

# Package ‘sparseMVN’

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**Type** Package

**Title** Multivariate Normal Functions for Sparse Covariance and Precision Matrices

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**Description** Computes multivariate normal (MVN) densities, and samples from MVN distributions, when the covariance or precision matrix is sparse.

**License** MPL (>= 2.0)

**Depends** R (>= 3.4.0)

**Imports** Matrix (>= 1.2.12), methods

**Suggests** mvtnorm (>= 1.0.6), plyr, knitr, testthat, dplyr (>= 0.5.0), scales, reshape2, trustOptim (>= 0.8.5), xtable (>= 1.8), ggplot2 (>= 2.2.1), tidyr (>= 0.6.1)

**VignetteBuilder** knitr

**RoxygenNote** 6.0.1

**NeedsCompilation** no

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**Repository** CRAN

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sparseMVN-package	<i>Multivariate Normal Functions for Sparse Covariate and Precision Matrices</i>
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### Description

MVN functions for sparse covariance and precision matrices.

### Details

Computes multivariate normal (MVN) densities, and samples from MVN distributions, when either the covariance or precision matrix is stored as a sparse Matrix (a dsCMatrix object, as defined in the Matrix package). The user can provide the precision matrix directly, rather than convert it to a covariance via matrix inversion.

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binary	<i>Binary choice example</i>
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### Description

Functions for binary choice example in the vignette.

### Usage

```
binary.f(P, data, priors, order.row = FALSE)
binary.grad(P, data, priors, order.row = FALSE)
binary.hess(P, data, priors, order.row = FALSE)
binary.sim(N, k, T)
```

### Arguments

P	Numeric vector of length $(N + 1)k$ . First $Nk$ elements are heterogeneous coefficients. The remaining $k$ elements are population parameters.
data	Named list of data matrices Y and X, and choice count integer T
priors	Named list of matrices inv.Omega and inv.A.
order.row	Determines order of heterogeneous coefficients in parameter vector. If TRUE, heterogeneous coefficients are ordered by unit. If FALSE, they are ordered by covariate.
N	Number of heterogeneous units
k	Number of heterogeneous parameters
T	Observations per household

**Details**

These functions are used by the heterogeneous binary choice example in the vignette. There are  $N$  heterogeneous units, each making  $T$  binary choices. The choice probabilities depend on  $k$  covariates. `binary.sim` simulates a dataset suitable for running the example.

**Value**

For `binary.f`, `binary.df` and `binary.hess`, the log posterior density, gradient and Hessian, respectively. The Hessian is a `dgCMatrix` object. `binary.sim` returns a list with simulated  $Y$  and  $X$ , and the input  $T$ .

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<code>rmvn.sparse</code>	<i>Multivariate normal functions with sparse covariance/precision matrix.</i>
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**Description**

Efficient sampling and density calculation from a multivariate normal, when the covariance or precision matrix is sparse. These functions are designed for MVN samples of very large dimension.

**Usage**

```
rmvn.sparse(n, mu, CH, prec = TRUE)
```

```
dmvn.sparse(x, mu, CH, prec = TRUE, log = TRUE)
```

**Arguments**

<code>n</code>	number of samples
<code>mu</code>	mean (numeric vector)
<code>CH</code>	An object of class <code>dCHMsimpl</code> or <code>dCHMsuper</code> that represents the Cholesky factorization of either the precision (default) or covariance matrix. See details.
<code>prec</code>	If <code>TRUE</code> , <code>CH</code> is the Cholesky decomposition of the precision matrix. If <code>false</code> , it is the decomposition for the covariance matrix.
<code>x</code>	numeric matrix, where each row is an MVN sample.
<code>log</code>	If <code>TRUE</code> (default), returns the log density, else returns density.

**Details**

These functions uses sparse matrix operations to sample from, or compute the log density of, a multivariate normal distribution. The user must compute the Cholesky decomposition first, using the Cholesky function in the `Matrix` package. This function operates on a sparse symmetric matrix, and returns an object of class `dCHMsimpl` or `dCHMsuper` (this depends on the algorithm that was used for the decomposition). This object contains information about any fill-reducing permutations that were used to preserve sparsity. The `rmvn.sparse` and `dmvn.sparse` functions use this permutation information, even if pivoting was turned off.

**Examples**

```
require(Matrix)
m <- 20
p <- 2
k <- 4

## build sample sparse covariance matrix
Q1 <- tril(kronecker(Matrix(seq(0.1,p,length=p*p),p,p),diag(m)))
Q2 <- cbind(Q1,Matrix(0,m*p,k))
Q3 <- rbind(Q2,cbind(Matrix(rnorm(k*m*p),k,m*p),Diagonal(k)))
V <- tcrossprod(Q3)
CH <- Cholesky(V)

x <- rmvn.sparse(10,rep(0,p*m+k),CH, FALSE)
y <- dmvn.sparse(x[1,],rep(0,p*m+k), CH, FALSE)
```

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