Package ‘mdgsa’

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Description Functions to perform a Gene Set Analysis in several genomic dimensions. Including methods for miRNAs.
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**annotFilter**

Checks and filters an annotation list.

**Description**

Checks that the annotated genes (those in the annotation list) are consistent with the universe of genes defined by the ranking index. Filters out functional blocks too 'big' or too 'small'.

**Usage**

```r
annotFilter(annot, index, minBlockSize = 10, maxBlockSize = 500, verbose = TRUE)
```

**Arguments**

- `annot`: an annotation list.
- `index`: ranking index. Vector, matrix or data.frame
- `minBlockSize`: minimum block size kept
- `maxBlockSize`: maximum block size kept
- `verbose`: verbose

**Details**

`index` is optional. When it is not provided, the annotation list is just filtered out by the sizes of the blocks of genes defined in the list.

If a ranking index is provided its names are assumed to be the universe of genes under study. The genes in the annotation list are compared against those of the ranking index and the ones not belonging to the universe are removed from the annotation in order to compute the size of each functional block. Then the list is filtered by sizes; too big and too small blocks are removed.

No transformation is done over the ranking index or its names (gene IDs).

`index` may just be a character vector containing the names of the genes in the universe, that is, the names or row names of the ranking index.

**Value**

a filtered annotation list.

**Author(s)**

David Montaner <dmontaner@cipf.es>
annotList2mat

See Also
annotMat2list

Examples

rindex <- 1:10
names (rindex) <- paste ("gene", rindex, sep = "")
rindex

annot <- list (paste ("gene", 1:2, sep = ","),
               paste ("gene", 1:6, sep = ","),
               paste ("gene", 1:5, sep = ","),
               paste ("gene", c(1:3, 1:3), sep = ","))
annot[[2]][1] <- NA
annot[[2]][2] <- ""
annot[[2]][3] <- "BAD_ID"
annot

annotFilter (annot, minBlockSize = 3, maxBlockSize = 5)
annotFilter (annot, rindex, minBlockSize = 3, maxBlockSize = 5)

annotList2mat  Convert an annotation list into an annotation matrix.

Description
Converts an annotation list to an annotation matrix. The annotation matrix should have 2 columns,
the first one with the gene ids; the second one with the annotation ids.

Usage
annotList2mat(lis, tag = "listPos")

Arguments
lis  annotation list.
tag  substitutes missing list names if any.

Details
Each element of the annotation list represents a functional block; it is a character vector containing
the gene ids annotated under the function. The names of the list are the annotation ids.

Value
An annotation matrix: the first column contains the gene or feature ids, the second column contains
the Gene Set or functional block ids.

Author(s)
David Montaner <dmontaner@cipf.es>
See Also

annotMat2list, revList, split

Examples

lis <- list (Block1 = c("gen1", "gen2"), Block2 = c("gen3"))
annotList2mat (lis)

---

annotMat2list

Convert an annotation matrix into an annotation list.

Description

Converts an annotation matrix to an annotation list. The annotation matrix should have 2 columns, the first one with the gene ids; the second one with the annotation ids.

Usage

annotMat2list(mat)

Arguments

mat annotation matrix; gene IDs in the first column; block IDs in the second column.

Details

Each element of the annotation list represents a functional block; it is a character vector containing the gene ids annotated under the function. The names of the list are the annotation ids.

Value

An annotation list: elements of the list are vectors of genes; names of the list are Gene Set ids.

Author(s)

David Montaner <dmontaner@cipf.es>

See Also

annotList2mat, revList, split

Examples

mat <- cbind (c("gen1", "gen2", "gen3"), c(Block1, Block1, Block2))
annotMat2list (mat)
getGOnames

Get Gene Ontology names

Description

Finds the GO name form GO id.

Usage

getGOnames(x, verbose = TRUE)

Arguments

x
a character vector of GO ids.

verbose
verbose.

Details

Uses the library GO.db.

x may be a data.frame. In such case, GO ids are expected in its row names.

Value

A character vector with the corresponding GO names.

Author(s)

David Montaner <dmontaner@cipf.es>

See Also

propagateGO, goLeaves, splitOntologies, getKEGGnames, getOntology

Examples

getGOnames (c("GO:0000018", "GO:0000038", "BAD_GO"))

getKEGGnames

Get KEGG names

Description

Finds the KEGG name form KEGG id.

Usage

getKEGGnames(x, verbose = TRUE)
getOntology

Arguments

x a character vector of KEGG ids.
verbose verbose.

Details

Uses the library KEGG.db.
x may be a data.frame. In such case, GO ids are expected in its row names.

Value

A character vector with the corresponding KEGG names.

Author(s)

David Montaner <dmontaner@cipf.es>

See Also

gtGOnames

Examples

getKEGGnames (c("00010", "00020", "BAD_KEGG"))

gtOntology

Description

Finds the ontology of a term from its id.

Usage

getOntology(x, verbose = TRUE)

Arguments

x a character vector of GO ids.
verbose verbose.

Details

Uses the library GO.db.
x may be a data.frame. In such case, GO ids are expected in its row names.

Value

A character vector with the corresponding GO names.
Author(s)
David Montaner <dmontaner@cipf.es>

See Also
getGOnames, propagateGO, goLeaves, splitOntologies, getKEGGnames

Examples
getOntology (c("GO:0000018", "GO:0005788", "BAD_GO"))

Description
Keep just leaf nodes from the Gene Ontology DAG.

Usage
goLeaves(gsaout, cutoff = 0.05, pvalue = "padj", statistic = "lor", verbose = TRUE, sort = TRUE)

Arguments
gsaout data.frame; output from uvGsa.
cutoff p-value cutoff for considering significant a Gene Set.
pvalue p-value column to be used. Default is named "padj" as in uvGsa output.
statistic name of the column containing the log odds ratio from the uvGsa analysis.
verbose verbose
sort if TRUE the output data.frame is ordered according to significance.

Details
Uses the library GO.db to find the 'ancestors' of each GO term. Those ancestors are discarded from the uvGsa results.
Alternatively, the function may also take a character vector of GO ids in the gsaout parameter. In such case the function returns also a character vector of GO ids, containing just the GO terms being "leaves" of the original set.

Value
The input data.frame but keeping just the 'significant' and 'non redundant' GO terms.

Author(s)
David Montaner <dmontaner@cipf.es>

See Also
uvGsa, uvPat, propagateGO, pval2index
indexTransform

Transform ranking index distribution.

Description
The function performs a transformation of the ranking index so that its distribution is suitable as independent variable of the logistic regression model.

Usage
indexTransform(index, method = "normalize")

Arguments
index a ranking index; a numeric vector, matrix or data.frame.
method transformation method. See details.

Details
Works for vector, matrices and data.frames. In the case of matrices the function transforms each column separately from the other ones.
Two methods are currently implemented:
- normalize: transforms the index into quantiles of a normal distribution.
- standardize: performs an statistical standardization by subtracting the mean and dividing by the standard deviation.

Value
A transformed index. Its class will be that of the the input object.

Author(s)
David Montaner <dmontaner@cipf.es>

See Also
transferIndex, uvGsa, mdPat

Examples
myIndex <- runif (1000)
myTransformedIndex <- indexTransform (myIndex)
plot (myIndex, myTransformedIndex)
**mdGsa**

*Multi-Dimensional Gene Set Analysis.*

**Description**

Performs a Multi-Variate Gene Set Analysis for two genomic measurements.

**Usage**

```r
mdGsa(index, annot, p.adjust.method = "BY", family = quasibinomial(),
       verbose = TRUE, verbosity = 100, fulltable = FALSE,
       useColnames = TRUE, ...)
```

**Arguments**

- `index`: ranking index, generally a two column matrix.
- `annot`: an annotation list.
- `p.adjust.method`: p-value adjustment method for multiple testing.
- `family`: see `glm`.
- `verbose`: verbose.
- `verbosity`: integer indicating which iterations should be indicated when `verbose = TRUE`.
- `fulltable`: if TRUE, 'sd', 't' and 'convergence' indicator from the glm fit are included in the output.
- `useColnames`: if TRUE the names of the two first columns of the matrix 'index' are used in the results data.frame.
- `...`: further arguments to be pasted to `glm.fit`, for instance 'weights'.

**Details**

-index’ must be a numerical matrix or data.frame with at least two columns.

If there are more than three columns, the ranking indexes are taken form the two first one. The remaining columns are used as covariates to correct for within the analysis.

Default p-value correction is "BY".

In the output data.frame there are three parameters of each type: 'lor', 'pval',...one for each of the two genomic conditions analyzed and the third one for the interaction between them.

If available, names of the fist two columns of the index matrix are used in the output data.frame.

Changing the order of these two first columns will change the report order, but will not change the interpretation of the results. See Montaner et al. (2010) for further details on the algorithm.

**Value**

A data.frame with a row for each Gene Set or block. Columns are:

- **N**: number of genes annotated to the Gene Set.
- **lor**: log Odds Ratio estimated for the Gene Set.
- **pval**: p-values associated to each log Odds Ratio.
mdPat: adjusted p-values.

sd: standard deviations associated to each log Odds Ratio.

t: t statistic associated to each log Odds Ratio.

Apart from the 'N' coefficient, all other indices appear in triplicate: one coefficient for each genomic condition and a third one for the interaction.

Author(s)

David Montaner <dmontaner@cipf.es>

References


See Also

uvGsa, mdPat, glm.fit, p.adjust

Examples

\[
\text{rindexMat} \leftarrow \text{matrix}(\text{runif}(2000), \text{ncol} = 2)
\]
\[
\text{colnames}(\text{rindexMat}) \leftarrow \text{c}(\text{"genomicVar1"}, \text{"genomicVar2"})
\]
\[
\text{rownames}(\text{rindexMat}) \leftarrow \text{paste0}(\text{"gen"}, 1:1000)
\]
\[
\text{annotList} \leftarrow \text{list} (\text{geneSet1} = \text{sample}(\text{rownames}(\text{rindexMat}), \text{size} = 10),
\text{geneSet2} = \text{sample}(\text{rownames}(\text{rindexMat}), \text{size} = 15),
\text{geneSet3} = \text{sample}(\text{rownames}(\text{rindexMat}), \text{size} = 20))
\]
\[
\text{res} \leftarrow \text{mdGsa}(\text{rindexMat}, \text{annotList})
\]
\[
\text{res}
\]

mdPat

Multi-Dimensional Gene Set Analysis Pattern Classification.

Description

Classifies significant patterns form a Multi-Variate Gene Set Analysis.

Usage

mdPat(gsaout, cutoff = 0.05, pvalue = "padj")

Arguments

gsaout data.frame; output from mdGsa.
cutoff p-value cutoff for considering significant a Gene Set.
pvalue p-value column to be used. Default is named "padj" as in mdGsa output.
mdPat

Details

Sign of the three 'lor' and p-values are used to classify functional blocks. The classification is done in the two dimensional space previously analyzed by mdGsa.

All possible functional block classifications in the bi-dimensional gene set analysis are:

- q1i: block displaced toward quadrant 1 (0 < X & 0 < Y) with interaction.
- q2i: block displaced toward quadrant 2 (0 > X & 0 < Y) with interaction.
- q3i: block displaced toward quadrant 3 (0 > X & 0 > Y) with interaction.
- q4i: block displaced toward quadrant 4 (0 < X & 0 > Y) with interaction.
- q1f: block displaced toward quadrant 1, no interaction.
- q2f: block displaced toward quadrant 2, no interaction.
- q3f: block displaced toward quadrant 3, no interaction.
- q4f: block displaced toward quadrant 4, no interaction.
- xh: block shifted to positive X values.
- xl: block shifted to negative X values.
- yh: block shifted to positive Y values.
- yl: block shifted to negative Y values.
- b13: bimodal block. Half of the genes displaced towards quadrant 1 and the other half towards quadrant 3.
- b24: bimodal block. Half of the genes displaced towards quadrant 2 and the other half towards quadrant 4.
- NS: non significant block.

Value

A character vector indicating the pattern associated to each Gene Set.

Author(s)

David Montaner <dmontaner@cipf.es>

References


See Also

mdGsa, uvPat

Examples

N <- c(10, 20, 30, 40)
lor.X <- c(1.45, -0.32, 1.89, -1.66)
lor.Y <- c(2.36, -1.86, 0.43, -2.01)
lor.I <- c(0.89, -0.12, 0.24, 3.55)
pval.X <- c(0.001, 0.002, 0.003, 0.06)
pval.Y <- c(0.002, 0.003, 0.06, 0.07)
pval.I <- c(0.003, 0.02, 0.05, 0.08)
padj.X <- p.adjust(pval.X, "BY")
padj.Y <- p.adjust (pval.Y, "BY")
padj.I <- p.adjust (pval.I, "BY")

mdGsa.res <- as.data.frame (cbind (N,
                              lor.X, lor.Y, lor.I,
                              pval.X, pval.Y, pval.I,
                              padj.X, padj.Y, padj.I))

mdGsa.res

mdGsa.res[,"pat"] <- mdPat (mdGsa.res)
mdGsa.res

---

**plotMdGsa**  
*Plot Multi-Dimensional Gene Set*

**Description**
Plots confidence region for a Gene Set in a two dimensional space.

**Usage**

```r
plotMdGsa(index, block, cr = 0.95, pch = ".", pch.block = 20, lwd = 2,
col.all = "blue", col.block = "red", project = FALSE,
col.proj = "green", diagonals = FALSE, col.diag = "gray", ...)
```

**Arguments**

- `index`  
  matrix or data frame with the two columns of ranking statistics.
- `block`  
  matrix or data frame with gene ids in the first column and gene set ids in the second column.
- `cr`  
  level of the confidence region.
- `pch`  
  plotting character for all genes.
- `pch.block`  
  plotting character for the genes in the gene set or functional block.
- `lwd`  
  line width. Used when drawing ellipses and other lines.
- `col.all`  
  color used to represent all genes.
- `col.block`  
  color used to represent the genes in the gene set being plotted.
- `project`  
  if TRUE projection over the axis are displayed for the genes of the gene set.
- `col.proj`  
  color used to plot the projection.
- `diagonals`  
  if TRUE diagonals are plotted.
- `col.diag`  
  color used to plot the diagonals.
- `...`  
  arguments to be passed to plot

**Details**
Black dots show all genes in the dataset. Red stars show the genes in the Gene Set. Blue axis show the "center" of the distribution of all genes; blue ellipse shows the confidence region for all genes. Red axis show the "center" of the distribution of the genes in the Gene Set; red ellipse shows the confidence region for genes in the Gene Set.
propagateGO

Value
A plot.

Author(s)
David Montaner <dmontaner@cipf.es>

See Also
mdGsa, mdPat, mdPat, ellipsoidPoints

Examples
```r
## Not run:
res <- mdGsa (rindexMat, annotList)
plotMdGsa (rindexMat, block = annotList[["GO:0006915"]])
## End(Not run)
```

propagateGO  

Propagate Gene Ontology annotation.

Description
Genes annotated under a GO term inherit the annotation from all its ancestors.

Usage
```r
propagateGO(annot, verbose = FALSE)
```

Arguments
- `annot`  
  annotation list or matrix.
- `verbose`  
  verbose

Details
Uses the library GO.db.

Value
A annotation matrix or list with the propagated annotation.

Author(s)
David Montaner <dmontaner@cipf.es>

See Also
annotMat2list, annotFilter
`pval2index`  

Transform p-values into a ranking index.

Description

After a genomic test, p-values are numerical indexes which account for certain biological characteristic. By definition p-values are bounded between zero and one, but this may not be suitable as an index. Moreover, p-values are always derived from a statistic which sign may be important. The function helps transforming the p-value and its associated statistic into a ranking index.

Usage

```r
pval2index(pval, sign, names = NULL, log = TRUE, offset, verbose = TRUE)
```

Arguments

- `pval`: a vector or matrix of p-values.
- `sign`: a vector or matrix of signs associated to the p-values.
- `names`: a character vector of the names of the features.
- `log`: = TRUE
- `offset`: value used to replace p-values equal to zero
- `verbose`: verbose

Details

The default transformation is \((-1) \times \log(pval) \times \text{sign}(sign)\). When \(\log = \text{FALSE}\) the transformation is \((1 - pval) \times \text{sign}(sign)\).

If \(\text{sign}\) is missing all p-values are associated with a positive sign.

Missing values are allowed and return NA values.

An offset may be provided to replace p-values equal to zero when \(\log = \text{TRUE}\). In such way infinite values are not generated. If the `offset` parameter is not provided, the minimum p-value other than zero is used for the replacement. You can explicitly specify `offset = 0` if you want `Inf` values to be returned.

By default the names of the output vector (or row names in a matrix) are those of `pval` or `sign`. If `names` is provided, then it is used instead.

Value

A transformed index. A vector or matrix, depending on the input parameters.
revList

Revert an annotation list.

Description

Inverts a list: names to elements / elements to names

Usage

revList(lis, tag = "listPos")
splitOntologies

Arguments
lis annotation list.
tag substitutes missing list names if any.

Value
An inverted list.

Author(s)
David Montaner <dmontaner@cipf.es>

See Also
annotMat2list, revList annotMat2list, annotList2mat

Examples
lis <- list (Block1 = c("gen1", "gen2"), Block2 = c("gen1", "gen3"))
revList (lis)

splitOntologies Split an annotation list of GO terms by ontologies.

Description
Splits an annotation list of GO terms according to the ontology to which each term belongs to.

Usage
splitOntologies(annot, na.rm = TRUE, verbose = TRUE)

Arguments
annot annotation list.
na.rm if TRUE 'unknown' terms are excluded.
verbose verbose

Details
Uses the information form the library GO.db. If some id could not be associated to any ontology, they are returned in an unknown ontology named "missing".

Value
A list with tree components, one for each ontology. A fourth component is included is some term could not be allocated to any of the three GO ontologies.

Author(s)
David Montaner <dmontaner@cipf.es>
transferIndex

See Also

propagateGO, goLeaves

Examples

getGOnames (c("GO:0006915", "GO:0016020", "GO:0008152", "GO:0015288"))

annot <- list("GO:0006915" = c("g1"),
"GO:0016020" = c("g2", "g3"),
"GO:0008152" = c("g1", "g2", "g3"),
"GO:0015288" = c("g4", "g5"))

transferIndex(annot)

transferIndex(index, targets, method = "sum", verbose = TRUE,
transferMatrix = FALSE)

Arguments

index ranking index, generally a numerical named vector.
targets a list describing the regulation blocks. See details.
method the method to collapse the gene information. Currently 'sum' and 'average' are available.
verbose verbose.
transferMatrix if true the transference matrix is returned instead of the ranking statistic.

Details

The function was in principle designed to transfer a ranking index defined for miRNAs to their target genes, but it may also be used to deal with some other regulatory elements as transcription factors for instance.

If we have for instance a t statistic accounting for miRNAs differential expression levels, we may add up (or average) all t values from the miRNAs that regulate a gene in order to derive an interference score for that gene. Thus we may get an interference index which may be interpreted in terms of functional blocks or gene sets.

index may be a matrix. In such case just the first column will be used.
targets should be a named list. The names of the list have to coincide (or at least overlap) with the names in the index. The elements of the list are character vectors containing gene IDs. In the miRNA example, each element of targets will contain the genes regulated by a miRNA, and the miRNA IDs will appear in the names of the targets list as well as in the ranking index.

**Value**

A ranking index transferred to the IDs in the elements of the list targets.

**Author(s)**

David Montaner <dmontaner@cipf.es>

**See Also**

uvGsa, mdGsa, indexTransform

**Examples**

```r
## miRNA to gene list (targets)
targets <- list(mirna1 = "g1", mirna2 = c("g1", "g2"), mirna3 = "g3")

## original index
index <- rnorm(5)
names(index) <- paste0("mirna", 1:5)

## transferred index
index <- transferIndex(index, targets)

## transformed (normalized) index
rindex <- indexTransform(tindex)

## NOTICE in this case:
index["mirna1"] + index["mirna2"] == tindex["g1"]

## Not run:
res <- uvgsa(rindex, annot)
## End(Not run)
```

---

**uvGsa**

*Uni-Variate Gene Set Analysis.*

**Description**

Performs a Uni-Variate Gene Set Analysis using a logistic regression model.

**Usage**

```r
uvGsa(index, annot, p.adjust.method = "BY", family = quasibinomial(),
   verbose = TRUE, verbosity = 100, fulltable = FALSE, ...)
```
Arguments

index  ranking index, generally a numerical named vector.
annot  an annotation list.
p.adjust.method  p-value adjustment method for multiple testing.
family  see glm.fit.
verbose  verbose.
verbosity  integer indicating which iterations should be indicated if verbose = TRUE.
fulltable  if TRUE, 'sd', 't' and 'convergence' indicator from the glm fit are included in the output.
...  further arguments to be pasted to glm.fit, for instance 'weights'.

Details

'index' may also be a numerical matrix or data.frame. If such a matrix has more than one column, the ranking index is taken form the first one. The remaining columns are used as covariates to correct for within the analysis.
Default p-value correction is "BY".

Value

A data.frame with a row for each Gene Set or block. Columns are:
-N: number of genes annotated to the Gene Set.
-1or: log Odds Ratio estimated for the Gene Set.
pval: p-values associated to each log Odds Ratio.
-padj: adjusted p-values.
-sd: standard deviations associated to each log Odds Ratio.
-t: t statistic associated to each log Odds Ratio.

Author(s)

David Montaner <dmontaner@cipf.es>

See Also

mdGsa, uvPat, glm.fit, p.adjust

Examples

rindex <- rnorm (1000)
names (rindex) <- paste0 ("gen", 1:1000)
annotList <- list (geneSet1 = sample (names (rindex), size = 10),
   geneSet2 = sample (names (rindex), size = 15),
   geneSet3 = sample (names (rindex), size = 20))
res <- uvGsa (rindex, annotList)
res
uvPat

Uni-Variate Gene Set Analysis Pattern Classification.

Description
Classifies significant patterns form a Uni-Variate Gene Set Analysis.

Usage
uvPat(gsaout, cutoff = 0.05, pvalue = "padj", statistic = "lor")

Arguments
gsaout data.frame; output from uvGsa.
cutoff p-value cutoff for considering significant a Gene Set.
pvalue p-value column to be used. Default is named "padj" as in uvGsa output.
statistic name of the column containing the log odds ratio from the uvGsa analysis.

Details
Sign of the 'lor' and p-value are used to define functional blocks as up-regulated, down-regulated or not enriched.

Value
A numeric vector (values: -1, 0, 1) indicating relationship between the Gene Set and the ranking variable:
- 1: indicates that the gene set is significantly associated to high values of the ranking statistic.
- -1: indicates that the gene set is significantly associated to low values of the ranking statistic.
- 0: indicates that the gene set not related to the ranking statistic (no enrichment).

Author(s)
David Montaner <dmontaner@cipf.es>

See Also
uvGsa, mdPat

Examples
uvGsa.res <- as.data.frame (list (N = c (10, 20, 30, 40),
                                  lor = c (1.45, -0.32, 1.89, -1.66),
                                  pval = c (0.001, 0.002, 0.05, 0.06)))
uvGsa.res[,"padj"] <- p.adjust (uvGsa.res$pval, "BY")
uvGsa.res

uvGsa.res[,"pat"] <- uvPat (uvGsa.res)
uvGsa.res
uvSignif

Filter significant terms in the univariate gene set analysis.

Description

Filters the rows in the data.frame returned by uvGsa so that only the enriched blocks are kept.

Usage

uvSignif(gsaout, cutoff = 0.05, pvalue = "padj", statistic = "lor",
verbose = TRUE, sort = TRUE)

Arguments

gsaout data.frame; output from uvGsa.
cutoff p-value cutoff for considering significant a Gene Set.
pvalue p-value column to be used. Default is named "padj" as in uvGsa output.
statistic name of the column containing the log odds ratio from the uvGsa analysis.
verbose verbose
sort if TRUE the output data.frame is ordered according to significance.

Details

Works as goLeaves but without removing redundant terms.

Value

The input data.frame but keeping just the 'significant' functional blocks.

Author(s)

David Montaner <dmontaner@cipf.es>

See Also

uvGsa, uvPat, propagateGO, pval2index, goLeaves

Examples

uvGsa.res <- as.data.frame (list (N = c (10, 20, 30, 40),
lor = c (1.45, -0.32, 1.89, -1.66),
pval = c (0.001, 0.002, 0.05, 0.06)))

uvGsa.res[,"padj"] <- p.adjust (uvGsa.res$pval, "BY")

uvSignif (uvGsa.res)

## Not run:
res <- uvGsa (rindex, annotList)

uvSignif (res)

## End(Not run)
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