

Package: dng (via r-universe)

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Type Package

Title Distributions and Gradients

Version 1.0.0

Depends R (>= 3.0.0)

Description Provides density, distribution function, quantile function and random generation for the split normal and split-t distributions, and computes their mean, variance, skewness and kurtosis for the two distributions (Li, F, Villani, M. and Kohn, R. (2010) <[doi:10.1016/j.jspi.2010.04.031](https://doi.org/10.1016/j.jspi.2010.04.031)>).

License GPL (>= 2)

BugReports <https://github.com/feng-li/dng/issues>

URL <https://github.com/feng-li/dng/>

Encoding UTF-8

Imports Rcpp (>= 0.12.9)

LinkingTo Rcpp

Suggests testthat

RoxygenNote 7.3.1

NeedsCompilation yes

Repository <https://feng-li.r-universe.dev>

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ghypergeo	<i>Generalized hypergeometric function</i>
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Description

Evaluate generalized hypergeometric series used by the split-t gradient calculations.

Usage

```
ghypergeo(a, b, z, k)
```

Arguments

a	matrix of upper hypergeometric parameters.
b	matrix of lower hypergeometric parameters.
z	vector of hypergeometric function arguments.
k	maximum number of hypergeometric series terms. Non-positive values use the package default.

Value

A one-column numeric matrix of generalized hypergeometric function values. Rows of a, rows of b, and values of z are recycled to the output length.

See Also

[gsplitt\(\)](#)

splitn	<i>Split-normal distribution</i>
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Description

Density distribution function, quantile function and random generation function for the split normal distribution.

Usage

```
dsplitn(x, mu, sigma, lmd, logarithm)
gsplitn(y, par, parCaller, denscaller)
psplitn(q, mu, sigma, lmd)
qsplitn(p, mu, sigma, lmd)
rsplitn(n, mu, sigma, lmd)
```

Arguments

x	vector of quantiles.
mu	vector of location parameter. (The mode of the density)
sigma	vector of standard deviations.
lmd	vector of skewness parameters (>0). If is 1, reduced to symmetric normal distribution.
logarithm	logical; if TRUE, probabilities p are given as log(p).
y	vector of quantiles for gradient evaluation.
par	list with mu, sigma, and lmd parameter vectors.
parCaller	character scalar naming the parameter to differentiate: "mu", "sigma", or "lmd".
denscaller	character vector selecting gradients to compute. Use "u" for the CDF gradient and "d" for the log-density gradient.
q	vector of quantiles.
p	vector of probability.
n	number of observations. If length(n) > 1, the length is taken to be the number required.

Details

The random variable y follows a split-normal distribution, $y \sim N(\mu, \sigma, \lambda)$, which has density:

$$1/(1 + \lambda)\sigma \sqrt{(2/\pi)} \exp(-(y - \mu)^2 / 2\sigma^2), \text{ if } y \leq \mu$$

,

$$1/(1 + \lambda)\sigma \sqrt{(2/\pi)} \exp(-(y - \mu)^2 / 2\sigma^2 \lambda^2), \text{ if } y > \mu$$

where $\sigma > 0$ and $\lambda > 0$. The Split-normal distribution reduce to normal distribution when $\lambda = 1$.

Value

`dsplitn` gives the density; `psplitn` gives the percentile; `qsplitn` gives the quantile; and `rsplitn` gives the random variables. `gsplitn` returns a list with elements `u` and `d` containing gradients of the CDF and log-density. Invalid arguments will result in return value `NaN`, with a warning.

The numerical arguments other than `n` are recycled to the length of the result. Only the first elements of the logical arguments are used.

Functions

- `gsplitn()`: Gradients for the split-normal CDF and log-density.
- `psplitn()`: Percentile for the split-normal distribution.
- `qsplitn()`: Quantile for the split-normal distribution.
- `rsplitn()`: Random variables from the split-normal distribution.

Author(s)

Feng Li, Jiayue Zeng

References

Villani, M., & Larsson, R. (2006) The Multivariate Split Normal Distribution and Asymmetric Principal Components Analysis. Sveriges Riksbank Working Paper Series, No. 175.

See Also

[splitn_mean\(\)](#), [splitn_var\(\)](#), [splitn_skewness\(\)](#) and [splitn_kurtosis\(\)](#) for numerical characteristics of the split-normal distribution.

Examples

```
n <- 3
mu <- c(0,1,2)
sigma <- c(1,2,3)
lmd <- c(1,2,3)

q0 <- rsplitn(n, mu, sigma, lmd)
d0 <- dsplitn(q0, mu, sigma, lmd, logarithm = FALSE)
p0 <- psplitn(q0, mu, sigma, lmd)
q1 <- qsplitn(p0, mu, sigma, lmd)
all.equal(q0, q1)
```

splitn_kurtosis	<i>Moments of the split normal distribution</i>
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Description

Computing the mean, variance, skewness and kurtosis for the split-normal distribution.

Usage

```
splitn_kurtosis(lmd)

splitn_mean(mu, sigma, lmd)

splitn_skewness(sigma, lmd)

splitn_var(sigma, lmd)
```

Arguments

lmd	vector of skewness parameters (>0). If is 1, reduce to normal distribution.
mu	vector of location parameter. (The mode of the density)
sigma	vector of standard deviations.

Value

`splitn_mean` gives the mean. `splitn_var` gives the variance. `splitn_skewness` gives the skewness. `splitn_kurtosis` gives the kurtosis. (`splitn_mean`, `splitn_var`, `splitn_skeness` and `splitn_kurtosis` are all vectors.

Functions

- `splitn_kurtosis()`: Kurtosis for the split-normal distribution.
- `splitn_skewness()`: Skewness for the split-normal distribution.
- `splitn_var()`: Variance for the split-normal distribution.

Author(s)

Feng Li, Jiayue Zeng

References

Villani, M., & Larsson, R. (2006) The Multivariate Split Normal Distribution and Asymmetric Principal Components Analysis. Sveriges Riksbank Working Paper Series, No. 175.

See Also

[psplitn\(\)](#) [dsplitn\(\)](#) [qsplitn\(\)](#) and [rsplitn\(\)](#) for the split-normal distribution.

Examples

```
mu <- c(0,1,2)
sigma <- c(0.5,1,2)
lmd <- c(1,2,3)

mean0 <- splitn_mean(mu, sigma, lmd)
var0 <- splitn_var(sigma, lmd)
skewness0 <- splitn_skewness(sigma, lmd)
kurtosis0 <- splitn_kurtosis(lmd)
```

Description

Density, distribution function, quantile function and random generation for the normal distribution for the split student-t distribution.

Usage

```
dsplitt(x, mu, df, phi, lmd, logarithm)
```

```
gsplitt(y, par, parCaller, denscaller)
```

```
psplitt(q, mu, df, phi, lmd)
```

```
qsplitt(p, mu, df, phi, lmd)
```

```
rsplitt(n, mu, df, phi, lmd)
```

Arguments

x	vector of quantiles.
mu	vector of location parameter. (The mode of the density)
df	degrees of freedom (> 0, can be non-integer). df = Inf is also allowed.
phi	vector of scale parameters (>0).
lmd	vector of skewness parameters (>0). If is 1, reduced to the symmetric student t distribution.
logarithm	logical; if TRUE, probabilities p are given as log(p).
y	vector of quantiles for gradient evaluation.
par	list with mu, df, phi, and lmd parameter vectors.
parCaller	character scalar naming the parameter to differentiate: "mu", "df", "phi", or "lmd".
denscaller	character vector selecting gradients to compute. Use "u" for the CDF gradient and "d" for the log-density gradient.
q	vector of quantiles.
p	vector of probability.
n	number of observations. If length(n) > 1, the length is taken to be the number required.

Details

The random variable y follows a split- t distribution with $\nu > 0$ degrees of freedom, $y \sim t(\mu, \phi, \lambda, \nu)$, if its density function is of the form

$$CK(\mu, \phi, \nu, \lambda)I(y \leq \mu) + CK(\mu, \lambda\phi, \nu)I(y > \mu),$$

where,

$$K(\mu, \phi, \nu, \lambda) = [\nu / (\nu + (y - \mu)^2 / \phi^2)]^{(\nu+1)/2}$$

is the kernel of a student t density with variance $\phi^2\nu/(\nu - 2)$ and

$$c = 2[(1 + \lambda)\phi(\sqrt{\nu})Beta(\nu/2, 1/2)]^{-1}$$

is the normalization constant.

Value

`dsplitt` gives the density; `psplitt` gives the percentile; `qsplitt` gives the quantile; and `rsplitt` gives the random variables. `gsplitt` returns a list with elements `u` and `d` containing gradients of the CDF and log-density. Invalid arguments will result in return value `NaN`, with a warning.

The numerical arguments other than `n` are recycled to the length of the result. Only the first elements of the logical arguments are used.

Functions

- `gsplitt()`: Gradients for the split-t CDF and log-density.
- `psplitt()`: Percentile for the split-t distribution.
- `qsplitt()`: Quantile for the split-t distribution.
- `rsplitt()`: Random variables from the split-t distribution.

Author(s)

Feng Li, Jiayue Zeng

References

Li, F., Villani, M., & Kohn, R. (2010). Flexible modeling of conditional distributions using smooth mixtures of asymmetric student t densities. *Journal of Statistical Planning & Inference*, 140(12), 3638-3654.

See Also

[splitt_mean\(\)](#), [splitt_var\(\)](#), [splitt_skewness\(\)](#) and [splitt_kurtosis\(\)](#) for numerical characteristics of the Split-t distribution.

Examples

```
n <- 3
mu <- c(0,1,2)
df <- rep(10,3)
phi <- c(0.5,1,2)
lmd <- c(1,2,3)

q0 <- rsplitt(n, mu, df, phi, lmd)
d0 <- dsplitt(q0, mu, df, phi, lmd, logarithm = FALSE)
p0 <- psplitt(q0, mu, df, phi, lmd)
q1 <- qsplitt(p0,mu, df, phi, lmd)
all.equal(q0, q1)
```

splitt_kurtosis *Moments of the split-t distribution*

Description

Computing the mean, variance, skewness and kurtosis for the split student-t distribution.

Usage

```
splitt_kurtosis(df, phi, lmd)
```

```
splitt_mean(mu, df, phi, lmd)
```

```
splitt_skewness(df, phi, lmd)
```

```
splitt_var(df, phi, lmd)
```

Arguments

df	degrees of freedom (> 0, can be non-integer). df = Inf is allowed.
phi	vector of scale parameters (> 0).
lmd	vector of skewness parameters (> 0). If is 1, reduced to symmetric student t distribution.
mu	vector of location parameter. (The mode of the density)

Value

splitt_mean gives the mean. splitt_var gives the variance. splitt_skewness gives the skewness. splitt_kurtosis gives the kurtosis. (splitt_mean, splitt_var, splitt_skeness and splitt_kurtosis are all vectors.)

Invalid arguments will result in return value NaN, with a warning.

Functions

- splitt_kurtosis(): Kurtosis for the split-t distribution.
- splitt_skewness(): Skewness for the split-t distribution.
- splitt_var(): Variance for the split-t distribution.

Author(s)

Feng Li, Jiayue Zeng

References

Li, F., Villani, M., & Kohn, R. (2010). Flexible modeling of conditional distributions using smooth mixtures of asymmetric student t densities. *Journal of Statistical Planning & Inference*, 140(12), 3638-3654.

See Also

[dsplitt\(\)](#), [psplitt\(\)](#), [qsplitt\(\)](#) and [rsplitt\(\)](#) for the split-t distribution.

Examples

```
mu <- c(0,1,2)
df <- rep(10,3)
phi <- c(0.5,1,2)
lmd <- c(1,2,3)

mean0 <- splitt_mean(mu, df, phi, lmd)
var0 <- splitt_var(df, phi, lmd)
skewness0 <- splitt_skewness(df, phi, lmd)
kurtosis0 <- splitt_kurtosis(df, phi, lmd)
```

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