Package 'cobindR'

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Title Finding Co-occuring motifs of transcription factor binding sites

Description Finding and analysing co-occuring motifs of transcription factor binding sites in groups of genes

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Imports methods, seqinr, yaml, rtfbs, gplots, mclust, gmp, BiocGenerics (>= 0.13.8), IRanges, Biostrings, BSgenome, biomaRt

Suggests RUnit

Enhances rGADEM, seqLogo, genoPlotR, parallel, VennDiagram, RColorBrewer, vcd, MotifDb, snowfall

biocViews ChIPSeq, CellBiology, MultipleComparison, SequenceMatching

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cobindR-package *An R package for analyzing co-occurring transcription factor binding sites*

Description

Many transcription factors (TFs) regulate gene expression by binding to specific DNA motifs near genes. Often the regulation of gene expression is not only controlled by one TF, but by many TFs together, that can either interact in a cooperative manner or interfere with each other. In recent years high thoughput methods, like ChIP-Seq, have become available to produce large amounts of data, that contain potential regulatory regions. In silico analysis of trancription factor binding sites can help to interpret these enormous datasets in a convenient and fast way or narrow down the results to the most significant regions for further experimental studies.

cobindR provides a complete set of methods to analyse and detect pairs of TFs, including support of diverse input formats and different background models for statistical testing. Several visualization tools are implemented to ease the interpretation of the results.

Author(s)

Yue-Hien Lee, Robert Lehmann, Stefan Kroeger, Manuela Benary

See Also

The core class in this package: `cobindr-class`. The core function in this package: `find.pairs`.

bg_binding_sites *motif hits in the background sequences*

Description

motif hits in the background sequences

Usage

```
## S4 method for signature 'cobindr'
bg_binding_sites(x)
## S4 replacement method for signature 'cobindr,data.frame'
bg_binding_sites(x) <- value
```

Arguments

x	a cobindr object
value	data.frame holding the binding site hits in the background sequences

Value

motif hits in background sequences (data.frame)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,pfm,bg_binding_sites,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak bg_binding_sites'
cbr <- cobindr(cfg)
bg_binding_sites(cbr)
```

---

bg_pairs *motif hit pairs in the background sequences*

Description

motif hit pairs in the background sequences

Usage

```
## S4 method for signature 'cobindr'
bg_pairs(x)
## S4 replacement method for signature 'cobindr,data.frame'
bg_pairs(x) <- value
```

Arguments

x	a cobindr object
value	data.frame holding the binding site pairs in the background sequences

Value

background motif pairs (data.frame)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak bg_pairs'
cbr <- cobindr(cfg)
bg_pairs(cbr)
```

---

bg_sequences *list of background sequence*

Description

list of background sequence

Usage

```
## S4 method for signature 'cobindr'
bg_sequences(x)
## S4 replacement method for signature 'cobindr,list'
bg_sequences(x) <- value
```

Arguments

x	a cobindr object
value	list of background sequence of type SeqObj

Value

list of background sequences (SeqObj)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,bg_sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pai

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak bg_sequences'
cbr <- cobindr(cfg)
length(bg_sequences(cbr))
```

bg_sequence_origin *background sequence origin note*

Description

background sequence origin note

Usage

```
## S4 method for signature 'configuration'
bg_sequence_origin(x)
## S4 replacement method for signature 'configuration,character'
bg_sequence_origin(x) <- value
```

Arguments

x	a cobindR configuration object
value	a character

Value

background sequence origin (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
bg_sequence_origin(cfg)
```

bg_sequence_source *background sequence source note*

Description

background sequence source note

Usage

```
## S4 method for signature 'configuration'
bg_sequence_source(x)
## S4 replacement method for signature 'configuration,character'
bg_sequence_source(x) <- value
```

Arguments

x	a cobindR configuration object
value	a character

Value

background sequence source (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
bg_sequence_source(cfg)
```

---

bg_sequence_type *background sequence type note*

Description

background sequence type note

Usage

```
## S4 method for signature 'configuration'
bg_sequence_type(x)
## S4 replacement method for signature 'configuration,character'
bg_sequence_type(x) <- value
```

Arguments

x	a cobindR configuration object
value	a character

Value

bg_sequence_type (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
bg_sequence_type(cfg)
```

`binding_sites` *motif hits on the foreground sequences*

Description

motif hits on the foreground sequences

Usage

```
## S4 method for signature 'cobindr'
binding_sites(x)
## S4 replacement method for signature 'cobindr,data.frame'
binding_sites(x) <- value
```

Arguments

`x`	a cobindr object
`value`	data.frame holding the binding site hits in the foreground sequences

Value

motif hits in foreground sequences as data.frame

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak binding_sites'
cbr <- cobindr(cfg)
binding_sites(cbr)
```

cobindr-class *Class* "cobindr"

Description

Container for experiment run and its meta-data

Objects from the Class

Objects can be created by calls of the form new("cobindr", conf, name, desc).

Slots

uid: Object of class "character" ~~ unique id for internal representation

name: Object of class "character" ~~ name of the experiment

sequences: Object of class "list" ~~ list of sequence objects to be analyzed

bg_sequences: Object of class "list" ~~list of background sequences for statistical analyses

desc: Object of class "character" ~~ verbal experiment description

configuration: Object of class "configuration" ~~the configuration object used to describe the experiment

pfm: Object of class "list" ~~list of pfms to be used

binding_sites: Object of class "data.frame" ~~ data frame for predicted binding sites. Data frame structure: uid:integer, seqObj_uid:integer, pfm:factor, start:integer, end:integer, score:double, seq:character, strand:factor, source:factor.

bg_binding_sites: Object of class "data.frame" ~~ data frame for predicted binding sites in the background sequences. Data frame structure: uid:integer, seqObj_uid:integer, pfm:factor, start:integer, end:integer, score:double, seq:character, strand:factor, source:factor.

pairs: Object of class "data.frame" ~~ data frame for predicted pairs of transcription factors. Data frame structure: uid:integer, seqObj_uid:integer, pair:factor, bs_uid1:integer, bs_uid2:integer, distance_start:integer.

bg_pairs: Object of class "data.frame" ~~ data frame for predicted pairs of transcription factors in the background sequences. Data frame structure: uid:integer, seqObj_uid:integer, pair:factor, bs_uid1:integer, bs_uid2:integer, distance_start:integer.

pairs_of_interest: Object of class "factor" ~~ contains pairs for search

Methods

detrending signature(object = "cobindr"): ...

find.pairs signature(object = "cobindr"): ...

generate.background signature(object = "cobindr"): ...

get.bindingsite.ranges signature(object = "cobindr"): ...

get.pairs signature(object = "cobindr"): ...

get.significant.pairs signature(object = "cobindr"): ...

initialize signature(.Object = "cobindr"): ...

input.pwm signature(object = "cobindr"): ...

plot.detrending `signature(object = "cobindr")`: ...
plot.gc `signature(object = "cobindr")`: ...
plot.pairdistance `signature(object = "cobindr")`: ...
plot.pairdistribution `signature(object = "cobindr")`: ...
plot.positionprofile `signature(object = "cobindr")`: ...
plot.positions.simple `signature(object = "cobindr")`: ...
plot.positions `signature(object = "cobindr")`: ...
plot.tfbs.heatmap `signature(object = "cobindr")`: ...
plot.tfbs.venndiagram `signature(object = "cobindr")`: ...
plot.tfbslogo `signature(object = "cobindr")`: ...
predicted2pwm `signature(object = "cobindr")`: ...
rtfbs `signature(object = "cobindr")`: ...
search.gadem `signature(object = "cobindr")`: ...
search.pwm `signature(object = "cobindr")`: ...
testCpG `signature(object = "cobindr")`: ...
write.bindingsites.table `signature(object = "cobindr")`: ...
write.bindingsites `signature(object = "cobindr")`: ...
write.sequences `signature(object = "cobindr")`: ...
write `signature(x = "cobindr", file = "character")`: ...

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de>

See Also

`SeqObj configuration`

Examples

```
showClass("cobindr")
```

`cobindRConfiguration` *cobindR configuration object constructor*

Description

cobindR configuration object constructor

Usage

```
## S4 method for signature 'character'
cobindRConfiguration(x)
```

Arguments

x	path to configuration file. NULL by default

Value

cobindR configuration object

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

seqObj

Examples

```
cfg <- cobindRConfiguration()
```

---

comment *comment of cobindR SeqObj object*

Description

comment of cobindR SeqObj object

Usage

```
## S4 method for signature 'SeqObj'
comment(x)
## S4 replacement method for signature 'SeqObj,character'
comment(x) <- value
```

Arguments

x	a cobindR seqObj object
value	comment to the sequence (character)

Value

comment (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,species,comment,location,sequence

Examples

```
library(Biostrings)
so <- seqObj(DNAString('A'), id='', name='', species='',comment='',location='')
comment(so)
```

configuration *configuration of cobindr object*

Description

configuration of cobindr object

Usage

```
## S4 method for signature 'cobindr'
configuration(x)
## S4 replacement method for signature 'cobindr,configuration'
configuration(x) <- value
```

Arguments

x	a cobindr object
value	returns the configuration object used in this cobindR object

Value

cobindR configuration object

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak configuration'
cbr <- cobindr(cfg)
configuration(cbr)
```

configuration-class *Class* "configuration"

Description

Container for experiment description.

Objects from the Class

Objects can be created by calls of the form `new("configuration", fname)`.

Slots

id: Object of class "character" ~~ unique id for internal representation

experiment_description: Object of class "character" ~~ verbal experiment description

sequence_source: Object of class "character" ~~ file path or list of paths

sequence_origin: Object of class "character" ~~ source of sequence data, e.g. ensembl

sequence_type: Object of class "character" ~~ either ChipSeq or Fasta or BED are available

bg_sequence_source: Object of class "character" ~~ file path or list of paths

bg_sequence_origin: Object of class "character" ~~ how the background is obtained - either simulated or from fasta files or from gene ids

bg_sequence_type: Object of class "character" ~~ determines the generation of the background sequences. Possible values: simulated, fasta and geneid

species: Object of class "character" ~~ reference species

downstream: Object of class "numeric" ~~ length of sequence downstream of reference point, e.g. transcription start site

upstream: Object of class "numeric" ~~ length of sequence upstream of reference point, e.g. transcription start site

max_distance: Object of class "numeric" ~~ maximal distance allowed between cooccuring transcription factor binding sites

pairs: Object of class "character" ~~ list of pairs of interesting transcription factors

pfm_path: Object of class "character" ~~ path to pfm matrix file

threshold: Object of class "numeric" ~~ threshold for transcription factor binding site prediction

fdrThreshold: Object of class "numeric" ~~ false discovery rate for filtering results (used in rtfbs)

date: Object of class "character" ~~ data of experiment run

path: Object of class "character" ~~ path of configuration file

mart: Object of class "character" ~~ optional mirror for biomart

pseudocount: Object of class "numeric" ~~ sets the pseudocount for the detrending analysis

pValue: Object of class "numeric" ~~ optional p-Value for search with RGadem

Methods

initialize `signature(.Object = "configuration")`: ...

read.background.fasta `signature(object = "configuration")`: ...

read.pfm `signature(object = "configuration")`: ...

read.sequences `signature(object = "configuration")`: ...

write `signature(x = "configuration", file = "character")`: ...

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de>

See Also

SeqObj cobindr

Examples

```
showClass("configuration")
```

---

downstream *downstream range [bp] used in experiment*

Description

downstream range [bp] used in experiment

Usage

```
## S4 method for signature 'configuration'
downstream(x)
## S4 replacement method for signature 'configuration,numeric'
downstream(x) <- value
```

Arguments

x	a cobindR configuration object
value	downstream distance [bp] of feature to be included (numeric)

Value

considered downstream range [bp]

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
downstream(cfg)
```

`experiment_description` *description of cobindR or configuration object*

Description

description of cobindR or configuration object

Usage

```
## S4 method for signature 'configuration'
experiment_description(x)
## S4 replacement method for signature 'configuration,character'
experiment_description(x) <- value
## S4 method for signature 'cobindr'
experiment_description(x)
## S4 replacement method for signature 'cobindr,character'
experiment_description(x) <- value
```

Arguments

x	a cobindR or configuration object
value	description

Value

experiment description (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()

experiment_description(cfg)

sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak desc'
cbr <- cobindr(cfg)

experiment_description(cbr)
```

fdrThreshold *fdrThreshold of cobindR configuration object*

Description

fdrThreshold of cobindR configuration object.

Usage

```
## S4 method for signature 'configuration'
fdrThreshold(x)
## S4 replacement method for signature 'configuration,numeric'
fdrThreshold(x) <- value
```

Arguments

x	a cobindR configuration object
value	the false discovery rate threshold to be used for hit search

Value

fdrThreshold (numeric)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
fdrThreshold(cfg)
```

find.pairs *function to find pairs of binding sites for every sequence in a given object of class "cobindr"*

Description

find.pairs creates a data frame with all pairs in all sequences within the given distance.

Usage

```
find.pairs(x, background_scan = FALSE, n.cpu = NA)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
background_scan	logical flag, if background_scan = TRUE the pairs for the background sequences will be found.
n.cpu	number of CPUs to be used for parallelization. Default value is 'NA' in which case the number of available CPUs is checked and than used.

Value

runObj	an object of the class "cobindr" including the pairs of transcription factor binding sites

Author(s)

Yue-Hien Lee <>

See Also

plot.detrending

---

get.bindingsite.ranges

convenience function to convert predicted binding sites to GRanges object.

Description

Function converts predicted binding sites into a GRanges object (package: GenomicFeatures). This allows for easy interaction with other tools as well as output of different formats (bed, gff).

Usage

```
get.bindingsite.ranges(x, ...)
```

Arguments

x	An object of the class "cobindr", which will hold the predicted binding site locations.
...	optional additional parameters

Value

A GRanges object holding the positions of all predicted transcription factor binding sites relative to the input sequence.

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

get.pairs write.bindingsites write.bindingsites.table

Examples

```
# export(get.bindingsite.ranges(runObj), "tfbs_hits.gff3")
```

`get.pairs` *function to get output of findPairs*

Description

Function returns the results of findPairs() as a data frame. The data.frame consists of 6 columns, namely

- a unique id for each pair,
- the unique id of the sequence, where the pair was found,
- the names of the corresponding PFMs,
- the unique id for each PFM, and
- the distance window in which the pair occurs.

Usage

```
## S4 method for signature 'cobindr'
get.pairs(x, background = FALSE)
```

Arguments

`x`	an object of the class "cobindr", which holds all necessary information about the sequences and the predicted binding sites.
`background`	logical flag. If background is 'TRUE' the pairs found in the background sequences are used.

Author(s)

Stefan Kroeger <kroeger@informatik.hu-berlin.de>

See Also

`get.significant.pairs`, `write.bindingsites`, `write.sequences`, `write`

get.significant.pairs *function to returns the results of detrending as a data.frame*

Description

get.significant.pairs returns a data.frame of observed distances between the specified pair of PWMs in the foreground set of the sequences as well as the background set of sequences. The distance distribution for the pair in the background is used for detrending.

Usage

```
## S4 method for signature 'cobindr'
get.significant.pairs(x, pwm1, pwm2, bin_length=20, z_value=3, overlap=0, abs.distance=FALSE)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
pwm1	name of the first PWM
pwm2	name of the second PWM
bin_length	defines size of bins for distance analysis, default value is 20nucleotides
z_value	level of significance
overlap	number of nucleotides which are allowed for an overlap
abs.distance	logical flag

Author(s)

Stefan Kroeger <kroeger@informatik.hu-berlin.de>

See Also

plot.detrending, get.pairs, find.pairs

id *id of cobindR configuration object*

Description

id of cobindR configuration object.

Usage

```
## S4 method for signature 'configuration'
id(x)
## S4 replacement method for signature 'configuration,character'
id(x) <- value
```

Arguments

x	a cobindR configuration object
value	the identifier of the configuration object

Value

id (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
id(cfg)
```

---

location *location of cobindR SeqObj object*

Description

location of cobindR seqObj object (e.g. chr1)

Usage

```
## S4 method for signature 'SeqObj'
location(x)
## S4 replacement method for signature 'SeqObj,character'
location(x) <- value
```

Arguments

x	a cobindR seqObj object
value	the location description of the sequence

Value

returns location (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,species,location,comment,sequence

Examples

```
library(Biostrings)
so <- seqObj(DNAString('A'), id='', name='', species='',comment='',location='')
location(so)
```

`mart` *biomart of cobindR configuration object*

Description

biomart of cobindR configuration object. Set to "ensembl" as default

Usage

```
## S4 method for signature 'configuration'
mart(x)
## S4 replacement method for signature 'configuration,character'
mart(x) <- value
```

Arguments

`x`	a cobindR configuration object
`value`	name of biomart to retrieve sequence data

Value

mart (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

`id`,`experiment_description`,`sequence_source`,`sequence_origin`,`sequence_type`,`bg_sequence_source`,`bg_seque`

Examples

```
cfg <- cobindRConfiguration()
mart(cfg)
```

max_distance *max_distance of cobindR configuration object*

Description

max_distance of cobindR configuration object.

Usage

```
## S4 method for signature 'configuration'
max_distance(x)
## S4 replacement method for signature 'configuration,numeric'
max_distance(x) <- value
```

Arguments

x	a cobindR configuration object
value	the maximal distance of two hits to be considered a pair

Value

max_distance (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
max_distance(cfg)
```

name *name of cobindR SeqObj object*

Description

name of cobindR seqObj object.

Usage

```
## S4 method for signature 'SeqObj'
name(x)
## S4 method for signature 'cobindr'
name(x)
## S4 replacement method for signature 'SeqObj,character'
name(x) <- value
## S4 replacement method for signature 'cobindr,character'
name(x) <- value
```

Arguments

x	a cobindR seqObj object
value	the name describing the sequence object

Value

name (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,species,location,comment,sequence

Examples

```
library(Biostrings)
so <- seqObj(DNAString('A'), id='', name='', species='',comment='',location='')
name(so)
```

---

pairs *motif hit pairs in the foreground sequences*

Description

motif hit pairs in the foreground sequences

Usage

```
## S4 method for signature 'configuration'
pairs(x)
## S4 replacement method for signature 'configuration,character'
pairs(x) <- value
## S4 method for signature 'cobindr'
pairs(x)
## S4 replacement method for signature 'cobindr,data.frame'
pairs(x) <- value
```

Arguments

x	a cobindR configuration object
value	for a configuration object, pairs is a character specifying the motif pairs which should be considered. for a cobindR object, pairs is a data.frame holding the detected motif pairs.

Value

pairs (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
pairs(cfg)
```

---

pairs_of_interest *pairs_of_interest of cobindr object*

Description

pairs_of_interest of cobindr object.

Usage

```
## S4 method for signature 'cobindr'
pairs_of_interest(x)
## S4 replacement method for signature 'cobindr,factor'
pairs_of_interest(x) <- value
```

Arguments

x	a cobindr object
value	factors specifying the motif pairs that are to be evaluated

Value

pairs_of_interest (factor)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak pairs_of_interest'
cbr <- cobindr(cfg)
pairs_of_interest(cbr)
```

---

path *path of cobindR configuration object*

Description

path of cobindR configuration object.

Usage

```
## S4 method for signature 'configuration'
path(x)
## S4 replacement method for signature 'configuration,character'
path(x) <- value
```

Arguments

x	a cobindR configuration object
value	the path of the loaded configuration file

Value

path (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
path(cfg)
```

pfm *pfm list used in experiment*

Description

pfm list used in experiment

Usage

```
## S4 method for signature 'cobindr'
pfm(x)
## S4 replacement method for signature 'cobindr,list'
pfm(x) <- value
```

Arguments

x	a cobindr object
value	a list of motif matrices

Value

pfm (list of motif matrices)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak pfm'
cbr <- cobindr(cfg)
pfm(cbr)
```

pfm_path *path to pfms to be used*

Description

path to pfms to be used

Usage

```
## S4 method for signature 'configuration'
pfm_path(x)
## S4 replacement method for signature 'configuration,character'
pfm_path(x) <- value
```

Arguments

x	a cobindR configuration object
value	the path to the folder containing the motif matrices to be used

Value

pfm_path (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
pfm_path(cfg)
```

plot.detrending *function to plot distances between a pair of PWMs*

Description

plot.detrending plots a histograms of observed distances between the specified pair of PWMs in the foreground set of the sequences as well as the background set of sequences. The distance distribution for the pair in the background is used for detrending.

Usage

```
## S4 method for signature 'cobindr'
plot.detrending(x, pwm1, pwm2, bin_length=20, z_value=3, overlap=0,
abs.distance=FALSE)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
pwm1	name of the first PWM
pwm2	name of the second PWM
bin_length	defines size of bins for distance analysis, default value is 20 nucleotides
z_value	level of significance
overlap	number of nucleotides which are allowed for an overlap
abs.distance	logical flag

Author(s)

Yue-Hien Lee

See Also

plot.pairdistribution, plot.pairdistance

---

plot.gc *function to visualize GC content or CpG content of input sequences*

Description

plot.gc calculates the GC (or CpG) content based on a window size for each sequence and plots the content for all sequences as a heatmap over position and sequence.

Usage

```
## S4 method for signature 'cobindr'
plot.gc(x, seq.ids, cpg = F, wind.size = 50,
sig.test = F, hm.margin = c(4, 10), frac = 10, n.cpu = NA)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences.
seq.ids	list of sequence identifiers, for which the GC (or CpG) content will be plotted.
cpg	logical flag, if cpg=TRUE the CpG content rather than the GC content will be calculated and plotted.
wind.size	integer describing the window size for GC content calculation
sig.test	logical flag, if sig.test=TRUE wilcoxon.test is performed per individual window against all windows in other sequence at the same position. The significance test might be slow for large number of sequences
hm.margin	optional argument providing the margin widths for the heatmap (if sig.test=FALSE)
frac	determines the overlap between consecutive windows as fraction wind.size/frac
n.cpu	number of CPUs to be used for parallelization. Default value is 'NA' in which case the number of available CPUs is checked and than used.

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

testCpG

Examples

```
library(Biostrings)

n <- 50 # number of input sequences
l <- 100 # length of sequences
bases <- c("A","C","G","T") # alphabet
# generate random input sequences with two groups with differing GC content
seqs <- sapply(1:(3*n/4), function(x) paste(sample(bases, l, replace=TRUE,
prob=c(.3,.22,.2,.28)), collapse=""))
seqs <- append(seqs, sapply(1:(n/4), function(x) paste(sample(bases, l,
replace=TRUE, prob=c(.25,.25,.25,.25)), collapse="")))
#save sample sequences in fasta file
tmp.file <- tempfile(pattern = "cobindr_sample_seq", tmpdir = tempdir(),
fileext = ".fasta")
writeXStringSet(DNAStringSet(seqs), tmp.file)

cfg <- new('configuration')
slot(cfg, 'sequence_type') <- 'fasta'
slot(cfg, 'sequence_source') <- tmp.file
# avoid complaint of validation mechanism
slot(cfg, 'pfm_path') <- system.file('extdata/pfms',package='cobindR')
slot(cfg, 'pairs') <- ''

runObj <- new('cobindr', cfg, 'test')

plot.gc(runObj, cpg = TRUE)

unlink(tmp.file)
```

---

plot.pairdistance *function to plot the distance of the pairs in the sequences*

Description

For a specified pair of PWMs the function creates histogram plot of distances between pairs of TFs as specified by pwm1 and pwm2

Usage

```
## S4 method for signature 'cobindr'
plot.pairdistance(x, pwm1, pwm2, breaks=50, main=NA, xlab=NA, ylab=NA, background=FALSE)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
pwm1	name of the first PWM
pwm2	name of the second PWM
breaks	number of breaks to separate the distance distribution into
main	figure title
xlab	label for the x-axis of the figure
ylab	label for the y-axis of the figure
background	flag allowing to plot foreground or background distance distribution

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de>

See Also

plot.pairdistribution

---

plot.pairdistribution *function to plot the distribution of the number of pairs in the sequences*

Description

For a specified pair of PWMs the function visualizes in how many sequences how many of the pairs can be found.

Usage

```
## S4 method for signature 'cobindr'
plot.pairdistribution(x, pwm1, pwm2)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
pwm1	name of the first PWM
pwm2	name of the second PWM

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de>

See Also

plot.detrending, plot.pairdistance

`plot.positionprofile` *function to plot a profile over the total number of predicted transcription factor binding sites for each PWM.*

Description

plot.positionprofile provides position-wise profile plot over total number of predicted TFBS for each PWM over all input sequences. Windowing is used to provide a smoother appreance, the window size can be adjusted with the window parameter.

Usage

```
## S4 method for signature 'cobindr'
plot.positionprofile(x, wind.len = 50)
```

Arguments

`x`	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
`wind.len`	integer, defining the length of the window for counting the hits.

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

`plot.positions`

`plot.positions` *function to plot hits for each PWM on the individual sequence*

Description

plot.positions plots hits for each PWM on the individual sequence. Which sequences to plot can be specified by providing a list of sequence identifiers seq.ids. Which PWMs to plot can be specified as list of PWMs. The total height of the plot can be adjusted via argument height.

Usage

```
## S4 method for signature 'cobindr'
plot.positions(x, seq.ids, pwms, main, order.seq = FALSE, wind.size = 400, frac = 10)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
seq.ids	list of sequence identifiers, for which the positions of TFBS will be plotted.
pwms	list of PWMs, for which the positions will be visualized. If no list is given, all PWMs in runObj are used.
main	title for the plot, if no title is given than 'predicted TFBS positions per sequence' will be used
order.seq	logical flag, if TRUE similar patterns of TFBS are shown together. This is computationally expensive for large numbers of sequences.
wind.size	integer describing the windows which will be used to enhance clustering of TFBS patterns. Necessary if order.seq=TRUE
frac	integer

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de

---

plot.positions.simple *function to plot hits for each PWM on the individual sequence*

Description

plot.positions plots hits for each PWM on the individual sequence. Which sequences to plot can be specified by providing a list of sequence identifiers seq.ids. Which PWMs to plot can be specified as list of PWMs. The total height of the plot can be adjusted via argument height.

Usage

```
## S4 method for signature 'cobindr'
plot.positions.simple(x, seq.ids, pwms, main)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
seq.ids	list of sequence identifiers, for which the positions of TFBS will be plotted.
pwms	list of PWMs, for which the positions will be visualized. If no list is given, all PWMs in runObj are used.
main	title for the plot, if no title is given than 'predicted TFBS positions per sequence' will be used

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de

See Also

plot.positionprofile

`plot.tfbs.heatmap` *function to do plot a heatmap of overlaps between all specified PWMs*

Description

plot.tfbs.heatmap plots a heatmap of overlaps between all specified PWMs. For each overlap, the significance is determined based on the hypergeometric test. If a file path is specified in pdf.name, the diagram will be written into the specified file.

Usage

```
## S4 method for signature 'cobindr'
plot.tfbs.heatmap(x, pwms, include.empty.seqs = FALSE)
```

Arguments

`x`	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
`pwms`	list of PWMs, for which the overlap will be visualized. If no list is given, all PWMs in runObj are used.
`include.empty.seqs`	logical flag, if include.empty.seqs == TRUE, sequences without hits of the specified PWMs are also included in the diagram.

Details

In this plot for each pair of PWMs the overlap of sequences with hits of the given PWMs is calculated. The number of sequences in each overlap are color-coded in the heatmap. For each overlap the significance is calculated using the hypergeometric test. If the significance is below 0.05 (or below 0.01), the corresponding field is marked with one (or two) *.

Warning

- unknown identifier if the list of PWMs contains unknown PWM identifiers a warning is given and the method stops
- no hits if no hits are found in the object, the method gives a warning and stops

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de>

See Also

`plot.tfbs.venndiagram`

`plot.tfbs.venndiagram` *function visualize the overlaps of PWM hits over the sequences.*

Description

The distribution of PWM hits over the sequences is visualized as Venn diagram. If a list of PWM names is provided, only these PWMs are included in the Venn diagram. If include.empty.seqs == TRUE, sequences without hits of the specified PWMs are also included in the diagram. If a file path is specified in pdf.name, the diagram will be written into the specified file.

Usage

```
## S4 method for signature 'cobindr'
plot.tfbs.venndiagram(x, pwms, include.empty.seqs = FALSE)
```

Arguments

`x`	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
`pwms`	list of PWMs, which shall be visualized in the Venn-Diagram. If no list is given, all PWMs in the runObj are used. The package "VennDiagram" only allows Venn plots with up to 4 elements.
`include.empty.seqs`	logical flag, if include.empty.seqs == TRUE, sequences without hits of the specified PWMs are also included in the diagram.

Warning

- unknown identifier: if the list of PWMs contains unknown PWM identifiers a warning is given and the method stops
- too many PWMs: if more than 4 PWMs are listed a warning is given and the method stops
- no hits: if no hits are found in the object, the method gives a warning and stops

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de

References

using the package "VennDiagram" (http://www.biomedcentral.com/1471-2105/12/35/)

See Also

`plot.tfbs.heatmap`

plot.tfbslogo *function to plot sequence logos based on hits of tools*

Description

plot.tfbslogo produces a sequence logo based on all hits per position weight matrix. If a file path is specified in pdf.name, sequences logos will be written into the specified file.

Usage

```
## S4 method for signature 'cobindr'
plot.tfbslogo(x, pwms)
```

Arguments

x	Object
pwms	vector of names of position weight matrices used for searching the sequences. For each pwm a new sequence logo based on the hits is produced.

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de

predicted2pwm *function to convert predicted TFBS hits into a PWM*

Description

function converts for each input PWM the predicted TFBS hits into a PWM. Function is intended to be used together with the sequence logo creation function 'plot.tfbslogo'.

Usage

```
## S4 method for signature 'cobindr'
predicted2pwm(x, as.pfm=FALSE)
```

Arguments

x	object of class "cobindr" describing the sequences and the predicted TFBS.
as.pfm	logical flag, to indicate whether the function should return a PFM (TRUE) or a PWM (FALSE)

Value

predPwm	positional frequency matrix based on consensus matrix

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

plot.tfbslogo

---

pseudocount *pseudocount of cobindR configuration object*

Description

pseudocount of cobindR configuration object. Set to 10 as default

Usage

```
## S4 method for signature 'configuration'
pseudocount(x)
## S4 replacement method for signature 'configuration,character'
pseudocount(x) <- value
```

Arguments

x	a cobindR configuration object
value	pseudocount for detrending analysis, i.e. the default number in each distance bin.

Value

pseudocount (numeric)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
pseudocount(cfg)
```

pValue *pValue threshold used for motif hit finding*

Description

pValue threshold used for motif hit finding

Usage

```
## S4 method for signature 'configuration'
pValue(x)
## S4 replacement method for signature 'configuration,numeric'
pValue(x) <- value
```

Arguments

x	a cobindR configuration object
value	the p-value threshold used for hit searching

Value

pValue threshold (numeric)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
pValue(cfg)
```

rtfbs *function performs TFBS prediction using the package rtfbs*

Description

function performs TFBS prediction using the package rtfbs

Usage

```
## S4 method for signature 'cobindr'
rtfbs(x, append = F, background_scan = FALSE, n.cpu = NA)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
append	logical flag, if append=TRUE the binding sites will be appended to already existing results
background_scan	logical flag, if background_scan=TRUE the background sequences will be searched for transcription factor binding sites
n.cpu	number of CPUs to be used for parallelization. Default value is 'NA' in which case the number of available CPUs is checked and than used.

Value

x	an object of the class "cobindr" including the predicted transcription factor binding sites

Author(s)

Yue-Hien Lee <>

References

uses the package "rtfbs" (http://cran.r-project.org/web/packages/rtfbs/index.html)

See Also

search.pwm, search.gadem

Examples

```
############################################################
# use simulated sequences
library(Biostrings)

n <- 400 # number of input sequences
l <- 500 # length of sequences
n.hits <- 250 # number of 'true' binding sites
bases <- c("A","C","G","T") # alphabet
# generate random input sequences with two groups with differing GC content
seqs <- sapply(1:(3*n/4), function(x) paste(sample(bases, l, replace=TRUE,
prob=c(.3,.22,.2,.28)), collapse=""))
seqs <- append(seqs, sapply(1:(n/4), function(x) paste(sample(bases, l,
replace=TRUE, prob=c(.25,.25,.25,.25)), collapse="")))
path <- system.file('extdata/pfms/myod.tfpfm',package='cobindR')
motif <- read.transfac.pfm(path)[[1]] # get PFM of binding site
# add binding sites with distance specificity
for(position in c(110, 150)) {
hits <- apply(apply(motif, 2, function(x) sample(x=bases, size=n.hits,
prob=x, replace=TRUE)), 1, paste, collapse='')
pos.hits <- round(rnorm(n.hits, mean=position, sd=8))
names(pos.hits) <- sample(1:n, n.hits)
for(i in 1:n.hits) substr(seqs[as.integer(names(pos.hits)[i])],
start=pos.hits[i], stop=pos.hits[i]+ncol(motif)) <- hits[i]
```

```
}
#save sample sequences in fasta file
tmp.file <- tempfile(pattern = "cobindr_sample_seq", tmpdir = tempdir(), fileext = ".fasta")
writeXStringSet(DNAStringSet(seqs), tmp.file)
#run cobindr
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- tmp.file
sequence_origin(cfg) <- 'artificial sequences'
pfm_path(cfg) <- system.file('extdata/pfms',package='cobindR')
pairs(cfg) <- 'V$MYOD_01 V$MYOD_01'
fdrThreshold(cfg) <- 0
runObj <- cobindr(cfg, name='cobindr test using sampled sequences')
# perform tfbs prediction using rtfbs
runObj.bs <- rtfbs(runObj)
# show results
plot.positionprofile(runObj.bs)

#clean up
unlink(tmp.file)
```

`search.gadem` *function performs TFBS prediction denovo or based on transfac / jaspar matrices pwms using rGADEM.*

Description

function performs TFBS prediction denovo or based on transfac / jaspar matrices pwms using rGADEM. If append=T, predicted hits are appended to the hits in the input object.

Usage

```
## S4 method for signature 'cobindr'
search.gadem(x, deNovo = FALSE, append = F, background_scan = FALSE)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
deNovo	logical flag, if deNOVO=TRUE a denovo search is startet. Otherwise the given PFMs are used as seed.
append	logical flag, if append=TRUE the binding sites will be appended to already existing results
background_scan	logical flag, if background_scan=TRUE the function will search for binding sites in the set of background sequences

Value

x	an object of the class "cobindr" including the predicted transcription factor binding sites

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de>

References

uses package "rGADEM" (http://www.bioconductor.org/packages/release/bioc/html/rGADEM.html)

See Also

rtfbs, search.pwm

Examples

```
############################################################
# use simulated sequences
library(Biostrings)

n <- 600 # number of input sequences
l <- 150 # length of sequences
n.hits <- 600 # number of 'true' binding sites
bases <- c("A","C","G","T") # alphabet
# generate random input sequences with two groups with differing GC content
seqs <- sapply(1:(3*n/4), function(x) paste(sample(bases, l, replace=TRUE,
prob=c(.3,.22,.2,.28)), collapse=""))
seqs <- append(seqs, sapply(1:(n/4), function(x) paste(sample(bases, l,
replace=TRUE, prob=c(.25,.25,.25,.25)), collapse="")))
path <- system.file('extdata/pfms/myod.tfpfm',package='cobindR')
motif <- read.transfac.pfm(path)[[1]] # get PFM of binding site
# add binding sites with distance specificity
for(position in c(70, 90)) {
hits <- apply(apply(motif, 2, function(x) sample(x=bases, size=n.hits,
prob=x, replace=TRUE)), 1, paste, collapse='')
pos.hits <- round(rnorm(n.hits, mean=position, sd=8))
names(pos.hits) <- sample(1:n, n.hits)
for(i in 1:n.hits) substr(seqs[as.integer(names(pos.hits)[i])], start=pos.hits[i],
stop=pos.hits[i]+ncol(motif)) <- hits[i]
}
#save sample sequences in fasta file
tmp.file <- tempfile(pattern = "cobindr_sample_seq", tmpdir = tempdir(), fileext = ".fasta")
writeXStringSet(DNAStringSet(seqs), tmp.file)
#run cobindr
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- tmp.file
sequence_origin(cfg) <- 'artificial sequences'
pfm_path(cfg) <- system.file('extdata/pfms',package='cobindR')
pairs(cfg) <- 'V$MYOD_01 V$MYOD_01'
runObj <-cobindr(cfg, name='cobindr test using sampled sequences')

# perform tfbs prediction using rGADEM - commented out due to long time required
# runObj.bs <- search.gadem(runObj)
# show results
# plot.positions(runObj.bs)

#clean up
unlink(tmp.file)
```

search.pwm *function to predict transcription factor binding sites using the method matchPWM from package Biostrings*

Description

function to predict transcription factor binding sites using the method matchPWM from package Biostrings

Usage

```
## S4 method for signature 'cobindr'
search.pwm(x, min.score = "80%", append = FALSE, background_scan =
FALSE, n.cpu = NA)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
min.score	minimal score to define threshold for hits (default = .8)
append	logical flag, if append=TRUE the binding sites will be appended to already existing results
background_scan	logical flag, if background_scan=TRUE the background sequences will be searched for transcription factor binding sites
n.cpu	number of CPUs to be used for parallelization. Default value is 'NA' in which case the number of available CPUs is checked and than used.

Value

x	an object of the class "cobindr" including the predicted transcription factor binding sites

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de

References

uses matchPWM from package "Biostrings" (http://www.bioconductor.org/packages/release/bioc/html/Biostrings.html)

See Also

rtfbs, search.gadem

Examples

```
############################################################
# use simulated sequences
library(Biostrings)

n <- 400 # number of input sequences
l <- 500 # length of sequences
n.hits <- 250 # number of 'true' binding sites
bases <- c("A","C","G","T") # alphabet
# generate random input sequences with two groups with differing GC content
seqs <- sapply(1:(3*n/4), function(x) paste(sample(bases, l, replace=TRUE,
prob=c(.3,.22,.2,.28)), collapse=""))
seqs <- append(seqs, sapply(1:(n/4), function(x) paste(sample(bases, l, replace=TRUE,
prob=c(.25,.25,.25,.25)), collapse="")))
path <- system.file('extdata/pfms/myod.tfpfm',package='cobindR')
motif <- read.transfac.pfm(path)[[1]] # get PFM of binding site
# add binding sites with distance specificity
for(position in c(110, 150)) {
hits <- apply(apply(motif, 2, function(x) sample(x=bases, size=n.hits, prob=x,
replace=TRUE)), 1, paste, collapse='')
pos.hits <- round(rnorm(n.hits, mean=position, sd=8))
names(pos.hits) <- sample(1:n, n.hits)
for(i in 1:n.hits) substr(seqs[as.integer(names(pos.hits)[i])], start=pos.hits[i],
stop=pos.hits[i]+ncol(motif)) <- hits[i]
}
#save sample sequences in fasta file
tmp.file <- tempfile(pattern = "cobindr_sample_seq", tmpdir = tempdir(), fileext = ".fasta")
writeXStringSet(DNAStringSet(seqs), tmp.file)
#run cobindr
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- tmp.file
sequence_origin(cfg) <- 'artificial sequences'
pfm_path(cfg) <- system.file('extdata/pfms',package='cobindR')
pairs(cfg) <- 'V$MYOD_01 V$MYOD_01'
runObj <- cobindr(cfg, name='cobindr test using sampled sequences')
# perform tfbs prediction using matchPWM
runObj.bs <- search.pwm(runObj, min.score = '90')
# show results
plot.positionprofile(runObj.bs)
# clean up
unlink(tmp.file)
```

---

seqObj *cobindR SeqObj object constructor*

Description

cobindR SeqObj object constructor

Usage

```
## S4 method for signature
## 'DNAString,character,character,character,character,character'
seqObj(seq,id,name,species,comment,location)
```

Arguments

seq	DNAString object holding the sequence
id	id (character)
name	id (character)
species	id (character)
comment	id (character)
location	id (character)

Value

cobindR SeqObj object

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

cobindRConfiguration

Examples

```
library(Biostrings)
so <- seqObj(DNAString('A'), id='', name='', species='',comment='',location='')
sequence(so)
```

SeqObj-class *Class* "SeqObj"

Description

Container for DNA sequence and its meta-data.

Objects from the Class

Objects can be created by calls of the form new("SeqObj", seq, id, species, name, comment, location).

Slots

uid: Object of class "character" ~~ unique id for internal representation

name: Object of class "character" ~~ biological reference name, if available

species: Object of class "character" ~~ reference species

location: Object of class "character" ~~ location on the reference genome

comment: Object of class "character" ~~ comments and notes

sequence: Object of class "DNAString" ~~ the sequence

Methods

initialize `signature(.Object = "SeqObj")`: ...
rtfbs.intern `signature(object = "SeqObj")`: ...
write.fasta `signature(sequences = "SeqObj")`: ...

Author(s)

Manuela Benary <manuela.benary@cms.hu-berlin.de>

See Also

`cobindr configuration`

Examples

```
showClass("SeqObj")
```

---

sequence *returns sequence of cobindR SeqObj object*

Description

returns sequence of cobindR seqObj object.

Usage

```
## S4 method for signature 'SeqObj'
sequence(x)
## S4 replacement method for signature 'SeqObj,DNAString'
sequence(x) <- value
```

Arguments

x	a cobindR seqObj object
value	DNAString of the actual DNA sequence in this SeqObj

Value

sequence (DNAString)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

`uid`,`name`,`species`,`location`,`comment`,`sequence`

Examples

```
library(Biostrings)
so <- seqObj(DNAString('A'), id='', name='', species='',comment='',location='')
sequence(so)
```

sequences *sequences of cobindr object*

Description

sequences of cobindr object.

Usage

```
## S4 method for signature 'cobindr'
sequences(x)
## S4 replacement method for signature 'cobindr,list'
sequences(x) <- value
```

Arguments

x	a cobindr object
value	the list of input sequences of type SeqObj

Value

sequences (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,sequences,bg_sequences,desc,configuration,binding_sites,bg_binding_sites,pfm,pairs,bg_pairs,

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/sox_oct_example_vignette_seqs.fasta',package='cobindR')
sequence_origin(cfg) <- 'Mouse Embryonic Stem Cell Example ChIP-Seq Oct4 Peak Sequences'
cbr <- cobindr(cfg)
length(sequences(cbr))
```

sequence_origin *returns sequence_origin of cobindR configuration object*

Description

returns sequence_origin of cobindR configuration object.

Usage

```
## S4 method for signature 'configuration'
sequence_origin(x)
## S4 replacement method for signature 'configuration,character'
sequence_origin(x) <- value
```

Arguments

x	a cobindR configuration object
value	the origin of the sequence

Value

sequence_origin (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
sequence_origin(cfg)
```

sequence_source *returns sequence_source of cobindR configuration object*

Description

returns sequence_source of cobindR configuration object.

Usage

```
## S4 method for signature 'configuration'
sequence_source(x)
## S4 replacement method for signature 'configuration,character'
sequence_source(x) <- value
```

Arguments

x	a cobindR configuration object
value	the source of which the sequence is retrieved

Value

sequence_source (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
sequence_source(cfg)
```

---

sequence_type *sequence type of cobindR configuration object*

Description

sequence type of cobindR configuration object

Usage

```
## S4 method for signature 'configuration'
sequence_type(x)
## S4 replacement method for signature 'configuration,character'
sequence_type(x) <- value
```

Arguments

x	a cobindR configuration object
value	the type of the sequence used in this experiment (e.g. promotor)

Value

sequence_type (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg)
```

`species` *species of cobindR configuration or SeqObj*

Description

species of cobindR configuration or SeqObj

Usage

```
## S4 method for signature 'configuration'
species(object)
## S4 replacement method for signature 'configuration'
species(object) <- value
## S4 method for signature 'SeqObj'
species(object)
## S4 replacement method for signature 'SeqObj'
species(object) <- value
```

Arguments

`object`	a cobindR configuration object
`value`	name of species in this experiment or SeqObj

Value

sequence / experiment species (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

`id`,`experiment_description`,`sequence_source`,`sequence_origin`,`sequence_type`,`bg_sequence_source`,`bg_seque`

Examples

```
cfg <- cobindRConfiguration()
species(cfg)
```

testCpG *function to cluster sequences based on their CpG and GC content*

Description

diagnostical function - GC content and CpG content are clustered using 2D gaussian models (Mclust). FALSE is returned if > max.clust (default=1) subgroups are found using the bayesian information criterion (BIC). If do.plot=TRUE, the results are visualized.

Usage

```
## S4 method for signature 'cobindr'
testCpG(x, max.clust = 4, do.plot = F, n.cpu = NA)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the hits.
max.clust	integer describing the maximal number of clusters which are used for separating the data.
do.plot	logical flag, if do.plot=TRUE a scatterplot for the GC and CpG content for each sequence is produced and the clusters are color coded.
n.cpu	number of CPUs to be used for parallelization. Default value is 'NA' in which case the number of available CPUs is checked and than used.

Value

result	logical flag, FALSE is returned if more than one subgroups are found using the bayesian information criterion (BIC)
gc	matrix with rows corresponding to sequences and columns corresponding to GC and CpG content

Author(s)

Robert Lehmann <r.lehmann@biologie.hu-berlin.de>

References

the method uses clustering functions from the package "mclust" (http://www.stat.washington.edu/mclust/)

See Also

plot.gc

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/example.fasta', package='cobindR')
# avoid complaint of validation mechanism
pfm_path(cfg) <- system.file('extdata/pfms',package='cobindR')
pairs(cfg) <- ''
runObj <- cobindr( cfg)
testCpG(runObj, max.clust = 2, do.plot = TRUE)
```

---

threshold *threshold used in motif hit finding*

Description

threshold used in motif hit finding

Usage

```
## S4 method for signature 'configuration'
threshold(x)
## S4 replacement method for signature 'configuration,numeric'
threshold(x) <- value
```

Arguments

x	a cobindR configuration object
value	the hit threshold

Value

threshold (numeric)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
threshold(cfg)
```

uid *uid of cobindR SeqObj object*

Description

uid of cobindR seqObj object.

Usage

```
## S4 method for signature 'SeqObj'
uid(x)
## S4 method for signature 'cobindr'
uid(x)
## S4 replacement method for signature 'SeqObj,character'
uid(x) <- value
## S4 replacement method for signature 'cobindr,character'
uid(x) <- value
```

Arguments

x	a cobindR seqObj object
value	the unique id of the sequence or cobindr object

Value

uid (character)

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

uid,name,species,location,comment,sequence

Examples

```
library(Biostrings)
so <- seqObj(DNAString('A'), id='', name='', species='',comment='',location='')
uid(so)
```

upstream *upstream range [bp] used in experiment*

Description

upstream range [bp] used in experiment

Usage

```
## S4 method for signature 'configuration'
upstream(x)
## S4 replacement method for signature 'configuration,numeric'
upstream(x) <- value
```

Arguments

x	a cobindR configuration object
value	upstream distance [bp] of feature to be included (numeric)

Value

considered upstream range [bp]

Author(s)

Rob Lehmann <r.lehmann@biologie.hu-berlin.de>

See Also

id,experiment_description,sequence_source,sequence_origin,sequence_type,bg_sequence_source,bg_seque

Examples

```
cfg <- cobindRConfiguration()
upstream(cfg)
```

write.bindingsites *writes predicted binding sites as a BED file.*

Description

writes predicted binding sites as a BED file.

Usage

```
## S4 method for signature 'cobindr'
write.bindingsites(x, file = NULL, background = FALSE)
```

Arguments

x	an object of the class "cobindr", which holds all necessary information about the sequences and the predicted binding sites.
file	path to file. If filename is 'NULL' a filename is generated based on the name of the object of class "cobindr".
background	logical flag. If background is 'TRUE' the binding sites found in the background sequences are used.

Note

At the moment write.bindingsites() only works for sequences based on gene ids. Otherwise please use write.bindingsites.table().

Author(s)

Stefan Kroeger <kroeger@informatik.hu-berlin.de>

See Also

write.bindingsites.table, write.pairs, write.sequences, write

---

write.bindingsites.table

function to write predicted TFBS into a tab-separated file.

Description

function to write predicted TFBS into a tab-separated file.

Usage

```
## S4 method for signature 'cobindr'
write.bindingsites.table(x, file = NULL)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences and the predicted binding sites.
file	path to file. If filename is 'NULL' a filename is generated based on the name of the object of class "cobindr".

Author(s)

Stefan Kroeger <kroeger@informatik.hu-berlin.de>

See Also

write.pairs, write.bindingsites, write.sequences, write

write.pairs *function to write output of findPairs into file*

Description

Function writes the results of findPairs() as a tab-separated file. The file consists of 6 columns, namely

- a unique id for each pair,
- the unique id of the sequence, where the pair was found,
- the names of the corresponding PFMs,
- the unique id for each PFM, and
- the distance window in which the pair occurs.

Usage

```
## S4 method for signature 'cobindr'
write.pairs(x, file = NULL, background = FALSE)
```

Arguments

x	an object of the class "cobindr", which holds all necessary information about the sequences and the predicted binding sites.
file	path to file. If filename is 'NULL' a filename is generated based on the name of the object of class "cobindr".
background	logical flag. If background is 'TRUE' the pairs found in the background sequences are used.

Author(s)

Stefan Kroeger <kroeger@informatik.hu-berlin.de>

See Also

write.bindingsites.table, write.bindingsites, write.sequences, write

write.sequences *writes the sequences of a cobindr-object into a fasta file.*

Description

writes the sequences of a cobindr-object into a fasta file.

Usage

```
## S4 method for signature 'cobindr'
write.sequences(x, slotname = "sequences", file = NULL)
```

Arguments

x	an object of the class "cobindr", which will hold all necessary information about the sequences.
slotname	string, describing whether to use foreground sequences (default) or background sequences
file	path to file. If filename is 'NULL' a filename is generated based on the name of the object of class "cobindr".

Author(s)

Stefan Kroeger <kroeger@informatik.hu-berlin.de>

See Also

write.bindingsites.table, write.bindingsites, write.pairs, write

Examples

```
cfg <- cobindRConfiguration()
sequence_type(cfg) <- 'fasta'
sequence_source(cfg) <- system.file('extdata/example.fasta', package='cobindR')
# avoid complaint of validation mechanism
pfm_path(cfg) <- system.file('extdata/pfms',package='cobindR')
pairs(cfg) <- ''
runObj <- cobindr(cfg)
write.sequences(runObj, file = file.path(tempfile("example.txt",tempdir())) )
```

Index