

Package ‘genomicper’

July 22, 2025

Type Package

Title Circular Genomic Permutation using Genome Wide Association
p-Values

Version 1.7

Date 2021-05-06

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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 permuted 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

NeedsCompilation no

Depends R (>= 3.5.0)

Repository CRAN

Date/Publication 2021-05-08 08:00:05 UTC

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genomicper-package	<i>Circular Genomic Permutations</i>
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Description

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Details

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Version: 1.7
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License: GPL-2

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="Perm", 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	<i>Gene-level Permutations</i>
-------------------	--------------------------------

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)
```

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 significant 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	<i>Hypergeometric Test (phyper)</i>
--------	-------------------------------------

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	<i>Plot Results Circular Permutation</i>
--------------	--

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"

```
"RHS1474244" "418"      "7"      "10"
"RHS164843"  "11"      "0"      "0"
"RHS446343"  "4"       "1"      "1"
"RHS8876384" "32"      "1"      "1"
"RHS8964572" "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(RHS164843, RHS446343, RHS8876384, RHS8964572, RHS109582, RHS1474244, env=gper.env)

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

read_pvals	<i>Read GWAS p-values of association and Merge with SNP annotations</i>
------------	---

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	BMPRI1B	+	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)
```

RHSAXXXX*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	<i>SNP-level permutations</i>
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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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