Package ‘SeqGSEA’

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Type Package

Title Gene Set Enrichment Analysis (GSEA) of RNA-Seq Data: integrating differential expression and splicing

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Description The package generally provides methods for gene set enrichment analysis of high-throughput RNA-Seq data by integrating differential expression and splicing. It uses negative binomial distribution to model read count data, which accounts for sequencing biases and biological variation. Based on permutation tests, statistical significance can also be achieved regarding each gene's differential expression and splicing, respectively.

License GPL (>= 3)

Depends Biobase, doParallel, DESeq

Imports methods, biomaRt

Suggests easyRNASeq, GenomicRanges

biocViews Sequencing, RNASeq, GeneSetEnrichment, GeneExpression, DifferentialExpression

NeedsCompilation no

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Description

SeqGSEA is an R package for gene set enrichment analysis of RNA-Seq data with the ability to integrate differential expression and differential splice in functional analysis.

Details

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A User’s Guide is available as well as the usual help page documentation for each of the individual functions.

The most useful functions are listed below:

* ReadCountSet class
  • ReadCountSet-class
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  • exonID
  • geneID
  • counts-methods
  • label
  • subsetByGenes

* SeqGeneSet class
  • SeqGeneSet-class
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* Load data
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* Result tables
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  - plotES
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  - plotSig
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* Miscellaneous
  - genpermuteMat
  - convertEnsembl2Symbol
  - convertSymbol2Ensembl
Author(s)

Xi Wang and Murray J. Cairns
Maintainer: Xi Wang <xi.wang@newcastle.edu.au>

References


---

**calES**

*Calculate running enrichment scores of gene sets*

**Description**

This is an internal function to calculate running enrichment scores of each gene set in the `SeqGeneSet` object specified.

**Usage**

`calES(gene.set, gene.score, weighted.type = 1)`

**Arguments**

- `gene.set` a `SeqGeneSet` object.
- `gene.score` a vector of gene scores corresponding to the `geneList` slot of `gene.set`.
- `weighted.type` gene score weight type.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

`GSEnrichAnalyze`, `calES.perm`

**Examples**

```r
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(GS_example, package="SeqGSEA")
rES <- calES(GS_example, gene.score)
rES[1,]
```
### calES.perm

*Calculate enrichment scores for gene sets in the permutation data sets*

**Description**

This is an internal function to calculate enrichment scores for gene sets in the permutation data sets.

**Usage**

```r
calES.perm(gene.set, gene.score.perm, weighted.type = 1)
```

**Arguments**

- `gene.score.perm` : a matrix of gene scores on the permutation data sets.
- `weighted.type` : gene score weight type.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

`GSEnrichAnalyze`, `calES`.

**Examples**

```r
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
ES.perm <- calES.perm(GS_example, gene.score.perm)
ES.perm[1:5,1:5]
```

### convertEnsembl2Symbol

*Convert ensembl gene IDs to gene symbols*

**Description**

Convert ensembl gene IDs to gene symbols

**Usage**

```r
convertEnsembl2Symbol(ensembl.genes)
```

**Arguments**

- `ensembl.genes` : ensembl gene ID(s).
convertSymbol2Ensembl

Value

A 2-column matrix showing the correspondence of ensembl gene IDs and gene symbols.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

convertSymbol2Ensembl

Examples

convertEnsembl2Symbol("ENSG00000162946") #DISC1

csvtSymbol2Ensembl("DISC1") #ENSG00000162946

Description

Convert gene symbols to ensembl gene IDs

Usage

convertSymbol2Ensembl(symbols)

Arguments

symbols gene symbol(s).

Value

A 2-column matrix showing the correspondence of gene symbols and ensembl gene IDs.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

convertEnsembl2Symbol

Examples

convertSymbol2Ensembl("DISC1") #ENSG00000162946
### DENBStat4GSEA

**Calculate NB-statistics quantifying differential expression for each gene**

**Description**

Calculate NB-statistics quantifying differential expression between two groups of samples compared. The results will be used for GSEA run. Comparing with `DENBTest`, this function will not calculate NB test p-values.

This function only works with two-group comparison.

**Usage**

```r
DENBStat4GSEA(cds)
```

**Arguments**

- `cds` A `CountDataSet` object with size factors and dispersion parameters estimated. Recommended to take the output of `runDESeq`.

---

### counts-methods

**Accessors for the `counts` slot of a `ReadCountSet` object.**

**Description**

Accessors for the `counts` slot of a `ReadCountSet` object.

**Usage**

```r
## S4 method for signature 'ReadCountSet'
counts(object)
## S4 replacement method for signature 'ReadCountSet,matrix'
counts(object) <- value
```

**Arguments**

- `object` a `ReadCountSet` object
- `value` a matrix of read counts

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**Examples**

```r
data(RCS_example, package="SeqGSEA")
readCounts <- counts(RCS_example)
head(readCounts)
```
DENBStatPermut4GSEA

Value
A data frame containing each gene’s expression means and variances in each group, and each gene’s DE NB-statistics.

Note
The results with the output of DENBStatPermut4GSEA can also be used to run DEpermutePval.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au

References

See Also
DENBTest, runDESeq, DENBStatPermut4GSEA

Examples
```r
data(RCS_example, package="SeqGSEA")
geneCounts <- getGeneCount(RCS_example)
label <- label(RCS_example)
DEG <- runDESeq(geneCounts, label)
DEGres <- DENBStat4GSEA(DEG)
head(DEGres)
```

---

DENBStatPermut4GSEA  *Calculate NB-statistics quantifying DE for each gene in the permutation data sets*

Description
Calculate NB-statistics quantifying differential expression for each gene in the permutation data sets. The results will be used for GSEA run.

Usage
```
DENBStatPermut4GSEA(DEG, permuteMat)
```

Arguments
- **DEG** a CountDataSet object, can be the output of runDESeq.
- **permuteMat** a permutation matrix generated by genpermuteMat.

Value
A matrix of NB-statistics. Each row corresponds to each gene, and each column to each permutation.
Note

The results with the output of DENBStat4GSEA can also be used to run DEpermutePval.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

DENBStat4GSEA, runDESeq, DEpermutePval, genpermuteMat

Examples

data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
geneCounts <- getGeneCount(RCS_example)
label <- label(RCS_example)
DEG <- runDESeq(geneCounts, label)
DEpermNBstat <- DENBStatPermut4GSEA(DEG, permuteMat)
DEpermNBstat[1:10,1:10]

---

**DENBTest**

Perform negative binomial exact test for differential expression

Description

Perform negative binomial exact test for differential expression - a modified version of nbinomTest in DESeq package.

Usage

DENBTest(cds)

Arguments

cds A CountDataSet object with size factors and dispersion parameters estimated. Recommended to take the output of runDESeq.

Value

A data frame of the test results. Information contains mean expression values, NB-statistics, (log) fold-changes, p-values, and adjusted p-values.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au
DEpermutePval

References


See Also

runDESeq, DENBStat4GSEA

Examples

data(RCS_example, package="SeqGSEA")
geneCounts <- getGeneCount(RCS_example)
label <- label(RCS_example)
DEG <- runDESeq(geneCounts, label)
DEGres <- DENBTest(DEG)
head(DEGres)

DEpermutePval

Permutation for p-values in differential expression analysis

Description

Calculate permutation p-values in differential expression analysis for each genes.

Usage

DEpermutePval(DEGres, permuteNBstat)

Arguments

DEGres the output of DENBStat4GSEA.
permuteNBstat the output of DENBStatPermut4GSEA.

Value

A data frame containing the expression means and variances for each gene in each group compared, and NB-stats, permutation p-values and adjusted p-values for each gene.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

runDESeq, DENBStat4GSEA, DENBStatPermut4GSEA, DENBTest
**Examples**

```r
data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
geneCounts <- getGeneCount(RCS_example)
label <- label(RCS_example)
DEG <- runDESeq(geneCounts, label)
DEGres <- DENBStat4GSEA(DEG)
DEpermNBstat <- DENBStatPermut4GSEA(DEG, permuteMat)
DEGres <- DEpermutePval(DEGres, DEpermNBstat)
head(DEGres)
```

**DEscore**  
*Pre-calculated DE/DS scores*

**Description**

DEscore and DSScore are pre-calculated DE and DS scores, respectively; DEscore.perm and DSScore.perm are pre-calculated DE and DS scores on the permutation data sets, respectively; They are used in examples of the SeqGSEA package. Note that these scores are of no meaning but to demonstrate the usage of functions.

**Usage**

```r
data("DEscore")
data("DEscore.perm")
data("DSScore")
data("DSScore.perm")
```

**References**


**DSpermute4GSEA**  
*Compute NB-statistics quantifying differential splicing on the permutation data set.*

**Description**

This function is to calculate NB-statistics quantifying differential splicing for each gene on each permutation data set. The results will be used for GSEA run as DS background.

**Usage**

```r
DSpermute4GSEA(RCS, permuteMat)
```

**Arguments**

- **RCS**  
  a ReadCountSet object after running `exonTestability`

- **permuteMat**  
  a permutation matrix generated by `genpermuteMat`
DSpermutePval

Details

Parallel running configuration: TODO

Value

A ReadCountSet object with slot permute_NBstat_gene updated.

Note

Please run exonTestability before run this function.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

exonTestability, genpermuteMat, DENBStatPermut4GSEA, DSpermutePval

Examples

data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- DSpermute4GSEA(RCS_example, permuteMat)
head(RCS_example@permute_NBstat_gene)

---

DSpermutePval Permutation for p-values in differential splicing analysis

Description

Calculate permutation p-values in differential splicing analysis.

Usage

DSpermutePval(RCS, permuteMat)

Arguments

RCS a ReadCountSet object after running estiExonNBstat and estiGeneNBstat.
permuteMat a permutation matrix generated by genpermuteMat.

Details

Permutation p-values are computed based on NB-statistics for comparison of the studied groups and NB-statistics from the permutation data sets.
DSresultExonTable

Value

A ReadCountSet object with slots `permute_NBstat_exon`, `permute_NBstat_gene`, `featureData`, and `featureData_gene` updated.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

`estiExonNBstat`, `estiGeneNBstat`, `genpermuteMat`, `DSpermute4GSEA`

Examples

data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermutePval(RCS_example, permuteMat)
head(DSresultExonTable(RCS_example))
head(DSresultGeneTable(RCS_example))

---

**DSresultExonTable**  
*Form a table for DS analysis results at the Exon level*

Description

Form a table for differential splicing analysis results at the Exon level.

Usage

`DSresultExonTable(RCS)`

Arguments

RCS  
A ReadCountSet object with `DSpermutePval` done.

Details

A data frame containing each exon’s NB-statistics, p-values and adjusted p-values for differential splicing analysis.

Value

A matrix containing exon DS analysis results, including testability, NBstats, p-values and adjusted p-values.
Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

DSresultGeneTable, DSpermutePval

Examples

data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermutePval(RCS_example, permuteMat)
head(DSresultGeneTable(RCS_example))

DSresultGeneTable

Form a table for DS analysis results at the gene level

Description

Form a table for differential splicing analysis results at the gene level.

Usage

DSresultGeneTable(RCS)

Arguments

RCS

A ReadCountSet object with DSpermutePval done.

Value

A data frame containing each gene’s NB-statistics, p-values and adjusted p-values for differential splicing analysis.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

DSresultExonTable, DSpermutePval

Examples

data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermutePval(RCS_example, permuteMat)
head(DSresultGeneTable(RCS_example))
**estiExonNBstat**  
*Calculate NB-statistics quantifying differential splicing for individual exons*

**Description**

Calculate NB-statistics quantifying differential splicing for individual exons between two groups of samples compared.

**Usage**

`estiExonNBstat(RCS)`

**Arguments**

- **RCS** a ReadCountSet object after running `exonTestability`.

**Value**

A ReadCountSet object with the slot `featureData` updated.

**Note**

Please run `exonTestability` before you run this function.

**Author(s)**

Xi Wang. xi.wang@newcastle.edu.au

**References**


**See Also**

`exonTestability`, `estiGeneNBstat`

**Examples**

```r
data(RCS_example, package="SeqGSEA")
RCS_example <- exonTestability(RCS_example, cutoff=5)
RCS_example <- estiExonNBstat(RCS_example)
head(fData(RCS_example))
```
estieGeneNBstat

Calculate NB-statistics quantifying differential splicing for each gene

Description

Calculate NB-statistics quantifying differential splicing for each gene between two groups of samples compared. The results will be used for GSEA run (as DS-scores).

Usage

estiGeneNBstat(RCS)

Arguments

RCS

a ReadCountSet object after running estiExonNBstat.

Value

A ReadCountSet object with slot featureData_gene updated.

Note

Please run estiExonNBstat before run this function.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

estiExonNBstat

Examples

data(RCS_example, package="SeqGSEA")
RCS_example <- exonTestability(RCS_example, cutoff=5)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
head(RCS_example@featureData_gene)
### exonID

**Accessor to the exonID slot of ReadCountSet objects**

**Description**

Accessor to the exonID slot of ReadCountSet objects

**Usage**

```r
exonID(RCS)
exonID(RCS) <- value
```

**Arguments**

- `RCS` - a ReadCountSet object
- `value` - a vector of exon IDs

**Value**

A character vector of exon IDs; or a ReadCountSet object.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

`newReadCountSet`, `geneID`

**Examples**

```r
data(RCS_example, package="SeqGSEA")
exonID(RCS_example)
```

---

### exonTestability

**Check exon testability**

**Description**

Check exon testability, filtering out exons with very few (default: 5) read counts

**Usage**

```r
exonTestability(RCS, cutoff = 5)
```

**Arguments**

- `RCS` - a ReadCountSet object.
- `cutoff` - exons with read counts less than this cutoff are to be marked as untestable.
geneID

Value

A character vector of gene IDs, which can be duplicated; or a ReadCountSet object.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

geneTestability

testability

testability

Examples

data(RCS_example, package="SeqGSEA")
RCS_example <- exonTestability(RCS_example, cutoff=5)
head(fData(RCS_example))

geneID(RCS_example)
geneList

Get the gene list in a SeqGeneSet object

Description

Get the gene list in a SeqGeneSet object

Usage

geneList(GS)

Arguments

GS  A SeqGeneSet object.

Details

TBA

Value

A vector of gene IDs.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

loadGenesets, SeqGeneSet-class

Examples

##
gs <- newGeneSets(GS=list(1:10, 6:15, 11:20),
                    geneList=paste("Gene", 1:22, sep=""),
                    GSNames=c("gs1","gs2","gs3"),
                    GSDescs=c("test1","test2","test3"),
                    name="gs examples")
geneList(gs)
## End
genePermuteScore

Calculate gene scores on permutation data sets

Description
Calculate gene scores on permutation data sets

Usage
genePermuteScore(DEsporeMat, DSScoreMat = NULL, method = c("linear", "quadratic", "rank"), DEweight = 0.5)

Arguments
- **DEscoreMat**: normalized DE scores on permutation data sets.
- **DSScoreMat**: normalized DS scores on permutation data sets.
- **method**: one of the integration methods: linear, quadratic, or rank; default: linear.
- **DEweight**: any number between 0 and 1 (included), the weight of differential expression scores (the weight for differential splice is (1-DEweight)).

Details
The integration methods including "linear", "quadratic", and "rank" are detailed in Wang and Cairns (2013). Here the rank method refers only to the method using data-set-specific ranks.

For DE-only analysis, just specify DEweight to be 1, and the DSScoreMat value can be NULL.

Value
A gene score matrix.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au

References

See Also
geneScore

Examples
data(DEscore.perm, package="SeqGSEA")
data(DSScore.perm, package="SeqGSEA")
# linear combination with weight for DE 0.3
gene.score.perm <- genePermuteScore(DEscore.perm, DSScore.perm, method="linear", DEweight=0.3)
# DE only analysis
gene.score.perm <- genePermuteScore(DEscore.perm, DEweight=1)
geneScore  

*Calculate gene scores by integrating DE and DS scores*

**Description**

Calculate gene scores by integrating DE and DS scores

**Usage**

```
geneScore(DEscore, DSscore = NULL, method = c("linear", "quadratic", "rank"), DEweight = 0.5)
```

**Arguments**

- `DEscore`: normalized DE scores.
- `DSscore`: normalized DS scores.
- `method`: one of the integration methods: linear, quadratic, or rank; default: linear.
- `DEweight`: any number between 0 and 1 (included), the weight of differential expression scores (the weight for differential splice is (1-DEweight)).

**Details**

The integration methods including "linear", "quadratic", and "rank" are detailed in Wang and Cairns (2013). Here the rank method refers only to the method using data-set-specific ranks.

For DE-only analysis, just specify DEweight to be 1, and the DSscore value can be NULL.

**Value**

A vector of gene scores.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**References**


**See Also**

genePermuteScore

**Examples**

```
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
# linear combination with weight for DE 0.3
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
# DE only analysis
gene.score <- geneScore(DEscore, DEweight = 1)
```
geneSetDescs  

*Get the descriptions of gene sets in a SeqGeneSet object*

**Description**

Get the descriptions of gene sets in a SeqGeneSet object

**Usage**

```r
geneSetDescs(GS)
```

**Arguments**

- **GS**
  - a SeqGeneSet object.

**Details**

Gene sets with size less than `GSSizeMin` or more than `GSSizeMax` are not included.

**Value**

A vector of descriptions of each gene set in the SeqGeneSet object.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

- `geneSetNames`
- `geneSetSize`
- `SeqGeneSet-class`
- `loadGenesets`

**Examples**

```r
data(GS_example, package="SeqGSEA")
geneSetDescs(GS_example)
```

---

geneSetNames  

*Get the names of gene set in a SeqGeneSet object*

**Description**

Get the names of gene set in a SeqGeneSet object

**Usage**

```r
geneSetNames(GS)
```

**Arguments**

- **GS**
  - a SeqGeneSet object.


Details

Gene sets with size less than GSSizeMin or more than GSSizeMax are not included.

Value

A vector of gene set names in this SeqGeneSet object.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

geneSetDescs, geneSetSize, SeqGeneSet-class, loadGenesets

Examples

data(GS_example, package="SeqGSEA")
geneSetNames(GS_example)


geneSetSize

Get the numbers of genes in each gene set in a SeqGeneSet object

Description

Get the numbers of genes in each gene set in a SeqGeneSet object

Usage

geneSetSize(GS)

Arguments

GS a SeqGeneSet object.

Details

Gene sets with size less than GSSizeMin or more than GSSizeMax are not included.

Value

A vector of integers indicating the number of genes in each gene set in this SeqGeneSet object.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

geneSetNames, geneSetDescs, SeqGeneSet-class, loadGenesets
geneTestability

Examples

```r
data(GS_example, package="SeqGSEA")
geneSetSize(GS_example)
```

```r
geneTestability(RCS)
```

Description

This function is to determine each gene’s testability. A gene is testable if at least one of its exons are testable.

Usage

```r
geneTestability(RCS)
```

Arguments

- `RCS` a ReadCountSet object after exon testability checked, usually the output of `exonTestability`.

Details

This result can be applied to filter out genes not expressed.

Value

A logical vector indicating which genes are testable, i.e., having at least one exon testable.

Note

Please run `exonTestability` before run this function.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

`exonTestability`, `subsetByGenes`

Examples

```r
data(RCS_example, package="SeqGSEA")
RCS_example <- exonTestability(RCS_example, cutoff=5)
geneTestable <- geneTestability(RCS_example)
head(geneTestable)
```
genpermuteMat Generate permutation matrix

Description
Generate permutation matrix from ReadCountSet objects or from label vectors.

Usage
genpermuteMat(obj, times = 1000, seed = NULL)

Arguments
- obj: a ReadCountSet object or a label vector. This function needs the original sample label information to generate permutation matrix.
- times: an integer indication the times of permutation.
- seed: an integer or NULL, to produce the random seed (an integer vector) for generating random permutation matrix: the same seed generates the same permutation matrix, which is introduced for reproducibility.

Value
A sample label shuffled matrix, rows corresponding to samples and columns for each permutation.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au

See Also
DSpermute4GSEA, DENBStatPermut4GSEA

Examples
data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10, seed=0)
RCS_example <- exonTestability(RCS_example)
RCS_example <- DSpermute4GSEA(RCS_example, permuteMat)

getGeneCount Calculate read counts of genes from a ReadCountSet object

Description
Calculate read counts of genes from a ReadCountSet object

Usage
getGeneCount(RCS)
GSEAresultTable

Arguments

RCS    a ReadCountSet object

Details

This function can be used to get gene read counts from exon read counts.

Value

a matrix of gene read counts for each gene (row) and each sample (col).

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

loadExonCountData, runDESeq

Examples

data(RCS_example, package="SeqGSEA")
geneCounts <- getGeneCount(RCS_example)

GSEAresultTable

Form a table for GSEA results

Description

Form a table for GSEA results.

Usage

GSEAresultTable(gene.set, GSDesc = FALSE)

Arguments

gene.set    a SeqGeneSet object after running GSEnrichAnalyze.
GSDesc      logical indicating whether to output gene set descriptions. default: FALSE

Value

A data frame containing columns of GSName, GSSize, ES, ES.pos, pval, FDR, and FWER.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

GSEnrichAnalyze, topGeneSets
Examples

data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
GS_example <- GSEnrichAnalyze(GS_example, gene.score, gene.score.perm)
head(GSEAresultTable(GS_example))

GSEnrichAnalyze  
Main function of gene set enrichment analysis

Description

The main function of gene set enrichment analysis

Usage

GSEnrichAnalyze(gene.set, gene.score, gene.score.perm, weighted.type = 1)

Arguments

gene.set     a SeqGeneSet object.
gene.score   a vector of integrated gene scores in the same order as genes listed in the geneList slot of gene.set.
gene.score.perm a matrix of integrated gene scores on permutation data sets; row: genes; col: permutation.
weighted.type weight type for gene scores; default: 1.

Value

A SeqGeneSet object with many slots updated, such as GSEA.ES and GSEA.pval.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

normES, signifES
Examples

data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
GS_example <- GSEnrichAnalyze(GS_example, gene.score, gene.score.perm)
topGeneSets(GS_example, 5)

GS_example

SeqGeneSet object example

Description

An exemplified SeqGeneSet object to demonstrate functions in the SeqGSEA package. This object was generated with collection #6 (C6) gene sets of the Molecular Signatures Database (MSigDB) v3.1.

Usage

data("GS_example")

References


label

Get the labels of samples in a ReadCountSet object

Description

Get the labels of samples in a ReadCountSet object

Usage

label(RCS)

Arguments

RCS a ReadCountSet object

Author(s)

Xi Wang, xi.wang@newcastle.edu.au
loadExonCountData

See Also
newReadCountSet

Examples

data(RCS_example, package="SeqGSEA")
label(RCS_example)

loadExonCountData(case.files, control.files)

Arguments
case.files a character vector containing the exon count file names for case samples
control.files a character vector containing the exon count file names for control samples

Details
You may need the Python script count_in_exons.py (released with this package) to generate your exon count files from read mapping results (say BAM files). The detailed usage can be obtained by simply typing python \path\to\count_in_exons.py. Users can also use other scripts or software for exon read counting.

The format of the exon count file is:

GeneName1:001[tab]Count11
GeneName1:002[tab]Count12
...
GeneName1:00N[tab]Count1N
GeneName2:001[tab]Count21
...

Value
This function returns a ReadCountSet object.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au

See Also
newReadCountSet, ReadCountSet-class
Examples

```r
library(SeqGSEA)

dat.dir = system.file("extdata", package="SeqGSEA", mustWork=TRUE)
case.pattern <- "^SC"
ctrl.pattern <- "^SN"

case.files <- dir(dat.dir, pattern=case.pattern, full.names = TRUE)
control.files <- dir(dat.dir, pattern=ctrl.pattern, full.names = TRUE)

## Not run:

RCS <- loadExonCountData(case.files, control.files)
RCS

## End (Not run)
```

### loadGenesets

**Load gene sets from files**

**Description**

This function is to load annotation of gene sets from files. The files are in the format of Molecular Signatures Database (MSigDB), and those files can be downloaded at [http://www.broadinstitute.org/gsea/msigdb/index.jsp](http://www.broadinstitute.org/gsea/msigdb/index.jsp).

**Usage**

```r
loadGenesets(geneset.file, geneIDs, geneID.type = c("gene.symbol", "ensembl"),
gen esetsize.min = 5, genesetsize.max = 1000)
```

**Arguments**

- `geneset.file`: the file containing the gene set annotation.
- `geneIDs`: gene IDs that have expression values in the studied data set.
- `geneID.type`: indicating the type of gene IDs, gene symbol or emsembl gene IDs.
- `genesetsize.min`: the minimum number of genes in a gene set that will be treated in the analysis.
- `genesetsize.max`: the maximum number of genes in a gene set that will be treated in the analysis.

**Details**

TBA

**Value**

A SeqGeneSet object.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au
newGeneSets

Initialize a new SeqGeneSet object

Description
This is an internal function to generate a new SeqGeneSet object.

Usage
newGeneSets(GS, GSNames, GSDescs, geneList, name = NA_character_,
sourceFile = NA_character_, GSSizeMin = 5, GSSizeMax = 1000)

Arguments
- GS: a list, each element is an integer vector, indicating the indexes of genes in each
gene set. See Details below.
- GSNames: a character string vector, each is the name of each gene set.
- GSDescs: a character string vector, each is the description of each gene set.
- geneList: a character string vector of gene IDs. See Details below.
- name: the name of this category of gene sets.
- sourceFile: the source file name of this category of gene sets.
- GSSizeMin: the minimum number of genes in a gene set to be analyzed. Default: 5
- GSSizeMax: the maximum number of genes in a gene set to be analyzed. Default: 1000

Details
TBA

Value
A SeqGeneSet object.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au
newReadCountSet

See Also

loadGenesets, SeqGeneSet-class

Examples

```r
##
gs <- newGeneSets(GS=list(1:10, 6:15, 11:20),
genList=paste("Gene", 1:22, sep=""),
GSNames=c("gs1","gs2","gs3"),
GSDescs=c("test1","test2","test3"),
name="gs examples")
gs
## End
```

---

newReadCountSet Generate a new ReadCountSet object

Description

This is an internal function to generate a new ReadCountSet object.

Usage

```r
newReadCountSet(readCounts, exonIDs, geneIDs)
```

Arguments

- **readCounts**: a data frame, read counts for each exon of each samples. Must have colnames, which indicate the label of samples.
- **exonIDs**: a character vector indicating exon IDs.
- **geneIDs**: a character vector indicating gene IDs.

Value

A object of the ReadCountSet class.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

loadExonCountData, ReadCountSet-class
Examples

rcounts <- cbind(t(sapply(1:10, function(x) {rnbinom(5, size=10, prob=runif(1))} ) ) ,
                t(sapply(1:10, function(x) {rnbinom(5, size=10, prob=runif(1))} ) ) )
colnames(rcounts) <- c(paste("S", 1:5, sep=""), paste("C", 1:5, sep=""))
geneIDs <- c(rep("G1", 4), rep("G2", 6))
exonIDs <- c(paste("E", 1:4, sep=""), paste("E", 1:6, sep=""))
##
RCS <- newReadCountSet(rcounts, exonIDs, geneIDs)
RCS
## End

---

**normES**

*Normalize enrichment scores*

**Description**

This is an internal function to normalize enrichment scores. For advanced users only.

**Usage**

normES(gene.set)

**Arguments**

- **gene.set**: a SeqGeneSet object after running `calES` and `calES.perm`.

**Value**

A SeqGeneSet object with ES scores normalized.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

GSEnrichAnalyze, signifES

---

**normFactor**

*Get normalization factors for normalization DE or DS scores*

**Description**

Get normalization factors from permutation scores for normalization DE or DS scores

**Usage**

normFactor(permStat)
plotES

Arguments

permStat  a matrix of NB-statistics from permutation data sets, with row corresponding to
genomes and columns to permutations.

Value

A vector of normalization factors, each for one gene.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

scoreNormalization

Examples

data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermute4GSEA(RCS_example, permuteMat)
## (not run)
DSScore.normFac <- normFactor(RCS_example@permute_NBstat_gene)
DSScore <- scoreNormalization(RCS_example@featureData_gene$NBstat, DSScore.normFac)
DSScore.perm <- scoreNormalization(RCS_example@permute_NBstat_gene, DSScore.normFac)
## End (not run)

plotES  Plot the distribution of enrichment scores

Description

This function is to plot the distribution of enrichment scores, with comparison with permutation enrichment scores.

Usage

plotES(gene.set, pdf = NULL)

Arguments

gene.set  a SeqGeneSet object after running GSEnrichAnalyze.

pdf  whether to save the plot to PDF file; if yes, provide the name of the PDF file.
plotGeneScore

Description

This function is to plot gene scores, as well as DE scores and DS scores.

Usage

plotGeneScore(score, perm.score = NULL, pdf = NULL, 
main = c("Overall", "Expression", "Splicing"))

Arguments

score the gene/DE/DS score vector.
perm.score a matrix of the corresponding gene/DE/DS scores on the permutation data sets.
pdf if a PDF file name provided, plot will be save to that file.
main the key words representing the type of scores that will be shown in the plot main title.

Details

The plot shows the ranked scores from the largest to the smallest. Lines also show the maximum and average scores, values shown on the top left.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au
Examples

```r
data(DEscore, package="SeqGSEA")
plotGeneScore(DEscore, main="Expression")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
plotGeneScore(gene.score)
```

---

**plotSig**

*Plot showing SeqGeneSet's p-values/FDRs vs. NESs*

Description

The function is to generate a plot of p-values (FDRs) versus normalized enrichment scores (NES). It also shows the distribution of p-values (FDRs) in this gene set category.

Usage

```r
plotSig(gene.set, pdf = NULL)
```

Arguments

- `gene.set`: a SeqGeneSet object after running `GSEnrichAnalyze`.
- `pdf`: whether to save the plot to PDF file; if yes, provide the name of the PDF file.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

`GSEnrichAnalyze`, `plotSigGeneSet`

Examples

```r
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
GS_example <- GSEnrichAnalyze(GS_example, gene.score, gene.score.perm)
plotSig(GS_example)
```
plotSigGeneSet

**Plot gene set details**

**Description**

This function is to generate a two-panel plot showing detailed information of the gene set specified. One panel is showing the running enrichment scores and the position where the ES appear. The other panel shows the significance level of the ES, comparing with permutation ESs.

**Usage**

```r
plotSigGeneSet(gene.set, i, gene.score, pdf = NULL)
```

**Arguments**

- `gene.set`: a SeqGeneSet object after running `GSEnrichAnalyze`.
- `i`: the i-th gene set in the SeqGeneSet object. `topGeneSets` is useful to find the most significantly overrepresented gene set.
- `gene.score`: the gene score vector containing gene scores for each gene.
- `pdf`: whether to save the plot to PDF file; if yes, provide the name of the PDF file.

**Details**

See `writeSigGeneSet`, which writes the detailed gene set information to a file or to the screen.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

`GSEnrichAnalyze`, `topGeneSets`, `plotSig`, `plotES`, `writeSigGeneSet`

**Examples**

```r
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
GS_example <- GSEnrichAnalyze(GS_example, gene.score, gene.score.perm)
topGeneSets(GS_example, n=5)
plotSigGeneSet(GS_example, 9, gene.score) # 9th gene set is the most significant one.
```
Integration of differential expression and differential splice scores with a rank-based strategy

Description
Integration of differential expression and differential splice scores with a rank-based strategy, which simultaneously integrates observed scores and permutation scores using the same ranks.

Usage
rankCombine(DEscore, DSscore, DEscoreMat, DSscoreMat, DEweight = 0.5)

Arguments
- **DEscore**: differential expression scores, normalized.
- **DSscore**: differential splice scores, normalized.
- **DEscoreMat**: differential expression scores in permuted data sets, normalized.
- **DSscoreMat**: differential splice scores in permuted data sets, normalized.
- **DEweight**: any number between 0 and 1 (included), the weight of differential expression scores (so the weight for differential splice is (1-DEweight)).

Details
This integration method is also known as integration with global ranks. See Wang and Cairns (2013) for details.

Value
A list with two elements geneScore and genePermuteScore.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au

References

See Also
geneScore, genePermuteScore

Examples
```
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
combine <- rankCombine(DEscore, DSscore, DEscore.perm, DSscore.perm, DEweight=0.3)
gene.score <- combine$geneScore
gene.score.perm <- combine$genePermuteScore
```
RCS_example  

ReadCountSet object example

Description

An exemplified ReadCountSet object to demonstrate functions in the SeqGSEA package. This object is comprised of 20 samples across 5,000 exons, a part of the prostate cancer RNA-Seq data set from Kannan et al (2011). Please note that the count data in this example object is incomplete.

Usage

data("RCS_example")

References


ReadCountSet-class  

Class "ReadCountSet"

Description

ReadCountSet class

Objects from the Class

Objects can be created by calls of the form newReadCountSet.

Slots

featureData_gene: Object of class "data.frame". Data for each genes.
permute_NBstat_exon: Object of class "matrix". NB statistics of exons on the permutation data sets.
permute_NBstat_gene: Object of class "matrix". NB statistics of genes on the permutation data sets.
assayData: Object of class "AssayData". The read count data.
phenoData: Object of class "AnnotatedDataFrame". Data for each samples.
featureData: Object of class "AnnotatedDataFrame". Data for each exons.
experimentData: Object of class "MIAxE". Experiment data.
annotation: Object of class "character". Not used.
protocolData: Object of class "AnnotatedDataFrame". Protocol information.
.__classVersion__: Object of class "Versions". Version information.
Methods

- **counts**: Get counts from a ReadCountSet object. See `counts`.
- **counts<-**: Set counts to a ReadCountSet object. See `counts`.

Extends

Class "eSet", directly.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

- `newReadCountSet`
- `loadExonCountData`
- `exonID`
- `geneID`
- `counts-methods`
- `label`
- `subsetByGenes`

Examples

```r
showClass("ReadCountSet")
```

---

**runDESeq**

*Run DESeq for differential expression analysis*

Description

This function provides a wrapper to run DESeq for differential expression analysis. It includes two steps, `DESeq::estimateSizeFactors` and `DESeq::estimateDispersions`.

Usage

```r
runDESeq(geneCounts, label)
```

Arguments

- **geneCounts**: a matrix containing read counts for each gene, can be the output of `getGeneCount`.
- **label**: the sample classification labels.

Value

A CountDataSet object with size factors and dispersion parameters been estimated.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au
runSeqGSEA

An all-in function that allows end users to apply SeqGSEA to their
data with one step.

Description

This function provides typical SeqGSEA analysis pipelines for end users to apply the SeqGSEA
method in the easiest fashion. It assumes the pipelines start with exon reads counts, even for the
DE-only analysis. Users should specify their file locations and a few parameters before running this
pipeline.

It allows DE-only analysis, which will skip the DS analysis portion, and it also allows users to try
different weights in integrating DE and DS scores, which will save time in computing the DE and
DS scores.

The function returns a list of SeqGSEA analysis results in the format of `GSEAresultTable`, and
generates a few plots and writes a few files, whose name prefix can be specified. The output files
will either be in PDF format or TXT format, and generated by `plotGeneScore`, `writeScores`,
`plotES`, `plotSig`, `plotSigGeneSet`, and `writeSigGeneSet`.

Usage

```r
runSeqGSEA(data.dir, case.pattern, ctrl.pattern, geneset.file, output.prefix, topGS=10,
geneID.type=c("gene.symbol", "ensembl"), nCores=1, perm.times=1000, seed=NULL,
minExonReadCount=5, integrationMethod=c("linear", "quadratic", "rank"),
DEweight=c(0.5), DEonly=FALSE, minGSsize=5, maxGSsize=1000, GSEA.WeightedType=1)
```

Arguments

- `data.dir` a character vector, the path to your count data directory.
- `case.pattern` a character vector, the unique pattern in the file names of case samples. E.g. if
  file names starting with "SC", the pattern writes "^SC".
- `ctrl.pattern` a character vector, the unique pattern in the file names of control samples.
- `geneset.file` a character vector, the path to your gene set file. The gene set file must be in
- `output.prefix` a character vector, the path with prefix for output files.
runSeqGSEA

**topGS**
an integer, this number of top ranked gene sets will be output with details; if
geneset.file contains less than this number of gene sets, all gene sets’ result
details will be output. Default: 10.

**geneID.type**
the gene ID type in geneset.file. Currently only support "gene.symbol" and "en-
semble". Default: gene.symbol.

**nCores**
an integer. The number of cores for running SeqGSEA. Default: 1

**perm.times**
an integer. The number of times for permutation, which will be used for nor-
malizing DE and DS scores and for GSEA significance analysis. Recommended
values are greater than 1000. Default: 1000.

**seed**
an integer or NULL, used for setting the seeds to generate random numbers. The
same seed will guarantee the same analysis results given by SeqGSEA. Default:
NULL.

**minExonReadCount**
an integer. An exon with total read count across all samples less than this number
will be marked as untestable and be excluded in SeqGSEA analysis. Default: 5.

**integrationMethod**
one of the three integration methods for DE and DS score integration: linear,
quadratic, or rank. Default: linear.

**DEweight**
a real number between 0 and 1 OR a vector of those. Each number is the DE
weight in DE and DS integration. If using a vector of real numbers, SeqGSEA
will run with each of them individually. Default: 0.5.

**DEonly**
logical, whether to run SeqGSEA only considering DE. Default: FALSE

**minGSsize**
an integer. The minimum gene set size: gene sets with genes less than this
number will be skipped. Default: 5.

**maxGSsize**
an integer. The maximum gene set size: gene sets with genes greater than this
number will be skipped. Default: 1000.

**GSEA.WeightedType**
the weight type of the main GSEA algorithm, can be 0 (unweighted = Kolmogorov-
Smirnov), 1 (weighted), and 2 (over-weighted). Default: 1. It is recommended
not to change it.

**Value**
A list of SeqGSEA analysis results in the format of **GSEAresultTable**, which allows users for
meta-analysis.

**Author(s)**
Xi Wang, xi.wang@mdc-berlin.de

**References**
Xi Wang and Murray J. Cairns (2013). Gene Set Enrichment Analysis of RNA-Seq Data: Integrat-

**See Also**
GSEAresultTable, geneScore, GSEnrichAnalyze
Examples

```r
### Initialization ###
# input file location and pattern
data.dir <- system.file("extdata", package="SeqGSEA", mustWork=TRUE)
case.pattern <- "^SC" # file name starting with "SC"
ctrl.pattern <- "^SN" # file name starting with "SN"
# gene set file and type
geneset.file <- system.file("extdata", "gs_symb.txt",
package="SeqGSEA", mustWork=TRUE)
geneID.type <- "ensembl"
# output file prefix
output.prefix <- "SeqGSEAexample"
# analysis parameters
nCores <- 1
perm.times <- 10
DEonly <- FALSE
DEweight <- c(0.2, 0.5, 0.8) # a vector for different weights
integrationMethod <- "linear"

### one step SeqGSEA running ###
# Caution: if running the following command line, it will generate many files in your working directory
runSeqGSEA(data.dir=data.dir, case.pattern=case.pattern, ctrl.pattern=ctrl.pattern,
geneset.file=geneset.file, geneID.type=geneID.type, output.prefix=output.prefix,
nCores=nCores, perm.times=perm.times, integrationMethod=integrationMethod,
DEonly=DEonly, DEweight=DEweight)
```

scoreNormalization

Normalized DE/DS scores

Description

Normalization of DE/DS scores or permutation DE/DS scores.

Usage

```r
scoreNormalization(scores, norm.factor)
```

Arguments

- **scores**: a vector (a nX1 matrix) of a matrix of scores, rows corresponding to genes and columns corresponding to a study or permutation.
- **norm.factor**: normalization factor, output of the function `normFactor`.

Value

A normalized vector or matrix depending on the input: with the same dimensions as the input.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au
**References**


**See Also**

normFactor

**Examples**

```r
data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermute4GSEA(RCS_example, permuteMat)
## (not run)
DSscore.normFac <- normFactor(RCS_example@permute_NBstat_gene)
DSscore <- scoreNormalization(RCS_example@featureData_gene$NBstat, DSScore.normFac)
DSscore.perm <- scoreNormalization(RCS_example@permute_NBstat_gene, DSScore.normFac)
## End (not run)
```

---

**SeqGeneSet-class**

**Class** "SeqGeneSet"

**Description**

SeqGeneSet class

**Objects from the Class**

Objects can be created by calls of the function `newGeneSets`.

**Slots**

- `name`: Object of class "character" the name of this gene set category
- `sourceFile`: Object of class "character" the source file of gene set category
- `geneList`: Object of class "character" the gene ID list indicating genes involved in this GSEA
- `GS`: Object of class "list" a list of gene indexes corresponding to `geneList`, each element in the list indicating which genes are in each gene set of this SeqGeneSet object
- `GSNames`: Object of class "character". Gene set names.
- `GSDescs`: Object of class "character". Gene set descriptions.
- `GSSize`: Object of class "numeric". Gene set sizes.
- `GSSizeMin`: Object of class "numeric". The minimum gene set size to be analyzed.
- `GSSizeMax`: Object of class "numeric". The maximum gene set size to be analyzed.
- `GS.Excluded`: Object of class "list". Gene sets excluded to be analyzed.
- `GSNames.Excluded`: Object of class "character". Gene set names excluded to be analyzed.
- `GSDescs.Excluded`: Object of class "character". Gene set descriptions excluded to be analyzed.
GSEA.ES: Object of class "numeric". Enrichment scores.
GSEA.ES.pos: Object of class "numeric". The positions where enrichment scores appear.
GSEA.ES.perm: Object of class "matrix". The enrichment scores of the permutation data sets.
GSEA.score.cumsum: Object of class "matrix". Running enrichment scores.
GSEA.normFlag: Object of class "logical". Logical indicating whether GSEA.ES has been normalized.
GSEA.pval: Object of class "numeric". P-values of each gene set.
GSEA.FWER: Object of class "numeric". Family-wise error rate of each gene set.
GSEA.FDR: Object of class "numeric". False discovery rate of each gene set.
version: Object of class "Versions". Version information.

Methods

- Get a sub-list of gene sets, and return a SeqGeneSet object.
- show  Show basic information of the SeqGeneSet object.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

References


See Also

newGeneSets, size, geneSetNames, geneSetDescs, geneSetSize

Examples

showClass("SeqGeneSet")

signifES  Calculate significance of ESs

Description

The is an internal function to calculate significance of ESs of each gene set. For advanced users only.

Usage

signifES(gene.set)

Arguments

gene.set  a GeneSet object after running normES.
The `size` function is used to get the number of gene sets in a `SeqGeneSet` object. Its syntax is as follows:

```r
size(GS)
```

The arguments are:

- `GS` an object of class `SeqGeneSet`.

The function returns the number of gene sets in this `SeqGeneSet` object.

### Details

Gene sets with size less than `GSSizeMin` or more than `GSSizeMax` are not included.

### Value

The number of gene sets in this `SeqGeneSet` object.

### Examples

```r
data(GS_example, package="SeqGSEA")
size(GS_example)
```
subsetByGenes

Get a new ReadCountSet with specified gene IDs.

Description

Get a new ReadCountSet with specified gene IDs.

Usage

subsetByGenes(RCS, genes)

Arguments

RCS a ReadCountSet object.

genes a list of gene IDS.

Value

This function returns a new ReadCountSet object, with changes in slots assayData, featureData, featureData_gene, and permute_NBstat_exon and permute_NBstat_gene if they have been calculated.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

cnewReadCountSet, ReadCountSet

Examples

data(RCS_example, package="SeqGSEA")
RCS_example
genes <- c("ENSG00000000938", "ENSG00000000005")
RCS_sub <- subsetByGenes(RCS_example, genes)
RCS_sub


topDEGenes

Extract top differentially expressed genes.

Description

This function is to extract top n differentially expressed genes, ranked by either DESeq p-values, DESeq adjusted p-values, permutation p-values, permutation adjusted p-values, or NB-statistics.

Usage

topDEGenes(DEGres, n = 20,
sortBy = c("padj", "pval", "perm.pval", "perm.padj", "NBstat", "foldChange"))
topDSExons

Arguments

DEGres DE analysis results.
n the number of top DE genes.
sortBy indicating which method to rank genes.

Details

If the sortBy method is not among the column names, the function will result in an error.

Value

A table for top n DE genes with significance metrics.

Author(s)

Xi Wang, xi.wang@newcastle.edu.au

See Also

topDSGenes, topDSExons

Examples

data(RCS_example, package="SeqGSEA")
geneCounts <- getGeneCount(RCS_example)
label <- label(RCS_example)
DEG <- runDESeq(geneCounts, label)
permuteMat <- genpermuteMat(RCS_example, times=10)
DEGres <- DENBTest(DEG)
DEpermNBstat <- DENBStatPermut4GSEA(DEG, permuteMat)
DEGres <- DEpermutePval(DEGres, DEpermNBstat)
topDEGenes(DEGres, n = 10, sortBy = "NBstat")

topDSExons Extract top differentially spliced exons

Description

This function is to extract top n differentially spliced exons, ranked by p-values or NB-stats.

Usage

topDSExons(RCS, n = 20, sortBy = c("pvalue", "NBstat"))

Arguments

RCS a ReadCountSet object after running DSpermutePval.
n the number of top genes.
sortBy indicating whether p-value or NBstat to be used for ranking genes.
**topDSGenes**

**Value**
A table for top n exons. Columns include: geneID, exonID, testable, NBstat, pvalue, padjust, and meanCounts.

**Author(s)**
Xi Wang, xi.wang@newcastle.edu.au

**See Also**
topDSGenes, DSpermutePval

**Examples**
```r
data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermutePval(RCS_example, permuteMat)
topDSEXons(RCS_example, 10, "NB")
```

---

**topDSGenes**  
Extract top differentially spliced genes

**Description**
This function to extract top n differentially spliced genes, ranked by p-values or NBstats.

**Usage**
topDSGenes(RCS, n = 20, sortBy = c("pvalue", "NBstat"))

**Arguments**
- **RCS** a ReadCountSet object after running DSpermutePval.
- **n** the number of top genes.
- **sortBy** indicating whether p-value or NBstat to be used for ranking genes.

**Value**
A table for top n genes. Columns include: geneID, NBstat, pvalue, and padjust.

**Author(s)**
Xi Wang, xi.wang@newcastle.edu.au

**See Also**
topDSEXons, DSpermutePval
topGeneSets

Examples

```r
data(RCS_example, package="SeqGSEA")
permuteMat <- genpermuteMat(RCS_example, times=10)
RCS_example <- exonTestability(RCS_example)
RCS_example <- estiExonNBstat(RCS_example)
RCS_example <- estiGeneNBstat(RCS_example)
RCS_example <- DSpermutePval(RCS_example, permuteMat)
topDSGenes(RCS_example, 10, "NB")
```

---

topGeneSets  Extract top significant gene sets

Description

This function is to extract n top significant gene sets overrepresented in the samples studied, ranked by FDR, p-values, or FWER.

Usage

```r
topGeneSets(gene.set, n = 20, sortBy = c("FDR", "pvalue", "FWER"), GSDesc = FALSE)
```

Arguments

- `gene.set`: an object of class SeqGeneSet after GSEA runs.
- `n`: the number of top gene sets.
- `sortBy`: indicating which method to rank gene sets.
- `GSDesc`: logical indicating whether or not to output gene set descriptions.

Value

A data frame for top n gene sets detected with respect to the ranking method specified. Information includes: GSName, GSSize, ES, ES.pos, pval, FDR, and FWER.

Author(s)

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See Also

GSEnrichAnalyze, GSEAresultTable

Examples

```r
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
GS_example <- GSEnrichAnalyze(GS_example, gene.score, gene.score.perm)
topGeneSets(GS_example, n=5)
```
writeScores  Write DE/DS scores and gene scores

Description
This function is to write DE and DS scores, and optionally gene scores.

Usage
writeScores(DEscore, DSscore, geneScore=NULL, geneScoreAttr=NULL, file="")

Arguments
- DEscore: normalized DE scores.
- DSscore: normalized DS scores.
- geneScore: gene scores integrated from DE and DS scores.
- geneScoreAttr: the parameters for integrating DE and DS scores.
- file: output file name, if not specified print to screen.

Author(s)
Xi Wang, xi.wang@newcastle.edu.au

See Also
DEscore, geneScore

Examples
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
writeScores(DEscore, DSscore) # without gene scores
writeScores(DEscore, DSscore, geneScore = gene.score, geneScoreAttr = "linear,0.3") # gene scores with attr.

writeSigGeneSet  Write gene set supporting information

Description
This function is to write the specified gene set (whose index is i) with significance information, including p-value and FDR, and gene scores for each gene in this set.

Usage
writeSigGeneSet(gene.set, i, gene.score, file = "")
**writeSigGeneSet**

**Arguments**

- `gene.set` an object of class SeqGeneSet with `GSEnrichAnalyze` done.
- `i` the i-th gene set in the SeqGeneSet object. `topGeneSets` is useful to find the most significantly overrepresented gene set.
- `gene.score` the vector of gene scores for running GSEA.
- `file` output file name, if not specified print to screen.

**Details**

See `plotSigGeneSet`, which shows graphic information of the gene set specified.

**Author(s)**

Xi Wang, xi.wang@newcastle.edu.au

**See Also**

`GSEnrichAnalyze`, `topGeneSets`, `plotSigGeneSet`

**Examples**

```r
data(DEscore, package="SeqGSEA")
data(DSscore, package="SeqGSEA")
gene.score <- geneScore(DEscore, DSscore, method="linear", DEweight = 0.3)
data(DEscore.perm, package="SeqGSEA")
data(DSscore.perm, package="SeqGSEA")
gene.score.perm <- genePermuteScore(DEscore.perm, DSscore.perm, method="linear", DEweight=0.3)
data(GS_example, package="SeqGSEA")
GS_example <- GSEnrichAnalyze(GS_example, gene.score, gene.score.perm)
topGeneSets(GS_example, n=5)
writeSigGeneSet(GS_example, 9, gene.score) # 9th gene set is the most significant one.
```
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