Package ‘TFisher’

November 7, 2017

Type Package

Title Optimal Thresholding Fisher's P-Value Combination Method

Version 0.1.0

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Description We provide the cumulative distribution function (CDF),
quantile, and statistical power calculator for a collection of
thresholding Fisher's p-value combination methods, including Fisher's
p-value combination method, truncated product method and, in particular, soft-thresholding
Fisher's p-value combination method which is proven to be optimal in some
context of signal detection. The p-value calculator for the omnibus version
of these tests are also included. For reference, please see Hong Zhang and Zheyang Wu. ``Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection'', submitted.

License GPL-2

Imports stats, sn, mvtnorm

Encoding UTF-8

LazyData true

RoxygenNote 6.0.1

NeedsCompilation no

Repository CRAN

Date/Publication 2017-11-07 12:55:41 UTC

R topics documented:

`p.soft` *CDF of soft-thresholding Fisher's p-value combination statistic under the null hypothesis.*

Description

CDF of soft-thresholding Fisher's p-value combination statistic under the null hypothesis.

Usage

```
p.soft(q, n, tau1)
```

Arguments

`q`	- quantile, could be a vector.
`n`	- dimension parameter, i.e. the number of p-values to be combined.
`tau1`	- truncation parameter=normalization parameter. tau1 > 0.

Value

The left-tail probability of the null distribution of soft-thresholding Fisher's p-value combination statistic at the given quantile.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.soft` for the definition of the statistic.

Examples

```
pval <- runif(100)
softstat <- stat.soft(p=pval, tau1=0.05)
p.soft(q=softstat, n=100, tau1=0.05)
```

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p.soft.omni — *CDF of omnibus soft-thresholding Fisher's p-value combination statistic under the null hypothesis.*

Description

CDF of omnibus soft-thresholding Fisher's p-value combination statistic under the null hypothesis.

Usage

```
p.soft.omni(q, n, TAU1)
```

Arguments

q	- quantile, could be a vector.
n	- dimension parameter, i.e. the number of p-values to be combined.
TAU1	- a vector of truncation parameters (=normalization parameters). Must be in non-descending order.

Value

The left-tail probability of the null distribution of omnibus soft-thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

stat.soft.omni for the definition of the statistic.

Examples

```
q = 0.01
n = 20
TAU1 = c(0.01, 0.05, 0.5, 1)
p.soft.omni(q=q, n=n, TAU1=TAU1)
```

p.tfisher — *CDF of thresholding Fisher's p-value combination statistic under the null hypothesis.*

Description

CDF of thresholding Fisher's p-value combination statistic under the null hypothesis.

Usage

```
p.tfisher(q, n, tau1, tau2)
```

Arguments

`q`	- quantile, could be a vector.
`n`	- dimension parameter, i.e. the number of p-values to be combined.
`tau1`	- truncation parameter. 0 < tau1 <= 1.
`tau2`	- normalization parameter. tau2 >= tau1.

Value

The left-tail probability of the null distribution of thresholding Fisher's p-value combination statistic at the given quantile.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.tfisher` for the definition of the statistic.

Examples

```
pval <- runif(100)
tfstat <- stat.tfisher(p=pval, tau1=0.75, tau2=0.25)
p.tfisher(q=tfstat, n=100, tau1=0.75, tau2=0.25)
```

p.tfisher.omni — *CDF of omnibus thresholding Fisher's p-value combination statistic under the null hypothesis.*

Description

CDF of omnibus thresholding Fisher's p-value combination statistic under the null hypothesis.

Usage

```
p.tfisher.omni(q, n, TAU1, TAU2)
```

Arguments

`q`	- quantile, could be a vector.
`n`	- dimension parameter, i.e. the number of p-values to be combined.
`TAU1`	- a vector of truncation parameters. Must be in non-descending order.
`TAU2`	- a vector of normalization parameters. Must be in non-descending order.

Value

The left-tail probability of the null distribution of omnibus thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.tfisher.omni` for the definition of the statistic.

Examples

```
q = 0.05
n = 20
TAU1 = c(0.01, 0.05, 0.5, 1)
TAU2 = c(0.1, 0.2, 0.5, 1)
p.tfisher.omni(q=q, n=n, TAU1=TAU1, TAU2=TAU2)
```

p.tpm *CDF of truncated product method statistic under the null hypothesis.*

Description

CDF of truncated product method statistic under the null hypothesis.

Usage

```
p.tpm(q, n, tau1)
```

Arguments

`q`	- quantile, could be a vector.
`n`	- dimension parameter, i.e. the number of p-values to be combined.
`tau1`	- truncation parameter. 0 < tau1 <= 1.

Value

The left-tail probability of the null distribution of truncated product method statistic at the given quantile.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

2. Zaykin, D.V., Zhivotovsky, L. A., Westfall, P.H. and Weir, B.S. (2002), Truncated product method for combining P-values. Genet. Epidemiol., 22: 170–185. doi:10.1002/gepi.0042

See Also

`stat.tpm` for the definition of the statistic.

Examples

```
pval <- runif(100)
tpmstat <- stat.tpm(p=pval, tau1=0.05)
p.tpm(q=tpmstat, n=100, tau1=0.05)
```

`p.tpm.omni` *CDF of omnibus truncated product method statistic under the null hypothesis.*

Description

CDF of omnibus truncated product method statistic under the null hypothesis.

Usage

```
p.tpm.omni(q, n, TAU1)
```

Arguments

`q`	- quantile, could be a vector.
`n`	- dimension parameter, i.e. the number of p-values to be combined.
`TAU1`	- a vector of truncation parameters. Must be in non-descending order.

Value

The left-tail probability of the null distribution of omnibus truncated product method statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.tpm.omni` for the definition of the statistic.

Examples

```
q = 0.05
n = 20
TAU1 = c(0.01, 0.05, 0.5, 1)
p.tpm.omni(q=q, n=n, TAU1=TAU1)
```

`power.soft` *Statistical power of soft-thresholding Fisher's p-value combination test under Gaussian mixture model.*

Description

Statistical power of soft-thresholding Fisher's p-value combination test under Gaussian mixture model.

Usage

```
power.soft(alpha, n, tau1, eps = 0, mu = 0)
```

Arguments

`alpha`	- type-I error rate.
`n`	- dimension parameter, i.e. the number of input p-values.
`tau1`	- truncation parameter=normalization parameter. tau1 > 0.
`eps`	- mixing parameter of the Gaussian mixture.
`mu`	- mean of non standard Gaussian model.

Details

We consider the following hypothesis test,

$$H_0 : X_i \sim F_0, H_a : X_i \sim (1-\epsilon)F_0 + \epsilon F_1$$

, where ϵ is the mixing parameter, F_0 is the standard normal CDF and $F = F_1$ is the CDF of normal distribution with μ defined by mu and $\sigma = 1$.

Value

Power of the soft-thresholding Fisher's p-value combination test.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.soft` for the definition of the statistic.

Examples

```
alpha = 0.05
#If the alternative hypothesis Gaussian mixture with eps = 0.1 and mu = 1.2:#
power.soft(alpha, 100, 0.05, eps = 0.1, mu = 1.2)
```

`power.tfisher` *Statistical power of thresholding Fisher's p-value combination test under Gaussian mixture model.*

Description

Statistical power of thresholding Fisher's p-value combination test under Gaussian mixture model.

Usage

```
power.tfisher(alpha, n, tau1, tau2, eps = 0, mu = 0)
```

Arguments

`alpha`	- type-I error rate.
`n`	- dimension parameter, i.e. the number of input p-values.
`tau1`	- truncation parameter. 0 < tau1 <= 1.
`tau2`	- normalization parameter. tau2 >= tau1.
`eps`	- mixing parameter of the Gaussian mixture.
`mu`	- mean of non standard Gaussian model.

Details

We consider the following hypothesis test,

$$H_0 : X_i \sim F_0, H_a : X_i \sim (1-\epsilon)F_0 + \epsilon F_1$$

, where ϵ is the mixing parameter, F_0 is the standard normal CDF and $F = F_1$ is the CDF of normal distribution with μ defined by mu and $\sigma = 1$.

Value

Power of the thresholding Fisher's p-value combination test.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.tfisher` for the definition of the statistic.

Examples

```
alpha = 0.05
#If the alternative hypothesis Gaussian mixture with eps = 0.1 and mu = 1.2:#
power.tfisher(alpha, 100, 0.05, 0.25, eps = 0.1, mu = 1.2)
```

`power.tpm` *Statistical power of truncated product method test under Gaussian mixture model.*

Description

Statistical power of truncated product method test under Gaussian mixture model.

Usage

```
power.tpm(alpha, n, tau1, eps = 0, mu = 0)
```

Arguments

`alpha`	- type-I error rate.
`n`	- dimension parameter, i.e. the number of input p-values.
`tau1`	- truncation parameter. 0 < tau1 <= 1. tau1 > 0.
`eps`	- mixing parameter of the Gaussian mixture.
`mu`	- mean of non standard Gaussian model.

Details

We consider the following hypothesis test,

$$H_0 : X_i \sim F_0, H_a : X_i \sim (1 - \epsilon)F_0 + \epsilon F_1$$

, where ϵ is the mixing parameter, F_0 is the standard normal CDF and $F = F_1$ is the CDF of normal distribution with μ defined by mu and $\sigma = 1$.

Value

Power of the truncated product method test.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.soft` for the definition of the statistic.

Examples

```
alpha = 0.05
#If the alternative hypothesis Gaussian mixture with eps = 0.1 and mu = 1.2:#
power.tpm(alpha, 100, 0.05, eps = 0.1, mu = 1.2)
```

`q.soft` *Quantile of soft-thresholding Fisher's p-value combination statistic under the null hypothesis.*

Description

Quantile of soft-thresholding Fisher's p-value combination statistic under the null hypothesis.

Usage

```
q.soft(p, n, tau1)
```

Arguments

p	- a scalar left probability that defines the quantile.
n	- dimension parameter, i.e. the number of input p-values.
tau1	- truncation parameter=normalization parameter. tau1 > 0.

Value

Quantile of soft-thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

`stat.soft` for the definition of the statistic.

Examples

```
## The 0.05 critical value of soft-thresholding statistic when n = 10:
q.soft(p=.99, n=10, tau1 = 0.05)
```

q.tfisher *Quantile of thresholding Fisher's p-value combination statistic under the null hypothesis.*

Description

Quantile of thresholding Fisher's p-value combination statistic under the null hypothesis.

Usage

```
q.tfisher(p, n, tau1, tau2)
```

Arguments

p	- a scalar left probability that defines the quantile.
n	- dimension parameter, i.e. the number of input p-values.
tau1	- truncation parameter. 0 < tau1 <= 1.
tau2	- normalization parameter. tau2 >= tau1.

Value

Quantile of thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

See Also

stat.tfisher for the definition of the statistic.

Examples

```
## The 0.05 critical value of TFisher statistic when n = 10:
q.tfisher(p=.95, n=10, tau1 = 0.05, tau2 = 0.25)
```

q.tpm — *Quantile of truncated product method statistic under the null hypothesis.*

Description

Quantile of truncated product method statistic under the null hypothesis.

Usage

```
q.tpm(p, n, tau1)
```

Arguments

p	- a scalar left probability that defines the quantile.
n	- dimension parameter, i.e. the number of input p-values.
tau1	- truncation parameter. 0 < tau1 <= 1.

Value

Quantile of truncated product method statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

2. Zaykin, D.V., Zhivotovsky, L. A., Westfall, P.H. and Weir, B.S. (2002), Truncated product method for combining P-values. Genet. Epidemiol., 22: 170–185. doi:10.1002/gepi.0042

See Also

stat.tpm for the definition of the statistic.

Examples

```
## The 0.05 critical value of TPM statistic when n = 10:
q.tpm(p=.95, n=10, tau1 = 0.05)
```

`stat.soft` *Construct soft-thresholding Fisher's p-value combination statistic.*

Description

Construct soft-thresholding Fisher's p-value combination statistic.

Usage

```
stat.soft(p, tau1)
```

Arguments

`p`	- input p-values.
`tau1`	- truncation parameter=normalization parameter. tau1 > 0.

Details

Let $p_i, i = 1, ..., n$ be a sequence of p-values, the soft-thresholding statistic

$$Soft = \sum_{i=1}^{n} -2\log(p_i/\tau_1) I(p_i \leq \tau_1)$$

. Soft-thresholding is the special case of TFisher when tau1=tau2.

Value

Soft-thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

Examples

```
pval <- runif(100)
stat.soft(p=pval, tau1=0.05)
```

`stat.soft.omni` *Construct omnibus soft-thresholding Fisher's p-value combination statistic.*

Description

Construct omnibus soft-thresholding Fisher's p-value combination statistic.

Usage

```
stat.soft.omni(p, TAU1)
```

Arguments

`p`	- input p-values.
`TAU1`	- a vector of truncation parameters (=normalization parameters). Must be in non-descending order.

Details

Let p_i, $i = 1, ..., n$ be a sequence of p-values, the soft-thresholding statistics

$$Soft_j = \sum_{i=1}^{n} -2\log(p_i/\tau_{1j})I(p_i \leq \tau_{1j})$$

, $j = 1, ..., d$. The omnibus test statistic is the minimum p-value of these soft-thresholding tests,

$$W_o = min_j G_j(Soft_j)$$

, where G_j is the survival function of $Soft_j$.

Value

Omnibus soft-thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

Examples

```
pval = runif(20)
TAU1 = c(0.01, 0.05, 0.5, 1)
stat.soft.omni(p=pval, TAU1=TAU1)
```

`stat.tfisher` *Construct thresholding Fisher's p-value combination statistic.*

Description

Construct thresholding Fisher's p-value combination statistic.

Usage

```
stat.tfisher(p, tau1, tau2)
```

Arguments

`p`	- input p-values.
`tau1`	- truncation parameter. 0 < tau1 <= 1.
`tau2`	- normalization parameter. tau2 >= tau1.

Details

Let $p_i, i = 1, ..., n$ be a sequence of p-values, the thresholding Fisher's p-value combination statistic

$$TFisher = \sum_{i=1}^{n} -2\log(p_i/\tau_2)I(p_i \leq \tau_2)$$

Value

Thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

Examples

```
pval <- runif(100)
stat.tfisher(p=pval, tau1=0.05, tau2=0.25)
```

stat.tfisher.omni — *Construct omnibus thresholding Fisher's p-value combination statistic.*

Description

Construct omnibus thresholding Fisher's p-value combination statistic.

Usage

```
stat.tfisher.omni(p, TAU1, TAU2)
```

Arguments

`p`	- input p-values.
`TAU1`	- a vector of truncation parameters. Must be in non-descending order.
`TAU2`	- a vector of normalization parameters. Must be in non-descending order.

Details

Let $p_i, i = 1, ..., n$ be a sequence of p-values, the thresholding statistics

$$TFisher_j = \sum_{i=1}^{n} -2\log(p_i/\tau_{2j}) I(p_i \leq \tau_{1j})$$

, $j = 1, ..., d$. The omnibus test statistic is the minimum p-value of these thresholding tests,

$$W_o = min_j G_j(Soft_j)$$

, where G_j is the survival function of $Soft_j$.

Value

Omnibus thresholding Fisher's p-value combination statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

Examples

```
pval = runif(20)
TAU1 = c(0.01, 0.05, 0.5, 1)
TAU2 = c(0.1, 0.2, 0.5, 1)
stat.tfisher.omni(p=pval, TAU1=TAU1, TAU2=TAU2)
```

stat.tpm	*Construct truncated product method statistic.*

Description

Construct truncated product method statistic.

Usage

```
stat.tpm(p, tau1)
```

Arguments

p	- input p-values.
tau1	- truncation parameter. 0 < tau1 <= 1.

Details

Let $p_i, i = 1, ..., n$ be a sequence of p-values, the TPM statistic

$$TPM = \sum_{i=1}^{n} -2\log(p_i) I(p_i \leq \tau_2)$$

. TPM is the special case of TFisher when tau2=1.

Value

Truncated product method statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

2. Zaykin, D.V., Zhivotovsky, L. A., Westfall, P.H. and Weir, B.S. (2002), Truncated product method for combining P-values. Genet. Epidemiol., 22: 170–185. doi:10.1002/gepi.0042

Examples

```
pval <- runif(100)
stat.tpm(p=pval, tau1=0.05)
```

`stat.tpm.omni` *Construct omnibus truncated product method statistic.*

Description

Construct omnibus truncated product method statistic.

Usage

```
stat.tpm.omni(p, TAU1)
```

Arguments

`p`	- input p-values.
`TAU1`	- a vector of truncation parameters. Must be in non-descending order.

Details

Let $p_i, i = 1, ..., n$ be a sequence of p-values, the truncated product method statistics

$$TPM_j = \sum_{i=1}^{n} -2\log(p_i) I(p_i \leq \tau_{1j})$$

, $j = 1, ..., d$. The omnibus test statistic is the minimum p-value of these truncated product method tests,

$$W_o = min_j G_j(TPM_j)$$

, where G_j is the survival function of TPM_j.

Value

Omnibus truncated product method statistic.

References

1. Hong Zhang and Zheyang Wu. "Optimal Thresholding of Fisher's P-value Combination Tests for Signal Detection", submitted.

Examples

```
pval = runif(20)
TAU1 = c(0.01, 0.05, 0.5, 1)
stat.tpm.omni(p=pval, TAU1=TAU1)
```

Index