Package ‘OwenQ’

January 8, 2020

Type Package

Title Owen Q-Function

Version 1.0.3

Date 2019-12-21

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Description Evaluates the Owen Q-function for an integer value of the degrees of freedom, by applying Owen's algorithm (1965) <doi:10.1093/biomet/52.3-4.437>.
It is useful for the calculation of the power of equivalence tests.

License GPL-3

Imports Rcpp (>= 0.12.10), stats

LinkingTo Rcpp, BH, RcppNumerical, RcppEigen

Suggests testthat, knitr, rmarkdown, mvtnorm

Encoding UTF-8

LazyData true

SystemRequirements C++11

RoxygenNote 7.0.2

VignetteBuilder knitr

URL https://github.com/stla/OwenQ

BugReports https://github.com/stla/OwenQ/issues

NeedsCompilation yes

Repository CRAN

Date/Publication 2020-01-08 09:20:07 UTC

R topics documented:

`OwenQ1` *First Owen Q-function*

Description

Evaluates the first Owen Q-function (integral from 0 to R) for an integer value of the degrees of freedom.

Usage

```
OwenQ1(nu, t, delta, R, algo = 2)
```

Arguments

`nu`	integer greater than 1, the number of degrees of freedom
`t`	number, positive or negative, possibly infinite
`delta`	vector of finite numbers, with the same length as `R`
`R`	(upper bound of the integral) vector of finite positive numbers, with the same length as `delta`
`algo`	the algorithm, `1` or `2`

Value

A vector of numbers between 0 and 1, the values of the integral from 0 to R.

Note

When the number of degrees of freedom is odd, the procedure resorts to the Owen T-function (`OwenT`).

References

Owen, D. B. (1965). A special case of a bivariate noncentral t-distribution. *Biometrika* **52**, 437-446.

Examples

```
# As R goes to Inf, OwenQ1(nu, t, delta, R) goes to pt(t, nu, delta):
OwenQ1(nu=5, t=3, delta=2, R=100)
pt(q=3, df=5, ncp=2)
```

OwenQ2 *Second Owen Q-function*

Description

Evaluates the second Owen Q-function (integral from R to ∞) for an integer value of the degrees of freedom.

Usage

```
OwenQ2(nu, t, delta, R, algo = 2)
```

Arguments

nu	integer greater than 1, the number of degrees of freedom
t	number, positive or negative, possibly infinite
delta	vector of finite numbers, with the same length as R
R	(lower bound of the integral) vector of finite positive numbers, with the same length as delta
algo	the algorirthm used, 1 or 2

Value

A vector of numbers between 0 and 1, the values of the integral from R to ∞.

Note

When the number of degrees of freedom is odd, the procedure resorts to the Owen T-function (OwenT).

References

Owen, D. B. (1965). A special case of a bivariate noncentral t-distribution. *Biometrika* **52**, 437-446.

Examples

```
# OwenQ1(nu, t, delta, R) + OwenQ2(nu, t, delta, R) equals pt(t, nu, delta):
OwenQ1(nu=5, t=3, delta=2, R=1) + OwenQ2(nu=5, t=3, delta=2, R=1)
pt(q=3, df=5, ncp=2)
```

OwenT — *Owen T-function*

Description

Evaluates the Owen T-function.

Usage

```
OwenT(h, a)
```

Arguments

h	numeric scalar
a	numeric scalar

Details

This is a port of the function `owens_t` of the **boost** collection of C++ libraries.

Value

A number between `0` and `0.25`.

References

Owen, D. B. (1956). Tables for computing bivariate normal probabilities. *Ann. Math. Statist.* **27**, 1075-1090.

Examples

```
integrate(function(x) pnorm(1+2*x)^2*dnorm(x), lower=-Inf, upper=Inf)
pnorm(1/sqrt(5)) - 2*OwenT(1/sqrt(5), 1/3)
```

powen — *Owen distribution functions when* $\delta\_1 > \delta\_2$

Description

Evaluates the Owen distribution functions when the noncentrality parameters satisfy $\delta_1 > \delta_2$ and the number of degrees of freedom is integer.

- `powen1` evaluates $P(T_1 \leq t_1, T_2 \leq t_2)$ (Owen's equality 8)
- `powen2` evaluates $P(T_1 \leq t_1, T_2 > t_2)$ (Owen's equality 9)
- `powen3` evaluates $P(T_1 > t_1, T_2 > t_2)$ (Owen's equality 10)
- `powen4` evaluates $P(T_1 > t_1, T_2 \leq t_2)$ (Owen's equality 11)

Usage

```
powen1(nu, t1, t2, delta1, delta2, algo = 2)

powen2(nu, t1, t2, delta1, delta2, algo = 2)

powen3(nu, t1, t2, delta1, delta2, algo = 2)

powen4(nu, t1, t2, delta1, delta2, algo = 2)
```

Arguments

`nu`	integer greater than 1, the number of degrees of freedom; infinite allowed
`t1, t2`	two numbers, positive or negative, possible infinite
`delta1, delta2`	two vectors of possibly infinite numbers with the same length, the noncentrality parameters; must satisfy `delta1>delta2`
`algo`	the algorithm used, `1` or `2`

Value

A vector of numbers between 0 and 1, possibly containing some `NaN`.

Note

When the number of degrees of freedom is odd, the procedure resorts to the Owen T-function (`OwenT`).

References

Owen, D. B. (1965). A special case of a bivariate noncentral t-distribution. *Biometrika* **52**, 437-446.

See Also

Use `psbt` for general values of `delta1` and `delta2`.

Examples

```
nu=5; t1=2; t2=1; delta1=3; delta2=2
# Wolfram integration gives 0.1394458271284726
( p1 <- powen1(nu, t1, t2, delta1, delta2) )
# Wolfram integration gives 0.0353568969628651
( p2 <- powen2(nu, t1, t2, delta1, delta2) )
# Wolfram integration gives 0.806507459306199
( p3 <- powen3(nu, t1, t2, delta1, delta2) )
# Wolfram integration gives 0.018689824158
( p4 <- powen4(nu, t1, t2, delta1, delta2) )
# the sum should be 1
p1+p2+p3+p4
```

psbt *Owen distribution functions*

Description

Evaluates the Owen cumulative distribution function for an integer number of degrees of freedom.

- psbt1 evaluates $P(T_1 \leq t_1, T_2 \leq t_2)$
- psbt2 evaluates $P(T_1 \leq t_1, T_2 > t_2)$
- psbt3 evaluates $P(T_1 > t_1, T_2 > t_2)$
- psbt4 evaluates $P(T_1 > t_1, T_2 \leq t_2)$

Usage

```
psbt1(nu, t1, t2, delta1, delta2, algo = 2)

psbt2(nu, t1, t2, delta1, delta2, algo = 2)

psbt3(nu, t1, t2, delta1, delta2, algo = 2)

psbt4(nu, t1, t2, delta1, delta2, algo = 2)
```

Arguments

nu	integer greater than 1, the number of degrees of freedom; infinite allowed
t1, t2	two numbers, positive or negative, possibly infinite
delta1, delta2	two vectors of possibly infinite numbers with the same length, the noncentrality parameters
algo	the algorithm used, 1 or 2

Value

A vector of numbers between 0 and 1, possibly containing some NaN.

Note

When the number of degrees of freedom is odd, the procedure resorts to the Owen T-function (OwenT).

References

Owen, D. B. (1965). A special case of a bivariate noncentral t-distribution. *Biometrika* **52**, 437-446.

See Also

It is better to use powen if delta1>delta2.

Examples

```
nu=5; t1=1; t2=2; delta1=2; delta2=3
( p1 <- psbt1(nu, t1, t2, delta1, delta2) )
( p2 <- psbt2(nu, t1, t2, delta1, delta2) )
( p3 <- psbt3(nu, t1, t2, delta1, delta2) )
( p4 <- psbt4(nu, t1, t2, delta1, delta2) )
# the sum should be 1
p1+p2+p3+p4
```

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ptOwen *Student CDF with integer number of degrees of freedom*

Description

Cumulative distribution function of the noncentrel Student distribution with an integer number of degrees of freedom.

Usage

```
ptOwen(q, nu, delta = 0)
```

Arguments

`q`	quantile, a finite number
`nu`	integer greater than 1, the number of degrees of freedom; possibly infinite
`delta`	numeric vector of noncentrality parameters; possibly infinite

Value

Numeric vector, the CDF evaluated at `q`.

Note

The results are theoretically exact when the number of degrees of freedom is even. When odd, the procedure resorts to the Owen T-function.

References

Owen, D. B. (1965). A special case of a bivariate noncentral t-distribution. *Biometrika* **52**, 437-446.

Examples

```
ptOwen(2, 3) - pt(2, 3)
ptOwen(2, 3, delta=1) - pt(2, 3, ncp=1)
```

spowen2 *Special case of second Owen distribution function*

Description

Evaluation of the second Owen distribution function in a special case (see details).

Usage

```
spowen2(nu, t, delta, algo = 2)
```

Arguments

nu	positive integer, possibly infinite
t	positive number
delta	vector of positive numbers
algo	the algorithm used, 1 or 2

Details

The value of `spowen2(nu,t,delta)` is the same as the value of `powen2(nu,t,-t,delta,-delta)`, but it is evaluated more efficiently.

Value

A vector of numbers between 0 and 1.

See Also

powen2

Examples

```
spowen2(4, 1, 2) == powen2(4, 1, -1, 2, -2)
```

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