

Package ‘csn’

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Type Package

Title Closed Skew-Normal Distribution

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Imports mvtnorm

Description Provides functions for computing the density and the log-likelihood function of closed-skew normal variates, and for generating random vectors sampled from this distribution. See Gonzalez-Farias, G., Dominguez-Molina, J., and Gupta, A. (2004). The closed skew normal distribution, Skew-elliptical distributions and their applications: a journey beyond normality, Chapman and Hall/CRC, Boca Raton, FL, pp. 25-42.

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Contents

dcsn	2
loglcsn	3
pcsn	4
rdsn	5

Index	7
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`dcsn`*The probability density function*

Description

The probability density function of the closed-skew normal distribution

Usage

```
dcsn(x, mu, sigma, gamma, nu, delta)
```

Arguments

<code>x</code>	this is either a vector of length <code>n</code> or a matrix with <code>n</code> columns, where <code>n=ncol(sigma)</code> , giving the coordinates of the point(s) where the density must be evaluated
<code>mu</code>	a numeric vector representing the location parameter of the distribution; it must be of length <code>n</code> , as defined above
<code>sigma</code>	a positive definite matrix representing the scale parameter of the distribution; a vector of length 1 is also allowed
<code>gamma</code>	a matrix representing the skewness parameter of the distribution; a vector of length 1 is also allowed
<code>nu</code>	a numeric vector allows for closure with conditional densities; it must be of length <code>q</code> , as defined above
<code>delta</code>	a positive definite matrix allows for closure with the marginal densities; a vector of length 1 is also allowed

Details

Function `dcsn` makes use of `pmvnorm` and `dmvnorm` from package `mvtnorm`

Value

`dcsn` returns a vector of density values

See Also

[pmvnorm](#), [dmvnorm](#)

Examples

```
x1 <- seq(4.5,11,length=100)
x2 <- cbind(seq(3,9,length=100),seq(7,13,length=100))
mu <- c(5,7)
sigma <- matrix(c(1,0.2,0.2,4),2)
gamma <- matrix(c(4,0,0,5),2)
nu <- c(-2,6)
delta <- matrix(c(1,0,0,1),2)
```

```
f1 <- dcsn(x1,5,9,1,0,0.05)
f2 <- dcsn(x2, mu, sigma, gamma, nu, delta)
```

loglcsn *The log-likelihood function*

Description

The log-likelihood function of the closed-skew normal distribution

Usage

```
loglcsn(x, mu, sigma, gamma, nu, delta)
```

Arguments

x	this is either a vector of length n or a matrix with n columns, where $n = \text{ncol}(\text{sigma})$, giving the coordinates of the point(s) where the density must be evaluated
mu	a numeric vector representing the location parameter of the distribution; it must be of length n, as defined above
sigma	a positive definite matrix representing the scale parameter of the distribution; a vector of length 1 is also allowed
gamma	a matrix representing the skewness parameter of the distribution; a vector of length 1 is also allowed
nu	a numeric vector allows for closure with conditional densities; it must be of length q, as defined above
delta	a positive definite matrix allows for closure with the marginal densities; a vector of length 1 is also allowed

Details

Function loglcsn makes use of pmvnorm and dmvnorm from package mvtnorm

Value

loglcsn returns a sum of log-transformed density values

See Also

[pmvnorm](#), [dmvnorm](#)

Examples

```
x <- cbind(seq(3,9,length=100),seq(7,13,length=100))
mu <- c(5,7)
sigma <- matrix(c(1,0.2,0.2,4),2)
gamma <- matrix(c(4,0,0,5),2)
nu <- c(-2,6)
delta <- matrix(c(1,0,0,1),2)
L <- loglcsn(x, mu, sigma, gamma, nu, delta)
```

pcsn

The cumulative distribution function

Description

The cumulative distribution function of the closed-skew normal distribution

Usage

```
pcsn(x, mu, sigma, gamma, nu, delta)
```

Arguments

x	this is either a vector of length n or a matrix with n columns, where $n = \text{ncol}(\text{sigma})$, giving the coordinates of the point(s) where the cdf must be evaluated
mu	a numeric vector representing the location parameter of the distribution; it must be of length n, as defined above
sigma	a positive definite matrix representing the scale parameter of the distribution; a vector of length 1 is also allowed
gamma	a matrix representing the skewness parameter of the distribution; a vector of length 1 is also allowed
nu	a numeric vector allows for closure with conditional densities; it must be of length q, as defined above
delta	a positive definite matrix allows for closure with the marginal densities; a vector of length 1 is also allowed

Details

Function pcsn makes use of pmvnorm from package mvtnorm

Value

pcsn returns a vector of cdf values

See Also

[pmvnorm](#)

Examples

```

x1 <- seq(4,6,by = 0.1)
x2 <- x1+sin(x1)
x3 <- x1-cos(x1)
x <- cbind(x1,x2,x3)
mu <- c(1,2,3)
sigma <- matrix(c(2,-1,0,-1,2,-1,0,-1,2),3)
gamma <- matrix(c(0,1,0,2,2,3),2,3)
nu <- c(1,3)
delta <- matrix(c(1,1,1,2),2)
pcsn(6,5,9,1,0,0.05)
pcsn(c(3,4,5),mu,sigma,gamma,nu,delta)
pcsn(x,mu,sigma,gamma,nu,delta)

```

rdsn

*Random number generation***Description**

Random number generation of the closed-skew normal distribution

Usage

```
rdsn(k, mu = rep(0, n), sigma, gamma, nu = rep(0, q), delta)
```

Arguments

k	the number of random numbers to be generated
mu	a numeric vector representing the location parameter of the distribution; it must be of length n, as defined above
sigma	a positive definite matrix representing the scale parameter of the distribution; a vector of length 1 is also allowed
gamma	a matrix representing the skewness parameter of the distribution; a vector of length 1 is also allowed
nu	a numeric vector allows for closure with conditional densities; it must be of length q, as defined above
delta	a positive definite matrix allows for closure with the marginal densities; a vector of length 1 is also allowed

Details

Function rdsn makes use of rmvnorm from package mvtnorm;

Value

rdsn returns a matrix of k rows of random vectors

See Also[rmvnorm](#)**Examples**

```
mu <- c(1,2,3)
sigma <- matrix(c(2,-1,0,-1,2,-1,0,-1,2),3)
gamma <- matrix(c(0,1,0,2,2,3),2,3)
nu <- c(1,3)
delta <- matrix(c(1,1,1,2),2)
x1 <- rdsn(100, mu, sigma, gamma, nu, delta)
x2 <- rdsn(100,5,9,1,0,0.05)
```

Index

dcsn, 2
dmvnorm, 2, 3
loglcsn, 3
pcsn, 4
pmvnorm, 2–4
rcsn, 5
rmvnorm, 6