

Package: dng (via r-universe)

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Type Package

Title Distributions and Gradients

Version 1.1

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

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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 functions by their defining series.

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 100000 terms.

Details

Only the convergent defining series and terminating polynomials are supported; analytic continuation outside the series domain is not performed. Invalid parameters, failure to converge within k terms, and severe cancellation return NaN, with a warning. The split-t gradients do not depend on this routine.

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 longest input length. Empty input rows or an empty z return a matrix with zero rows. Missing values propagate.

See Also

[gsplitt\(\)](#)

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

Density, distribution, quantile, random generation, and parameter gradients for the split-normal distribution.

Usage

```
dsplitn(x, mu, sigma, lmd, log = FALSE, logarithm = NULL)
```

```
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 finite location parameters (the modes of the densities).
sigma	vector of finite positive left-side scale parameters.
lmd	vector of finite positive skewness parameters. If 1, reduced to symmetric normal distribution.
log	logical scalar; if TRUE, return log-densities. Defaults to FALSE.
logarithm	optional logical scalar retained for backward compatibility. When non-NULL, overrides log.
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 density is

$$f(y) = \frac{2}{(1 + \lambda)\sigma} \varphi(z),$$

where φ is the standard normal density, $z = (y - \mu)/\sigma$ for $y \leq \mu$, and $z = (y - \mu)/(\sigma\lambda)$ otherwise. The scale σ describes the left side; it is the overall standard deviation only when $\lambda = 1$. Random values are sampled from a mixture of negative and positive half-normal distributions, with left-side probability $1/(1 + \lambda)$.

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. Unrequested gradient components are `NaN`; an empty `denscaller` selects both. Missing inputs propagate. Invalid parameters or probabilities return `NaN`, with a warning.

Numerical arguments are recycled to their longest length, or the length specified by `n` for random generation. An empty numerical input gives an empty result, except random generation returns `n` `NaN`s with a warning for an empty parameter vector. `log` and `logarithm` must be logical scalars.

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, log = 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 finite positive skewness parameters. If 1, reduce to normal distribution.
mu	vector of finite location parameters (the modes of the densities).
sigma	vector of finite positive left-side scale parameters.

Value

splitn_mean gives the mean. splitn_var gives the variance. splitn_skewness gives the skewness. splitn_kurtosis gives excess kurtosis (zero for the normal distribution). All results are vectors, recycled to the longest numerical input. Empty inputs return an empty vector; missing values propagate. Invalid parameters return NaN, with a warning. Skewness and excess kurtosis do not depend on the positive scale.

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

[psplittn\(\)](#) [dsplittn\(\)](#) [qsplittn\(\)](#) and [rsplittn\(\)](#) for the split-normal distribution.

Examples

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

mean0 <- splittn_mean(mu, sigma, lmd)
var0 <- splittn_var(sigma, lmd)
skewness0 <- splittn_skewness(sigma, lmd)
kurtosis0 <- splittn_kurtosis(lmd)
```

splitt	<i>Split-t distribution</i>
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Description

Density, distribution, quantile, random generation, and parameter gradients for the split Student-t distribution.

Usage

```
dsplitt(x, mu, df, phi, lmd, log = FALSE, logarithm = NULL)

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 finite location parameters (the modes of the densities).
df	degrees of freedom (> 0, can be non-integer). df = Inf is also allowed.
phi	vector of finite positive left-side scale parameters.
lmd	vector of finite positive skewness parameters. If 1, reduced to the symmetric student t distribution.

<code>log</code>	logical scalar; if TRUE, return log-densities. Defaults to FALSE.
<code>logarithm</code>	optional logical scalar retained for backward compatibility. When non-NULL, overrides <code>log</code> .
<code>y</code>	vector of quantiles for gradient evaluation.
<code>par</code>	list with <code>mu</code> , <code>df</code> , <code>phi</code> , and <code>lmd</code> parameter vectors.
<code>parCaller</code>	character scalar naming the parameter to differentiate: "mu", "df", "phi", or "lmd".
<code>denscaller</code>	character vector selecting gradients to compute. Use "u" for the CDF gradient and "d" for the log-density gradient.
<code>q</code>	vector of quantiles.
<code>p</code>	vector of probability.
<code>n</code>	number of observations. If <code>length(n) > 1</code> , the length is taken to be the number required.

Details

The density is

$$f(y) = \frac{2}{(1 + \lambda)\phi} t_{\nu}(z),$$

where t_{ν} is the standard Student-t density, $z = (y - \mu)/\phi$ for $y \leq \mu$, and $z = (y - \mu)/(\phi\lambda)$ otherwise. With `df = Inf` the distribution is split-normal with `sigma = phi`. Random values are sampled from negative and positive half-t distributions, with left-side probability $1/(1 + \lambda)$.

The CDF derivative with respect to `df` is evaluated by integrating the analytic density score using R's QUADPACK routines. Failure to converge returns NaN, with a warning. At `df = Inf`, the derivatives with respect to `df` are zero.

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. Unrequested gradient components are NaN; an empty `denscaller` selects both. Missing inputs propagate. Invalid parameters or probabilities return NaN, with a warning.

Numerical arguments are recycled to their longest length, or the length specified by `n` for random generation. An empty numerical input gives an empty result, except random generation returns n NaNs with a warning for an empty parameter vector. `log` and `logarithm` must be logical scalars.

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, log = FALSE)
p0 <- psplitt(q0, mu, df, phi, lmd)
q1 <- qsplitt(p0,mu, df, phi, lmd)
all.equal(q0, q1)
```

splitt_kurtosis	<i>Moments of the split-t distribution</i>
-----------------	--

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 finite positive left-side scale parameters.
lmd	vector of finite positive skewness parameters. If 1, reduced to symmetric student t distribution.
mu	vector of finite location parameters (the modes of the densities).

Value

splitt_mean gives the mean. splitt_var gives the variance. splitt_skewness gives the skewness. splitt_kurtosis gives excess kurtosis. All results are vectors, recycled to the longest numerical input. Empty inputs return an empty vector; missing values propagate. With $df = \text{Inf}$, results equal the split-normal moments.

The mean requires $df > 1$. Variance is NaN for $df \leq 1$ and Inf for $1 < df \leq 2$. Skewness and excess kurtosis require $df > 3$ and $df > 4$, respectively. Undefined moments and invalid parameters return 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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