Package ‘RnBeads’

September 1, 2018

Title RnBeads

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

Date 2018-05-07

Version 1.12.1

Suggests Category, GOstats, Gviz,
IlluminaHumanMethylation450kmanifest, RPMM, RefFreeEWAS,
RnBeads.hg19, XML, annotate, biomaRt, foreach, doParallel,
ggbio, isva, mclust, mgcv, minfi, nlme, org.Hs.eg.db,
org.Mm.eg.db, org.Rn.eg.db, quadprog, rtracklayer, qvalue, sva,
wateRmelon, wordcloud, argparse, glmnet, GLAD,
IlluminaHumanMethylation450kanno.ilmn12.hg19, scales,
missMethyl, impute, shiny, shinyjs, plotrix, hexbin, RUnit

Depends R (>= 3.0.0), BiocGenerics, S4Vectors (>= 0.9.25),
GenomicRanges, MASS, cluster, ff, fields, ggplot2 (>= 0.9.2),
gplots, gridExtra, limma, matrixStats, methods, illuminaio,
methylumi, plyr

Imports IRanges

License GPL-3

biocViews DNAMethylation, MethylationArray, MethylSeq, Epigenetics,
QualityControl, Preprocessing, BatchEffect,
DifferentialMethylation, Sequencing, CpGIsland, TwoChannel,
DataImport

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'
'exportGEO.R' 'filtering.R' 'filteringSummary.R' 'gender.R'
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'
'qualityControl.R' 'readGEO.R' 'regionDescription.R'
'regionProfiles.R' 'subSegments.R' 'sva.R' 'utilities.R'
'wbcInference.R'

RoxygenNote 6.0.1

git_url https://git.bioconductor.org/packages/RnBeads

git_branch RELEASE_3_7

git_last_commit f662e69

git_last_commit_date 2018-05-07

Date/Publication 2018-08-31

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Page dimensions: 595.3x841.9
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`. 
addDiffMethTable.RnBDiffMeth-method

**Format**

`infos` 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

---

**addDiffMethTable, RnBDiffMeth-method**

**addDiffMethTable-methods**

**Description**

Adds a differential methylation table

**Usage**

```r
## 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
Experiments

```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(pheno(object))`.

**Value**

The modified dataset as an object of type `RnBSet`.

**Author(s)**

Fabian Mueller
Examples

```r
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)
```

---

addRegionSubsegments

**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**

```r
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

```r
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"))
```

Description

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

Usage

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

Arguments

- `object`: 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. Otherwise, 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

```r
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**

```r
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

---

**as.RnBeadRawSet**

**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
## 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

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

auto.select.rank.cut  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
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**

```r
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.
ClusterArchitecture-class

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

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

correction-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**

**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**

```r
cols.to.rank.site(diff.var)
```

```r
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**

**Description**

Combine two objects inheriting from `RnBSet` class

**Usage**

```r
## 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.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.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

```r
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)
```

Description

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.
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

a 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

**computeDiffTab.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 a 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:

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

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

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

Arguments

- `object`: Dataset of interest.
- `type`: character. If `sites` DNA methylation information per each available site is returned. Otherwise should be one of region types 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)
```

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)
```
create.hex.summary.plot

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

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

Description

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

Usage

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

create.scatter.dens.points

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
**Examples**

```r
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**

Creates a new report object.

**Usage**

```r
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 (-), 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 parameter is TRUE, the method creates the respective directory and copies configuration 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 multiple 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".
• "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 names. 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

```r
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**

```r
data.frame2GRanges

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**

```r
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
create a deviation plot based on the methylation beta values of a population.

Usage

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.
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**

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

**Usage**

```r
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

Dimensions of BigFfMat

Description

Dimensions of BigFfMat

Usage

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

Arguments

x

BigFfMat object

downloadLolaDbs

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

Description

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

Usage

\[
\text{dpval}(\text{object}, \text{type} = \text{"sites"}, \text{row.names} = \text{FALSE}, \text{i} = \text{NULL}, \text{j} = \text{NULL})
\]

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)
**Description**

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

**Usage**

```r
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 intermediate steps (see details).

**Note**

Requires the package `nlme`.

---

**estimateProportionsCP estimateProportionsCP**
Description

exportDmrs2regionFile exports 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)

- Pavlo Lutsik
- 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")
**get.adjustment.variables**

### 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")
```
get.comparison.grouplabels,RnBDiffMeth-method

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)

get.comparison.groupsizes,RnBDiffMeth-method

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)

Arguments

object RnBDiffMeth object

Value

character matrix containing comparison group sizes
Arguments

object 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)

dm <- rnb.execute.computeDiffMeth(rnb.set.example,pheno.cols=c("Sample_Group","Treatment"))

get.comparison.info(dm)

get.comparison.info

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"),
adjjust.na.rm = TRUE)

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

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` 41

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

get.comparisons-methods

Description

Gets all comparisons represented in the object as character vector

Usage

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

Arguments

object RnBDiffMeth object

Value

character vector containing comparisons

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)

---

gcovariates.ct

description

Retrieves an NxK matrix of cell type contributions stored in an RnBSet for a given target variable

Usage

get.covariates.ct(rnb.set)

Arguments

rnb.set RnBSet object
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")
get.covg.thres, RnBDiffMeth-method

get.covg.thres-methods

Description

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

Usage

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

Arguments

object RnBDiffMeth object

Value

integer coverage threshold

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.covg.thres(dm)

get.cpg.stats

Description

Computes CpG-related statistics for the specified regions.

Usage

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

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
Value
character describing the site test method

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.site.test.method(dm)
```

Description

Gets a differential methylation table

Usage

```r
## S4 method for signature 'RnBDiffMeth'
ge{}t.table(object, comparison, region.type, undump = TRUE, return.data.frame = FALSE)
```

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>RnBDiffMeth object</td>
</tr>
<tr>
<td>comparison</td>
<td>character or index of the comparison of the table to retrieve</td>
</tr>
<tr>
<td>region.type</td>
<td>character or index of the region type of the table to retrieve</td>
</tr>
<tr>
<td>undump</td>
<td>Flag indicating whether to convert the table into a matrix instead of using the file descriptor. Only meaningful if the object's disk.dump slot is true.</td>
</tr>
<tr>
<td>return.data.frame</td>
<td>should a data.frame be returned instead of a matrix?</td>
</tr>
</tbody>
</table>

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)
```

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

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**
gegetCellTypesFromLolaDb(lolaDb)

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

**Value**
character vector with cell types

**Author(s)**
Fabian Mueller

**Examples**

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

getExecutable,ClusterArchitecture,character-method

**Description**
Retrieves the executable associated with a name/identifier

**Usage**

```r
## S4 method for signature 'ClusterArchitecture,character'
getExecutable(object, exec.name)
```
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

```r
## 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 accross 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)
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
Description

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

Usage

```r
## 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
Usage

```r
## 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
- `depend.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

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

---

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.)
Usage

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

greedycut.filter.matrix

description

Performs all iterations of the Greedycut algorithm for removing rows and columns from the given 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.
greedycut.get.submatrix

Author(s)
Yassen Assenov

See Also

`greedycut.get.submatrix` for extracting the resulting matrix after filtering

---

Description
Calculates various statistics on the iterations of Greedycut.

Usage

```r
greedycut.get.statistics(filterinfo)
```

Arguments

- `filterinfo` Information on the filtering iterations as a data.frame returned by `greedycut.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

```r
greedycut.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.
hasCovg.RnBSet-method

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 RnBSet object contains coverage information for sites or the specified region type.

Usage

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

Arguments

object RnBSet of interest.
type character singleton. If sites or a region type summarized in the object

Value

TRUE if the RnBSet object contains coverage information for sites or the specified region type. FALSE otherwise

Examples

library(RnBeads.hg19)
data(small.example.object)
## per-site beta-value matrix
hasCovg(rnb.set.example)
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")
```
**Arguments**

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>A name or identifier</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>.Object</th>
<th>New instance of ClusterArchitectureSGE.</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>A name or identifier</td>
</tr>
<tr>
<td>...</td>
<td>arguments passed on to the constructor of ClusterArchitecture (the parent class)</td>
</tr>
</tbody>
</table>

**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

## 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

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

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

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)

isImputed,RnBSet-method

Description

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

Usage

## 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
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 important 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 a 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**

```r
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**

```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]]
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
load.rnb.set

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.
logger.getfiles

Author(s)
Yassen Assenov

Examples

n.iterations <- logger.argument("iterations", "number of iterations", "integer",
  accepted.values = 1:100, default = 1L)
logger.close()

Description

Gets the files currently used by the logger.

Usage

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 \texttt{rnb.options}) or the logger is not initialized, this function returns \texttt{NULL}.

Author(s)
Yassen Assenov

See Also

\texttt{logger.isinitialized} to check if logging is activated; \texttt{logger.start} for initializing a logger or
starting a section

Examples

if (NA %in% logger.getfiles())
  cat("Console logger is enabled\n")
**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**

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

---

**Description**

Log the machine name the analysis is run on

**Usage**

`logger.machine.name()`

**Value**

None (invisible NULL).

**Author(s)**

Fabian Mueller
**logger.start**  

### Description

Functions for logger management.

### Usage

```r
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

    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

    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
logger.validate.file

Examples

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

```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
lolaBarPlot(res$lolaDb, lolaRes, scoreCol="oddsRatio", orderCol="maxRnk", pvalCut=0.05)
```

Description

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

Usage

```r
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
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())
```
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"
# plot
lolaVolcanoPlot(res$lolaDb, lolaRes, signifCol="qValue")
```

---

**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 RnBeads for the corresponding platform.

Author(s)

Yassen Assenov

Description

Extract raw methylated probe intensity from an object of RnBeadRawSet class.

Usage

```r
## S4 method for signature 'RnBeadRawSet'
M(object, row.names = FALSE)
```

Arguments

- `object` : Dataset of interest.
- `row.names` : Flag indicating whether the resulting matrix will be assigned row names

Value

matrix of the methylated probe intensities

Examples

```r
library(RnBeads.hg19)
data(small.example.object)
M.intensity<-M(rnb.set.example)
head(M.intensity)
```
**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.

---

**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)
```

descrition: 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

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

## 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

```r
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)
```

Description

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

Usage

```r
## 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

```r
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)
```

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

```r
## 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.

---

parallel.getNumWorkers

```
parallel.getNumWorkers
```

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

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

---

```r
parallel.isEnabled  # parallel.isEnabled
```

---

**Description**

Checks if whether parallel processing is enabled.

**Usage**

```r
parallel.isEnabled()
```

**Value**

TRUE if multicore processing is enabled, FALSE otherwise.

**Author(s)**

Fabian Mueller

**Examples**

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

---

```
parallel.setup  # parallel.setup
```

---

**Description**

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

**Usage**

```r
parallel.setup(...)```
Arguments

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

Value

TRUE (invisible) to indicate that parallelization is set up.

Note

Requires the packages foreach and doParallel.

Author(s)

Fabian Mueller

Examples

parallel.setup(2)
parallel.teardown()

parallel.teardown

Description

Disables parallel processing.

Usage

parallel.teardown()

Value

TRUE, invisibly.

Author(s)

Fabian Mueller

Examples

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

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 mm5
...           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**

performGOEnrichment.diffVar

**Description**

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

**Usage**

```r
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

```r
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

```r
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 <- downloadLolaDbs(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

```
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 loadLolaDbs.

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

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

prepareSOFTfileForGEO  prepareSOFTfileForGEO

Description

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

Usage

```r
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

qc,RnBeadSet-method  qc-methods

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

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 suiting 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.

Further arguments which are passed to the internal function read.single.bed and to read.table

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

read.data.dir

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
dir directory containing the table files
pheno a file containing data sample annotations and phenotypic information
betas a file containing the beta values. If not supplied, the routine will look in dir for a file containing "beta" token in the filename
p.values a file containing the detection p values. If not supplied, the routine will look in dir for a file containing "pval" token in the filename
bead.counts a file containing the bead counts (optional). If not supplied, the routine will look in dir for a file containing "bead" token in the filename
sep character used as field separator in the tables files. Default value is taken by the call to rnb.getOption("import.table.separator")
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

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

Description

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

Usage

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
Description

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

Usage

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
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.

See Also

methylumIDAT in package methylumi
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**

```r
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

refFreeEWASP(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

regionMapping,RnBSet-method

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)
```

regions,RnBSet-method

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

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

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)
```

---

**Description**

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

**Usage**

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

Arguments

object Dataset of interest.
region.type Type of the region annotation for which the summarization should be removed

Value

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

Examples

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,remove.samples-methods

remove.samples,RnBeadSet-method

Description

Removes the specified samples from the dataset.

Usage

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

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

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

Arguments

object Dataset of interest.
samplelist 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.

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)
rnb.set.f<-remove.samples(rnb.set.example, s2r)
samples(rnb.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)
```

Report-class

**Report Class**

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.pnsgs** 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  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  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.
rnb.add.figure

Author(s)

Yassen Assenov

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

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

rnb.add.list

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

Arguments
- \text{report} \hspace{1cm} \text{Report to write the text to.}
- \text{txt} \hspace{1cm} \text{character vector (or array) storing the text to be written. The elements of this vector are concatenated without a separator.}
- \text{paragraph.class} \hspace{1cm} \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
\text{Report} for other functions adding contents to an HTML report

Examples
\[
\text{report} \leftarrow \text{createReport}(\text{"example.html"}, \text{"Example"}, \text{init.configuration} = \text{TRUE})
\text{txt} \leftarrow \text{"A pessimist is a person who has had to listen to too many optimists."}
\text{txt} \leftarrow \text{c(txt, } \text{"<i>Don Marquis</i>"})
\text{rnb.add.paragraph}(\text{report}, \text{txt})
\]
Description

Adds a reference item to the given report.

Usage

```r
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

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

See [Report](#) for other functions adding contents to an HTML report

Examples

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

---

Description

Generates HTML code for a table in the specified report.

Usage

```r
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, ...)
Arguments

- **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

---

**Description**

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

**Usage**

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

**Arguments**

- **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

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

rnb.annotation2data.frame(rnb.get.annotation("probes450"))

Description

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

Usage

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

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
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 (_).
rnb.combine.arrays

**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**

```r
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**

```r
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.
NULL if no principal components for batch analysis are specified (\texttt{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 \texttt{permutations} is NULL.

Author(s)

Pavlo Lutsik

---

\texttt{rnb.execute.batcheffects}

\texttt{rnb.execute.batcheffects}

Description

Performs tests for association between traits and principal components.

Usage

\texttt{rnb.execute.batcheffects(rnb.set, pcoordinates = NULL)}

Arguments

\texttt{rnb.set} Methylation dataset as an object of type inheriting \texttt{RnBSet}.

\texttt{pcoordinates} Coordinates of the samples of \texttt{rnb.set} in the principal components space, as returned by \texttt{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 \texttt{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 \texttt{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 \texttt{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
See Also

\texttt{rnb.run.exploratory} for running the whole exploratory analysis module

Examples

\begin{verbatim}
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)
\end{verbatim}

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

\begin{verbatim}
rnb.execute.clustering(rnb.set, region.type = "sites")
\end{verbatim}

Arguments

\begin{itemize}
  \item \textbf{rnb.set} \hspace{1cm} Methylation dataset as an object of type inheriting \texttt{RnBSet}.
  \item \textbf{region.type} \hspace{1cm} the clustering is performed on methylation levels from regions of that type. see \texttt{rnb.region.types} for possible values.
\end{itemize}

Value

List of clustering results, whereby each element is an object of type \texttt{RnBeadClustering}. In case clustering cannot be performed, the return value is \texttt{NULL}. Reasons for a failure include, among others, the case when \texttt{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

```r
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

```r
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.
rnb.execute.computeDiffMeth

Description

computes differential methylation

Usage

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("covariate.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 an 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 `RnBeads`
- `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
rnb.execute.dreduction

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

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)
rnb.execute.export.csv

names(pcoordinates) <- regs
str(pcoordinates)

rnb.execute.export.csv

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 Methyltion 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 Rn-
Beads, 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

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

rnb.execute.filter.summary

Description

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

Usage

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

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

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**

```r
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**

```r
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 correspond to the number of samples</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 file</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 of a sample</td>
</tr>
<tr>
<td>&quot;rnb.set&quot;</td>
<td>RnBSet</td>
<td>1</td>
<td>object of class inheriting from data.name</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 MethylLumiSet (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")

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, ...)

rnb.execute.imputation

rnb.execute.imputation

rnb.execute.imputation

rnb.execute.imputation
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 temporarly be changed. If this value is FALSE, the region level methylation values are not updated and only the site-wise matrix is changed temporarily.
- ... - Optional arguments passed to knn.imputation

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

Description

Replaces all low coverage sites by NA.

Usage

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

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

**cogr.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

```r
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

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

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
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.quality

rnb.set.norm<-rnb.execute.normalization(rnb.set.example, method="illumina", bgcorr.method="none")

rnb.execute.quality  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
rnb.execute.sex.removal

**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

rnb.execute.snp.removal

**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
equal(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 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`
**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

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(rnb.set, out.dir, reg.type = "sites", ...)
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.
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**

```r
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**

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

---

**rnb.get.directory**

**Description**

Gets the location of the given report-specific directory.

**Usage**

```r
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.
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

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

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

```r
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

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

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

**Usage**

```r
rnb.get.reference(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), ",")
rnb.add.paragraph(report, txt)
```
**rnb.get.reliability.matrix**

Description

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

Usage

```r
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

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

```r
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
rnb.is.option

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

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

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

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

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

x11(width = 5, height = 5)
rnb.message.plot("Missing data")

rnb.mval2beta(rnb.mval2beta)

Description
Transforms M values to beta values.

Usage

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

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.

email = 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 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 Illumina 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; "bmimq" - beta-mixture quantile normalization method by Teschendorff et al; as well as "wm.dasen", "wm.nases", "wm.betaqn", "wm.naten", "wm.nanes", "wm.danes", "wm.danet", "wm.daten", "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.greedyCut = 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.greedyCut.pvalue.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.greedyCut is TRUE.

filtering.greedyCut.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.greedyCut 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 disables 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.cpgs", "mean.samples", "random", "median.cpgs", "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.
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.

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.

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.

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.

inference.age.prediction = TRUE Flag indicating if the epigenetic age prediction within the inference module is to be executed.

inference.age.prediction.training = FALSE Flag indicating if a new predictor should be created based on the provided data set.

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.

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.

exploratory = TRUE Flag indicating if the exploratory analysis module is to be executed.

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 rnb.sample.groups for how this is done.

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.

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.

exploratory.correlation.pvalue.threshold = 0.01 Significance threshold for a p-value resulting from applying a test for association. This is a value between 0 and 1.

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.

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.

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.

exploratory.custom.loci.bed = NULL  Path to a bed file containing custom genomic regions. Locus views will be generated for these regions.

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 anlaysis 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
Description

Draws plots that compare two distributions of beta values.

Usage

```r
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
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.probeCategories`
- `rnb.plot.betadistribution.sampleGroups`

Examples

```r
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")
```

Description

Plots beta value distributions given a sample grouping.

Usage

```r
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

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)

rnb.plot.biseq.coverage

Description

Plots the sequencing coverage of the RnBiseqSet object across the genomic coordinate

Usage

rnb.plot.biseq.coverage(rnbs.set, sample, type = "sites",
writeToFile = FALSE, numeric.names = FALSE, covg.lists = NULL, ...)

rnb.plot.biseq.coverage

rnb.plot.biseq.coverage

rnb.plot.biseq.coverage
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
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

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
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
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

\[
\text{rnb.plot.control.boxplot}(\text{rnb.set}, \\
\quad \text{type} = \text{rnb.infinium.control.targets}(\text{rnb.set@target}[1], \\
\quad \text{writeToFile} = \text{FALSE}, \text{numeric.names} = \text{FALSE}, \ldots)
\]

Arguments

- **rnb.set**: RnBeadRawSet or RnBeadSet object with valid quality control information.
- **type**: 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**: 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.
- **...**: 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.control.boxplot(rnb.set.example)
Description

Plots the number of remaining CpGs after applying different thresholds for coverage and support.

Usage

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
rnb.plot.ct.heatmap

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 plotted matrix otherwise

Author(s)
Pavlo Lutsik

rnb.plot.dreduction

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.
rnb.plot.marker.fstat

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

rnb.plot.marker.fstat  rnb.plot.marker.fstat

Description

Plot the the cell type marker selection based on the reference methylome data

Usage

rnb.plot.marker.fstat(ct.object, writeToFile = FALSE, ...)

Arguments

ct.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
rnb.plot.negative.boxplot

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

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"))
```
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`

Description

Plots the density of methylation levels across all regions of the specified type

Usage

```r
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
rnb.plot.region.profiles(rnb.set, group.index.list, region.type = "", region.profile = NULL, extend.by = 0.33, cvalues = rnb.getOption("colors.category"))
```
rnb.plot.region.site.density

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 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

```r
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

```r
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

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
rnb.plot.snp.boxplot(dataset, writeToFile = FALSE, ...)

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.

Value
If writeToFile is TRUE: plot as an object of type ReportPlot. Otherwise: plot as an object of type ggplot.

Author(s)
Pavlo Lutsik

Examples
library(RnBeads.hg19)
data(small.example.object)
rnb.plot.snp.boxplot(rnb.set.example)

Description
Heatmap of beta values from genotyping probes.

Usage
rnb.plot.snp.heatmap(dataset, writeToFile = FALSE, ...)

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.

Value
If writeToFile is TRUE: plot as an object of type ReportPlot. Otherwise: plot as an object of type ggplot.

Author(s)
Pavlo Lutsik

Examples
library(RnBeads.hg19)
data(small.example.object)
rnb.plot.snp.heatmap(rnb.set.example)
**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

```
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

```
"promoters" %in% rnb.region.types() # TRUE
```
Description

Identifies the region types that are summarized by the given dataset and pointed to for analysis.

Usage

`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  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 \texttt{rnb.get.assemblies} for the list of supported genomes.

Value
Invisibly, \texttt{TRUE} if the annotation has been successfully deleted, or \texttt{FALSE} if the specified region type is not supported.

Author(s)
Fabian Mueller

See Also
\texttt{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)
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)` if 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())

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 RnB-Sets, 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
**Description**
Executes the analysis pipeline for an example from the RnBeads web site.

**Usage**
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()

Description

Functions that start the predefined modules in the RnBeads analysis pipeline.

Usage

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

```r
### Running the modules step by step

# 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'

# Directory where the report files should be written to
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
```
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 details 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.
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 an analysis pipeline

rnb.sample.groups  rnb.sample.groups

Description

Identifies sample subgroups defined in the given annotation information.

Usage

rnb.sample.groups(annotations, columns = NULL, columns.pairs = NULL, min.group.size = rnb.getOption("min.group.size"), max.group.count = rnb.getOption("max.group.count"))

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.

columns.pairs  Optional; a 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 integer vectors storing the corresponding sample indices.

Author(s)

Yassen Assenov
Examples

```r
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

```r
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

```r
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_numDPval5em2,1em2,1em3** (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
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.
rnb.set.annotation.and.cpg.stats

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

```r
txt <- "First exon of the BEND5 gene and an overlapping CpG island."
my.regions <- data.frame(
  chromosome = c("chr1", "chr1"),
  start = c(49242278L, 49242372L),
  end = c(49242590L, 49242810L),
  rownames = c("BEND5E1", "CpG:38"))
rnb.set.annotation("my regions", my.regions, txt)
```

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
```r
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
**rnb.show.report**

**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
Details

If subsampling is enabled (i.e. \texttt{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 \( p_k = \frac{N_k}{N} \) is computed and from each group, \( S_k = p_k \cdot (K \cdot T) \) observations are randomly selected from all observations belonging to group \( k \).

Author(s)

Fabian Mueller

Description

 Writes a table to a file. Different formats and compression options are available.

Usage

\begin{verbatim}
\texttt{rnb.write.table(tt, fname, fpath = "", format = "csv", gz = FALSE, ...)}
\end{verbatim}

Arguments

\begin{itemize}
  \item \texttt{tt} : Table to be written to file, usually in the form of a \texttt{matrix} or \texttt{data.frame}.
  \item \texttt{fname} : Target file name. If this file already exists, it will be overwritten.
  \item \texttt{fpath} : Target file path. If "" (default value), \texttt{fname} is assumed to contain the absolute path.
  \item \texttt{format} : Target format; one of "csv", "tab" or "txt", denoting comma-separated, tab-separated and default text format, respectively. The last format allows for a user-specified delimiter through an additional parameter \texttt{sep}. See the documentation of \texttt{write.table} for more details.
  \item \texttt{gz} : Flag indicating whether the file should be zipped in \texttt{gz} format.
  \item ... : Any additional arguments to be passed on to \texttt{write.table} or \texttt{utils::write.csv}.
\end{itemize}

Value

The (possibly updated) target file name, invisibly. If \texttt{gz} is \texttt{TRUE}, the string ".gz" will be appended to \texttt{fname}.

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.group.labels**  A character matrix with 2 columns containing group labels of all comparisons 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 tables.
- **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 character vector
- **get.comparisons,RnBDiffMeth-method**  Gets all comparisons represented in the object as character vector
- **get.comparison.group.labels,RnBDiffMeth-method**  Gets all comparison group names as a matrix
- **get.covg.thres,RnBDiffMeth-method**  Gets the coverage threshold employed for obtaining statistics 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 microarray data which includes intensity information

Wrapper function RnBeadRawSet

Usage

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

- **pheno**
  - Phenotypic data.

- **probes**
  - character vector of Infinium(R) probe identifiers

- **M**
  - Matrix of intensities for the probes measuring the abundance of methylated molecules

- **U**
  - Matrix of intensities for the probes measuring the abundance of unmethylated molecules

- **M0**
  - Matrix of "out-of-band" intensities for the probes measuring the abundance of methylated molecules

- **U0**
  - Matrix of "out-of-band" intensities for the probes measuring the abundance of unmethylated molecules

- **bead.counts.M**
  - Matrix of bead counts per probe.

- **bead.counts.U**
  - Matrix of bead counts per probe.

- **p.values**
  - Matrix of detection p-values.

- **qc**
  - ...

- **platform**
  - character singleton specifying the microarray platform: "450k" corresponds to HumanMethylation450 microarray, and "27k" stands for HumanMethylation27.

- **beta.offset**
  - A regularization constant which is added to the denominator at beta-value calculation

- **summarize.bead.counts**
  - 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

- **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

- **ffcleanup**
  - If TRUE and disk dumping has been enabled the data of the input ff objects will be deleted

Value

- an object of class RnBeadRawSet

Slots

- **pheno**
  - Phenotypic data.

- **M**
  - Matrix of intensities for the probes measuring the abundance of methylated molecules.

- **U**
  - Matrix of intensities for the probes measuring the abundance of unmethylated molecules.

- **M0**
  - Matrix of "out-of-band" intensities for the probes measuring the abundance of methylated molecules.

- **U0**
  - Matrix of "out-of-band" intensities for the probes measuring the abundance of unmethylated molecules.

- **bead.counts.M**
  - Matrix of bead counts per probe.

- **bead.counts.U**
  - Matrix of bead counts per probe.
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

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RnBeads data

Analysis of genome-scale DNA methylation data with RnBeads

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


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RnBeads.data

RnBeads Annotation Tables

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

list of four elements - "regions", "sites", "controls" and "mappings". These elements are described below.

"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

RnBeadSet-class  RnBeadSet Class

Description

Stores the preprocessed information from HumanMethylation experiments

Wrapper function RnBeadSet

Usage

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 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 \texttt{rnb.execute.import} for more details.

Downloading from GEO See the function \texttt{rnb.read.geo} for details.

Converting from MethyLumiSet ...

Value

an object of class RnBeadSet

Slots

\texttt{pval.sites} matrix of detection p-values with the same dimensions as betas, or NULL if the detection p-values are not available.

\texttt{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.

\texttt{covg.sites} matrix of bead counts per probe with the same dimensions as betas, or NULL if this data are not available.

\texttt{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

\texttt{samples} Gets the identifiers of all samples in the dataset.

\texttt{pheno} Gets the phenotypic and processing data of the dataset.

\texttt{meth} Gets the matrix of methylation beta-values of the dataset.

\texttt{dpval} Gets the matrix of detection p-values of the dataset.

\texttt{covg} Gets the matrix of bead counts of the dataset.

\texttt{qc} Gets the intensities of the quality control probes.

\texttt{remove.sites} Removes probes from the dataset.

\texttt{remove.samples} Removes samples from the dataset.

\texttt{combine} Combines two datasets.

Author(s)

Pavlo Lutsik
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**

**RnB Set 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

---

rowOneSampleTP

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

```r
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 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
rowPairedTP

Author(s)
Fabian Mueller

Examples

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 frome with corresponsing 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` : `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)
```
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

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
Value

Result analogous to `apply(covg(rnbSet, type), 2, FUN=FUN)`

See Also

covg Retrieving the matrix of coverage values

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**

```r
## 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**

```r
library(RnBeads.hg19)
data(small.example.object)
samples(rnb.set.example)
```

---

**Description**

save an `RnBDiffMeth` object to disk

**Usage**

```r
save.rnb.diffmeth(object, path)
```
Arguments

object \texttt{RnBDiffMeth} object
path path on the disk to save to.

Author(s)

Fabian Mueller

Description

Consistent saving of an \texttt{RnBSet} objects with large matrices of type \texttt{ff}.

Usage

\texttt{save.rnb.set(object, path, archive = TRUE)}

Arguments

object \texttt{RnBSet}-inheriting object.
path the name of the output file (or directory if \texttt{archive} is \texttt{FALSE}) without an extension. If only the file name is given the object will be saved in the current working directory.
archive if \texttt{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 \texttt{archive} is \texttt{TRUE}), or to the output directory (otherwise)

Author(s)

Pavlo Lutsik
save.tables,RnBDiffMeth-method

Description
save the disk dumped tables to an ff archive for later reloading

Usage
## 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

- `rnb.set`: The RnBSet object to which the results should be added.
- `ct.obj`: An object of class `CellTypeInferenceResult` returned by `rnb.execute.ct.estimation`.

Value

The modified RnBSet.

Description

Adds the results of Surrogate Variable Analysis (SVA) to an RnBSet.

Usage

```r
define_arguments()

define_value()

set.covariates.sva(rnb.set, sva.obj)
```

Arguments

- `rnb.set`: The RnBSet object to which the results should be added.
- `sva.obj`: An object of class `SvaResult` as returned by `rnb.execute.sva`.

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
setModuleResourceRequirements(RnBClusterRun, 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)
```
### Arguments

**object**

Dataset of interest.

### Value

A matrix of type integer describing the sites, information for which is present in the object.

### Examples

```r
library(RnBeads.hg19)
data(small.example.object)
sites(rnb.set.example)
```

```r
summarize.regions(rnb.set.example, "genes", overwrite=TRUE)
```

```r
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)
```
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

```r
library(RnBeads.hg19)
data(small.example.object)
U.intensity<-U(rnb.set.example)
head(U.intensity)
```

Description

Replaces the methylation info with the specified data frame.

Usage

```r
## 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

updateRegionSummaries

Description

Updates the region information present in an RnBSet by invoking summarize.regions on all region types present in the object.

Usage

## S4 method for signature 'RnBSet'
updateRegionSummaries(object)

Arguments

object

Dataset of interest.

Value

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

[[], BigFfMat, ANY, ANY, ANY-method

Extract parts of BigFfMat

Description

Extract parts of BigFfMat

Usage

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

Arguments

x

BigFfMat object

i

row indices (integer, logical, character are allowed)

j

column indices (integer, logical, character are allowed)

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 are allowed)
- `j`: column indices (integer, logical, character are allowed)
- `value`: replacement values
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