

Package ‘fitVARMxID’

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Title Fit the Vector Autoregressive Model for Multiple Individuals

Version 1.0.5

Description Fit the vector autoregressive model for multiple individuals
using the 'OpenMx' package (Hunter, 2017 <[doi:10.1080/10705511.2017.1369354](https://doi.org/10.1080/10705511.2017.1369354)>).

URL <https://github.com/jeksterslab/fitVARMxID>,
<https://jeksterslab.github.io/fitVARMxID/>

BugReports <https://github.com/jeksterslab/fitVARMxID/issues>

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Depends R (>= 4.1.0), OpenMx (>= 2.22.10)

Imports stats, simStateSpace (>= 1.2.14)

Suggests knitr, rmarkdown, testthat

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coef.varmxid	<i>Parameter Estimates</i>
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Description

Parameter Estimates

Usage

```
## S3 method for class 'varmxid'
coef(
  object,
  mu = TRUE,
  alpha = TRUE,
  beta = TRUE,
  nu = TRUE,
  psi = TRUE,
  theta = TRUE,
  ncores = NULL,
  ...
)
```

Arguments

object	Object of class varmxid.
mu	Logical. If mu = TRUE, include estimates of the mu vector, if available. If mu = FALSE, exclude estimates of the mu vector.
alpha	Logical. If alpha = TRUE, include estimates of the alpha vector, if available. If alpha = FALSE, exclude estimates of the alpha vector.
beta	Logical. If beta = TRUE, include estimates of the beta matrix, if available. If beta = FALSE, exclude estimates of the beta matrix.
nu	Logical. If nu = TRUE, include estimates of the nu vector, if available. If nu = FALSE, exclude estimates of the nu vector.
psi	Logical. If psi = TRUE, include estimates of the psi matrix, if available. If psi = FALSE, exclude estimates of the psi matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
ncores	Positive integer. Number of cores to use.
...	additional arguments.

Value

Returns a list of vectors of parameter estimates.

Author(s)

Ivan Jacob Agaloos Pesigan

confint.varmxid

Confidence Intervals for the Parameter Estimates

Description

Confidence Intervals for the Parameter Estimates

Usage

```
## S3 method for class 'varmxid'
confint(
  object,
  parm = NULL,
  level = 0.95,
  mu = TRUE,
  alpha = TRUE,
  beta = TRUE,
  nu = TRUE,
  psi = TRUE,
  theta = TRUE,
  robust = FALSE,
  ncores = NULL,
  ...
)
```

Arguments

object	Object of class varmxid.
parm	Argument not used.
level	the confidence level required.
mu	Logical. If mu = TRUE, include estimates of the mu vector, if available. If mu = FALSE, exclude estimates of the mu vector.
alpha	Logical. If alpha = TRUE, include estimates of the alpha vector, if available. If alpha = FALSE, exclude estimates of the alpha vector.
beta	Logical. If beta = TRUE, include estimates of the beta matrix, if available. If beta = FALSE, exclude estimates of the beta matrix.
nu	Logical. If nu = TRUE, include estimates of the nu vector, if available. If nu = FALSE, exclude estimates of the nu vector.

psi	Logical. If psi = TRUE, include estimates of the psi matrix, if available. If psi = FALSE, exclude estimates of the psi matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
robust	Logical. If TRUE, use robust (sandwich) sampling variance-covariance matrix. If FALSE, use normal theory sampling variance-covariance matrix.
ncores	Positive integer. Number of cores to use.
...	additional arguments.

Value

Returns list of matrices of confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

converged

Check Model Convergence

Description

Determines whether each fitted **OpenMx** model in a varmxid object meets convergence criteria based on (a) acceptable optimizer status and gradient size, (b) a positive-definite Hessian, and (c) parameters not being at their bounds.

Usage

```
converged(object, ...)

## S3 method for class 'varmxid'
converged(object, prop = FALSE, ...)
```

Arguments

object	A fit object.
...	Passed to and/or used by methods.
prop	Logical. If prop = FALSE, a named logical vector indicating, for each individual fit, whether the convergence criteria are met. If prop = TRUE, the proportion of cases that converged.

Value

For the varmxid method: If prop = FALSE, a named logical vector indicating, for each individual fit, whether the convergence criteria are met. If prop = TRUE, the proportion of cases that converged.

Author(s)

Ivan Jacob Agaloos Pesigan

FitVARmxD

Fit the First-Order Vector Autoregressive Model by ID

Description

The function fits the first-order vector autoregressive model for each unit ID.

Usage

```
FitVARmxD(  
  data,  
  observed,  
  id,  
  time = NULL,  
  ct = FALSE,  
  center = TRUE,  
  mu_fixed = FALSE,  
  mu_free = NULL,  
  mu_values = NULL,  
  mu_lbound = NULL,  
  mu_ubound = NULL,  
  alpha_fixed = FALSE,  
  alpha_free = NULL,  
  alpha_values = NULL,  
  alpha_lbound = NULL,  
  alpha_ubound = NULL,  
  beta_fixed = FALSE,  
  beta_free = NULL,  
  beta_values = NULL,  
  beta_lbound = NULL,  
  beta_ubound = NULL,  
  psi_diag = FALSE,  
  psi_fixed = FALSE,  
  psi_d_free = NULL,  
  psi_d_values = NULL,  
  psi_d_lbound = NULL,  
  psi_d_ubound = NULL,  
  psi_d_equal = FALSE,  
  psi_l_free = NULL,  
  psi_l_values = NULL,  
  psi_l_lbound = NULL,  
  psi_l_ubound = NULL,  
  nu_fixed = TRUE,
```

```

nu_free = NULL,
nu_values = NULL,
nu_lbound = NULL,
nu_ubound = NULL,
theta_diag = TRUE,
theta_fixed = TRUE,
theta_d_free = NULL,
theta_d_values = NULL,
theta_d_lbound = NULL,
theta_d_ubound = NULL,
theta_d_equal = FALSE,
theta_l_free = NULL,
theta_l_values = NULL,
theta_l_lbound = NULL,
theta_l_ubound = NULL,
mu0_fixed = TRUE,
mu0_func = TRUE,
mu0_free = NULL,
mu0_values = NULL,
mu0_lbound = NULL,
mu0_ubound = NULL,
sigma0_fixed = TRUE,
sigma0_func = TRUE,
sigma0_diag = FALSE,
sigma0_d_free = NULL,
sigma0_d_values = NULL,
sigma0_d_lbound = NULL,
sigma0_d_ubound = NULL,
sigma0_d_equal = FALSE,
sigma0_l_free = NULL,
sigma0_l_values = NULL,
sigma0_l_lbound = NULL,
sigma0_l_ubound = NULL,
robust = FALSE,
seed = NULL,
tries_explore = 100,
tries_local = 100,
max_attempts = 10,
silent = FALSE,
ncores = NULL
)

```

Arguments

data	Data frame. A data frame object of data for potentially multiple subjects that contain a column of subject ID numbers (i.e., an ID variable), and at least one column of observed values.
observed	Character vector. A vector of character strings of the names of the observed

	variables in the data.
id	Character string. A character string of the name of the ID variable in the data.
time	Character string. A character string of the name of the TIME variable in the data. Used when ct = TRUE.
ct	Logical. If TRUE, fit a continuous-time vector autoregressive model. If FALSE, fit a discrete-time vector autoregressive model.
center	Logical. If TRUE, use the mean-centered (mean-reverting) state equation. When center = TRUE, alpha is implied and the set-point mu is estimated. When center = FALSE, alpha is estimated and mu is implied.
mu_fixed	Logical. If TRUE, the set-point mean vector mu is fixed to mu_values. If mu_fixed = TRUE and mu_values = NULL, mu is fixed to a zero vector. If FALSE, mu is estimated.
mu_free	Logical vector indicating which elements of mu are freely estimated. If NULL, all elements are free. Ignored if mu_fixed = TRUE.
mu_values	Numeric vector of values for mu. If mu_fixed = TRUE, these are fixed values. If mu_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros.
mu_lbound	Numeric vector of lower bounds for mu. Ignored if mu_fixed = TRUE.
mu_ubound	Numeric vector of upper bounds for mu. Ignored if mu_fixed = TRUE.
alpha_fixed	Logical. If TRUE, the dynamic model intercept vector alpha is fixed to alpha_values. If FALSE, alpha is estimated.
alpha_free	Logical vector indicating which elements of alpha are freely estimated. If NULL, all elements are free. Ignored if alpha_fixed = TRUE.
alpha_values	Numeric vector of values for alpha. If alpha_fixed = TRUE, these are fixed values. If alpha_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros.
alpha_lbound	Numeric vector of lower bounds for alpha. Ignored if alpha_fixed = TRUE.
alpha_ubound	Numeric vector of upper bounds for alpha. Ignored if alpha_fixed = TRUE.
beta_fixed	Logical. If TRUE, the dynamic model coefficient matrix beta is fixed. If FALSE, beta is estimated.
beta_free	Logical matrix indicating which elements of beta are freely estimated. If NULL, all elements are free. Ignored if beta_fixed = TRUE.
beta_values	Numeric matrix. Values for beta. If beta_fixed = TRUE, these are fixed values; if beta_fixed = FALSE, these are starting values. If NULL, defaults to a diagonal matrix with -0.001 when ct = TRUE and 0.001 when ct = FALSE.
beta_lbound	Numeric matrix. Lower bounds for beta. Ignored if beta_fixed = TRUE. If NULL and ct = FALSE, defaults to -2.5. If NULL and ct = TRUE, defaults to NA.
beta_ubound	Numeric matrix. Upper bounds for beta. Ignored if beta_fixed = TRUE. If NULL and ct = FALSE, defaults to +2.5. If NULL and ct = TRUE, diagonal upper bounds are set to -1e-05 and the off-diagonals are set to NA.
psi_diag	Logical. If TRUE, psi is diagonal. If FALSE, psi is symmetric.

psi_fixed	Logical. If TRUE, the process noise covariance matrix psi is fixed using psi_d_values and psi_l_values. If psi_d_values is NULL it is fixed to a zero matrix. If FALSE, psi is estimated.
psi_d_free	Logical vector indicating free/fixed status of the elements of psi_d. If NULL, all element of psi_d are free.
psi_d_values	Numeric vector with starting values for psi_d. If psi_fixed = TRUE, these are fixed values. If psi_fixed = FALSE, these are starting values.
psi_d_lbound	Numeric vector with lower bounds for psi_d.
psi_d_ubound	Numeric vector with upper bounds for psi_d.
psi_d_equal	Logical. When TRUE, all free diagonal elements of psi_d are constrained to be equal and estimated as a single shared parameter. Ignored if no diagonal elements are free.
psi_l_free	Logical matrix indicating which strictly-lower-triangular elements of psi_l are free. If NULL, all element of psi_l are free. Ignored if psi_diag = TRUE.
psi_l_values	Numeric matrix of starting values for the strictly-lower-triangular elements of psi_l.
psi_l_lbound	Numeric matrix with lower bounds for psi_l.
psi_l_ubound	Numeric matrix with upper bounds for psi_l.
nu_fixed	Logical. If TRUE, the measurement model intercept vector nu is fixed to nu_values. If FALSE, nu is estimated.
nu_free	Logical vector indicating which elements of nu are freely estimated. If NULL, all elements are free. Ignored if nu_fixed = TRUE.
nu_values	Numeric vector of values for nu. If nu_fixed = TRUE, these are fixed values. If nu_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros.
nu_lbound	Numeric vector of lower bounds for nu. Ignored if nu_fixed = TRUE.
nu_ubound	Numeric vector of upper bounds for nu. Ignored if nu_fixed = TRUE.
theta_diag	Logical. If TRUE, theta is diagonal. If FALSE, theta is symmetric.
theta_fixed	Logical. If TRUE, the measurement error covariance matrix theta is fixed using theta_d_values and theta_l_values. If theta_d_values is NULL it is fixed to a zero matrix. If FALSE, theta is estimated.
theta_d_free	Logical vector indicating free/fixed status of the diagonal parameters theta_d. If NULL, all element of theta_d are free.
theta_d_values	Numeric vector with starting values for theta_d. If theta_fixed = TRUE, these are fixed values. If theta_fixed = FALSE, these are starting values.
theta_d_lbound	Numeric vector with lower bounds for theta_d.
theta_d_ubound	Numeric vector with upper bounds for theta_d.
theta_d_equal	Logical. When TRUE, all free diagonal elements of theta_d are constrained to be equal and estimated as a single shared parameter. Ignored if no diagonal elements are free.
theta_l_free	Logical matrix indicating which strictly-lower-triangular elements of theta_l are free. If NULL, all element of theta_l are free. Ignored if theta_diag = TRUE.

theta_l_values	Numeric matrix of starting values for the strictly-lower-triangular elements of theta_l.
theta_l_lbound	Numeric matrix with lower bounds for theta_l.
theta_l_ubound	Numeric matrix with upper bounds for theta_l.
mu0_fixed	Logical. If TRUE, the initial mean vector mu0 is fixed. If mu0_fixed = TRUE and mu0_func = TRUE, mu0 is fixed to the implied stable mean vector. If mu0_fixed = TRUE and mu0_values = NULL, mu0 is fixed to a zero vector. If FALSE, mu0 is estimated.
mu0_func	Logical. If TRUE and mu0_fixed = TRUE, mu0 is fixed to the implied stable mean vector.
mu0_free	Logical vector indicating which elements of mu0 are free. Ignored if mu0_fixed = TRUE.
mu0_values	Numeric vector of values for mu0. If mu0_fixed = TRUE, these are fixed values. If mu0_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros. Ignored if mu0_fixed = TRUE and mu0_func = TRUE.
mu0_lbound	Numeric vector of lower bounds for mu0. Ignored if mu0_fixed = TRUE.
mu0_ubound	Numeric vector of upper bounds for mu0. Ignored if mu0_fixed = TRUE.
sigma0_fixed	Logical. If TRUE, the initial condition covariance matrix sigma0 is fixed using sigma0_d_values and sigma0_l_values. If sigma0_fixed = TRUE and sigma0_func = TRUE, sigma0 is fixed to the implied stable covariance matrix. If sigma0_fixed = TRUE and sigma0_d_values = NULL, sigma0 is fixed to a diffused matrix.
sigma0_func	Logical. If TRUE and sigma0_fixed = TRUE, sigma0 is fixed to the implied stable covariance matrix.
sigma0_diag	Logical. If TRUE, sigma0 is diagonal. If FALSE, sigma0 is symmetric.
sigma0_d_free	Logical vector indicating free/fixed status of the elements of sigma0_d. If NULL, all element of sigma0_d are free.
sigma0_d_values	Numeric vector with starting values for sigma0_d. If sigma0_fixed = TRUE, these are fixed values. If sigma0_fixed = FALSE, these are starting values.
sigma0_d_lbound	Numeric vector with lower bounds for sigma0_d.
sigma0_d_ubound	Numeric vector with upper bounds for sigma0_d.
sigma0_d_equal	Logical. When TRUE, all free diagonal elements of sigma0_d are constrained to be equal and estimated as a single shared parameter. Ignored if no diagonal elements are free.
sigma0_l_free	Logical matrix indicating which strictly-lower-triangular elements of sigma0_l are free. If NULL, all element of sigma0_l are free. Ignored if sigma0_diag = TRUE.
sigma0_l_values	Numeric matrix of starting values for the strictly-lower-triangular elements of sigma0_l.

sigma0_l_lbound	Numeric matrix with lower bounds for sigma0_l.
sigma0_l_ubound	Numeric matrix with upper bounds for sigma0_l.
robust	Logical. If TRUE, calculate robust (sandwich) sampling variance-covariance matrix.
seed	Random seed for reproducibility.
tries_explore	Integer. Number of extra tries for the wide exploration phase.
tries_local	Integer. Number of extra tries for local polishing.
max_attempts	Integer. Maximum number of remediation attempts after the first Hessian computation fails the criteria.
silent	Logical. If TRUE, suppresses messages during the model fitting stage.
ncores	Positive integer. Number of cores to use.

Details

Measurement Model:

By default, the measurement model is given by

$$\mathbf{y}_{i,t} = \boldsymbol{\eta}_{i,t}.$$

However, the full measurement model can be parameterized as follows

$$\mathbf{y}_{i,t} = \boldsymbol{\nu}_i + \boldsymbol{\Lambda} \boldsymbol{\eta}_{i,t} + \boldsymbol{\varepsilon}_{i,t}, \quad \text{with} \quad \boldsymbol{\varepsilon}_{i,t} \sim \mathcal{N}(\mathbf{0}, \boldsymbol{\Theta}_i)$$

where $\mathbf{y}_{i,t}$, $\boldsymbol{\eta}_{i,t}$, and $\boldsymbol{\varepsilon}_{i,t}$ are random variables and $\boldsymbol{\nu}_i$, $\boldsymbol{\Lambda}$, and $\boldsymbol{\Theta}_i$ are model parameters. $\mathbf{y}_{i,t}$ represents a vector of observed random variables, $\boldsymbol{\eta}_{i,t}$ a vector of latent random variables, and $\boldsymbol{\varepsilon}_{i,t}$ a vector of random measurement errors, at time t and individual i . $\boldsymbol{\nu}_i$ denotes a vector of intercepts (fixed to a null vector by default), $\boldsymbol{\Lambda}$ a matrix of factor loadings, and $\boldsymbol{\Theta}_i$ the covariance matrix of $\boldsymbol{\varepsilon}$. In this model, $\boldsymbol{\Lambda}$ is an identity matrix and $\boldsymbol{\Theta}_i$ is a diagonal matrix.

Discrete-Time Dynamic Structure:

The dynamic structure is given by

$$\boldsymbol{\eta}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i \boldsymbol{\eta}_{i,t-1} + \boldsymbol{\zeta}_{i,t}, \quad \text{with} \quad \boldsymbol{\zeta}_{i,t} \sim \mathcal{N}(\mathbf{0}, \boldsymbol{\Psi}_i)$$

where $\boldsymbol{\eta}_{i,t}$, $\boldsymbol{\eta}_{i,t-1}$, and $\boldsymbol{\zeta}_{i,t}$ are random variables, and $\boldsymbol{\alpha}_i$, $\boldsymbol{\beta}_i$, and $\boldsymbol{\Psi}_i$ are model parameters. Here, $\boldsymbol{\eta}_{i,t}$ is a vector of latent variables at time t and individual i , $\boldsymbol{\eta}_{i,t-1}$ represents a vector of latent variables at time $t-1$ and individual i , and $\boldsymbol{\zeta}_{i,t}$ represents a vector of dynamic noise at time t and individual i . $\boldsymbol{\alpha}_i$ denotes a vector of intercepts, $\boldsymbol{\beta}_i$ a matrix of autoregression and cross regression coefficients, and $\boldsymbol{\Psi}_i$ the covariance matrix of $\boldsymbol{\zeta}_{i,t}$.

If center = TRUE, the dynamic structure is parameterized as follows

$$\boldsymbol{\eta}_{i,t} = \boldsymbol{\mu}_i + \boldsymbol{\beta}_i (\boldsymbol{\eta}_{i,t-1} - \boldsymbol{\mu}_i) + \boldsymbol{\zeta}_{i,t}$$

where $\boldsymbol{\mu}_i$ is equilibrium level of the latent state toward which the system is pulled over time.

Continuous-Time Dynamic Structure:

The continuous-time parameterization, when `ct = TRUE`, for the dynamic structure is given by

$$d\boldsymbol{\eta}_{i,t} = (\boldsymbol{\alpha}_i + \boldsymbol{\beta}_i \boldsymbol{\eta}_{i,t}) dt + \boldsymbol{\Psi}_i^{\frac{1}{2}} d\mathbf{W}_{i,t}$$

note that $d\mathbf{W}$ is a Wiener process or Brownian motion, which represents random fluctuations.

If `center = TRUE`, the dynamic structure is parameterized as follows

$$d\boldsymbol{\eta}_{i,t} = \boldsymbol{\beta}_i (\boldsymbol{\eta}_{i,t} - \boldsymbol{\mu}_i) dt + \boldsymbol{\Psi}_i^{\frac{1}{2}} d\mathbf{W}_{i,t}$$

Value

Returns an object of class `varmxid` which is a list with the following elements:

call Function call.

args List of function arguments.

fun Function used ("FitVARmxD").

model A list of generated OpenMx models.

output A list of fitted OpenMx models.

converged A logical vector indicating converged cases.

robust A list of output from `OpenMx::imxRobustSE()` with argument `details = TRUE` for each `id` if `robust = TRUE`.

Author(s)

Ivan Jacob Agaloos Pesigan

References

Hunter, M. D. (2017). State space modeling in an open source, modular, structural equation modeling environment. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(2), 307–324. doi:10.1080/10705511.2017.1369354

Neale, M. C., Hunter, M. D., Pritikin, J. N., Zahery, M., Brick, T. R., Kirkpatrick, R. M., Estabrook, R., Bates, T. C., Maes, H. H., & Boker, S. M. (2015). OpenMx 2.0: Extended structural equation and statistical modeling. *Psychometrika*, 81(2), 535–549. doi:10.1007/s1133601494358

See Also

Other VAR Functions: `FitVARmxDsave()`, `LDL()`, `Softplus()`

Examples

```
# Generate data using the simStateSpace package-----
library(simStateSpace)
set.seed(42)
n <- 5
time <- 100
p <- 2
```

```

alpha <- rep(x = 0, times = p)
beta <- 0.50 * diag(p)
psi <- 0.001 * diag(p)
psi_l <- t(chol(psi))
mu0 <- SSMMeanEta(
  beta = beta,
  alpha = alpha
)
sigma0 <- SSMCovEta(
  beta = beta,
  psi = psi
)
sigma0_l <- t(chol(sigma0))
sim <- SimSSMVARFixed(
  n = n,
  time = time,
  mu0 = mu0,
  sigma0_l = sigma0_l,
  alpha = alpha,
  beta = beta,
  psi_l = psi_l
)
data <- as.data.frame(sim)

# Fit the model-----
# center = TRUE
library(fitVARMxID)
fit <- FitVARMxID(
  data = data,
  observed = paste0("y", seq_len(p)),
  id = "id",
  center = TRUE
)
print(fit)
summary(fit)
coef(fit)
vcov(fit)
converged(fit)
confint(fit)
plot(fit)

# Fit the model-----
# center = FALSE
library(fitVARMxID)
fit <- FitVARMxID(
  data = data,
  observed = paste0("y", seq_len(p)),
  id = "id",
  center = FALSE
)
print(fit)
summary(fit)
coef(fit)

```

```
vcov(fit)
converged(fit)
confint(fit)
plot(fit)
```

FitVARMxIDSave

Fit First-Order Vector Autoregressive Models by ID and Save Results

Description

Fits a first-order vector autoregressive model separately for each unit ID and saves each individual fitted model object to an '.Rds' file. This function fits the same individual-level models as [FitVARMxID\(\)](#), but saves each individual fit to disk. For each unique value of id, the model is fit using the corresponding subset of data. The fitted object for that ID is saved to path with file name prefix_id.Rds, where id is replaced by the unit ID value. The value added by `FitVARMxIDSave()` is that the individual fits are persisted to disk while the function still returns a collated object of class `varmxid`, similar to the object returned by [FitVARMxID\(\)](#).

Usage

```
FitVARMxIDSave(
  data,
  observed,
  id,
  time = NULL,
  ct = FALSE,
  center = TRUE,
  path = getwd(),
  prefix = "fitvarmx",
  overwrite = TRUE,
  mu_fixed = FALSE,
  mu_free = NULL,
  mu_values = NULL,
  mu_lbound = NULL,
  mu_ubound = NULL,
  alpha_fixed = FALSE,
  alpha_free = NULL,
  alpha_values = NULL,
  alpha_lbound = NULL,
  alpha_ubound = NULL,
  beta_fixed = FALSE,
  beta_free = NULL,
  beta_values = NULL,
  beta_lbound = NULL,
  beta_ubound = NULL,
```

```
psi_diag = FALSE,  
psi_fixed = FALSE,  
psi_d_free = NULL,  
psi_d_values = NULL,  
psi_d_lbound = NULL,  
psi_d_ubound = NULL,  
psi_d_equal = FALSE,  
psi_l_free = NULL,  
psi_l_values = NULL,  
psi_l_lbound = NULL,  
psi_l_ubound = NULL,  
nu_fixed = TRUE,  
nu_free = NULL,  
nu_values = NULL,  
nu_lbound = NULL,  
nu_ubound = NULL,  
theta_diag = TRUE,  
theta_fixed = TRUE,  
theta_d_free = NULL,  
theta_d_values = NULL,  
theta_d_lbound = NULL,  
theta_d_ubound = NULL,  
theta_d_equal = FALSE,  
theta_l_free = NULL,  
theta_l_values = NULL,  
theta_l_lbound = NULL,  
theta_l_ubound = NULL,  
mu0_fixed = TRUE,  
mu0_func = TRUE,  
mu0_free = NULL,  
mu0_values = NULL,  
mu0_lbound = NULL,  
mu0_ubound = NULL,  
sigma0_fixed = TRUE,  
sigma0_func = TRUE,  
sigma0_diag = FALSE,  
sigma0_d_free = NULL,  
sigma0_d_values = NULL,  
sigma0_d_lbound = NULL,  
sigma0_d_ubound = NULL,  
sigma0_d_equal = FALSE,  
sigma0_l_free = NULL,  
sigma0_l_values = NULL,  
sigma0_l_lbound = NULL,  
sigma0_l_ubound = NULL,  
robust = FALSE,  
seed = NULL,  
tries_explore = 100,
```

```

    tries_local = 100,
    max_attempts = 10,
    silent = FALSE,
    ncores = NULL
  )

```

Arguments

data	Data frame. A data frame object of data for potentially multiple subjects that contain a column of subject ID numbers (i.e., an ID variable), and at least one column of observed values.
observed	Character vector. A vector of character strings of the names of the observed variables in the data.
id	Character string. A character string of the name of the ID variable in the data.
time	Character string. A character string of the name of the TIME variable in the data. Used when ct = TRUE.
ct	Logical. If TRUE, fit a continuous-time vector autoregressive model. If FALSE, fit a discrete-time vector autoregressive model.
center	Logical. If TRUE, use the mean-centered (mean-reverting) state equation. When center = TRUE, alpha is implied and the set-point mu is estimated. When center = FALSE, alpha is estimated and mu is implied.
path	Character string. Path to the directory where the individual fitted model objects are saved. The directory must already exist.
prefix	Character string. Prefix used for the saved file names. Files are saved as prefix_id.Rds.
overwrite	Logical. If TRUE, existing saved fitted model objects from a previous run are overwritten. If FALSE, existing files are left unchanged and are read from disk instead.
mu_fixed	Logical. If TRUE, the set-point mean vector mu is fixed to mu_values. If mu_fixed = TRUE and mu_values = NULL, mu is fixed to a zero vector. If FALSE, mu is estimated.
mu_free	Logical vector indicating which elements of mu are freely estimated. If NULL, all elements are free. Ignored if mu_fixed = TRUE.
mu_values	Numeric vector of values for mu. If mu_fixed = TRUE, these are fixed values. If mu_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros.
mu_lbound	Numeric vector of lower bounds for mu. Ignored if mu_fixed = TRUE.
mu_ubound	Numeric vector of upper bounds for mu. Ignored if mu_fixed = TRUE.
alpha_fixed	Logical. If TRUE, the dynamic model intercept vector alpha is fixed to alpha_values. If FALSE, alpha is estimated.
alpha_free	Logical vector indicating which elements of alpha are freely estimated. If NULL, all elements are free. Ignored if alpha_fixed = TRUE.
alpha_values	Numeric vector of values for alpha. If alpha_fixed = TRUE, these are fixed values. If alpha_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros.

alpha_lbound	Numeric vector of lower bounds for alpha. Ignored if alpha_fixed = TRUE.
alpha_ubound	Numeric vector of upper bounds for alpha. Ignored if alpha_fixed = TRUE.
beta_fixed	Logical. If TRUE, the dynamic model coefficient matrix beta is fixed. If FALSE, beta is estimated.
beta_free	Logical matrix indicating which elements of beta are freely estimated. If NULL, all elements are free. Ignored if beta_fixed = TRUE.
beta_values	Numeric matrix. Values for beta. If beta_fixed = TRUE, these are fixed values; if beta_fixed = FALSE, these are starting values. If NULL, defaults to a diagonal matrix with -0.001 when ct = TRUE and 0.001 when ct = FALSE.
beta_lbound	Numeric matrix. Lower bounds for beta. Ignored if beta_fixed = TRUE. If NULL and ct = FALSE, defaults to -2.5. If NULL and ct = TRUE, defaults to NA.
beta_ubound	Numeric matrix. Upper bounds for beta. Ignored if beta_fixed = TRUE. If NULL and ct = FALSE, defaults to +2.5. If NULL and ct = TRUE, diagonal upper bounds are set to -1e-05 and the off-diagonals are set to NA.
psi_diag	Logical. If TRUE, psi is diagonal. If FALSE, psi is symmetric.
psi_fixed	Logical. If TRUE, the process noise covariance matrix psi is fixed using psi_d_values and psi_l_values. If psi_d_values is NULL it is fixed to a zero matrix. If FALSE, psi is estimated.
psi_d_free	Logical vector indicating free/fixed status of the elements of psi_d. If NULL, all element of psi_d are free.
psi_d_values	Numeric vector with starting values for psi_d. If psi_fixed = TRUE, these are fixed values. If psi_fixed = FALSE, these are starting values.
psi_d_lbound	Numeric vector with lower bounds for psi_d.
psi_d_ubound	Numeric vector with upper bounds for psi_d.
psi_d_equal	Logical. When TRUE, all free diagonal elements of psi_d are constrained to be equal and estimated as a single shared parameter. Ignored if no diagonal elements are free.
psi_l_free	Logical matrix indicating which strictly-lower-triangular elements of psi_l are free. If NULL, all element of psi_l are free. Ignored if psi_diag = TRUE.
psi_l_values	Numeric matrix of starting values for the strictly-lower-triangular elements of psi_l.
psi_l_lbound	Numeric matrix with lower bounds for psi_l.
psi_l_ubound	Numeric matrix with upper bounds for psi_l.
nu_fixed	Logical. If TRUE, the measurement model intercept vector nu is fixed to nu_values. If FALSE, nu is estimated.
nu_free	Logical vector indicating which elements of nu are freely estimated. If NULL, all elements are free. Ignored if nu_fixed = TRUE.
nu_values	Numeric vector of values for nu. If nu_fixed = TRUE, these are fixed values. If nu_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros.
nu_lbound	Numeric vector of lower bounds for nu. Ignored if nu_fixed = TRUE.
nu_ubound	Numeric vector of upper bounds for nu. Ignored if nu_fixed = TRUE.

theta_diag	Logical. If TRUE, theta is diagonal. If FALSE, theta is symmetric.
theta_fixed	Logical. If TRUE, the measurement error covariance matrix theta is fixed using theta_d_values and theta_l_values. If theta_d_values is NULL it is fixed to a zero matrix. If FALSE, theta is estimated.
theta_d_free	Logical vector indicating free/fixed status of the diagonal parameters theta_d. If NULL, all element of theta_d are free.
theta_d_values	Numeric vector with starting values for theta_d. If theta_fixed = TRUE, these are fixed values. If theta_fixed = FALSE, these are starting values.
theta_d_lbound	Numeric vector with lower bounds for theta_d.
theta_d_ubound	Numeric vector with upper bounds for theta_d.
theta_d_equal	Logical. When TRUE, all free diagonal elements of theta_d are constrained to be equal and estimated as a single shared parameter. Ignored if no diagonal elements are free.
theta_l_free	Logical matrix indicating which strictly-lower-triangular elements of theta_l are free. If NULL, all element of theta_l are free. Ignored if theta_diag = TRUE.
theta_l_values	Numeric matrix of starting values for the strictly-lower-triangular elements of theta_l.
theta_l_lbound	Numeric matrix with lower bounds for theta_l.
theta_l_ubound	Numeric matrix with upper bounds for theta_l.
mu0_fixed	Logical. If TRUE, the initial mean vector mu0 is fixed. If mu0_fixed = TRUE and mu0_func = TRUE, mu0 is fixed to the implied stable mean vector. If mu0_fixed = TRUE and mu0_values = NULL, mu0 is fixed to a zero vector. If FALSE, mu0 is estimated.
mu0_func	Logical. If TRUE and mu0_fixed = TRUE, mu0 is fixed to the implied stable mean vector.
mu0_free	Logical vector indicating which elements of mu0 are free. Ignored if mu0_fixed = TRUE.
mu0_values	Numeric vector of values for mu0. If mu0_fixed = TRUE, these are fixed values. If mu0_fixed = FALSE, these are starting values. If NULL, defaults to a vector of zeros. Ignored if mu0_fixed = TRUE and mu0_func = TRUE.
mu0_lbound	Numeric vector of lower bounds for mu0. Ignored if mu0_fixed = TRUE.
mu0_ubound	Numeric vector of upper bounds for mu0. Ignored if mu0_fixed = TRUE.
sigma0_fixed	Logical. If TRUE, the initial condition covariance matrix sigma0 is fixed using sigma0_d_values and sigma0_l_values. If sigma0_fixed = TRUE and sigma0_func = TRUE, sigma0 is fixed to the implied stable covariance matrix. If sigma0_fixed = TRUE and sigma0_d_values = NULL, sigma0 is fixed to a diffused matrix.
sigma0_func	Logical. If TRUE and sigma0_fixed = TRUE, sigma0 is fixed to the implied stable covariance matrix.
sigma0_diag	Logical. If TRUE, sigma0 is diagonal. If FALSE, sigma0 is symmetric.
sigma0_d_free	Logical vector indicating free/fixed status of the elements of sigma0_d. If NULL, all element of sigma0_d are free.

<code>sigma0_d_values</code>	Numeric vector with starting values for <code>sigma0_d</code> . If <code>sigma0_fixed = TRUE</code> , these are fixed values. If <code>sigma0_fixed = FALSE</code> , these are starting values.
<code>sigma0_d_lbound</code>	Numeric vector with lower bounds for <code>sigma0_d</code> .
<code>sigma0_d_ubound</code>	Numeric vector with upper bounds for <code>sigma0_d</code> .
<code>sigma0_d_equal</code>	Logical. When <code>TRUE</code> , all free diagonal elements of <code>sigma0_d</code> are constrained to be equal and estimated as a single shared parameter. Ignored if no diagonal elements are free.
<code>sigma0_l_free</code>	Logical matrix indicating which strictly-lower-triangular elements of <code>sigma0_l</code> are free. If <code>NULL</code> , all element of <code>sigma0_l</code> are free. Ignored if <code>sigma0_diag = TRUE</code> .
<code>sigma0_l_values</code>	Numeric matrix of starting values for the strictly-lower-triangular elements of <code>sigma0_l</code> .
<code>sigma0_l_lbound</code>	Numeric matrix with lower bounds for <code>sigma0_l</code> .
<code>sigma0_l_ubound</code>	Numeric matrix with upper bounds for <code>sigma0_l</code> .
<code>robust</code>	Logical. If <code>TRUE</code> , calculate robust (sandwich) sampling variance-covariance matrix.
<code>seed</code>	Random seed for reproducibility.
<code>tries_explore</code>	Integer. Number of extra tries for the wide exploration phase.
<code>tries_local</code>	Integer. Number of extra tries for local polishing.
<code>max_attempts</code>	Integer. Maximum number of remediation attempts after the first Hessian computation fails the criteria.
<code>silent</code>	Logical. If <code>TRUE</code> , suppresses messages during the model fitting stage.
<code>ncores</code>	Positive integer. Number of cores to use.

Value

Returns an object of class `varmxid`, with the same general structure as `FitVARmXID()`. The object collates the individual saved fits and contains:

call Function call.

args List of function arguments, including `path`, `prefix`, and `overwrite`.

fun Function used ("`FitVARmXIDSave`").

model A list of generated OpenMx models.

output A list of fitted OpenMx models.

converged A named logical vector indicating converged cases.

robust A list of output from `OpenMx::imxRobustSE()` with argument `details = TRUE` for each `id` if `robust = TRUE`; otherwise `NULL`.

In addition, each individual fit is saved to disk as an `‘.Rds’` file. If a model fails for a given ID, an error object is saved as `prefix_id_error.Rds`, and that ID is omitted from the returned collated `varmxid` object.

References

- Hunter, M. D. (2017). State space modeling in an open source, modular, structural equation modeling environment. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(2), 307–324. doi:10.1080/10705511.2017.1369354
- Neale, M. C., Hunter, M. D., Pritikin, S. M., Zahery, M., Brick, T. R., Kirkpatrick, R. M., Estabrook, R., Bates, T. C., Maes, H. H., & Boker, S. M. (2015). OpenMx 2.0: Extended structural equation and statistical modeling. *Psychometrika*, 81(2), 535–549. doi:10.1007/s1133601494358

See Also

Other VAR Functions: [FitVARmXID\(\)](#), [LDL\(\)](#), [Softplus\(\)](#)

Examples

```
# Generate data using the simStateSpace package -----
set.seed(42)
n <- 5
time <- 100
p <- 2
alpha <- rep(x = 0, times = p)
beta <- 0.50 * diag(p)
psi <- 0.001 * diag(p)
psi_l <- t(chol(psi))
mu0 <- simStateSpace::SSMMeanEta(
  beta = beta,
  alpha = alpha
)
sigma0 <- simStateSpace::SSMCovEta(
  beta = beta,
  psi = psi
)
sigma0_l <- t(chol(sigma0))
sim <- simStateSpace::SimSSMVARFixed(
  n = n,
  time = time,
  mu0 = mu0,
  sigma0_l = sigma0_l,
  alpha = alpha,
  beta = beta,
  psi_l = psi_l
)
data <- as.data.frame(sim)

# Save results to a temporary directory -----
path <- tempdir()

# Fit the model with person-mean centering -----
fit <- FitVARmXIDSave(
  data = data,
  observed = paste0("y", seq_len(p)),
  id = "id",
```

```

    center = TRUE,
    path = path,
    prefix = "fitvarmx_centered"
  )
  print(fit)
  summary(fit)
  coef(fit)
  vcov(fit)
  converged(fit)
  confint(fit)
  plot(fit)

```

 LDL

LDL' Decomposition of a Symmetric Positive-Definite Matrix

Description

Performs an LDL' factorization of a symmetric positive-definite matrix X , such that

$$X = LDL',$$

where L is unit lower-triangular (ones on the diagonal) and D is diagonal.

Usage

```
LDL(x, epsilon = 1e-10)
```

```
InvLDL(s_l, uc_d)
```

Arguments

<code>x</code>	Numeric matrix. Assumed symmetric positive-definite (not checked). Note: <code>LDL()</code> may error if the implied diagonal entries of D are not strictly positive.
<code>epsilon</code>	Numeric. Small positive value used to replace <i>exactly zero</i> diagonal entries of x prior to factorization.
<code>s_l</code>	Matrix. Strictly lower-triangular part of L . In <code>InvLDL()</code> , only the strictly lower triangle is used (upper triangle and diagonal are ignored).
<code>uc_d</code>	Vector. Unconstrained vector such that <code>Softplus(uc_d) = d</code> , where d are the diagonal entries of D .

Details

`LDL()` returns both the unit lower-triangular factor L and the diagonal factor D . The strictly lower-triangular part of L is also provided for convenience. The function additionally computes an unconstrained vector `uc_d` such that `Softplus(uc_d) = d`. This uses a numerically stable inverse

softplus implementation based on $\log(\exp(1/d))$ (and a large-d rewrite), rather than the unstable expression $\log(\exp(d) - 1)$.

InvLDL() returns a symmetric positive definite matrix from the strictly lower-triangular part of L and the unconstrained vector uc_d . The reconstructed matrix is symmetrized as $(\Sigma + \Sigma')/2$ to reduce numerical asymmetry.

Value

- LDL(): a list with components:
 - l: a unit lower-triangular matrix L
 - s_l: a strictly lower-triangular part of L
 - d: a vector of diagonal entries of D
 - uc_d: unconstrained vector with $\text{softplus}(uc_d) = d$
 - x: input matrix (with diagonal zeros possibly replaced by epsilon)
 - epsilon: the epsilon value used
- InvLDL(): a symmetric positive definite matrix

See Also

Other VAR Functions: [FitVARMxID\(\)](#), [FitVARMxIDSave\(\)](#), [Softplus\(\)](#)

Examples

```
set.seed(123)
x <- crossprod(matrix(rnorm(16), 4, 4)) + diag(1e-6, 4)
ldl <- LDL(x = x)
ldl
inv_ldl <- InvLDL(s_l = ldl$s_l, uc_d = ldl$uc_d)
inv_ldl
max(abs(x - inv_ldl))
```

plot.varmxid

Plot Method for an Object of Class varmxid

Description

Plot Method for an Object of Class varmxid

Usage

```
## S3 method for class 'varmxid'
plot(
  x,
  level = 0.95,
  mu = TRUE,
  alpha = TRUE,
```

```

    beta = TRUE,
    nu = TRUE,
    psi = TRUE,
    theta = TRUE,
    robust = FALSE,
    drop = NULL,
    ncores = NULL,
    ...
)

```

Arguments

<code>x</code>	Object of class <code>varmxid</code> .
<code>level</code>	the confidence level required.
<code>mu</code>	Logical. If <code>mu = TRUE</code> , include estimates of the <code>mu</code> vector, if available. If <code>mu = FALSE</code> , exclude estimates of the <code>mu</code> vector.
<code>alpha</code>	Logical. If <code>alpha = TRUE</code> , include estimates of the <code>alpha</code> vector, if available. If <code>alpha = FALSE</code> , exclude estimates of the <code>alpha</code> vector.
<code>beta</code>	Logical. If <code>beta = TRUE</code> , include estimates of the <code>beta</code> matrix, if available. If <code>beta = FALSE</code> , exclude estimates of the <code>beta</code> matrix.
<code>nu</code>	Logical. If <code>nu = TRUE</code> , include estimates of the <code>nu</code> vector, if available. If <code>nu = FALSE</code> , exclude estimates of the <code>nu</code> vector.
<code>psi</code>	Logical. If <code>psi = TRUE</code> , include estimates of the <code>psi</code> matrix, if available. If <code>psi = FALSE</code> , exclude estimates of the <code>psi</code> matrix.
<code>theta</code>	Logical. If <code>theta = TRUE</code> , include estimates of the <code>theta</code> matrix, if available. If <code>theta = FALSE</code> , exclude estimates of the <code>theta</code> matrix.
<code>robust</code>	Logical. If <code>TRUE</code> , use robust (sandwich) sampling variance-covariance matrix. If <code>FALSE</code> , use normal theory sampling variance-covariance matrix.
<code>drop</code>	Optional vector of unique IDs to drop.
<code>ncores</code>	Positive integer. Number of cores to use.
<code>...</code>	additional arguments.

Value

Displays plots of point estimates and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

print.varmxid

Print Method for Object of Class varmxid

Description

Print Method for Object of Class varmxid

Usage

```
## S3 method for class 'varmxid'
print(
  x,
  means = FALSE,
  mu = TRUE,
  alpha = TRUE,
  beta = TRUE,
  nu = TRUE,
  psi = TRUE,
  theta = TRUE,
  digits = 4,
  ...
)
```

Arguments

x	an object of class varmxid.
means	Logical. If means = TRUE, return means. Otherwise, the function returns raw estimates.
mu	Logical. If mu = TRUE, include estimates of the mu vector, if available. If mu = FALSE, exclude estimates of the mu vector.
alpha	Logical. If alpha = TRUE, include estimates of the alpha vector, if available. If alpha = FALSE, exclude estimates of the alpha vector.
beta	Logical. If beta = TRUE, include estimates of the beta matrix, if available. If beta = FALSE, exclude estimates of the beta matrix.
nu	Logical. If nu = TRUE, include estimates of the nu vector, if available. If nu = FALSE, exclude estimates of the nu vector.
psi	Logical. If psi = TRUE, include estimates of the psi matrix, if available. If psi = FALSE, exclude estimates of the psi matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
digits	Integer indicating the number of decimal places to display.
...	further arguments.

Value

Prints means or raw estimates depending the the value of the argument means.

Author(s)

Ivan Jacob Agaloos Pesigan

Softplus

Softplus and Inverse Softplus Transformations

Description

The softplus transformation maps unconstrained real values to the positive real line. This is useful when parameters (e.g., variances) must be positive. The inverse softplus transformation recovers the unconstrained value from a strictly positive input.

Usage

Softplus(x)

InvSoftplus(x)

Arguments

x Numeric vector or matrix. Input values to be transformed.

Details

Mathematical definitions:

- $\text{Softplus}(x) = \log(1 + \exp(x))$
- $\text{InvSoftplus}(x) = \log(\exp(x) - 1)$

Numerical implementation (stable forms):

- $\text{Softplus}(x) = \max(x, 0) + \log1p(\exp(-\text{abs}(x)))$
- $\text{InvSoftplus}(y)$ uses $\log(\text{expm1}(y))$, and for large y uses the rewrite $y + \log1p(-\exp(-y))$ for stability.

For numerical stability, these functions use `log1p()` and `expm1()` internally. `InvSoftplus()` requires strictly positive input and will error if any values are ≤ 0 .

Value

- `Softplus()`: numeric vector or matrix of nonnegative values (mathematically strictly positive for finite inputs, but can underflow to 0 for very negative values).
- `InvSoftplus()`: numeric vector or matrix of unconstrained values.

Author(s)

Ivan Jacob Agaloos Pesigan

See Also

Other VAR Functions: [FitVARMxID\(\)](#), [FitVARMxIDSave\(\)](#), [LDL\(\)](#)

Examples

```
# Apply softplus to unconstrained values
x <- c(-5, 0, 5)
y <- Softplus(x)

# Recover unconstrained values
x_recovered <- InvSoftplus(y)

y
x_recovered
```

summary.varmxid

Summary Method for Object of Class varmxid

Description

Summary Method for Object of Class varmxid

Usage

```
## S3 method for class 'varmxid'
summary(
  object,
  means = FALSE,
  mu = TRUE,
  alpha = TRUE,
  beta = TRUE,
  nu = TRUE,
  psi = TRUE,
  theta = TRUE,
  digits = 4,
  ncores = NULL,
  ...
)
```

Arguments

object	an object of class varmxid.
means	Logical. If means = TRUE, return means. Otherwise, the function returns raw estimates.
mu	Logical. If mu = TRUE, include estimates of the mu vector, if available. If mu = FALSE, exclude estimates of the mu vector.
alpha	Logical. If alpha = TRUE, include estimates of the alpha vector, if available. If alpha = FALSE, exclude estimates of the alpha vector.
beta	Logical. If beta = TRUE, include estimates of the beta matrix, if available. If beta = FALSE, exclude estimates of the beta matrix.
nu	Logical. If nu = TRUE, include estimates of the nu vector, if available. If nu = FALSE, exclude estimates of the nu vector.
psi	Logical. If psi = TRUE, include estimates of the psi matrix, if available. If psi = FALSE, exclude estimates of the psi matrix.
theta	Logical. If theta = TRUE, include estimates of the theta matrix, if available. If theta = FALSE, exclude estimates of the theta matrix.
digits	Integer indicating the number of decimal places to display.
ncores	Positive integer. Number of cores to use.
...	further arguments.

Value

Returns means or raw estimates depending on the value of the argument means.

Author(s)

Ivan Jacob Agaloos Pesigan

vcov.varmxid

Sampling Covariance Matrix of the Parameter Estimates

Description

Sampling Covariance Matrix of the Parameter Estimates

Usage

```
## S3 method for class 'varmxid'
vcov(
  object,
  mu = TRUE,
  alpha = TRUE,
  beta = TRUE,
  nu = TRUE,
```

```

    psi = TRUE,
    theta = TRUE,
    robust = FALSE,
    se = FALSE,
    ncores = NULL,
    ...
)

```

Arguments

<code>object</code>	Object of class <code>varmxid</code> .
<code>mu</code>	Logical. If <code>mu = TRUE</code> , include estimates of the <code>mu</code> vector, if available. If <code>mu = FALSE</code> , exclude estimates of the <code>mu</code> vector.
<code>alpha</code>	Logical. If <code>alpha = TRUE</code> , include estimates of the <code>alpha</code> vector, if available. If <code>alpha = FALSE</code> , exclude estimates of the <code>alpha</code> vector.
<code>beta</code>	Logical. If <code>beta = TRUE</code> , include estimates of the <code>beta</code> matrix, if available. If <code>beta = FALSE</code> , exclude estimates of the <code>beta</code> matrix.
<code>nu</code>	Logical. If <code>nu = TRUE</code> , include estimates of the <code>nu</code> vector, if available. If <code>nu = FALSE</code> , exclude estimates of the <code>nu</code> vector.
<code>psi</code>	Logical. If <code>psi = TRUE</code> , include estimates of the <code>psi</code> matrix, if available. If <code>psi = FALSE</code> , exclude estimates of the <code>psi</code> matrix.
<code>theta</code>	Logical. If <code>theta = TRUE</code> , include estimates of the <code>theta</code> matrix, if available. If <code>theta = FALSE</code> , exclude estimates of the <code>theta</code> matrix.
<code>robust</code>	Logical. If <code>TRUE</code> , use robust (sandwich) sampling variance-covariance matrix. If <code>FALSE</code> , use normal theory sampling variance-covariance matrix.
<code>se</code>	Logical. Option to return standard errors. Default value is <code>FALSE</code> .
<code>ncores</code>	Positive integer. Number of cores to use.
<code>...</code>	additional arguments.

Value

Returns a list of sampling variance-covariance matrices.

Author(s)

Ivan Jacob Agaloos Pesigan

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