

Package ‘mvnmle’

May 9, 2026

Type Package

Title ML Estimation for Multivariate Normal Data with Missing Values

Version 0.1-11.2

Description Finds the Maximum Likelihood (ML) Estimate of the mean vector and variance-covariance matrix for multivariate normal data with missing values.

License GPL (>= 2)

URL <https://github.com/indenkun/mvnmle>

BugReports <https://github.com/indenkun/mvnmle/issues>

Encoding UTF-8

LazyData true

NeedsCompilation yes

RoxygenNote 7.2.3

Imports stats

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Repository CRAN

Date/Publication 2023-02-27 08:32:30 UTC

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apple

Worm Infestations in Apple Crops

Description

The apple data frame provides the number of apples (in 100s) on 18 different apple trees. For 12 trees, the percentage of apples with worms (x 100) is also given.

Usage

```
apple
```

Format

This data frame contains the following columns:

size hundreds of apples on the tree.

worms percentage (x100) of apples harboring worms.

Source

Little, R. J. A., and Rubin, D. B. (1987) *Statistical Analysis with Missing Data*. New York: Wiley, ISBN:0471802549.

Cochran, W. G., and Snedecor, G. W. (1972) *Statistical Methods*, 6th ed. Ames: Iowa State University Press, ISBN:0813815606.

Examples

```
library(mvnmle)
data(apple)

mlest(apple)
```

getclf

Create likelihood function for multivariate data with missing values.

Description

getclf returns a function proportional to twice the negative log likelihood function for multivariate normal data with missing values. This is a private function used in mlest.

Usage

```
getclf(data, freq)
```

Arguments

data	A data frame sorted so that records with identical patterns of missingness are grouped together.
freq	An integer vector specifying the number of records in each block of data with identical patterns of missingness.

Details

The argument of the returned function is the vector of parameters. The parameterization is: mean vector first, followed by the log of the diagonal elements of the inverse of the Cholesky factor, and then the elements of the inverse of the Cholesky factor above the main diagonal. These off-diagonal elements are ordered by column (left to right), and then by row within column (top to bottom).

Value

A function proportional to twice the negative log likelihood of the parameters given the data.

References

Little, R. J. A., and Rubin, D. B. (1987) *Statistical Analysis with Missing Data*. New York: Wiley, ISBN:0471802549.

See Also

[mlest](#)

getstartvals	<i>Obtain starting values for maximum likelihood estimation.</i>
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Description

Calculates the starting values to be passed to `nlm` for minimization of the negative log-likelihood for multivariate normal data with missing values. This function is private to `mlest`.

Usage

```
getstartvals(x, eps = 0.001)
```

Arguments

x	Multivariate data, potentially with missing values.
eps	All eigenvalues of the variance-covariance matrix less than <code>eps</code> times the smallest positive eigenvalue are set to <code>eps</code> times the smallest positive eigenvalue.

Details

Starting values for the mean vector are simply sample means. Starting values for the variance-covariance matrix are derived from the sample variance-covariance matrix, after setting eigenvalues less than `eps` times the smallest positive eigenvalue equal to `eps` times the smallest positive eigenvalue to enforce positive definiteness.

Value

A numeric vector, containing the mean vector first, followed by the log of the diagonal elements of the inverse of the Cholesky factor of the adjusted sample variance-covariance matrix, and then the elements of the inverse of the Cholesky factor above the main diagonal. These off-diagonal elements are ordered by column (left to right), and then by row within column (top to bottom).

See Also

[mlest](#)

make.del

Make the upper triangular matrix del from a parameter vector

Description

`make.del` takes a parameter vector of length $k * (k + 1)/2$ and returns the upper triangular $k \times k$ matrix Δ . `make.del` is a private function intended for use inside `mlest`.

Usage

```
make.del(pars)
```

Arguments

`pars` A length $k * (k + 1)/2$ numerical vector giving the elements of Δ .

Details

The first k elements of `pars` are the log of the diagonal elements of Δ . The next $k * (k - 1)/2$ elements are the elements above the main diagonal of Δ , ordered by column (left to right), and then by row within column (top to bottom). That is to say, if Δ_{ij} is the element in the i th row and j th column of Δ , then the order of the parameters is $\Delta_{11}, \Delta_{22}, \dots, \Delta_{kk}, \Delta_{12}, \Delta_{13}, \Delta_{23}, \Delta_{14}, \dots, \Delta_{(k-1)k}$.

Value

An upper triangular $k \times k$ matrix.

References

Pinheiro, J. C., and Bates, D. M. (2000) *Mixed-effects models in S and S-PLUS*. New York: Springer, ISBN:1441903178.

See Also[mlest](#)

`missvals`*A multivariate data set with missing values.*

Description

The `missvals` data frame has 13 rows and 5 columns. These are data from Draper and Smith (1966, ISBN:0471221708), and are included to demonstrate Maximum Likelihood (ML) estimation of mean and variance-covariance parameters of multivariate normal data when some observations are missing.

Usage`missvals`**Format**

This data frame contains the following columns:

`x1,x2,x3,x4,x5` numeric vectors

Source

Draper, N. R., and Smith, H. (1966) *Applied Regression Analysis*. New York: Wiley, ISBN:0471221708.

Little, R. J. A., and Rubin, D. B. (1987) *Statistical Analysis with Missing Data*. New York: Wiley, ISBN:0471802549.

Rubin, D. B. (1976) Comparing regressions when some predictor variables are missing. *Psychometrika* **43**, 3–10, doi:[10.2307/1267523](https://doi.org/10.2307/1267523).

Examples

```
library(mvnmle)
data(missvals)

mlest(missvals, iterlim = 400)
```

mlest

ML Estimation of Multivariate Normal Data

Description

Finds the Maximum Likelihood (ML) Estimates of the mean vector and variance-covariance matrix for multivariate normal data with (potentially) missing values.

Usage

```
mlest(data, ...)
```

Arguments

data	A data frame or matrix containing multivariate normal data. Each row should correspond to an observation, and each column to a component of the multivariate vector. Missing values should be coded by 'NA'.
...	Optional arguments to be passed to the nlm optimization routine.

Details

The estimate of the variance-covariance matrix returned by `mlest` is necessarily positive semi-definite. Internally, `nlm` is used to minimize the negative log-likelihood, so optional arguments may be passed to `nlm` which modify the details of the minimization algorithm, such as `iterlim`. The likelihood is specified in terms of the inverse of the Cholesky factor of the variance-covariance matrix (see Pinheiro and Bates (2000, ISBN:1441903178)).

`mlest` cannot handle data matrices with more than 50 variables. Each variable must also be observed at least once.

Value

muhat	Maximum Likelihood Estimation (MLE) of the mean vector.
sigmahat	MLE of the variance-covariance matrix.
value	The objective function that is minimized by <code>nlm</code> . Is is proportional to twice the negative log-likelihood.
gradient	The curvature of the likelihood surface at the MLE, in the parameterization used internally by the optimization algorithm. This parameterization is: mean vector first, followed by the log of the diagonal elements of the inverse of the Cholesky factor, and then the elements of the inverse of the Cholesky factor above the main diagonal. These off-diagonal elements are ordered by column (left to right), and then by row within column (top to bottom).
stop.code	The stop code returned by <code>nlm</code> .
iterations	The number of iterations used by <code>nlm</code> .

References

- Little, R. J. A., and Rubin, D. B. (1987) *Statistical Analysis with Missing Data*. New York: Wiley, ISBN:0471802549.
- Pineiro, J. C., and Bates, D. M. (1996) Unconstrained parametrizations for variance-covariance matrices. *Statistics and Computing* **6**, 289–296, doi:10.1007/BF00140873.
- Pineiro, J. C., and Bates, D. M. (2000) *Mixed-effects models in S and S-PLUS*. New York: Springer, ISBN:1441903178.

See Also

[nlm](#)

Examples

```
library(mvnmle)

data(apple)
mlest(apple)

data(missvals)
mlest(missvals, iterlim = 400)
```

mysort	<i>Sort a multivariate data matrix according to patterns of missingness.</i>
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Description

mysort sorts a multivariate data matrix so that records with identical patterns of missingness are adjacent to one another. mysort is a private function used inside of mlest.

Usage

```
mysort(x)
```

Arguments

x	A multivariate data matrix. Rows correspond to individual records and columns correspond to components of the multivariate vector.
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Value

sorted.data	A matrix of the same size as x but with the rows re-arranged so that records with identical patterns of missingness are adjacent to one another.
freq	An integer vector giving the number of records in each block of rows with a unique pattern of missingness. The first element in freq counts the number of rows in the top block of sorted.data, and so on.

See Also[mlest](#)

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