# The mnormt Package

February 16, 2008

**Version** 1.2-1

**Date** 2007-03-16

**Title** The multivariate normal and t distributions

**Author** Fortran code by Alan Genz, R code by Adelchi Azzalini

**Maintainer** Adelchi Azzalini <azzalini@stat.unipd.it>

**Depends** R (>= 2.2.0)

**Description** This package provides functions for computing the density and the distribution function of, and for generating random vectors from the multivariate normal and multivariate t distributions. It provides functions similar in scope to those of the package 'mvtnorm', but with some differences; one of these is that probabilities are computed via a non-Monte Carlo method.

**License** GPL Version 2

**URL** http://azzalini.stat.unipd.it/SW/Pkg-mnormt

## R topics documented:



---

`dmnorm` *Multivariate normal distribution*

---

### Description

The probability density function, the distribution function and random number generation for the multivariate normal (Gaussian) probability distribution

## Usage

```
dmnorm(x, mean = rep(0, d), varcov, log = FALSE)
pmnorm(x, mean = rep(0, length(x)), varcov, ...)
rmnorm(n = 1, mean = rep(0, d), varcov)
sadmvn(lower, upper, mean, varcov, maxpts = 2000 * d, abseps = 1e-06, releps = 0)
```

## Arguments

| | |
|---|---|
| x | for dmnorm, this is either a vector of length d or a matrix with d columns, where d=ncol(varcov), giving the coordinates of the point(s) where the density must be evaluated; for pmnorm, only a vector of length d is allowed, and d cannot exceed 20 |
| mean | a numeric vector representing the expected value of the distribution; it must be of length d, as defined above |
| varcov | a positive definite matrix representing the variance-covariance matrix of the distribution; a vector of length 1 is also allowed (in this case, d=1 is set) |
| log | a logical value; if TRUE, the logarithm of the density is computed |
| ... | parameters passed to sadmvn, among maxpts, absrel, releps |
| n | the number of random numbers to be generated |
| lower | a numeric vector of lower integration limits of the density function; must be of maximal length 20; +Inf and -Inf entries are allowed |
| upper | a numeric vector of upper integration limits of the density function; must be of maximal length 20; +Inf and -Inf entries are allowed |
| maxpts | the maximum number of function evaluations (default value: 2000*d) |
| abseps | absolute error tolerance (default value: 1e-6) |
| releps | relative error tolerance (default value: 0) |

## Details

Function sadmvn is an interface to a Fortran-77 routine with the same name written by Alan Genz, and available from his web page; this makes uses of some auxiliary functions whose authors are documented in the Fortran code. The routine uses an adaptive integration method.

## Value

dmnorm returns a vector of density values (possibly log-transformed); pmnorm and sadmvn return a single probability with attributes giving details on the achieved accuracy; rmnorm returns a matrix of n rows of random vectors

## Note

The attributes error and status of the probability returned by pmnorm and sadmvn indicate whether the function had a normal termination, achieving the required accuracy. If this is not the case, re-run the function with an higher value of maxpts

## Author(s)

Fortran code of SADMVN and most auxiliary functions by Alan Genz, some additional auxiliary functions by people referred to within his program. Porting to R and additional R code by Adelchi Azzalini

## References

Genz, A. (1992). Numerical Computation of Multivariate Normal Probabilities. *J. Computational and Graphical Statist.*, **1**, 141-149.

Genz, A. (1993). Comparison of methods for the computation of multivariate normal probabilities. *Computing Science and Statistics*, **25**, 400-405.

Genz, A.: Fortran code available at http://www.math.wsu.edu/math/faculty/genz/software/mvn.f

## See Also

dnorm, dmt

## Examples

```
x <- seq(-2,4,length=21)
y <- 2*x+10
z <- x+cos(y)
mu <- c(1,12,2)
Sigma <- matrix(c(1,2,0,2,5,0.5,0,0.5,3), 3, 3)
f <- dmnorm(cbind(x,y,z), mu, Sigma)
p1 <- pmnorm(c(2,11,3), mu, Sigma)
p2 <- pmnorm(c(2,11,3), mu, Sigma, maxpts=10000, abseps=1e-10)
x <- rmnorm(10, mu, Sigma)
p <- sadmvn(lower=c(2,11,3), upper=rep(Inf,3), mu, Sigma) # upper tail
#
p1 <- pnorm(0, 1, 2)
p2 <- pmnorm(0, 1, 2^2)
```

---

# dmt *Multivariate t distribution*

---

## Description

The probability density function, the distribution function and random number generation for the multivariate t probability distribution

## Usage

```
dmt(x, mean = rep(0, d), S, df=Inf, log = FALSE)
pmt(x, mean = rep(0, length(x)), S, df=Inf, ...)
rmt(n = 1, mean = rep(0, d), S, df=Inf)
sadmvt(df, lower, upper, mean, S, maxpts = 2000 * d, abseps = 1e-06, releps = 0)
```

## Arguments

| | |
|---|---|
| x | for dmt, this is either a vector of length d or a matrix with d columns, where d=ncol(S), giving the coordinates of the point(s) where the density must be evaluated; for pmt, only a vector of length d is allowed, and d cannot exceed 20 |
| mean | a numeric vector representing the location parameter of the distribution (equal to the expected value when df>1); it must be of length d, as defined above |
| S | a positive definite matrix representing the scale matrix of the distribution, such that S*df/(df-2) is the variance-covariance matrix when df>2; a vector of length 1 is also allowed (in this case, d=1 is set) |
| df | degrees of freedom; it must be a positive integer for pmt and sadmvt, otherwise a positive number; if df=Inf (default value), the corresponding *mnorm function is called |
| log | a logical value; if TRUE, the logarithm of the density is computed |
| ... | parameters passed to sadmvt, among maxpts, absrel, releps |
| n | the number of random numbers to be generated |
| lower | a numeric vector of lower integration limits of the density function; must be of maximal length 20; +Inf and -Inf entries are allowed |
| upper | a numeric vector of upper integration limits of the density function; must be of maximal length 20; +Inf and -Inf entries are allowed |
| maxpts | the maximum number of function evaluations (default value: 2000*d) |
| abseps | absolute error tolerance (default value: 1e-6) |
| releps | relative error tolerance (default value: 0) |

## Details

Function sadmvt is an interface to a Fortran-77 routine with the same name written by Alan Genz, and available from his web page; this makes uses of some auxiliary functions whose authors are documented in the Fortran code. The routine uses an adaptive integration method.

## Value

dmt returns a vector of density values (possibly log-transformed); pmt and sadmvt return a single probability with attributes giving details on the achieved accuracy; rmt returns a matrix of n rows of random vectors

## Note

The attributes error and status of the probability returned by pmt and sadmvt indicate whether the function had a normal termination, achieving the required accuracy. If this is not the case, re-run the function with an higher value of maxpts

## Author(s)

Fortran code of SADMVT and most auxiliary functions by Alan Genz, some additional auxiliary functions by people referred to within his program. Porting to R and additional R code by Adelchi Azzalini

## References

Genz, A.: Fortran code available at http://www.math.wsu.edu/math/faculty/genz/software/mvt.f

## See Also

dt, dmnorm

## Examples

```
x <- seq(-2,4,length=21)
y <- 2*x+10
z <- x+cos(y)
mu <- c(1,12,2)
Sigma <- matrix(c(1,2,0,2,5,0.5,0,0.5,3), 3, 3)
df <- 4
f  <- dmt(cbind(x,y,z), mu, Sigma,df)
p1 <- pmt(c(2,11,3), mu, Sigma, df)
p2 <- pmt(c(2,11,3), mu, Sigma, df, maxpts=10000, abseps=1e-8)
x  <- rmt(10, mu, Sigma, df)
p  <- sadmvt(df, lower=c(2,11,3), upper=rep(Inf,3), mu, Sigma) # upper tail
```

# Index