two datasets.

Author(s)

Pavlo Lutsik
RnBiseqSet-class

RnBiseqSet Class

Description

A class for storing the DNA methylation and quality information from bisulfite sequencing experiments.

Wrapper function RnBiseqSet

Usage

RnBiseqSet(pheno, sites, meth, covg = NULL, assembly = "hg19", target = "CpG", summarize.regions = TRUE,
region.types = rnb.region.types.for.analysis(assembly),
useff = rnb.getOption("disk.dump.big.matrices"),
usebigff = rnb.getOption("disk.dump.bigff"), verbose = FALSE)

Arguments

- `pheno` phenotypic data.
- `sites` CpG site definition, as a data.frame with 3 variables: chromosome (of type character), position (integer) and strand (character, one of "+", "-" or ")
- `meth` summarized methylation calls as a matrix or ff_matrix
- `covg` read coverage information as a matrix or ff_matrix
- `assembly` the genome assembly
- `target` target DNA methylation features (CpG sites)
- `summarize.regions` ...
- `region.types` region annotations for which the methylation data should be summarized
- `useff` flag specifying whether the ff functionality should be used
- `usebigff` flag specifying whether the extended ff functionality should be used (large matrix support for ff)
- `verbose` flag specifying whether the diagnostic messages should be written to the console or to the RnBeads logger, if the latter is initialized

Details

TBA

Value

an object of class RnBiseqSet

Slots

- `status` Normalization status.
Methods and Functions

combine  Combines two datasets.

Author(s)

Pavlo Lutsik

RnBSet-class  RnBSet Class

Description

Basic class for storing DNA methylation and experimental quality information

Details

It is a virtual class and objects of type RnBSet should not be instantiated. Instead, the child classes are used: RnBeadRawSet and RnBeadSet for Infinium HumanMethylation and RnBiseqSet for bisulfite sequencing data

Slots

pheno  Sample annotations (phenotypic and processing data) in the form of a data.frame.
sites  A matrix object storing the identifiers of the methylation sites for which the methylation information is present
meth.sites  matrix of methylation values. Every row corresponds to a methylation site, and every column - to a sample.
covg.sites  matrix of coverage values. Every row corresponds to a methylation site, and every column - to a sample.
regions  list of all identifiers of methylation sites for which methylation information is available.
meth.regions  list of methylation matrix objects, one per available region type. Every row in a matrix corresponds to a methylation site, and every column - to a sample.
covg.regions  list of coverage matrix objects, one per available region type. Every row corresponds to a region, and every column - to a sample.
status  list with meta-information about the object.
assembly  character vector of length one, specifying the genome assembly which the object is linked to, e.g. "hg19".
target  character vector of length one, specifying the feature class: "CpG" for sequencing data, "probes450" and "probes27" for HumanMethylation450 and HumanMethylation27 microarrays respectively.
inferred.covariates  list with covariate information. Can contain elements "sva" and "cell.types".
version  Package version in which the dataset was created.
imputed  Flag indicating if methylation matrix has been imputed.
Methods and Functions

- **pheno** Gets the phenotypic and processing data of the dataset.
- **samples** Gets the identifiers of all samples in the dataset.
- **summarized.regions** Gets the genomic annotations for which methylation data is present.
- **meth** Gets a matrix of methylation values in the dataset.
- **mval** Gets a matrix of M values in the dataset.
- **covg** Gets the matrix of coverage values of the dataset.
- **remove/sites** Removes sites from the dataset.
- **remove.samples** Removes samples from the dataset.
- **addPheno,RnBSet-method** Add sample annotation to the dataset.
- **combine** Combines two datasets.
- **regionMapping,RnBSet-method** Retrieve the sites mapping to a given region type
- **rnb.sample.summary.table** Creates a sample summary table from an RnBSet object.
- **isImputed,RnBSet-method** Getter for the imputation slot.

Author(s)

Pavlo Lutsik

---

Description

performs a two-sided t-test for paired samples on each row of a matrix X with the indices inds.1 vs indices inds.g2 as group assignments.

Usage

```
rowOneSampleTP(X, mu = 0, alternative = "two.sided")
```

Arguments

- **X** Matrix on which the test is performed for every row
- **mu** The mean that is tested against
- **alternative** Testing alternative. Must be one of "two.sided" (default),"less","greater" or "all". in case of "all" a data frome with corresping alternative variables is returned. Otherwise the result is a vector.

Value

vector (or data.frame if alternative=="all") of p-values from a paired t-test

Note

Requires matrixStats package
Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
p.vals <- rowOneSampleTP(meth.mat, mu=0, alternative="greater")
```

Description

performs a two-sided t-test for paired samples on each row of a matrix X with the indices `inds.1` vs indices `inds.g2` as group assignments.

Usage

`rowPairedTP(X, inds.g1, inds.g2 = -inds.g1, alternative = "two.sided")`

Arguments

- **X**: Matrix on which the test is performed for every row
- **inds.g1**: column indices of group 1 members. `length(inds.g1) == length(inds.g2)` has to hold true.
- **inds.g2**: column indices of group 2 members. `length(inds.g1) == length(inds.g2)` has to hold true.
- **alternative**: Testing alternative. Must be one of "two.sided" (default), "less", "greater" or "all". In case of "all" a data frame with corresponding alternative variables is returned. Otherwise the result is a vector.

Value

vector (or data.frame if alternative=="all") of p-values from a paired t-test

Note

Requires `matrixStats` package

Author(s)

Fabian Mueller
Description

performs a two-sided Welch's t-test (unequal variances, unequal sample sizes) on each row of a matrix X with the indices inds.1 vs indices inds.g2 as group assignments.

Usage

rowWelchP(X, inds.g1, inds.g2 = -inds.g1, na.rm = FALSE, alternative = "two.sided")

Arguments

X Matrix on which the test is performed for every row
inds.g1 column indices of group 1 members
inds.g2 column indices of group 2 members
na.rm Should NAs be removed (logical)
alternative Testing alternative. Must be one of "two.sided" (default), "less", "greater" or "all". In case of "all" a data frame with corresponding alternative variables is returned. Otherwise the result is a vector.

Value

vector (or data.frame if alternative=="all") of p-values resulting from the Welch's t-test

Note

Requires matrixStats package

Author(s)

Fabian Mueller

Examples

library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
meth.mat <- meth(rnb.set.example)
sample.groups <- rnb.sample.groups(rnb.set.example)[[1]]
p.vals <- rowWelchP(meth.mat, sample.groups[[1]], sample.groups[[2]])
Description

Runs the analysis by submitting jobs for each module to the compute cluster

Usage

```r
## S4 method for signature 'RnBClusterRun'
run(object, analysis.id, config.xml,
    split.differential = TRUE, dry.run = FALSE, long.cmd.thres = 1024L)
```

Arguments

- `object` \texttt{RnBClusterRun} object
- `analysis.id` analysis id. used for naming submitted jobs and log files
- `config.xml` XML file specifying the analysis options and parameter settings
- `split.differential` flag indicating whether to split the differential methylation module into separate jobs according to sample annotation column and region type.
- `dry.run` Prevent the actual job submission. Rather only write to a shell script file
- `long.cmd.thres` commands that are longer than this number will be encapsulated in shell scripts rather than being submitted as direct command

Value

Nothing of importance

Author(s)

Fabian Mueller

Examples

```r
#specify the xml file for your analysis
xml.file <- "MY_ANALYSIS_SETTINGS.XML"
#set the cluster architecture specific to your environment
arch <- new("ClusterArchitectureSGE")
rnb.cr <- new("RnBClusterRun", arch)
#set up the cluster so that 32GB of memory are required (SGE resource is called "mem_free")
rnb.cr <- setModuleResourceRequirements(rnb.cr, c(mem_free="32G"), "all")
#set up the cluster to use 4 cores on each node for all modules
rnb.cr <- setModuleNumCores(rnb.cr, 4L, "all")
#set up the cluster to use 2 cores for the exploratory analysis module
rnb.cr <- setModuleNumCores(rnb.cr, 2L, "exploratory")
#run the actual analysis (remove dry.run=TRUE, to really submit the jobs)
run(rnb.cr, "rnbeads_analysis", xml.file, dry.run=TRUE)
```
run.cross.validation

Description
This function performs 10-fold cross validation to estimate the performance of a newly trained predictor. If parallel.isEnabled(), the function performs cross validation in parallel. The function adds a table to the specified report containing the result of the 10-fold cross validation.

Usage
run.cross.validation(rnbSet, report, alpha = 0.8)

Arguments

rnbSet a RnBSet object containing the methylation info and ages on which the new predictor should be trained
report report to which the table should be added
alpha alpha parameter used in the elastic net regression

Value
modified report object

Author(s)
Michael Scherer

sampleCovgApply.RnBSet-method
sampleCovgApply-methods

Description
Applies a function over the coverage values for all samples in an RnBSet using a low memory footprint.

Usage
## S4 method for signature 'RnBSet'
sampleCovgApply(object, fn, type = "sites", ...)

Arguments

object object inheriting from RnBSet
fn function to be applied
type character singleton. Specify "sites" (default) or a region type over which the function is applied
... arguments passed on to the function
Description

Applies a function over the methylation values for all samples in an RnBSet using a low memory footprint.

Usage

```r
## S4 method for signature 'RnBSet'
sampleMethApply(object, fn, type = "sites", ...)
```

Arguments

- `object` object inheriting from `RnBSet`
- `fn` function to be applied
- `type` character singleton. Specify "sites" (default) or a region type over which the function is applied
- `...` arguments passed on to the function

Value

Result analogous to `apply(meth(rnbSet, type), 2, FUN=FUN)`

See Also

- `meth` Retrieving the matrix of methylation values
Description

Extracts sample identifiers

Usage

## S4 method for signature 'RnBSet'
samples(object)

## S4 method for signature 'RnBeadClustering'
samples(object)

Arguments

object          Dataset of interest.

Details

The column of the sample annotation table which contains identifiers is globally controlled via the "identifiers.column" option. In case the latter is NULL column names of the matrix returned by the meth method are treated as sample identifiers. In case the latter are also missing, a character vector with sample numbers is returned.

Value

character vector of sample identifiers.

Examples

library(RnBeads.hg19)
data(small.example.object)
samples(rnb.set.example)

save.rnb.diffmeth

Description

save an RnBDiffMeth object to disk

Usage

save.rnb.diffmeth(object, path)
Arguments

object \( \text{RnBDiffMeth} \) object

path path on the disk to save to.

Author(s)

Fabian Mueller

Description

Consistent saving of an \( \text{RnBSet} \) objects with large matrices of type \( \text{ff} \).

Usage

\texttt{save.rnb.set(object, path, archive = TRUE)}

Arguments

object \( \text{RnBSet-heriting object.} \)

path the name of the output file (or directory if \( \text{archive} \) is \( \text{FALSE} \)) without an extension. If only the file name is given the object will be saved in the current working directory.

archive if \( \text{TRUE} \) (default value) the output is a ZIP-file.

Details

The saved object can be reloaded with the \texttt{load.rnb.set} function.

Value

invisibly, the full path to the ZIP file (if \( \text{archive} \) is \( \text{TRUE} \)), or to the output directory (otherwise)

Author(s)

Pavlo Lutsik
**Description**

save the disk dumped tables to an ff archive for later reloading

**Usage**

```r
## S4 method for signature 'RnBDiffMeth'
save.tables(object, file)
```

**Arguments**

- `object`: RnBDiffMeth object
- `file`: path on the disk to save to.

**Value**

success

**Author(s)**

Fabian Mueller

**Examples**

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
pcols <- c("Sample_Group","Treatment")
tdir <- tempfile()
dm <- rnb.execute.computeDiffMeth(rnb.set.example,pcols,disk.dump=TRUE,disk.dump.dir=tdir)
save.tables(dm,tempfile())
```

---

**set.covariates.ct**

**Description**

Adds the results of cell type estimation to an RnBSet

**Usage**

```r
set.covariates.ct(rnb.set, ct.obj)
```
Arguments

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rnb.set</td>
<td>The RnBSet object to which the results should be added</td>
</tr>
<tr>
<td>ct.obj</td>
<td>An object of class CellTypeInferenceResult returned by rnb.execute.ct.estimation.</td>
</tr>
</tbody>
</table>

Value

The modified RnBSet.

Description

Adds the results of Surrogate Variable Analysis (SVA) to an RnBSet

Usage

```r
set.covariates.sva(rnb.set, sva.obj)
```

Arguments

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rnb.set</td>
<td>The RnBSet object to which the results should be added</td>
</tr>
<tr>
<td>sva.obj</td>
<td>An object of class SvaResult as returned by rnb.execute.sva.</td>
</tr>
</tbody>
</table>

Value

The modified RnBSet. Note that the association information will not be stored.

Author(s)

Fabian Mueller

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
logger.start(fname=NA)
sva.obj <- rnb.execute.sva(rnb.set.example,c("Sample_Group","Treatment"),numSVmethod="be")
sva.obj$sva.performed
sva.obj$num.components
rnb.set.mod <- set.covariates.sva(rnb.set.example, sva.obj)
has.covariates.sva(rnb.set.example,"Sample_Group")
has.covariates.sva(rnb.set.mod,"Sample_Group")
```
**setExecutable, ClusterArchitecture, character, character-method**

### setExecutable-methods

**Description**

Tells the cluster architecture about an executable that can be submitted as job

**Usage**

```r
## S4 method for signature 'ClusterArchitecture, character, character'
setExecutable(object, exec.name, exec.loc)
```

**Arguments**

- `object`: ClusterArchitecture object
- `exec.name`: A name/identifier that will be associated with the given executable
- `exec.loc`: The executable's location

**Value**

The modified object

**Author(s)**

Fabian Mueller

**setModuleNumCores, RnBClusterRun, integer, character-method**

### setModuleNumCores-methods

**Description**

Specifies the number of cores used by the different pipeline modules

**Usage**

```r
## S4 method for signature 'RnBClusterRun, integer, character'
setModuleNumCores(object, num.cores, modules = "all")
```

**Arguments**

- `object`: RnBClusterRun object
- `num.cores`: an integer specifying the number of cores to be used
- `modules`: vector of applicable pipeline modules. Can be "all" to specify all modules
Value

The modified object

Author(s)

Fabian Mueller

---

**setModuleResourceRequirements, RnBSet, character, character-method**

Description

Specifies resource requirements for the different pipeline modules

Usage

```r
## S4 method for signature 'RnBClusterRun,character,character'
setModuleResourceRequirements(object, resources, modules = "all")
```

Arguments

- `object`: RnBClusterRun object
- `resources`: A NAMED character vector containing the resource requirements as value and the resource name as name
- `modules`: vector of applicable pipeline modules. Can be "all" to specify all modules

Value

The modified object

Author(s)

Fabian Mueller

---

**sites, RnBSet-method**

Description

Methylation sites object information for which is present in the RnBSet object.

Usage

```r
## S4 method for signature 'RnBSet'
sites(object)
```
summarize.regions,RnBSet-method

Arguments

object

Dataset of interest.

Value

A matrix of type integer describing the sites, information for which is present in the object

Examples

library(RnBeads.hg19)
data(small.example.object)
sites(rnb.set.example)

summarize.regions-methods

Description

Summarize DNA methylation information for which is present in the RnBSet object.

Usage

## S4 method for signature 'RnBSet'
summarize.regions(object, region.type,
  aggregation = rnb.getOption("region.aggregation"), overwrite = TRUE)

Arguments

object

Dataset of interest.

region.type

Type of the region annotation for which the summarization will be performed or "strands" for summarizing the methylation values from both strands

aggregation

Operation to summarize the methylation values. Currently supported values are "mean", "median", "min", "max" and "coverage.weighted"

overwrite

If TRUE the existing region-level information for region.type is discarded

Value

object of the same class as the supplied one containing the summarized methylation information for the specified region types

Examples

library(RnBeads.hg19)
data(small.example.object)
rnb.set.summarized<-summarize.regions(rnb.set.example, "genes", overwrite=TRUE)
head(meth(rnb.set.summarized, type="genes", row.names=TRUE))
summarized.regions,RnBSet-method

Description

Gets the genomic annotations for which methylation data is present in the RnBSet object.

Usage

```r
## S4 method for signature 'RnBSet'
summarized.regions(object)
```

Arguments

- `object` Methylation dataset of interest.

Value

character vector listing all genomic annotations summarized in the given dataset. If the dataset contains methylation in sites only, an empty vector is returned.

Author(s)

Yassen Assenov

See Also

- `summarize.regions` for calculating region-wise methylation in a dataset;
- `rnb.set.annotation` for adding or replacing a region annotation table

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
summarized.regions(rnb.set.example)
```

U,RnBeadRawSet-method

Description

Extract raw unmethylated probe intensity from an object of RnBeadRawSet class.

Usage

```r
## S4 method for signature 'RnBeadRawSet'
U(object, row.names = FALSE)
```
updateMethylationSites,RnBSet-method

Arguments

object  Dataset of interest.
row.names  Flag indicating whether the resulting matrix will be assigned row names

Value

matrix of the unmethylated probe intensities

Examples

library(RnBeads.hg19)
data(small.example.object)
U.intensity<-U(rnb.set.example)
head(U.intensity)

updateMethylationSites,RnBSet-method

updateMethylationSites-methods

Description

Replaces the methylation info with the specified data frame.

Usage

## S4 method for signature 'RnBSet'
updateMethylationSites(object, meth.data, verbose = FALSE)

Arguments

object  Dataset of interest.
meth.data  This object has to be a data.frame of equal dimension than the one already contained in object, containing the methylation info that should be associated with the object.
verbose  if TRUE additional diagnostic output is generated

Value

The modified dataset. #
updateRegionSummaries, RnBSet-method

Description

Updates the region information present in an RnBSet by invoking \texttt{summarize.regions} on all region types present in the object.

Usage

\begin{verbatim}
## S4 method for signature 'RnBSet'
updateRegionSummaries(object)
\end{verbatim}

Arguments

- \texttt{object} Dataset of interest.

Value

Sample annotation information available for the dataset in the form of a data.frame.

\[\text{[,BigFfMat,ANY,ANY,ANY-method}

Extract parts of BigFfMat

Description

Extract parts of BigFfMat.

Usage

\begin{verbatim}
## S4 method for signature 'BigFfMat,ANY,ANY,ANY'
x[i, j, drop = TRUE]
\end{verbatim}

Arguments

- \texttt{x} BigFfMat object
- \texttt{i} row indices (integer, logical, character are allowed)
- \texttt{j} column indices (integer, logical, character are allowed)
- \texttt{drop} analogous to generic drop
Description
Replace parts of BigFfMat

Usage

```r
## S4 replacement method for signature 'BigFfMat,ANY,ANY,ANY'
x[i, j] <- value
```

Arguments

- `x`: BigFfMat object
- `i`: row indices (integer, logical, character allowed)
- `j`: column indices (integer, logical, character allowed)
- `value`: replacement values
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