Package ‘phantasus’

March 26, 2024

**Title**  Visual and interactive gene expression analysis

**Version**  1.22.2

**Description**  Phantasus is a web-application for visual and interactive gene expression analysis. Phantasus is based on Morpheus – a web-based software for heatmap visualisation and analysis, which was integrated with an R environment via OpenCPU API. Aside from basic visualization and filtering methods, R-based methods such as k-means clustering, principal component analysis or differential expression analysis with limma package are supported.

**URL**  https://genome.ifmo.ru/phantasus, https://artyomovlab.wustl.edu/phantasus

**BugReports**  https://github.com/ctlab/phantasus/issues

**Depends**  R (>= 3.5)

**biocViews**  GeneExpression, GUI, Visualization, DataRepresentation, Transcriptomics, RNASeq, Microarray, Normalization, Clustering, DifferentialExpression, PrincipalComponent, ImmunoOncology

**Imports**  ggplot2, protolite, Biobase, GEOquery, Rook, htmltools, httpuv, jsonlite, limma, edgeR, opencpu, assertthat, methods, httr, rhdf5, utils, parallel, stringr, fgsea (>= 1.9.4), svglite, gtable, stats, Matrix, pheatmap, scales, ccaPP, grid, grDevices, AnnotationDbi, DESeq2, data.table, curl

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**Author** Daria Zenkova [aut], Vladislav Kamenev [aut], Rita Sablina [ctb], Maxim Kleverov [ctb], Maxim Artyomov [aut], Alexey Sergushichev [aut, cre]

**Maintainer** Alexey Sergushichev <alsergbox@gmail.com>

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**adjustDataset**

Adjust dataset

**Usage**

```r
adjustDataset(
es,
scaleColumnSum = NULL,
log2 = FALSE,
onePlusLog2 = FALSE,
inverseLog2 = FALSE,
quantileNormalize = FALSE,
zScore = FALSE,
robustZScore = FALSE,
sweep = NULL
)
```

**Arguments**

- `es` Expression set to perform adjustment on
- `scaleColumnSum` perform sum scaling of columns (default FALSE)
- `log2` perform logarithm2 adjustment (default FALSE)
- `onePlusLog2` perform log2(1+x) adjustment (default FALSE)
- `inverseLog2` perform 2^x adjustment (default FALSE)
- `quantileNormalize` perform quantile normalization (default FALSE)
- `zScore` perform zScore adjustment: subtract mean, divide by std (default FALSE)
- `robustZScore` perform robustZScore adjustment: subtract median, divide by MAD (default FALSE)
- `sweep` perform sweep adjustment on rows/columns (default FALSE)

**Value**

Nothing. Adjusted dataset will be assigned as ES in global environment
calcPCA

Principal Component Analysis.

Description

calcPCA calculates PCA-matrix for the given ExpressionSet and returns this matrix encoded to JSON.

Usage

calcPCA(es, replacena = "mean")

annotationDBMeta

Create meta file for AnnotationDB

Description

createES function creates an rds file containing meta information of provided sqlite files for AnnotationDB

Usage

annotationDBMeta(cacheDir)

Arguments

cacheDir cacheDir for phantasus

Value

nothing

Examples

## Not run:
annotationDBMeta('~/var/phantasus/cache')

## End(Not run)

Examples

## Not run:

```r
es <- gseGSE('GSE53986')[[1]]
adjustDataset(es, log2 = T, quantileNormalize = T)
```

## End(Not run)
calculatedAnnotation

Arguments

- `es`: an ExpressionSet object, should be normalized
- `replacena`: method for replacing NA values (mean by default)

Value

json with full description of the plot for plotly.js

Examples

```r
## Not run:
data(es)
calcPCA(es)
## End(Not run)
```

Description

`calculatedAnnotation` adds a column calculated by operation

Usage

```r
calculatedAnnotation(
es, operation, 
rows = c(), 
columns = c(), 
isColumns = FALSE, 
name = NULL
)
```

Arguments

- `es`: ExpressionSet object.
- `operation`: Name of the operation to perform calculation
- `rows`: List of specified rows’ indices (optional), indices start from 0
- `columns`: List of specified columns’ indices (optional), indices start from 0
- `isColumns`: Apply fn to columns
- `name`: Name of the new annotation

Value

Nothing. Annotated dataset will be assigned to es in environment
checkGPLsFallback  

*Check possible annotations for GEO Dataset.*

**Description**

checkGPLs returns GPL-names for the specified GEO identifier.

**Usage**

```r
checkGPLsFallback(name)
```

**Arguments**

- **name**  
  String, containing GEO identifier of the dataset.

**Value**

Vector of filenames serialized in JSON format. If there is only one GPL for that dataset, the function will return `name`.

**Examples**

```r
## Not run:
checkGPLs('GSE27112')
checkGPLs('GSE14308')
## End(Not run)
```

---

collapseDataset  

*Collapse dataset*

**Description**

collapseDataset performs a collapse action on expression set

**Usage**

```r
collapseDataset(
es,  
isRows = TRUE,  
selectOne = FALSE,  
fn,  
fields,  
removeEmpty = TRUE
)
```
Arguments

- es: Expression set
- isRows: Work with rows. False if columns (default True - row mode)
- selectOne: select best match or merge duplicates
- fn: select/merge function
- fields: fields to unique on
- removeEmpty: remove unannotated genes

Value

Nothing. Collapsed dataset will be assigned to es in environment

Examples

```r
## Not run:
es <- getGSE('GSE53986')[[1]]
collapseDataset(es, isRows = TRUE, selectOne = TRUE,
fn = mean, fields = c('Gene ID', 'Gene symbol'))
## End(Not run)
```

---

**Description**

Calculate column averages in row groups

**Usage**

```r
colMeansByGroups(m, groups)
```

**Arguments**

- m: matrix n x m
- groups: vector of size n of numbers from 1 to k

**Value**

matrix k*m of column averages by groups
convertByAnnotationDB  Map indexes using Annotation DB

Description

createES function creates an rds file containing meta information of provided sqlite files for AnnotationDB

Usage

convertByAnnotationDB(
  es,
  dbName,
  columnName,
  columnType,
  keyType,
  otherOptions
)

Arguments

es          source ExpressionSet
dbName      name of AnnotationDB file
columnName  name of column in featureData of source ExpressionSet
columnType  Type of indexes in columnName
keyType     Type of mapped indexes
otherOptions additional parameters for conversion. Currently only named boolean delete-DotVersion is not ignored.

Value

JSON object with a vector of converted IDs

createES  Create ExpressionSet.

Description

createES function produces an ExpressionSet object from given data, and exports it to global scope.

Usage

createES(data, pData, varLabels, fData, fvarLabels, eData)
Arguments

data: Gene expression matrix.
pData: Matrix with phenotypical data.
varLabels: Names of phenoData columns.
fData: Matrix with feature data.
fvarLabels: Names of featureData columns.
eData: List with experimentData

Value

produced ExpressionSet object

Examples

```r
## Not run:
data <- matrix(1:15, 5, 3)
pData <- c("A", "B", "C")
varLabels <- "cat"
fData <- c("p", "r", "s", "t", "u")
fvarLabels <- "id"
eData <- list(name="", lab="", contact="", title="", url="", other=list(), pubMedIds="")
createES(data, pData, varLabels, fData, fvarLabels, eData)
## End(Not run)
```

---

**es**

*Example dataset*

**Description**

Small slice from GSE27112-GPL6103 for runnable examples.

**Usage**

data(es)

**Format**

An object of class ExpressionSet with 20 rows and 5 columns.

**Examples**

```r
## Not run:
data(es)
performKmeans(es, k = 2)
## End(Not run)
```
generatePreloadedSession

Example pathway data.frame for fgsea tool

Description
Example pathway data.frame for fgsea tool

generatePreloadedSession

Generate files for preloaded session from a session link.

Description
Generate files for preloaded session from a session link.

Usage
generatePreloadedSession(sessionURL, preloadedName, preloadedDir)

Arguments
- sessionURL: String with session link produced by phantasus.
- preloadedName: String with name that should be assigned to the session.
- preloadedDir: Path to the directory with preloaded datasets and sessions.

Value
Function produces two files (preloadedName.rda with ExpressionSet and preloadedName.json with session features) in preloadedDir folder.

Examples
```r
## Not run:
sessionURL <- "https://ctlab.itmo.ru/phantasus/?session=x063c1b365b9211" # link from 'Get dataset link...' tool in phantasus
newName <- "my_session" # user defined name
preloadedDir <- "./preloaded" # directory where files will be stored. In order too get access through phantasus web-app, dir.create(preloadedDir, showWarnings = FALSE)
generatePreloadedSession(sessionURL= sessionURL, preloadedName = newName, preloadedDir = preloadedDir)

servePhantasus(preloadedDir=preloadedDir, openInBrowser=FALSE)
# open browser manually at http://0.0.0.0:8000/phantasus/index.html?preloaded=my_session

## End(Not run)
```
getArchs4Files

Returns list of ARCHS4 hdf5 files with expression data

Description

Returns list of ARCHS4 hdf5 files with expression data

Usage

getArchs4Files(cacheDir)

Arguments

cacheDir base directory for cache

Value

list of .h5 files

getCountsMetaPart

Create meta-data for single counts collection

Description

Creates a part of counts collections meta-data

Usage

getCountsMetaPart(counts_dir, collection_name, verbose)

Arguments

counts_dir path to directory with count collections
collection_name name of collection and collection’s directory
verbose logical value which determines a content of the output.

Details

Function assumes that collection_name contains meta.txt which is valid (in sense of validateCountsCollection). For each row in meta.txt function reads specified sample_id dataset and writes every sample id to the resulting data.table with source file name and collection name.

Value

data.table with meta-data or nothing if destdir does not exist or does not contain files.
getES

 Load ExpressionSet by GEO identifier

Description

getES return the ExpressionSet object(s) corresponding to GEO identifier.

Usage

getES(
  name, 
  type = NA, 
  destdir = tempdir(), 
)

Arguments

name String, containing GEO identifier of the dataset. It should start with 'GSE' or 'GDS' and can include exact GPL to annotate dataset, separated with dash ('-') from the identifier.

type Type of the dataset: 'GSE' or 'GDS'. If not specified, the function will take first three letters of name variable as type.

destdir Directory for caching loaded Series and GPL files from GEO database.

mirrorPath URL string which specifies the source of matrices.

Value

List of ExpressionSet objects, that were available by given in name variable GEO identifier.
getGDS

Load ExpressionSet from GEO Datasets

Description

getGDS return the ExpressionSet object corresponding to GEO Dataset identifier.

Usage


Arguments

name String, containing GEO identifier of the dataset. It should start with 'GSE' or 'GDS' and can include exact GPL to annotate dataset, separated with dash ('-') from the identifier.
destdir Directory for caching loaded Series and GPL files from GEO database.
mirrorPath URL string which specifies the source of matrices.

Value

ExpressionSet object wrapped in list, that was available by given in name variable GEO identifier.

Examples

getGDS('GDS4922')

Examples

## Not run:
getES('GSE14308', type = 'GSE', destdir = 'cache')
getES('GSE27112')

## End(Not run)
getES('GDS4922')
### getGSE

**Load ExpressionSet from GEO Series**

#### Description

getGSE return the ExpressionSet object(s) corresponding to GEO Series Identifier.

#### Usage

```
```

#### Arguments

- **name**
  - String, containing GEO identifier of the dataset. It should start with 'GSE' or 'GDS' and can include exact GPL to annotate dataset, separated with dash ('-') from the identifier.

- **destdir**
  - Directory for caching loaded Series and GPL files from GEO database.

- **mirrorPath**
  - URL string which specifies the source of matrices.

#### Value

List of ExpressionSet objects, that were available by given in name variable GEO identifier.

#### Examples

```r
## Not run:
getGSE('GSE14308', destdir = 'cache')
getGSE('GSE27112')

## End(Not run)
getGSE('GSE53986')
```

### gseaPlot

**Returns path to an svg file with enrichment plot**

#### Description

Returns path to an svg file with enrichment plot
**Usage**

```r
gseaPlot(
es, rankBy, selectedGenes, width, height, vertical = FALSE, addHeatmap = FALSE, showAnnotation = NULL, annotationColors = NULL, pallete = c("blue", "white", "red")
)
```

**Arguments**

- `es` (ExpressionSet object.)
- `rankBy` (name of the numeric column used for gene ranking)
- `selectedGenes` (indexes of selected genes (starting from one, in the order of fData))
- `width` (width of the image (in inches))
- `height` (height of the image (in inches))
- `vertical` (whether to use vertical orientation (default: FALSE))
- `addHeatmap` (whether to add an expression heatmap, sorted by rankBy (default: FALSE))
- `showAnnotation` (a name of column annotation to add to the heatmap, default: NULL (no annotation))
- `annotationColors` (a list of colors to use in annotation)
- `pallete` (a vector of colors to draw heatmap)

**Value**

path to an svg file

---

**limmaAnalysis**

*Differential Expression analysis.*

**Description**

`limmaAnalysis` performs differential expression analysis from limma package and returns a ProtoBuf-serialized resulting de-matrix.
loadCounts

Usage

loadCounts(es, counts_dir)

Description

Loads expression data from .h5 count files. Only samples with counted expression are kept. If es already contains expression data it is returned as is.

Usage

loadCounts(es, counts_dir)
**loadFromARCHS4**

**Arguments**

- **es**: ExpressionSet from GEO to check for expression in ARCHS4/dee2 or other h5 files
- **counts_dir**: directory with .h5 files collections. There must be meta.rda file in counts_dir and each collection’s sub directory must have meta.txt file with description. Also counts_dir must contain counts_priority.txt file.

**Value**

either original es or an ExpressionSet with loaded count data from ARCHS4

**Description**

Loads expression data from ARCHS4 count files. Only samples with counted expression are kept. If es already contains expression data it is returned as is.

**Usage**

```r
loadFromARCHS4(es, archs4_files)
```

**Arguments**

- **es**: ExpressionSet from GEO to check for expression in ARCHS4
- **archs4_files**: list of available .h5 files from ARCHS4 project

**Value**

either original es or an ExpressionSet with loaded count data from ARCHS4

**loadGEO**

Load GEO Dataset.

**Description**

loadGEO returns the file with serialized ExpressionSet using ProtoBuf, parsed from data downloaded from GEO by identifier.

**Usage**

```r
loadGEO(name, type = NA)
```
loadPreloaded

Arguments

name String, containing GEO identifier of the dataset. It should start with 'GSE' or 'GDS' and can include exact GPL to annotate dataset, separated with dash ('-') from the identifier.

type Type of the dataset: 'GSE' or 'GDS'. If not specified, the function will take first three letters of name variable as type.

Value

File with ProtoBuf-serialized ExpressionSet-s that were downloaded by this identifier. For GSE-datasets there can be multiple annotations, so in file will be a list mapping name with GPL to ExpressionSet.

Examples

## Not run:
loadGEO("GSE27112")
loadGEO("GDS4922")

## End(Not run)

loadPreloaded Load GEO Dataset.

Description

loadPreloaded returns the file with serialized ExpressionSets using ProtoBuf, that were preloaded on server.

Usage

loadPreloaded(name)

Arguments

name String, containing filename. Assuming that in the directory with preloaded files preloadedDir exists file filename.rda with list of ExpressionSets ess.

Value

File with ProtoBuf-serialized ExpressionSet-s that were loaded from specified file.
**performKmeans**

*K-means clusterisation.*

**Description**

performKmeans returns a vector of corresponding clusters for each gene from a given Expression-Set.

**Usage**

```r
performKmeans(es, k, replacena = "mean")
```

**Arguments**

- `es` ExpressionSet object.
- `k` Expected number of clusters.
- `replacena` Method for replacing NA values in series matrix (mean by default)

**Value**

Vector of corresponding clusters, serialized to JSON.

**Examples**

```r
## Not run:
data(es)
performKmeans(es, k = 2)
## End(Not run)
```

---

**queryAnnotationDBMeta**

*Get meta list for annotationDB files*

**Description**

createES Function reads an rds file containing meta information of provided sqlite files for AnnotationDB

**Usage**

```r
queryAnnotationDBMeta()
```

**Value**

meta info in JSON
Examples

```r
## Not run:
queryAnnotationDBMeta()

## End(Not run)
```

---

**read.gct**  
*Reads ExpressionSet from a GCT file.*

---

**Description**

Only versions 1.2 and 1.3 are supported.

**Usage**

```r
read.gct(gct, ...)
```

**Arguments**

- `gct`  
  Path to gct file
- `...`  
  Additional options for `read.csv`

**Value**

ExpressionSet object

**Examples**

```r
read.gct(system.file("extdata", "centers.gct", package = "phantasus"))
```

---

**reparseCachedESs**  
*Reparse cached expression sets from GEO.*

---

**Description**

The function should be used on phantasus version updates that change behavior of loading datasets from GEO. It finds all the datasets that were cached and runs 'getES' for them again. The function uses cached Series and other files from GEO.

**Usage**

```r
```
Arguments

destdir Directory used for caching loaded Series files from GEO database.
mirrorPath URL string which specifies the source of matrices.

Value

type of previously cached GSE IDs

Examples

reparseCachedESS(destdir=tempdir())

reproduceInR Reproduce session in R code

Description

Reproduce session in R code

Usage

reproduceInR(sessionName, leaf = T, step = 0, savedEnv = new.env())

Arguments

sessionName String, OCPU session name
leaf Boolean, is it leaf (default = F)
step Integer, step of recursion (default = 0)
savedEnv Environment, where to store complex arguments (default = new.env())

Value

JSON with R code

Examples

## Not run:
setwd(tempdir())
reproduceInR('x039f1672026678');

## End(Not run)
servePhantasus  

Serve phantasus.

Description

servePhantasus starts http server handling phantasus static files and opencpu server.

Usage

servePhantasus(
  host = "0.0.0.0",
  port = 8000,
  staticRoot = system.file("www/phantasus.js", package = "phantasus"),
  cacheDir = tempdir(),
  preloadedDir = NULL,
  openInBrowser = TRUE,
  quiet = TRUE
)

Arguments

- **host**: Host to listen.
- **port**: Port to listen.
- **staticRoot**: Path to static files with phantasus.js (on local file system).
- **cacheDir**: Full path to cache directory.
- **preloadedDir**: Full path to directory with preloaded files.
- **openInBrowser**: Boolean value which states if application will be automatically loaded in default browser.
- **quiet**: Boolean value which states whether the connection log should be hidden (default: TRUE)

Value

Running instance of phantasus application.

Examples

```
## Not run:
servePhantasus()

## End(Not run)
```
shinyGAMAnalysis

Constructs data frame with gene annotations and submits it into Shiny GAM web-server

Description

Constructs data frame with gene annotations and submits it into Shiny GAM web-server

Usage

shinyGAMAnalysis(es)

Arguments

es Expression set object

Value

URL for Shiny GAM

subsetES

Subsets es, if rows or columns are not specified, all are retained

Description

Subsets es, if rows or columns are not specified, all are retained

Usage

subsetES(es, columns = c(), rows = c())

Arguments

es ExpressionSet object
columns List of specified columns’ indices (optional), indices start from 0
rows List of specified rows’ indices (optional), indices start from 0

Value

new expression set ‘es’
updateARCHS4

*Update archs4 files.*

**Description**

Download archs4 or archs4zoo counts in cacheDir. If directory does not exists function makes nothing and produce corresponding warnings.

**Usage**

```r
updateARCHS4(
  cacheDir = file.path(getOption("phantasusCacheDir"), "counts/archs4"),
  organism = c("all"),
  force = FALSE
)
```

**Arguments**

- `cacheDir`: file path to archs4 cache directory
- `organism`: vector which determines organisms to download: human, mouse, zoo or all as default. Also can be a genus. Possible genus:
  1. drosophila
  2. gallus
  3. bos
  4. caenorhabditis
  5. danio
  6. rattus
  7. saccharomyces
  8. arabidopsis
- `force`: logical value which let function replace current files

updateARCHS4meta

*Update ARCHS4 meta files*

**Description**

Creates `meta.txt` file, which describes typical archs4 and archs4Zoo files.

**Usage**

```r
updateARCHS4meta(
  archDir = file.path(getOption("phantasusCacheDir"), "counts/archs4")
)
```
updateCountsMeta

Arguments

archDir        path to directory with arch4 .h5 files.

Details

This function produces very specific "hardcoded" meta.txt file for arch4 and archs4ZOO counts collections. See validateCountsCollection for more common information and meta.txt file structure.

See Also

validateCountsCollection

updateCountsMeta  Update meta-data for counts collections

Description

Creates meta.rda file which contain information about all samples in all collections. Also function checks priority.txt file. This file is used to manage collections with the same samples.

Usage

updateCountsMeta(
  counts_dir = file.path(getOption("phantasusCacheDir"), "counts"),
  force = FALSE,
  verbose = FALSE
)

Arguments

counts_dir  path to counts cache directory
force       logical value wich lets function replace existing meta.rda file
verbose     logical value which determines a content of the output.

Details

First of all function checks validity of priority.txt file. Every Collection should have unique priority. If priority.txt is not valid function creates new one, setting priorities for each subdirectory(=collection) equal to order in list.dir output.

Function updates meta.rda if this file is older than at least one .h5 file in counts files. meta.rda is data.table which is a result of union data.tables produced by getCountsMetaPart for each collection.

See Also

validateCountsCollection,updateCountsMeta  @import data.table
updateDEE2meta  

Update DEE2 meta files

Description

Creates meta.txt file, which describes typical dee2 files.

Usage

```r
updateDEE2meta(
  destDir = file.path(getOption("phantasusCacheDir"), "counts/dee2")
)
```

Arguments

- **destDir**  
  
  path to directory with DEE2.h5 files.

Details

This function produces very specific "hardcoded" meta.txt file for dee2 counts collection. See `validateCountsCollection` for more common information and meta.txt file structure.

See Also

`validateCountsCollection`

validateCountsCollection

Check a counts collection

Description

Function checks existing and structure of meta.txt file in specified counts folder. Also it checks accessibility of specified datasets in corresponding .h5 files.

Usage

```r
validateCountsCollection(collectionDir, verbose = FALSE)
```

Arguments

- **collectionDir**  
  
  path to directory with collection

- **verbose**  
  
  logical value which determines a content of the output.
write.gct

**Details**

collectionDir should contain a bunch of .h5 files and a single meta.txt. meta.txt is .tsv-like file where for each .h5 exists a row with columns:

- **file_name** name of .h5 file in collectionDir.
- **sample_id** name of dataset in file_name which contains sample IDs (sample_geo_accession for example).
- **sample_dim** which dimension of the expression matrix in file_name corresponds to samples. Should be one of c("rows", "columns")
- **gene_id** name of dataset in file_name which contains ids for genes and the "meaning" for that ids (column name in result ES). For correct work this dataset should contain unique values. Example: ENSEMBLID:/meta/genes/ensembl_gene_id
- **genes_annot** Names of datasets and their meanings to extract gene-related metadata from file_name. Can be empty or gene_id-like values separated with semicolon(;).

**Description**

Saves ExpressionSet to a GCT file (version 1.3).

**Usage**

```r
write.gct(es, file, gzip = FALSE)
```

**Arguments**

- **es** ExpressionSet object to save
- **file** Path to output gct file
- **gzip** Whether to gzip apply gzip-compression for the output file

**Value**

Result of the closing file (as in 'close()' function)

**Examples**

```r
es <- read.gct(system.file("extdata", "centers.gct", package = "phantasus"))
out <- tempfile(fileext = ".gct.gz")
write.gct(es, out, gzip=TRUE)
```
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