Package ‘condTruncMVN’

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condtMVN

Conditional Truncated Multivariate Normal Parameters

Description

Suppose that \( Z = (X,Y) \) is from a fully-joint multivariate normal distribution of dimension \( n \) with mean and covariance matrix \( \sigma \) truncated between \( \text{lower} \) and \( \text{upper} \). This function provides the parameters for the conditional mean and covariance matrix of \( Y \) given \( X \). See the vignette for more information.

Usage

condtMVN(
  mean,
  sigma,
  lower,
  upper,
  dependent.ind,
  given.ind,
  X.given,
  init = rep(0, length(mean))
)

Arguments

- **mean**: the mean vector for \( Z \) of length of \( n \)
- **sigma**: the symmetric and positive-definite covariance matrix of dimension \( n \times n \) of \( Z \).
- **lower**: a vector of lower bounds of length \( n \) that truncate \( Z \)
- **upper**: a vector of upper bounds of length \( n \) that truncate \( Z \)
- **dependent.ind**: a vector of integers denoting the indices of dependent variable \( Y \).
- **given.ind**: a vector of integers denoting the indices of conditioning variable \( X \). If specified as integer vector of length zero or left unspecified, the unconditional density is returned.
- **X.given**: a vector of reals denoting the conditioning value of \( X \). This should be of the same length as \( \text{given.ind} \)
- **init**: initial value used for random generation of truncated multivariate normal in a Gibbs sampler. Default: A vector of zeros, equal to the number of components.

Details

The first four arguments are the parameters of multivariate normal and the truncation space. \( \text{dependent.ind}, \text{given.ind}, X.given \) are all arguments that determines the conditional truncated MVN.

Using the full data \( Z \), the conditional mean and conditional variance of \( Y|X \) are determined (Wang, 2006). Additionally, to reflect the reduced dimension of \( Y|X \), the truncation limits are also adjusted. See the vignette for more information.
condtMVN

Value

Returns a list of:

- condMean - conditional mean of \( Y \mid X \)
- condVar - conditional variance of \( Y \mid X \)
- condLower - the lower bound of \( Y \mid X \)
- condUpper - the upper bound of \( Y \mid X \)
- condInit - the initial values adjusted to match the dimension of \( Y \mid X \). These are used to randomly generate the truncated multivariate normal \( \text{rmvtruncnorm} \).

Note

This function is based on \( \text{condMVN} \) from the \( \text{condMVNorm} \) package.

References


See Also

\( \text{cmvnorm}, \text{pmvnorm}, \text{Mvnorm} \)

Examples

# Suppose \( X_2, X_3, X_5 \mid X_2, X_4 \sim \text{N}_3(1, \Sigma) \) and truncated between \(-10\) and \(10\).
\[
\begin{align*}
\text{d} & \gets 5 \\
\text{rho} & \gets 0.9 \\
\text{Sigma} & \gets \text{matrix}(0, \text{nrow = d, ncol = d}) \\
\text{Sigma} & \gets \text{rho}^\text{abs(row(Sigma) - col(Sigma))}
\end{align*}
\]

# Conditional Truncated Normal Parameters
\[
\text{condtMVN(mean = rep(1, d),} \\
\text{sigma = Sigma,} \\
\text{lower = rep(-10, d),} \\
\text{upper = rep(10, d),} \\
\text{dependent.ind = c(2, 3, 5),} \\
\text{given.ind = c(1, 4), X.given = c(1, -1))}
\]
Density of the Conditional Truncated Multivariate Normal

**Description**

Calculates the density of truncated conditional multivariate normal \( Y|X: f(Y = y|X = X.given) \). See the vignette for more information.

**Usage**

```r
dcmvtruncnorm(
  y,  
  mean,  
  sigma,  
  lower,  
  upper,  
  dependent.ind,  
  given.ind,  
  X.given,  
  log = FALSE
)
```

**Arguments**

- `y` vector or matrix of quantiles of \( Y \). If a matrix, each row is taken to be a quantile. This is the quantity that the density is calculated from.
- `mean` the mean vector for \( Z \) of length of \( n \).
- `sigma` the symmetric and positive-definite covariance matrix of dimension \( n \times n \) of \( Z \).
- `lower` a vector of lower bounds of length \( n \) that truncate \( Z \).
- `upper` a vector of upper bounds of length \( n \) that truncate \( Z \).
- `dependent.ind` a vector of integers denoting the indices of dependent variable \( Y \).
- `given.ind` a vector of integers denoting the indices of conditioning variable \( X \). If specified as integer vector of length zero or left unspecified, the unconditional density is returned.
- `X.given` a vector of reals denoting the conditioning value of \( X \). This should be of the same length as `given.ind`.
- `log` logical; if `TRUE`, densities \( d \) are given as \( \log(d) \).

**References**

pcmvtruncnorm

Examples

# Example 1: X2,X3,X5|X2,X4 ~ N_3(1, Sigma)
# truncated between -10 and 10.
d <- 5
rho <- 0.9
Sigma <- matrix(0, nrow = d, ncol = d)
Sigma <- rho^abs(row(Sigma) - col(Sigma))

# Log-density of 0
dcmvtruncnorm(  
  rep(0, 3),
  mean = rep(1, 5),
  sigma = Sigma,
  lower = rep(-10, 5),
  upper = rep(10, d),
  dependent.ind = c(2, 3, 5),
  given.ind = c(1, 4), X.given = c(1, -1),
  log = TRUE
)

pcmvtruncnorm

CDF for the Conditional Truncated Multivariate Normal

Description

Computes the distribution function for a conditional truncated multivariate normal random variate Y|X.

Usage

pcmvtruncnorm(  
  lowerY,
  upperY,
  mean,
  sigma,
  lower,
  upper,
  dependent.ind,
  given.ind,
  X.given,
  ...
)

Arguments

lowerY the vector of lower limits for Y|X. Passed to tmvtnorm::ptmvnorm().
upperY the vector of upper limits for Y|X. Must be greater than lowerY. Passed to tmvtnorm::ptmvnorm().
pcmvtruncnorm

mean the mean vector for Z of length of n
sigma the symmetric and positive-definite covariance matrix of dimension n x n of Z.
lower a vector of lower bounds of length n that truncate Z
upper a vector of upper bounds of length n that truncate Z
dependent.ind a vector of integers denoting the indices of dependent variable Y.
given.ind a vector of integers denoting the indices of conditioning variable X. If specified
as integer vector of length zero or left unspecified, the unconditional density is returned.
X.given a vector of reals denoting the conditioning value of X. This should be of the
same length as given.ind
...
Additional arguments passed to tmvtnorm::ptmvnorm(). The CDF is calculated
using the Genz algorithm based on these arguments: maxpts, abseps, and releps.

Details
Calculates the probability that Y|X is between lowerY and upperY. Z = (X, Y) is the fully joint
multivariate normal distribution with mean equal mean and covariance matrix sigma, truncated
between lower and upper. See the vignette for more information.

Note
For one-dimension conditionals Y|X, this function uses the ptruncnorm() function in the truncnorm
package. Otherwise, this function uses tmvtnorm::ptmvnorm().

Examples
# Example 1: Let X2,X3,X5|X2,X4 ~ N_3(1, Sigma)
# truncated between -10 and 10.
d <- 5
rho <- 0.9
Sigma <- matrix(0, nrow = d, ncol = d)
Sigma <- rho^abs(row(Sigma) - col(Sigma))
# Find P(-0.5 < X2,X3,X5 < 0 | X2,X4)
pcmvtruncnorm(rep(-0.5, 3), rep(0, 3),
mean = rep(1, d),
sigma = Sigma,
lower = rep(-10, d),
upper = rep(10, d),
dependent.ind = c(2, 3, 5),
given.ind = c(1, 4), X.given = c(1, -1)
)

# Example 2: Let X1| X2 = 1, X3 = -1, X4 = 1, X5 = -1 ~ N(1, Sigma) truncated
# between -10 and 10. Find P(-0.5 < X1 < 0 | X2 = 1, X3 = -1, X4 = 1, X5 = -1).
pcmvtruncnorm(-0.5, 0,
mean = rep(1, d),
sigma = Sigma,
lower = rep(-10, d),
rcmvtruncnorm

```r
upper = rep(10, d),
dependent.ind = 1,
given.ind = 2:5, X.given = c(1, -1, 1, -1)
)
```

---

**rcmvtruncnorm**  
*Random Sample from Conditional Truncated Multivariate Normal*

---

**Description**

Randomly samples from conditional truncated multivariate normal distribution variate, \(Y|X\), where \(Z = (X, Y)\) is the fully joint multivariate normal distribution with mean, covariance matrix \(\sigma\), and truncated between \(\text{lower}\) and \(\text{upper}\). See the vignette for more information.

**Usage**

```r
rcmvtruncnorm(
  n,
  mean,
  sigma,
  lower,
  upper,
  dependent.ind,
  given.ind,
  X.given,
  init = rep(0, length(mean)),
  burn = 10L,
  thin = 1
)
```

**Arguments**

- `n` number of random samples desired (sample size).
- `mean` the mean vector for \(Z\) of length of \(n\)
- `sigma` the symmetric and positive-definite covariance matrix of dimension \(n \times n\) of \(Z\).
- `lower` a vector of lower bounds of length \(n\) that truncate \(Z\)
- `upper` a vector of upper bounds of length \(n\) that truncate \(Z\)
- `dependent.ind` a vector of integers denoting the indices of dependent variable \(Y\).
- `given.ind` a vector of integers denoting the indices of conditioning variable \(X\). If specified as integer vector of length zero or left unspecified, the unconditional density is returned.
- `X.given` a vector of reals denoting the conditioning value of \(X\). This should be of the same length as \(\text{given.ind}\)
- `init` initial value used for random generation of truncated multivariate normal in a Gibbs sampler. Default: A vector of zeros, equal to the number of components. For details, see tmvmixnorm::rtmvn().
burn the burn-in, which is the number of initial iterations to be discarded. Default: 10. Passed to \texttt{rtmvn}().

\texttt{thin} thinning lag (default as 1).

\textbf{Note}

Uses \texttt{rtmvn} from the \texttt{tmvmixnorm} package to find the random variate.

\textbf{Examples}

\begin{verbatim}
# Generate 2 random numbers from X2,X3,X5|X2,X4 ~ N_3(1, Sigma)
# truncated between -10 and 10.

set.seed(2342)
rcmvtruncnorm(2,
    mean = rep(1, d),
    sigma = Sigma,
    lower = rep(-10, d),
    upper = rep(10, d),
    dependent.ind = c(2, 3, 5),
    given.ind = c(1, 4), X.given = c(1, -1) )

# Example 2: Generate two random numbers from
# X1|X2, X3, X4, X5 ~ N(1, Sigma) truncated between -10 and 10.
set.seed(2342)
rcmvtruncnorm(2,
    mean = rep(1, d),
    sigma = Sigma,
    lower = rep(-10, d),
    upper = rep(10, d),
    dependent.ind = 1,
    given.ind = 2:5, X.given = c(1, -1, 1, -1) )
\end{verbatim}
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