Package: genomicper (via r-universe)

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Type Package

Title Circular Genomic Permutation using Genome Wide Association p-Values

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Imports stats,grDevices,utils,graphics,DBI,reactome.db,AnnotationDbi

Description Circular genomic permutation approach uses genome wide association studies (GWAS) results to establish the significance of pathway/gene-set associations whilst accounting for genomic structure(Cabrera et al (2012) <doi:10.1534/g3.112.002618>). All single nucleotide polymorphisms (SNPs) in the GWAS are placed in a 'circular genome' according to their location. Then the complete set of SNP association p-values are permuted by rotation with respect to the SNPs' genomic locations. Two testing frameworks are available: permutations at the gene level, and permutations at the SNP level. The permutation at the gene level uses Fisher's combination test to calculate a single gene p-value, followed by the hypergeometric test. The SNP count methodology maps each SNP to pathways/gene-sets and calculates the proportion of SNPs for the real and the permutated datasets above a pre-defined threshold. Genomicper requires a matrix of GWAS association p-values and SNPs annotation to genes. Pathways can be obtained from within the package or can be provided by the user.

License GPL-2

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Contents

`genomicper-package` *Circular Genomic Permutations*

Description

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Details

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Author(s)

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Maintainer: Claudia Cabrera <c.cabrera@qmul.ac.uk>

References

SNP-level Permutations:
Genomicper: genome-wide association SNP-set analysis
Claudia P. Cabrera*, Pau Navarro*, Jennifer E. Huffman, Alan F. Wright, Caroline Hayward,Harry Campbell, James F. Wilson, Igor Rudan, Nicholas D. Hastie, Veronique Vitart, Chris S. Haley*

Gene-level Permutations:
Uncovering Networks from Genome-Wide Association Studies via
Circular Genomic Permutation. G3: Genes|Genomes|Genetics 2, 1067-1075.
Claudia P. Cabrera*, Pau Navarro*, Jennifer E. Huffman, Alan F. Wright, Caroline Hayward,Harry Campbell, James F. Wilson, Igor Rudan, Nicholas D. Hastie, Veronique Vitart, Chris S. Haley*

See Also

Genomicper functions: 1) read_pvals, 2) genome_order, 3) get_pathways, 4) read2_paths, 5A) snps_permutation, 5B) genes_permutation, 6) get_results, 7) plot_results

Examples

```
##############################################################################
#  Genomicper functions                                            ##########
# 1)  read_pvals(data_name="",snps_ann="")
# 2)  genome_order(all_data="")
# 3)  get_pathways(source="reactome",all_paths="",envir="")
# 4) read2_paths(ordered_alldata="",gs_locs="",sets_from="",sets_prefix="RHSA",level="")
# 5A) snps_permutation(ordered_alldata="",pers_ids="",ntraits="",nper="",saveto="",
#  threshold="",gs_locs=gs_locs,envir = "")
# 5B) genes_permutation(ordered_alldata="",pers_ids="",pathways="",
#  ntraits="",nper="",threshold="",saveto="",gs_locs=gs_locs,envir = "")
# 6)  get_results(res_pattern="Permus",level="snp",from="workspace",
#  threshold=0.05, envir = "")
# 7) plot_results(results = "", by = "", plot_all = TRUE, var = "", save_plot = TRUE,
#       plot_name = "", bf = FALSE, save_qq = TRUE)
##############################################################################
############## DEMO: ##########################################################

#### SNP-level  ##############################################################
# SNPs annotation and Pathways provided by user
# all data stored at the WORKSPACE

### Load files for analysis
data(demo,SNPsAnnotation)

# Read & format GWAS pvalues
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
```

```
# Order data according to the genome
genome_results <-genome_order(all_data=all_data)
 # Results from genome_order
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs

# Create new environment to save variables (e.g. pathways, permutations):
gper.env <- new.env()

# Pathways can be downloaded using the function get_pathways()
# Load example pathways into the new environment.
data(RHSA164843,RHSA446343,RHSA8876384,RHSA8964572,RHSA109582,RHSA1474244,envir=gper.env)

# Map SNPs to pathways
paths_res <- read2_paths(ordered_alldata=ordered_alldata,
gs_locs=gs_locs,sets_from="workspace",sets_prefix="RHSA",
level="snp",envir=gper.env)
 # Results from read2_paths:
 pers_ids <- paths_res$per_ors
 pathways<- paths_res$pathways

# Perform permutations:
snps_permutation(ordered_alldata=ordered_alldata,
pers_ids=pers_ids,ntraits=c(7:13),nper=10,saveto="workspace",
threshold=0.05,gs_locs=gs_locs,envir = gper.env)

# Get results
results <- get_results(res_pattern="Permus",level="snp",
from="workspace",threshold=0.05,envir = gper.env)

# Plot results
## Not run:
#saves plots to working directory
qq <- plot_results(results=results,by="set",plot_all=TRUE)
qq <- plot_results(results=results,by="trait",
plot_all=FALSE,var="trait1")
# Displays interactive plot. Select a trait/set to plot and
# set arguments save_plot=FALSE, plot_all = FALSE
# IMPORTANT: to EXIT interactive plot, RIGHT CLICK on the
# plot and STOP.
qq <- plot_results(results=results,by="set",plot_all=FALSE,
var="RHSA109582",save_plot=FALSE)

## End(Not run)
# -- END OF DEMO
################################################
```

---

demo *GWAS p_values demo data*

Description

GWAS p-values (tab delimited file). First Column must contain the SNP ids and the column name = "name"

Usage

```
data(demo)
```

Format

A data frame with SNPs identifiers and gwas p-values of association

`name` a character vector

`Trait1` a numeric vector

`Trait2` a numeric vector

`Trait3` a numeric vector

`Trait4` a numeric vector

`Trait5` a numeric vector

`Trait6` a numeric vector

`Trait7` a numeric vector

`Trait8` a numeric vector

`Trait9` a numeric vector

```
 name       Trait1      Trait2    Trait3   Trait4  Trait5    Trait6
 rs10000010 0.9122360 0.30088096 0.2332038 0.5193068 0.1255104 0.07253145
 rs10000023 0.8642906 0.52064064 0.9243443 0.7177759 0.9512171 0.81716250
 rs10000030 0.2832705 0.99021664 0.8359339 0.9662707 0.8491221 0.50208681
```

Examples

```
#Read input demo file for "read_pvals" function
data(demo)
```

`genes_permutation` *Gene-level Permutations*

Description

Performs gene-level circular genomic permutations. In each permutation,the complete set of SNP association p-values are permuted by rotation with respect to the SNPs' genomic locations. Once these 'simulated' p-values are assigned,the joint gene p-values are calculated using Fisher's combination test,and pathways' association tested using the hypergeometric test

Usage

```
genes_permutation(ordered_alldata = "", pers_ids = "", pathways = "",
ntraits = "", nper = 100, threshold = 0.05, seed=10,saveto = "workspace",
gs_locs="", envir = "")
```

Arguments

ordered_alldata	Return variable from "genome_order". Ordered genome and trait p-values
gs_locs	Return variable from "genome_order". SNP indexes
pers_ids	Return variable "per_ors" from "read2_paths". Gene indexes
pathways	Return variable "pathways" from "read2_paths"
ntraits	Traits INDEX to be analysed. Index according to "ordered_alldata". Trait Columns index must start at 7. Example: ntraits=c(7:9), ntraits=7
nper	Number of permutations.Example: nper=1000
threshold	Threshold to be set by the hypergeometric test. threshold=0.05
seed	Set a number for random sampling
saveto	Save permutation results to "workspace" OR "directory"
envir	R environment to save the data to when saveto is set to "workspace"

Value

Returns "Permus_trait" variables or files (permutation datasets).

References

Imports phyper (from stats)

See Also

snps_permutation

Examples

```
#load data
data(demo,SNPsAnnotation)
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)

# Prepare Genome
genome_results <-genome_order(all_data=all_data)
 # Results from genome_order
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs

# Create new environment to save data:
gper.env <- new.env()
```

```
# Get pathways
data(RHSA164843,RHSA446343,RHSA8876384,RHSA8964572,RHSA109582,RHSA1474244,envir=gper.env)

# Map Genes to pathways
paths_res <- read2_paths(ordered_alldata=ordered_alldata,gs_locs=gs_locs,
sets_from="workspace",sets_prefix="RHSA",level="gene",envir=gper.env)
pers_ids <- paths_res$per_ors
pathways<- paths_res$pathways

# Perform Permutations:
genes_permutation(ordered_alldata=ordered_alldata,
pers_ids=pers_ids,pathways=pathways,ntraits=c(7:9),
nper=10,threshold=0.05, saveto="workspace",
gs_locs=gs_locs,envir = gper.env)

# Results
results <- get_results(res_pattern="Permus",level="gene",
from="workspace",threshold=0.05,envir= gper.env)
```

`genome_order` *Genome Order*

Description

Orders the SNPs according to their genomic location

Usage

```
genome_order(all_data = "")
```

Arguments

`all_data`	SNPs to Genes Annotation and Trait Pvalues of Association all_data = (read_pvals output) OR matrix/dataframe.

Details

```
Input Columns with "*" must be included for analysis

NOTE: Trait p-values must start at Column #7

# *Column 1: "name" (SNP_IDs - any SNP ID as character)
# *Column 2: Chromosome Location
# *Column 3: SNP Location
# *Column 4: Gene ID
# Column 5: Symbol (OR Annotation Field 1)
# Column 6: Annotaiton Field 2
# *Column 7: First trait pvalues of association
```

```
# Column N: Next trait pvalues of association
# Example Input Data:
name       Chromosome  Location GENE_ID Symbol Orientation abpi
rs10000010          4  21618674   80333 KCNIP4           - 0.91
rs10000023          4  95733906     658 BMPR1B           + 0.86
rs10000092          4  21895517   80333 KCNIP4           - 0.20
rs1000022          13  100461219 171425 CLYBL            + 0.26
rs10000300          4  40466547   54502 RBM47            - 0.58
```

Value

ordered_alldata
: SNPs annotated to Genes and Trait p-values

gs_locs
: Gene annotations, location indexes and number of observations

Format

```
 SNPs annotated to Genes and Trait p-values
#ordered_alldata[1:5,1:8]
name   Chromosome Location GENE_ID  Symbol Orientation Trait1 Trait2
rs3934834 1    1005806  NA     <NA>        <NA>    0.97  0.92
rs3737728 1  1021415  54991  C1orf159      -   0.91  0.69
rs6687776 1  1030565  54991  C1orf159      -   0.71  0.45
rs9651273 1  1031540  54991  C1orf159      -   0.22  0.60
rs4970405 1  1048955  54991  C1orf159      -   0.77  0.56

 Gene annotations, location indexes and number of observations
#gs_locs[1:5,]
#      Symbol     Chromosome Location    Gene_ID Start_Indx Observations
# [1,] "A1BG"     "19"       "58864479"  "1"     "293976"   "1"
# [2,] "A2M"      "12"       "9232268"   "2"     "215264"   "5"
# [3,] "NAT1"     "8"        "18077310"  "9"     "151804"   "1"
# [4,] "NAT2"     "8"        "18257280"  "10"    "151831"   "2"
# [5,] "SERPINA3" "14"       "95080803"  "12"    "249519"   "2"
```

See Also

read2_paths

Examples

```
## DEMO WORKSPACE

data(demo,SNPsAnnotation)
all_data<-read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
# GENOME ORDER
genome_results <- genome_order(all_data=all_data)
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs
```

get_pathways *Pathways*

Description

Helper function to download pathways and their gene identifiers. reactome.db used for pathway annotations.

Usage

```
get_pathways(source="reactome",all_paths=TRUE,envir = "")
```

Arguments

source	"reactome"
all_paths	TRUE or FALSE. If FALSE a subset will be asked by the function
envir	R environment to save Pathways to

Value

Returns "Pathways description" All downloaded pathways are saved in the workspace User will be prompt to set a prefix.

See Also

read2_paths

Examples

```
## Not run:
# get pathways source = "reactome"
if (!require("reactome.db")) install.packages("reactome.db")
library(reactome.db)

# Create new environment to save data:
gper.env <- new.env()

paths <- get_pathways(source="reactome",all_paths=FALSE,envir=gper.env)
# when prompted introduce species as listed
Homo sapiens
# when prompted introduce prefix. Avoid characters "-" and "_" (e.g mypath, or leave blank)
# if all_paths set to TRUE. All pathways are downloaded automatically
# IF all_paths set to FALSE, select a subset of pathway identifiers from
# list. Separated by ","
R-HSA-8964572,R-HSA-9613354,R-HSA-8876384,R-HSA-446343,R-HSA-9620244

## End(Not run)
```

get_results *Circular Permutation Results*

Description

Creates a summary dataframe of the genomic permutations datasets

Usage

```
get_results(res_pattern="Permus",level="snp",from="workspace",
threshold=0.05,envir = "")
```

Arguments

res_pattern	Pattern of the Permutation files/variable. eg. res=pattern="Permus"
level	Permutation level performed.level values "snp" or "gene"
from	Location of the permutation datasets.from values "workspace" or "directory"
threshold	Threshold of significance set
envir	R environment where save the data to

Value

results	Data frame with Pathway ID, Trait, Threshold set by permutations, Gene results include the theoretical hypergeometric p-value and the, observed (Empirical Hypergeometric p-values) SNP results include the count of significan SNPs and the overall score Score is the proportion of tests observed with more significant results

Format

```
## SNP level results
     PathID    Trait Threshold RealCount Score
1  hsa00010     abpi         0         0 0.037
2  hsa00010 abpildfa         0         0 0.040
3  hsa04720     abpi         2         0 0.311
## Gene level results
     PathID Trait   Threshold     P-Value  Observed
1  hsa00010  abpi 0.040441176 0.058823529 1.0000000
2  hsa00020  abpi 0.000000000 0.000000000 0.1666667
3  hsa00030  abpi 0.040441176 0.058823529 1.0000000
```

Examples

```
data(demo,SNPsAnnotation)
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
genome_results <-genome_order(all_data=all_data)
 # Results from genome_order
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs

# Create new environment to save data
gper.env <- new.env()

# Get pathways
data(RHSA164843,RHSA446343,RHSA8876384,RHSA8964572,RHSA109582,RHSA1474244,envir=gper.env)

paths_res <- read2_paths(ordered_alldata=ordered_alldata,gs_locs=gs_locs,
sets_from="workspace",sets_prefix="RHSA",level="snp",envir=gper.env)
  pers_ids <- paths_res$per_ors
  pathways<- paths_res$pathways

snps_permutation(ordered_alldata=ordered_alldata,pers_ids=pers_ids,
ntraits=c(7,9),nper=10,saveto="workspace",threshold=0.05,
gs_locs=gs_locs,envir= gper.env)

results <- get_results(res_pattern="Permus",level="snp",
from="workspace",threshold=0.05,envir = gper.env)
```

---

hyprbg *Hypergeometric Test (phyper)*

Description

Performs Hypergeometric test (phyper() from R)

Usage

```
hyprbg(Sig_in_Paths, uniSig, gns_in_Paths, universe)
```

Arguments

Sig_in_Paths	Number of significant genes in the pathway
uniSig	Number of significant genes in the dataset
gns_in_Paths	Number of genes in the pathway
universe	Number of genes in the dataset

Value

Returns hypergeometric test

References

hyprbg Imports phyper() (from stats)

`plot_results` *Plot Results Circular Permutation*

Description

QQ plots

Usage

```
plot_results(results="",by="",plot_all=TRUE, var = "", save_plot=TRUE, plot_name="",
bf= FALSE , save_qq = TRUE)
```

Arguments

`results`	Results datarame from "get_results()"
`by`	Visualize results by "trait" OR by "set"
`plot_all`	plot_all = TRUE plots all the variables in the results dataframe and saves a pdf file in the working directory. Setting plot_all to FALSE plots a single variable(trait or set). The argument "var" must be declared.
`var`	Variable name to plot
`save_plot`	save_plot = TRUE saves the plots in the working directory. save_plot = FALSE the plot is visualized at the console. save_plot = FALSE can be used only when plot_all is set to FALSE. The plot displayed at the console is interactive, clicking on a point displays the points name.
`plot_name`	Argument used to save the file name for the plots. Default value = Results_genomicper_[set/trait]
`bf`	Displays the bonferroni correction
`save_qq`	TRUE returns the qq plot values

Value

`qq`	Data frame with qq plot values

See Also

`get_results`

Examples

```
data(demo,SNPsAnnotation)
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
genome_results <-genome_order(all_data=all_data)
 # Results from genome_order
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs

# Create new environment to save the data:
gper.env <- new.env()

# Load Pathways
data(RHSA164843,RHSA446343,RHSA8876384,RHSA8964572,RHSA109582,RHSA1474244,envir=gper.env)


paths_res <- read2_paths(ordered_alldata=ordered_alldata,gs_locs=gs_locs,
sets_from="workspace",sets_prefix="RHSA",level="snp",envir=gper.env)
  pers_ids <- paths_res$per_ors
  pathways<- paths_res$pathways

snps_permutation(ordered_alldata=ordered_alldata,pers_ids=pers_ids,
ntraits=c(7,9),nper=10,saveto="workspace",threshold=0.05,
gs_locs=gs_locs,envir = gper.env)

results <- get_results(res_pattern="Permus",level="snp",
from="workspace",threshold=0.05,envir = gper.env)

#saves plots to working directory
## Not run:
qq <- plot_results(results=results,by="set",plot_all=TRUE)
qq <- plot_results(results=results,by="trait",plot_all=FALSE,var="trait1")
qq <- plot_results(results=results,by="set",
 plot_all=FALSE,var="R-HSA-8964572",
 save_plot=FALSE) ## IMPORTANT: to EXIT interactive plot
 ## right click on the plot to stop

## End(Not run)
```

`read2_paths` *Read to SNPs to sets; Map SNPs to gene-sets/pathways*

Description

Reads the sets/pathways, map the SNPs and genes to the gene-sets/pathways read2_paths uses the "genome_order" output(ordered_alldata, gs_locs) to assign genomic location indexes to each element in the gene-set. The permutation method must be defined (i.e. level = "snp" OR level = "gene").

Usage

```
read2_paths(ordered_alldata="",gs_locs="",sets_from="workspace",
sets_prefix="RHSA",level="snp",envir="")
```

Arguments

ordered_alldata	Ordered data according to the SNPs genomic location. Traits start at column 7 Return variable from: genome_results <-genome_order(all_data=all_data) ordered_alldata <- genome_results$ordered_alldata
gs_locs	Gene annotation,indexes and number of observations Return variable from genome_order(): genome_results <-genome_order(all_data=all_data) gs_locs <- genome_results$gs_locs
sets_from	Location of the gene-sets. Default set to "workspace" sets_from="workspace" OR sets_from="directory" "directory", only will search for information in the working directory.
sets_prefix	Prefix of the gene-set variables or files. Default set to sets_prefix= "RHSA" e.g. Variables "RHSA164843","RHSA446343","RHSA8876384" each variable/file contains the list of gene identifiers part of that pathway
level	The level at which the permutations will be performed. Assigns the indexes according to snps or genes Default value "snp" level values = "snp" OR "gene"
envir	R environment where pathway data is stored. e.g(envir=.GlobalEnv, envir=gper.env)

Value

pathways	Pathway Id, Description,Number of Genes in the pathway, Number of genes found in the dataset, Number of SNPs found in the dataset
per_ors	A list of identifiers mapped to each pathway

Format

```
Input: Ordered_alldata
name     Chromosome  Location GENE_ID   Symbol Orientation Trait1 Trait2
rs1001567          1 9194614     <NA>     <NA>        <NA> 0.96 0.89
rs1000313          1 15405489   23254 KIAA1026           + 0.93 0.57
rs1002365          1 19797248    <NA>     <NA>        <NA> 0.68 0.58
rs1002706          1 25051153    <NA>     <NA>        <NA> 0.71 0.02
rs1002487          1 26865971    6195  RPS6KA1           + 0.98 0.78

Input:gs_locs
      Symbol   Chromosome Location    Gene_ID Start_Indx Observations
 [1,] "ACYP2"  "2"        "54399633"  "98"    "35"       "1"
```

```
 [2,] "AMPD3"  "11"       "10514707"  "272"   "898"      "1"
 [3,] "ANK2"   "4"        "113830885" "287"   "479"      "4"

Input:pathway example
RHSA8964572
[1]   1149 128486 161247  29923 345275  63924

Output:pathways
     ID            GenesInPath GenesFound SNPsInPath
"RHSA109582"  "681"       "8"         "11"
"RHSA1474244" "418"       "7"         "10"
"RHSA164843"  "11"        "0"         "0"
"RHSA446343"  "4"         "1"         "1"
"RHSA8876384" "32"        "1"         "1"
"RHSA8964572" "6"         "1"         "1"
```

See Also

genes_permutation snps_permutation genome_order

Examples

```
## DEMO - SNP Level data stored in workspace ######################
# library(genomicper)
data(demo,SNPsAnnotation)
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
genome_results <-genome_order(all_data=all_data)
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs

# Create new environment to save variables (e.g. pathways, permutations):
gper.env <- new.env()

data(RHSA164843,RHSA446343,RHSA8876384,RHSA8964572,RHSA109582,RHSA1474244,envir=gper.env)

paths_res <- read2_paths(ordered_alldata=ordered_alldata,
gs_locs=gs_locs,sets_from="workspace",sets_prefix="RHSA",
level="snp",envir=gper.env)
 pers_ids <- paths_res$per_ors
 pathways<- paths_res$pathways
#####################################################################
```

---

read_pvals *Read GWAS p-values of association and Merge with SNP annotations*

Description

Read GWAS p-values of association and Merge with SNP annotations for analysis

Usage

```
read_pvals(data_name="",snps_ann="",from="workspace")
```

Arguments

data_name	GWAS p_values (tab delimited file)(SNP_IDs Trait1 Trait2 ...TraitN)
snps_ann	SNPs Annotation (SNPsAnnotation). Genomicper uses entrez gene ids to annotate associate SNPs-to genes-pathways The annotation MUST match your data input (coordinates and chromosome format) Any SNP ID is valid, as long the ID is set as character The examples below show an option on how to annotate the SNPs prior the use of genomicper
from	Datasets location. Values "workspace" OR "directory"

Value

Dataframe: name; chromosome; Location; GeneID; Symbol; Orientation; Trait1; TraitN

Formats

```
GWAS p_values (tab delimited file)(SNP_IDs Trait1 Trait2 ...TraitN)
name       Trait1      Trait2    TraitN
rs10000010 0.9122360 0.30088096 0.2332038
rs10000023 0.8642906 0.52064064 0.9243443
rs10000030 0.2832705 0.99021664 0.8359339

SNPs Annotation (SNPsAnnotation)
name        Chromosome  Location  GENE_ID   Symbol    Orientation
rs1000313   1           15405489  23254     KIAA1026  +
rs1000533   1           168282491 9095      TBX19     +
rs1000731   1           231963491 27185     DISC1     +

Output:
name       Chromosome  Location GENE_ID Symbol Orientation   Trait1
rs10000010          4  21618674   80333 KCNIP4           - 0.9122360
rs10000023          4  95733906     658 BMPR1B           + 0.8642906
rs10000030          4 103374154      NA   <NA>        <NA> 0.2832705
```

See Also

genome_order

Examples

```
## DEMO // WORKSPACE
data(demo,SNPsAnnotation)
```

```
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
```

RHSAXXXXX *Reactome Pathway examples*

Description

Each file "RHSAXXXX" contains the gene identifiers.

Usage

```
data(RHSA164843)
```

Format

The format is: num [1:6] 11168 155030 155348 155459 155908 2547...

Source

reactome.db

Examples

```
data(RHSA164843)
```

SNPsAnnotation *SNPs-Genes annotation to Distance 0 (SNPs within a gene)*

Description

SNPs annotated to genes. Annotation only when the SNPs fall within start and end of transcription of the genes.

Usage

```
data(SNPsAnnotation)
```

Format

Sample data frame with 339096 SNP observations on the following 6 variables.

`name` a character vector

`Chromosome` a character vector

`Location` a numeric vector of the SNP location

`GENE_ID` a numeric vector with entrez geneID

`Symbol` a character vector ; other annotation slot 1

`Orientation` a character vector; other annotation slot 2

```
 name      Chromosome  Location  GENE_ID    Symbol     Orientation
 rs1000313          1  15405489    23254    KIAA1026             +
 rs1000533          1 168282491     9095    TBX19                +
 rs1000731          1 231963491    27185    DISC1                +
```

Source

NCBI Gene database,(http://www.ncbi.nlm.nih.gov/gene ; Build.37.1).

Examples

```
data(SNPsAnnotation)
```

`snps_permutation` *SNP-level permutations*

Description

Performs SNP-level circular genomic permutations. In each permutation, the complete set of SNP association p-values are permuted by rotation with respect to the SNPs' genomic locations.
Once these 'simulated' p-values are assigned,the proportion of SNPs per set above a pre-defined threshold is calculated

Usage

```
snps_permutation(ordered_alldata = "", pers_ids = "", ntraits = "",
nper = 100, threshold = 0.05, seed=10,saveto = "workspace",
gs_locs = "",envir ="")
```

Arguments

ordered_alldata	Return variable from "genome_order". Ordered genome and trait p-values
gs_locs	Return variable from "genome_order". SNP indexes
pers_ids	Return variable "per_ors" from "read2_paths". SNP indexes
ntraits	Traits INDEX to be analysed. Index according to "ordered_alldata". Trait Columns index must start at 7. Example: ntraits=c(7:9), ntraits=7
nper	Number of permutations.Example: nper=1000
threshold	Threshold to be set by the hypergeometric test. threshold=0.05
seed	Set number for random sampling
saveto	Save permutation results to "workspace" OR "directory"
envir	R environment to save the Permutations to when saveto is set to "workspace"

Value

Returns "Permus_genesetsname" variables or files (permutation datasets).

See Also

genes_permutation

Examples

```
data(demo,SNPsAnnotation)
all_data <- read_pvals(data_name=demo,snps_ann=SNPsAnnotation)
genome_results <-genome_order(all_data=all_data)
 # Results from genome_order
 ordered_alldata <- genome_results$ordered_alldata
 gs_locs <- genome_results$gs_locs

# Create new environment to save the permutations to:
gper.env <- new.env()

data(RHSA164843,RHSA446343,RHSA8876384,RHSA8964572,RHSA109582,RHSA1474244,envir=gper.env)

paths_res <- read2_paths(ordered_alldata=ordered_alldata,gs_locs=gs_locs,
sets_from="workspace",sets_prefix="RHSA",level="snp",envir=gper.env)
  pers_ids <- paths_res$per_ors
  pathways<- paths_res$pathways


# SNP permutations
snps_permutation(ordered_alldata=ordered_alldata,pers_ids=pers_ids,
ntraits=c(7,9),nper=10,saveto="workspace",threshold=0.05,
gs_locs=gs_locs,envir = gper.env)

# Get results
results <- get_results(res_pattern="Permus",level="snp",
```

```
from="workspace",threshold=0.05,envir = gper.env)
```

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