

Package ‘methimpute’

November 15, 2024

Type Package

Title Imputation-guided re-construction of complete methylomes from WGBS data

Version 1.28.0

Author Aaron Taudt

Maintainer Aaron Taudt <aaron.taudt@gmail.com>

Description

This package implements functions for calling methylation for all cytosines in the genome.

Depends R (>= 3.4.0), GenomicRanges, ggplot2

Imports Rcpp (>= 0.12.4.5), methods, utils, grDevices, stats, GenomeInfoDb, IRanges, Biostrings, reshape2, minpack.lm, data.table

Suggests knitr, BiocStyle

LinkingTo Rcpp

License Artistic-2.0

LazyLoad yes

VignetteBuilder knitr

RoxygenNote 6.1.1

biocViews ImmunoOncology, Software, DNAMethylation, Epigenetics, HiddenMarkovModel, Sequencing, Coverage

git_url <https://git.bioconductor.org/packages/methimpute>

git_branch RELEASE_3_20

git_last_commit a8dc359

git_last_commit_date 2024-10-29

Repository Bioconductor 3.20

Date/Publication 2024-11-14

Contents

methimpute-package	2
arabidopsis_chromosomes	3
arabidopsis_genes	3
arabidopsis_TEs	3

arabidopsis_toydata	4
binning	4
binomialTestMethylation	5
callMethylation	6
callMethylationSeparate	7
collapseBins	8
distanceCorrelation	10
estimateTransDist	10
exportMethylome	11
extractCytosinesFromFASTA	12
getDistinctColors	13
getPosteriors	14
getStateColors	14
import	15
importRene	16
inflateMethylome	17
loadFromFiles	17
methimpute-objects	18
methimputeBinomialHMM	18
methimputeData	19
parameterScan	19
plotting	20
print.methimputeBinomialHMM	21
transCoord	22
Index	23

methimpute-package	<i>methIMPUTE: Imputation-guided methylation status calling for WGBS-seq</i>
--------------------	--

Description

methimpute is an R-package for methylation status calling in Whole-Genome Bisulfite-sequencing (WGBS-seq) data. Its powerful Hidden Markov model implementation enables imputation of methylation status calls for cytosines without any coverage.

Details

Please read the vignette for a tutorial on how to use this package. You can do this by typing `browseVignettes("methimpute")`. Here is an overview of all [plotting](#) functions.

Author(s)

Aaron Taudt

arabidopsis_chromosomes

Chromosome lengths for Arabidopsis

Description

A data.frame with chromosome lengths for Arabidopsis.

Format

A data.frame.

Examples

```
data(arabidopsis_chromosomes)
print(arabidopsis_chromosomes)
```

arabidopsis_genes

Gene coordinates for Arabidopsis (chr1)

Description

A [GRanges-class](#) object for demonstration purposes in examples of package [methimpute](#). The object contains gene coordinates of chr1 from Arabidopsis.

Format

A [GRanges-class](#) object.

Examples

```
data(arabidopsis_genes)
print(arabidopsis_genes)
```

arabidopsis_TEs

Transposable element coordinates for Arabidopsis (chr1)

Description

A [GRanges-class](#) object for demonstration purposes in examples of package [methimpute](#). The object contains transposable element coordinates of chr1 from Arabidopsis.

Format

A [GRanges-class](#) object.

Examples

```
data(arabidopsis_TEs)
print(arabidopsis_TEs)
```

arabidopsis_toydata	<i>Toy data for Arabidopsis (200.000bp of chr1)</i>
---------------------	---

Description

A `methimputeData` object for demonstration purposes in examples of package `methimpute`. The object contains the first 200.000 cytosines of chr1 from Arabidopsis.

Format

A `methimputeData` object.

Examples

```
data(arabidopsis_toydata)
print(arabidopsis_toydata)
```

binning	<i>Methimpute binning functions</i>
---------	-------------------------------------

Description

This page provides an overview of all `methimpute` binning functions.

Usage

```
binCounts(data, binsize)

binPositions(data, binsize)

binMethylome(data, binsize, contexts = "total", columns.average = NULL)
```

Arguments

<code>data</code>	A <code>GRanges-class</code> object with metadata columns 'context' and 'counts' (which is a matrix with columns 'methylated' and 'total').
<code>binsize</code>	The window size used for binning.
<code>contexts</code>	A character vector with contexts for which the binning will be done.
<code>columns.average</code>	A character vector with names of columns in data that should be averaged in bins.

Value

A `GRanges-class` object for `binCounts` and `binPostions`. A `list()` of `GRanges-class` objects for `binMethylome`.

Functions

- `binCounts`: Get the aggregated number of counts in each bin (no context).
- `binPositions`: Get the number of cytosines in each bin (total and per context).
- `binMethylome`: Get number of cytosines and aggregated counts for the specified contexts.

Examples

```
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData",
                    package="methimpute")
data <- get(load(file))
print(data)
## Bin the data in various ways
binCounts(data, binsize=1000)
binPositions(data, binsize=1000)
binMethylome(data, binsize=1000, contexts=c("total", "CG"),
              columns.average=NULL)
```

binomialTestMethylation

Call methylation status

Description

Call methylation status of cytosines (or bins) with a binomial test.

Usage

```
binomialTestMethylation(data, conversion.rate, min.coverage = 3,
                        p.threshold = 0.05)
```

Arguments

<code>data</code>	A <code>methimputeData</code> object.
<code>conversion.rate</code>	A conversion rate between 0 and 1.
<code>min.coverage</code>	Minimum coverage to consider for the binomial test.
<code>p.threshold</code>	Significance threshold between 0 and 1.

Details

The function uses a binomial test with the specified `conversion.rate`. P-values are then multiple testing corrected with the Benjamini & Yekutieli procedure. Methylated positions are selected with the `p.threshold`.

Value

A vector with methylation statuses.

Examples

```
## Get some toy data
file <- system.file("data","arabidopsis_toydata.RData", package="methimpute")
data <- get(load(file))
data$binomial <- binomialTestMethylation(data, conversion.rate=0.998)
```

callMethylation	<i>Call methylation status</i>
-----------------	--------------------------------

Description

Call methylation status of cytosines (or bins) with a Hidden Markov Model.

Usage

```
callMethylation(data, fit.on.chrom = NULL, transDist = Inf, eps = 1,
  max.time = Inf, max.iter = Inf, count.cutoff = 500,
  verbosity = 1, num.threads = 2 + include.intermediate,
  initial.params = NULL, include.intermediate = FALSE,
  update = "independent", min.reads = 0)
```

Arguments

data	A methimputeData object.
fit.on.chrom	A character vector specifying the chromosomes on which the HMM will be fitted.
transDist	The decaying constant for the distance-dependent transition matrix. Either a single numeric or a named numeric vector, where the vector names correspond to the transition contexts. Such a vector can be obtained from estimateTransDist .
eps	Convergence threshold for the Baum-Welch algorithm.
max.time	Maximum running time in seconds for the Baum-Welch algorithm.
max.iter	Maximum number of iterations for the Baum-Welch algorithm.
count.cutoff	A cutoff for the counts to remove artificially high counts from mapping artifacts. Set to Inf to disable this filtering (not recommended).
verbosity	An integer from 1 to 5 specifying the verbosity of the fitting procedure. Values > 1 are only for debugging.
num.threads	Number of CPU to use for the computation. Parallelization is implemented on the number of states, which is 2 or 3, so setting num.threads > 3 will not give additional performance increase.
initial.params	A methimputeBinomialHMM object. This parameter is useful to continue the fitting procedure for a methimputeBinomialHMM object.
include.intermediate	A logical specifying whether or not the intermediate component should be included in the HMM.
update	One of c("independent", "constrained"). If update="independent" probability parameters for the binomial test will be updated independently. If update="constrained" the probability parameter of the intermediate component will be constrained to the mean of the unmethylated and the methylated component.

`min.reads` The minimum number of reads that a position must have to contribute in the Baum-Welch fitting procedure.

Details

The Hidden Markov model uses a binomial test for the emission densities. Transition probabilities are modeled with a distance dependent decay, specified by the parameter `transDist`.

Value

A `methimputeBinomialHMM` object.

Examples

```
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData", package="methimpute")
data <- get(load(file))
print(data)
model <- callMethylation(data)
print(model)
```

callMethylationSeparate

Call methylation status

Description

Call methylation status of cytosines (or bins) with a separate Hidden Markov Model for each context.

Usage

```
callMethylationSeparate(data, fit.on.chrom = NULL, transDist = Inf,
  eps = 1, max.time = Inf, max.iter = Inf, count.cutoff = 500,
  verbosity = 1, num.threads = 2 + include.intermediate,
  initial.params = NULL, include.intermediate = FALSE,
  update = "independent", min.reads = 0)
```

Arguments

<code>data</code>	A <code>methimputeData</code> object.
<code>fit.on.chrom</code>	A character vector specifying the chromosomes on which the HMM will be fitted.
<code>transDist</code>	The decaying constant for the distance-dependent transition matrix. Either a single numeric or a named numeric vector, where the vector names correspond to the transition contexts. Such a vector can be obtained from <code>estimateTransDist</code> .
<code>eps</code>	Convergence threshold for the Baum-Welch algorithm.
<code>max.time</code>	Maximum running time in seconds for the Baum-Welch algorithm.
<code>max.iter</code>	Maximum number of iterations for the Baum-Welch algorithm.
<code>count.cutoff</code>	A cutoff for the counts to remove artificially high counts from mapping artifacts. Set to <code>Inf</code> to disable this filtering (not recommended).

verbosity	An integer from 1 to 5 specifying the verbosity of the fitting procedure. Values > 1 are only for debugging.
num.threads	Number of CPU to use for the computation. Parallelization is implemented on the number of states, which is 2 or 3, so setting num.threads > 3 will not give additional performance increase.
initial.params	A <code>methimputeBinomialHMM</code> object. This parameter is useful to continue the fitting procedure for a <code>methimputeBinomialHMM</code> object.
include.intermediate	A logical specifying wheter or not the intermediate component should be included in the HMM.
update	One of <code>c("independent", "constrained")</code> . If <code>update="independent"</code> probability parameters for the binomial test will be updated independently. If <code>update="constrained"</code> the probability parameter of the intermediate component will be constrained to the mean of the unmethylated and the methylated component.
min.reads	The minimum number of reads that a position must have to contribute in the Baum-Welch fitting procedure.

Details

The Hidden Markov model uses a binomial test for the emission densities. Transition probabilities are modeled with a distance dependent decay, specified by the parameter `transDist`.

Value

A `methimputeBinomialHMM` object.

Examples

```
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData", package="methimpute")
data <- get(load(file))
print(data)
model <- callMethylationSeparate(data)
print(model)
```

collapseBins

Collapse consecutive bins

Description

The function will collapse consecutive bins which have, for example, the same combinatorial state.

Usage

```
collapseBins(data, column2collapseBy = NULL, columns2sumUp = NULL,
             columns2average = NULL, columns2getMax = NULL, columns2drop = NULL)
```


Arguments

<code>data</code>	A data.frame containing the genomic coordinates in the first three columns.
<code>column2collapseBy</code>	The number of the column which will be used to collapse all other inputs. If a set of consecutive bins has the same value in this column, they will be aggregated into one bin with adjusted genomic coordinates.
<code>columns2sumUp</code>	Column numbers that will be summed during the aggregation process.
<code>columns2average</code>	Column numbers that will be averaged during the aggregation process.
<code>columns2getMax</code>	Column numbers where the maximum will be chosen during the aggregation process.
<code>columns2drop</code>	Column numbers that will be dropped after the aggregation process.

Details

The following tables illustrate the principle of the collapsing:

Input data:

seqnames	start	end	column2collapseBy	moreColumns	columns2sumUp
chr1	0	199	2	1 10	1 3
chr1	200	399	2	2 11	0 3
chr1	400	599	2	3 12	1 3
chr1	600	799	1	4 13	0 3
chr1	800	999	1	5 14	1 3

Output data:

seqnames	start	end	column2collapseBy	moreColumns	columns2sumUp
chr1	0	599	2	1 10	2 9
chr1	600	999	1	4 13	1 6

Value

A data.frame.

Author(s)

Aaron Taudt

Examples

```
## Load example data
## Get an example multiHMM
data(arabidopsis_toydata)
df <- as.data.frame(arabidopsis_toydata)
shortdf <- collapseBins(df, column2collapseBy='context', columns2sumUp='width', columns2average=7:8)
```

distanceCorrelation *Distance correlation*

Description

Compute the distance correlation from a [methimputeData](#) object.

Usage

```
distanceCorrelation(data, distances = 0:50, separate.contexts = FALSE)
```

Arguments

`data` A [methimputeData](#) object.

`distances` An integer vector specifying the distances for which the correlation will be calculated.

`separate.contexts` A logical indicating whether contexts are treated separately. If set to TRUE, correlations will only be calculated between cytosines of the same context.

Value

A list() with an array containing the correlation values and the corresponding [ggplot](#).

Examples

```
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData",
                    package="methimpute")
data <- get(load(file))
distcor <- distanceCorrelation(data)
print(distcor$plot)
```

estimateTransDist *transDist parameter*

Description

Obtain an estimate for the `transDist` parameter (used in function [callMethylation](#)) by fitting an exponential function to the supplied correlations (from [distanceCorrelation](#)).

Usage

```
estimateTransDist(distcor, skip = 2, plot.parameters = TRUE)
```

Arguments

distcor	The output produced by distanceCorrelation .
skip	Skip the first n cytosines for the fitting. This can be necessary to avoid periodicity artifacts due to the context definition.
plot.parameters	Whether to plot fitted parameters on to the plot or not.

Value

A list() with fitted transDist parameters and the corresponding [ggplot](#).

Examples

```
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData",
                    package="methimpute")
data <- get(load(file))
distcor <- distanceCorrelation(data)
fit <- estimateTransDist(distcor)
print(fit)
```

exportMethylome	<i>Export a methylome</i>
-----------------	---------------------------

Description

Export a methylome as a TSV file.

Usage

```
exportMethylome(model, filename)
```

Arguments

model	A methimputeBinomialHMM object.
filename	The name of the file to be exported.

Value

NULL

Examples

```
## Not run:
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData", package="methimpute")
data <- get(load(file))
print(data)
model <- callMethylation(data, max.iter=10)
exportMethylome(model, filename = tempfile())

## End(Not run)
```

 extractCytosinesFromFASTA

Extract cytosine coordinates

Description

Extract cytosine coordinates and context information from a FASTA file. Cytosines in ambiguous reference contexts are not reported.

Usage

```
extractCytosinesFromFASTA(file, contexts = c("CG", "CHG", "CHH"),
  anchor.C = NULL)
```

Arguments

file	A character with the file name.
contexts	The contexts that should be extracted. If the contexts are named, the returned object will use those names for the contexts.
anchor.C	A named vector with positions of the anchoring C in the contexts. This is necessary to distinguish contexts such as C*C*CG (anchor.C = 2) and *C*CCG (anchor.C = 1). Names must match the contexts. If unspecified, the first C within each context will be taken as anchor.

Value

A [GRanges-class](#) object with coordinates of extracted cytosines and meta-data column 'context'.

Examples

```
## Read a non-compressed FASTA files:
filepath <- system.file("extdata", "arabidopsis_sequence.fa.gz", package="methimpute")

## Only CG context
cytosines <- extractCytosinesFromFASTA(filepath, contexts = 'CG')
table(cytosines$context)

## Split CG context into subcontexts
cytosines <- extractCytosinesFromFASTA(filepath,
  contexts = c('DCG', 'CCG'),
  anchor.C = c(DCG=2, CCG=2))
table(cytosines$context)

## With contexts that differ only by anchor
cytosines <- extractCytosinesFromFASTA(filepath,
  contexts = c('DCG', 'CCG', 'CCG', 'CWG', 'CHH'),
  anchor.C = c(DCG=2, CCG=2, CCG=1, CWG=1, CHH=1))
table(cytosines$context)

## With named contexts
contexts <- c(CG='DCG', CG='CCG', CHG='CCG', CHG='CWG', CHH='CHH')
cytosines <- extractCytosinesFromFASTA(filepath,
```

```
contexts = contexts,  
anchor.C = c(DCG=2, CCG=2, CCG=1, CWG=1, CHH=1))  
table(cytosines$context)
```

getDistinctColors *Get distinct colors*

Description

Get a set of distinct colors selected from [colors](#).

Usage

```
getDistinctColors(n, start.color = "blue4", exclude.colors = c("white",  
"black", "gray", "grey", "\\<yellow\\>", "yellow1", "lemonchiffon"),  
exclude.brightness.above = 1, exclude.rgb.above = 210)
```

Arguments

`n` Number of colors to select. If `n` is a character vector, `length(n)` will be taken as the number of colors and the colors will be named by `n`.

`start.color` Color to start the selection process from.

`exclude.colors` Character vector with colors that should not be used.

`exclude.brightness.above`
 Exclude colors where the 'brightness' value in HSV space is above. This is useful to obtain a matt palette.

`exclude.rgb.above`
 Exclude colors where all RGB values are above. This is useful to exclude whitish colors.

Details

The function computes the euclidian distance between all [colors](#) and iteratively selects those that have the furthest closes distance to the set of already selected colors.

Value

A character vector with colors.

Author(s)

Aaron Taudt

Examples

```
cols <- getDistinctColors(5)  
pie(rep(1,5), labels=cols, col=cols)
```

getPosteriors *Get original posteriors*

Description

Transform the 'posteriorMeth', 'posteriorMax', and 'status' columns into original posteriors from the HMM.

Usage

```
getPosteriors(data)
```

Arguments

data The \$data entry from a [methimputeBinomialHMM](#) object.

Value

A matrix with posteriors.

getStateColors *Get state colors*

Description

Get the colors that are used for plotting.

Usage

```
getStateColors(states = NULL)
```

Arguments

states A character vector.

Value

A character vector with colors.

See Also

[plotting](#)

Examples

```
cols <- getStateColors()
pie(1:length(cols), col=cols, labels=names(cols))
```

import	<i>Methimpute data import</i>
--------	-------------------------------

Description

This page provides an overview of all **methimpute** data import functions.

Usage

```
importBSMAP(file, chrom.lengths = NULL, skip = 1, contexts = c(CG =
  "NNCGN", CHG = "NNCHG", CHH = "NNCHH"))
```

```
importMethylpy(file, chrom.lengths = NULL, skip = 1, contexts = c(CG
  = "CGN", CHG = "CHG", CHH = "CHH"))
```

```
importBSSeeker(file, chrom.lengths = NULL, skip = 0)
```

```
importBismark(file, chrom.lengths = NULL, skip = 0)
```

Arguments

file	The file to import.
chrom.lengths	A data.frame with chromosome names in the first, and chromosome lengths in the second column. Only chromosomes named in here will be returned. Alternatively a tab-separated file with such a data.frame (with headers).
skip	The number of lines to skip. Usually 1 if the file contains a header and 0 otherwise.
contexts	A character vector of the contexts that are to be assigned. Since some programs report 5-letter contexts, this parameter can be used to obtain a reduced number of contexts. Will yield contexts CG, CHG, CHH by default. Set contexts=NULL to obtain all available contexts.

Value

A **methimputeData** object.

Functions

- `importBSMAP`: Import a BSMAP methylation extractor file.
- `importMethylpy`: Import a Methylpy methylation extractor file.
- `importBSSeeker`: Import a BSSeeker methylation extractor file.
- `importBismark`: Import a Bismark methylation extractor file.

Examples

```
## Get an example file in BSSeeker format
file <- system.file("extdata", "arabidopsis_bsseeker.txt.gz", package="methimpute")
data(arabidopsis_chromosomes)
bsseeker.data <- importBSSeeker(file, chrom.lengths=arabidopsis_chromosomes)
```

```
## Get an example file in Bismark format
file <- system.file("extdata", "arabidopsis_bismark.txt", package="methimpute")
data(arabidopsis_chromosomes)
arabidopsis_chromosomes$chromosome <- sub('chr', '', arabidopsis_chromosomes$chromosome)
bismark.data <- importBismark(file, chrom.lengths=arabidopsis_chromosomes)

## Get an example file in BSMAP format
file <- system.file("extdata", "arabidopsis_BSMAP.txt", package="methimpute")
data(arabidopsis_chromosomes)
bsmap.data <- importBSMAP(file, chrom.lengths=arabidopsis_chromosomes)

## Get an example file in Methylypy format
file <- system.file("extdata", "arabidopsis_methylypy.txt", package="methimpute")
data(arabidopsis_chromosomes)
arabidopsis_chromosomes$chromosome <- sub('chr', '', arabidopsis_chromosomes$chromosome)
methylypy.data <- importMethylypy(file, chrom.lengths=arabidopsis_chromosomes)
```

importRene

Import a Rene methylation extractor file

Description

Import a Rene methylation extractor file into a [GRanges-class](#) object.

Usage

```
importRene(file, chrom.lengths = NULL, skip = 1)
```

Arguments

file	The file to import.
chrom.lengths	A data.frame with chromosome names in the first, and chromosome lengths in the second column. Only chromosomes named in here will be returned. Alternatively a tab-separated file with such a data.frame (with headers).
skip	The number of lines to skip. Usually 1 if the file contains a header and 0 otherwise.

Value

A [methimputeData](#) object.

Examples

```
## Get an example file in Rene format
file <- system.file("extdata", "arabidopsis_rene.txt", package="methimpute")
data(arabidopsis_chromosomes)
rene.data <- methimpute::importRene(file, chrom.lengths=arabidopsis_chromosomes)
```

inflateMethylome	<i>Inflate an imported methylation extractor file</i>
------------------	---

Description

Inflate an imported methylation extractor file to contain all cytosine positions. This is useful to obtain a full methylome, including non-covered cytosines, because most methylation extractor programs only report covered cytosines.

Usage

```
inflateMethylome(methylome, methylome.full)
```

Arguments

`methylome` A [GRanges-class](#) with methylation counts.
`methylome.full` A [GRanges-class](#) with positions for all cytosines or a file with such an object.

Value

The `methylome.full` object with added metadata column 'counts'.

Examples

```
## Get an example file in BSSeeker format
file <- system.file("extdata", "arabidopsis_bsseeker.txt.gz", package="methimpute")
bsseeker.data <- importBSSeeker(file)
bsseeker.data

## Inflate to full methylome (including non-covered sites)
data(arabidopsis_toydata)
full.methylome <- inflateMethylome(bsseeker.data, arabidopsis_toydata)
full.methylome
```

loadFromFiles	<i>Load methimpute objects from file</i>
---------------	---

Description

Wrapper to load [methimpute](#) objects from file and check the class of the loaded objects.

Usage

```
loadFromFiles(files, check.class = c("GRanges", "methimputeBinomialHMM"))
```

Arguments

`files` A list of [GRanges-class](#) or [methimputeBinomialHMM](#) objects or a character vector with files that contain such objects.
`check.class` Any combination of `c('GRanges', 'methimputeBinomialHMM')`. If any of the loaded objects does not belong to the specified class, an error is thrown.

Value

A list of [GRanges-class](#) or [methimputeBinomialHMM](#) objects.

Examples

```
## Get some files that you want to load
file <- system.file("data", "arabidopsis_toydata.RData",
                    package="methimpute")

## Load and print
data <- loadFromFiles(file)
print(data)
```

methimpute-objects *methimpute objects*

Description

[methimpute](#) defines several objects.

- [methimputeData](#): Returned by [importBSSeeker](#), [importBismark](#) and [inflateMethylome](#).
- [methimputeBinomialHMM](#): Returned by [callMethylation](#).

methimputeBinomialHMM *methimputeBinomialHMM*

Description

The `methimputeBinomialHMM` is a `list()` which contains various entries (see Value section). The main entry of this object is `$data`, which contains the methylation status calls and posterior values. See Details for a description of all columns.

Details

The `$data` entry in this object contains the following columns:

- `context` The sequence context of the cytosine.
- `counts` Counts for methylated and total number of reads at each position.
- `distance` The distance in base-pairs from the previous to the current cytosine.
- `transitionContext` Transition context in the form "previous-current".
- `posteriorMax` Maximum posterior value of the methylation status call, can be interpreted as the confidence in the call.
- `posteriorMeth` Posterior value of the "methylated" component.
- `posteriorUnmeth` Posterior value of the "unmethylated" component.
- `status` Methylation status.
- `rc.meth.lvl` Recalibrated methylation level, calculated as $r\data\$rc.meth.lvl = r\data\$params\$emissionParams * r\data$posteriorUnmeth + r$params\$emissionParams\$Methylated[data\$context,] * r\data$posteriorMeth$, where `r` is the `methimputeBinomialHMM` object.

Value

A list() with the following entries:

convergenceInfo	A list() with information about the convergence of the model fitting procedure.
params	A list() with fitted and non-fitted model parameters.
params.initial	A list() with initial values for the model parameters.
data	A GRanges-class with cytosine positions and methylation status calls.
segments	The data entry where coordinates of consecutive cytosines with the same methylation status have been merged.

See Also

[methimpute-objects](#)

methimputeData	<i>methimputeData</i>
----------------	-----------------------

Description

A [GRanges-class](#) object containing cytosine coordinates with meta-data columns 'context' and 'counts'.

See Also

[methimpute-objects](#)

parameterScan	<i>Perform a parameter scan</i>
---------------	---------------------------------

Description

Perform a parameter scan for an arbitrary parameter.

Usage

```
parameterScan(f, param, values, ...)
```

Arguments

f	A function for which to perform the scan.
param	A character with the parameter for which to perform the scan.
values	A vector with parameter values for which to perform the scan.
...	Other parameters passed through to f.

Value

A data.frame with loglikelihood values.

Description

This page provides an overview of all [methimpute](#) plotting functions.

Usage

```
plotHistogram(model, total.counts, binwidth = 1)

plotScatter(model, datapoints = 1000)

plotTransitionProbs(model)

plotConvergence(model)

plotEnrichment(model, annotation, windowsize = 100, insidewindows = 20,
  range = 1000, category.column = NULL, plot = TRUE,
  df.list = NULL)

plotPosteriorDistance(model, datapoints = 1e+06, binwidth = 5,
  max.coverage.y = 0, min.coverage.x = 3, xmax = 200,
  xbreaks.interval = xmax/10, cutoffs = NULL)
```

Arguments

<code>model</code>	A methimputeBinomialHMM object.
<code>total.counts</code>	The number of total counts for which the histogram is to be plotted.
<code>binwidth</code>	The bin width for the histogram/boxplot.
<code>datapoints</code>	The number of randomly selected datapoints for the plot.
<code>annotation</code>	A GRanges-class object with coordinates for the annotation.
<code>windowsize</code>	Resolution in base-pairs for the curve upstream and downstream of the annotation.
<code>insidewindows</code>	Number of data points for the curve inside the annotation.
<code>range</code>	Distance upstream and downstream for which the enrichment profile is calculated.
<code>category.column</code>	The name of a column in data that will be used for facetting of the plot.
<code>plot</code>	Logical indicating whether a plot or the underlying data.frame is to be returned.
<code>df.list</code>	A <code>list()</code> of data.frames, output from <code>plotEnrichment(..., plot=FALSE)</code> . If specified, option data will be ignored.
<code>max.coverage.y</code>	Maximum coverage for positions on the y-axis.
<code>min.coverage.x</code>	Minimum coverage for positions on the x-axis.
<code>xmax</code>	Upper limit for the x-axis.
<code>xbreaks.interval</code>	Interval for breaks on the x-axis.
<code>cutoffs</code>	A vector with values that are plotted as horizontal lines. The names of the vector must match the context levels in <code>data\$context</code> .

Value

A `ggplot` object.

Functions

- `plotHistogram`: Plot a histogram of count values and fitted distributions.
- `plotScatter`: Plot a scatter plot of read counts colored by methylation status.
- `plotTransitionProbs`: Plot a heatmap of transition probabilities.
- `plotConvergence`: Plot the convergence of the probability parameters.
- `plotEnrichment`: Plot an enrichment profile around an annotation.
- `plotPosteriorDistance`: Maximum posterior vs. distance to nearest covered cytosine.

Examples

```
## Get some toy data
file <- system.file("data", "arabidopsis_toydata.RData",
                    package="methimpute")
data <- get(load(file))
print(data)
model <- callMethylation(data)
## Make nice plots
plotHistogram(model, total.counts=5)
plotScatter(model)
plotTransitionProbs(model)
plotConvergence(model)
plotPosteriorDistance(model$data)

## Get annotation data and make an enrichment profile
# Note that this looks a bit ugly because our toy data
# has only 200000 datapoints.
data(arabidopsis_genes)
plotEnrichment(model, annotation=arabidopsis_genes)
```

```
print.methimputeBinomialHMM
      Print model object
```

Description

Print model object

Usage

```
## S3 method for class 'methimputeBinomialHMM'
print(x, ...)
```

Arguments

<code>x</code>	A <code>methimputeBinomialHMM</code> object.
<code>...</code>	Ignored.

Value

An invisible NULL.

transCoord	<i>Transform genomic coordinates</i>
------------	--------------------------------------

Description

Add two columns with transformed genomic coordinates to the [GRanges-class](#) object. This is useful for making genomewide plots.

Usage

```
transCoord(gr)
```

Arguments

`gr` A [GRanges-class](#) object.

Value

The input [GRanges-class](#) with two additional metadata columns 'start.genome' and 'end.genome'.

Index

arabidopsis_chromosomes, 3
arabidopsis_genes, 3
arabidopsis_TEs, 3
arabidopsis_toydata, 4

binCounts (binning), 4
binMethylome (binning), 4
binning, 4
binomialTestMethylation, 5
binPositions (binning), 4

callMethylation, 6, 10, 18
callMethylationSeparate, 7
collapseBins, 8
colors, 13

distanceCorrelation, 10, 10, 11

estimateTransDist, 6, 7, 10
exportMethylome, 11
extractCytosinesFromFASTA, 12

getDistinctColors, 13
getPosteriors, 14
getStateColors, 14
ggplot, 10, 11, 21

import, 15
importBismark, 18
importBismark (import), 15
importBSMAP (import), 15
importBSSeeker, 18
importBSSeeker (import), 15
importMethylpy (import), 15
importRene, 16
inflateMethylome, 17, 18

loadFromFiles, 17

methimpute, 3, 4, 15, 17, 18, 20
methimpute (methimpute-package), 2
methimpute-objects, 18
methimpute-package, 2
methimputeBinomialHMM, 6–8, 11, 14, 17, 18,
18, 20, 21

methimputeData, 4–7, 10, 15, 16, 18, 19

parameterScan, 19
plotConvergence (plotting), 20
plotEnrichment (plotting), 20
plotHistogram (plotting), 20
plotPosteriorDistance (plotting), 20
plotScatter (plotting), 20
plotting, 2, 14, 20
plotTransitionProbs (plotting), 20
print.methimputeBinomialHMM, 21

transCoord, 22