

Package ‘OPTtesting’

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Type Package

Title Optimal Testing

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Description Optimal testing under general dependence. The R package implements procedures proposed in Wang, Han, and Tong (2022). The package includes parameter estimation procedures, the computation for the posterior probabilities, and the testing procedure.

Encoding UTF-8

Imports rootSolve, quantreg, RSpectra, stats

Suggests MASS

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NeedsCompilation no

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AEB

AEB

Description

Estimate the parameters in the three-part mixture

Usage

```
AEB(
  Z,
  Sigma,
  eig = eigs_sym(Sigma, min(400, length(Z)), which = "LM"),
  eig_tol = 1,
  set_nu = c(0),
  set1 = c(0:10) * 0.01 + 0.01,
  set2 = c(0:10) * 0.01 + 0.01,
  setp = c(1:7) * 0.1
)
```

Arguments

Z	a vector of test statistics
Sigma	covariance matrix
eig	eig value information
eig_tol	the smallest eigen value used in the calculation
set_nu	a search region for nu_0
set1	a search region for tau_sqr_1
set2	a search region for tau_sqr_2
setp	a search region for proportion

Details

Estimate the parameters in the three-part mixture $Z|\mu N_p(\mu, \Sigma)$ where $\mu_i \pi_0 \delta_{\nu_0} + \pi_1 N(\mu_1, \tau_1^2) + \pi_2 N(\mu_2, \tau_2^2), i = 1, \dots, p$

Value

The return of the function is a list in the form of list(nu_0, tau_sqr_1, tau_sqr_2, pi_0, pi_1, pi_2, mu_1, mu_2, Z_hat).

nu_0, tau_sqr_1, tau_sqr_2: The best combination of $(\nu_0, \tau_1^2, \tau_2^2)$ that minimize the total variance from the regions $(D_{\nu_0}, D_{\tau_1^2}, D_{\tau_2^2})$.

pi_0, pi_1, pi_2, mu_1, mu_2: The estimates of parameters $\pi_0, \pi_1, \pi_2, \mu_1, \mu_2$.

Z_hat: A vector of simulated data base on the parameter estimates.

Examples

```

p = 500
n_col = 10
A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix
Z = rnorm(p,0,1) #this is just an example for testing the algorithm.
#Not true test statistics with respect to Sigma
best_set = AEB(Z,Sigma)
print(c(best_set$pi_0, best_set$pi_1, best_set$pi_2, best_set$mu_1, best_set$mu_2))

library(MASS)
#####
#construct a test statistic vector Z
p = 1000
n_col = 4
pi_0 = 0.6
pi_1 = 0.2
pi_2 = 0.2
nu_0 = 0
mu_1 = -1.5
mu_2 = 1.5
tau_sqr_1 = 0.1
tau_sqr_2 = 0.1

A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix

b = rmultinom(p, size = 1, prob = c(pi_0,pi_1,pi_2))
ui = b[1,]*nu_0 + b[2,]*rnorm(p, mean = mu_1,
    sd = sqrt(tau_sqr_1)) + b[3,]*rnorm(p, mean = mu_2,
    sd = sqrt(tau_sqr_2)) # actual situation
Z = mvrnorm(n = 1,ui, Sigma, tol = 1e-6, empirical = FALSE, EISPACK = FALSE)

best_set =AEB(Z,Sigma)
print(c(best_set$pi_0, best_set$pi_1, best_set$pi_2, best_set$mu_1, best_set$mu_2))

```

d_value

d_value

Description

Calculating the estimates for $P(\mu_i \leq 0|Z)$

Usage

```
d_value(
  Z,
  Sigma,
  best_set = AEB(Z, Sigma),
  eig = eigs_sym(Sigma, min(400, length(Z)), which = "LM"),
  sim_size = 3000,
  eig_value = 0.35
)
```

Arguments

Z	a vector of test statistics
Sigma	covariance matrix
best_set	a list of parameters (list(nu_0 = ..., tau_sqr_1 = ..., tau_sqr_2 = ..., pi_0 = ..., pi_1 = ..., pi_2 = ..., mu_1 = ..., mu_2 = ...)) or returns from AEB
eig	eig value information
sim_size	simulation size
eig_value	the smallest eigen value used in the calculation

Value

a vector of estimates for $P(\mu_i \leq 0|Z), i = 1, \dots, p$

Examples

```
p = 500
n_col = 10
A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix
Z = rnorm(p,0,1) #this is just an example for testing the algorithm.
#Not true test statistics with respect to Sigma
  d_value(Z,Sigma,sim_size = 5)
#To save time, we set the simulation size to be 10, but the default value is much better.

library(MASS)
#####
#construct a test statistic vector Z
p = 1000
n_col = 4
pi_0 = 0.6
pi_1 = 0.2
pi_2 = 0.2
nu_0 = 0
mu_1 = -1.5
mu_2 = 1.5
tau_sqr_1 = 0.1
tau_sqr_2 = 0.1
```

```

A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix

b = rmultinom(p, size = 1, prob = c(pi_0,pi_1,pi_2))
ui = b[1,]*nu_0 + b[2,]*rnorm(p, mean = mu_1,
  sd = sqrt(tau_sqr_1)) + b[3,]*rnorm(p, mean = mu_2,
  sd = sqrt(tau_sqr_2)) # actual situation
Z = mvrnorm(n = 1,ui, Sigma, tol = 1e-6, empirical = FALSE, EISPACK = FALSE)

d_value(Z,Sigma)

```

FDP_compute

FDP_compute

Description

False discovery proportion and False non-discovery proportion computation

Usage

```
FDP_compute(decision, ui, positive)
```

Arguments

decision	returns from the function <code>Optimal_procedure_3</code>
ui	true mean vector
positive	TRUE/FALSE valued. TRUE: H0: ui no greater than 0. FALSE: H0: ui no less than 0.

Value

False discovery proportion (FDP) and False non-discovery proportion (FNP)

Examples

```

ui = rnorm(10,0,1) #assume this is true parameter
decision = rbinom(10,1, 0.4) #assume this is decision vector
FDP_compute(decision,ui,TRUE)

```

```

library(MASS)
#####

```

```

#construct a test statistic vector Z
p = 1000
n_col = 4
pi_0 = 0.6
pi_1 = 0.2
pi_2 = 0.2
nu_0 = 0
mu_1 = -1.5
mu_2 = 1.5
tau_sqr_1 = 0.1
tau_sqr_2 = 0.1

A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix

b = rmultinom(p, size = 1, prob = c(pi_0,pi_1,pi_2))
ui = b[1,]*nu_0 + b[2,]*rnorm(p, mean = mu_1,
  sd = sqrt(tau_sqr_1)) + b[3,]*rnorm(p, mean = mu_2,
  sd = sqrt(tau_sqr_2)) # actual situation
Z = mvrnorm(n = 1,ui, Sigma, tol = 1e-6, empirical = FALSE, EISPACK = FALSE)

prob_p = d_value(Z,Sigma)
#decision
level = 0.1 #significance level
decision_p = Optimal_procedure_3(prob_p,level)
FDP_compute(decision_p$ai,ui,TRUE)

```

l_value

l_value

Description

Calculating the estimates for $P(\mu_i \geq 0|Z)$

Usage

```

l_value(
  Z,
  Sigma,
  best_set = AEB(Z, Sigma),
  eig = eigs_sym(Sigma, min(400, length(Z)), which = "LM"),
  sim_size = 3000,
  eig_value = 0.35
)

```

Arguments

Z	a vector of test statistics
Sigma	covariance matrix
best_set	a list of parameters (list(nu_0 = ..., tau_sqr_1 = ..., tau_sqr_2 = ..., pi_0 = ..., pi_1 = ..., pi_2 = ..., mu_1 = ..., mu_2 = ...)) or returns from Fund_parameter_estimation
eig	eig value information
sim_size	simulation size
eig_value	the smallest eigen value used in the calculation

Value

a vector of estimates for $P(\mu_i \geq 0|Z)$

Examples

```
p = 500
n_col = 10
A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix
Z = rnorm(p,0,1) #this is just an example for testing the algorithm.
#Not true test statistics with respect to Sigma
l_value(Z,Sigma,sim_size = 5)
#To save time, we set the simulation size to be 10, but the default value is much better.
```

```
library(MASS)
#####
#construct a test statistic vector Z
p = 1000
n_col = 4
pi_0 = 0.6
pi_1 = 0.2
pi_2 = 0.2
nu_0 = 0
mu_1 = -1.5
mu_2 = 1.5
tau_sqr_1 = 0.1
tau_sqr_2 = 0.1
```

```
A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix
```

```
b = rmultinom(p, size = 1, prob = c(pi_0,pi_1,pi_2))
ui = b[1,]*nu_0 + b[2,]*rnorm(p, mean = mu_1,
sd = sqrt(tau_sqr_1)) + b[3,]*rnorm(p, mean = mu_2,
```

```

sd = sqrt(tau_sqr_2)) # actual situation
Z = mvrnorm(n = 1,ui, Sigma, tol = 1e-6, empirical = FALSE, EISPACK = FALSE)

l_value(Z,Sigma)

```

Optimal_procedure_3 *Optimal_procedure_3*

Description

decision process

Usage

```
Optimal_procedure_3(prob_0, alpha)
```

Arguments

prob_0	d-values or l-values
alpha	significance level

Value

ai: a vector of decisions. (1 indicates rejection)
cj: The number of rejections
FDR_hat: The estimated false discovery rate (FDR).
FNR_hat: The estimated false non-discovery rate (FNR).

Examples

```

prob = runif(100,0,1) #assume this is the posterior probability vector
level = 0.3 #the significance level
Optimal_procedure_3(prob,level)

library(MASS)
#####
#construct a test statistic vector Z
p = 1000
n_col = 4
pi_0 = 0.6
pi_1 = 0.2
pi_2 = 0.2
nu_0 = 0
mu_1 = -1.5
mu_2 = 1.5
tau_sqr_1 = 0.1

```



```
tau_sqr_2 = 0.1

A = matrix(rnorm(p*n_col,0,1), nrow = p, ncol = n_col, byrow = TRUE)
Sigma = A %*% t(A) +diag(p)
Sigma = cov2cor(Sigma) #covariance matrix

b = rmultinom(p, size = 1, prob = c(pi_0,pi_1,pi_2))
ui = b[1,]*nu_0 + b[2,]*rnorm(p, mean = mu_1,
  sd = sqrt(tau_sqr_1)) + b[3,]*rnorm(p, mean = mu_2,
  sd = sqrt(tau_sqr_2)) # actual situation
Z = mvrnorm(n = 1,ui, Sigma, tol = 1e-6, empirical = FALSE, EISPACK = FALSE)

prob_p = d_value(Z,Sigma)
#decision
level = 0.1 #significance level
decision_p = Optimal_procedure_3(prob_p,level)
decision_p$cj
head(decision_p$ai)
```

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