Package ‘fitOU’

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Title The Ornstein–Uhlenbeck Model

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Description Fit the Ornstein–Uhlenbeck model using the 'dynr' package.

URL https://github.com/ijapesigan/fitOU,
https://ijapesigan.github.io/fitOU/

BugReports https://github.com/ijapesigan/fitOU/issues

License GPL (>= 3)

Encoding UTF-8

LazyData true

Roxygen list(markdown = TRUE)

VignetteBuilder knitr

Depends R (>= 3.5.0)

Imports stats, dynr, parallel, pbapply

Suggests knitr, rmarkdown, testthat

RoxygenNote 7.2.3

NeedsCompilation no

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`bivariate_ou` *Bivariate Ornstein–Uhlenbeck Model Data*

Description

Bivariate Ornstein–Uhlenbeck Model Data

Usage

```
bivariate_ou
```

Format

A dataframe with 10000 rows and 4 columns (`y1`, `y2`, `id`, and `time`) generated from the bivariate Ornstein–Uhlenbeck model from Chow et al. (2023).

References

Chow, S.-M., Losardo, D., Park, J., & Molenaar, P. C. M. (2023). Continuous-time dynamic models: Connections to structural equation models and other discrete-time models. In R. H. Hoyle (Ed.), Handbook of structural equation modeling (2nd ed.). The Guilford Press.

`FitOU` *Fit the Ornstein–Uhlenbeck Model*

Description

This is a wrapper function that makes fitting the Ornstein–Uhlenbeck model convenient using the `dynr` package.

Usage

```
FitOU(
  data,
  observed,
  id,
  time,
  mu0 = NULL,
  sigma0 = NULL,
  mu_start = NULL,
  phi_start = NULL,
  sigma_start = NULL,
  theta_start = NULL,
  center = FALSE,
  lb = NULL,
  ub = 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), a column indicating subject-specific measurement occasions (i.e., a TIME variable), 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.
`mu0`	Numeric vector. Mean of initial latent variable values ($\boldsymbol{\mu}_{\boldsymbol{\eta}\|0}$). If `mu0 = NULL`, a vector of zeros is used.
`sigma0`	Numeric matrix. Covariance matrix of initial latent variable values ($\boldsymbol{\Sigma}_{\boldsymbol{\eta}\|0}$). If `sigma0 = NULL`, an identity matrix is used.
`mu_start`	Numeric vector. Starting values of the `mu` vector, that is, the long-term mean or equilibrium level. If `mu_start = NULL`, a vector means of the observed variables is used.
`phi_start`	Numeric matrx. Starting values of the `phi` matrix, that is, the rate of mean reversion, determining how quickly the variable returns to its mean. If `phi_start = NULL`, a matrix of zeros is used.
`sigma_start`	Numeric matrx. Starting values of the `sigma` matrix, that is, the matrix of volatility or randomness in the process. If `sigma_start = NULL`, an identity matrix is used.
`theta_start`	Numeric matrx. Starting values of the `theta` matrix, that is, the measurement error covariance matrix ($\boldsymbol{\Theta}$). If `theta_start = NULL`, an identity matrix is used.
`center`	Logical. If `center = TRUE`, mean center by `id`.
`lb`	Numeric vector. Optional. The lower bounds for $\boldsymbol{\Phi}$.
`ub`	Numeric vector. Optional. The upper bounds for $\boldsymbol{\Phi}$.
`...`	Additional arguments to pass to `dynr::dynr.cook()`.

Details

The measurement model is given by

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

where $\mathbf{y}_{i,t}$, $\boldsymbol{\eta}_{i,t}$, and $\boldsymbol{\varepsilon}_{i,t}$ are random variables and $\boldsymbol{\nu}$, $\boldsymbol{\Lambda}$, and $\boldsymbol{\Theta}$ are model parameters. $\mathbf{y}_{i,t}$ is a vector of observed random variables at time t and individual i, $\boldsymbol{\eta}_{i,t}$ is a vector of latent random variables at time t and individual i, and $\boldsymbol{\varepsilon}_{i,t}$ is a vector of random measurement errors at time t and individual i, while $\boldsymbol{\nu}$ is a vector of intercept, $\boldsymbol{\Lambda}$ is a matrix of factor loadings, and $\boldsymbol{\Theta}$ is the covariance matrix of $\boldsymbol{\varepsilon}$.

The dynamic structure is given by

$$\mathrm{d}\boldsymbol{\eta}_{i,t} = \boldsymbol{\Phi}\left(\boldsymbol{\mu} - \boldsymbol{\eta}_{i,t}\right)\mathrm{d}t + \boldsymbol{\Sigma}^{\frac{1}{2}}\mathrm{d}\mathbf{W}_{i,t}$$

where $\boldsymbol{\mu}$ is the long-term mean or equilibrium level, $\boldsymbol{\Phi}$ is the rate of mean reversion, determining how quickly the variable returns to its mean, $\boldsymbol{\Sigma}$ is the matrix of volatility or randomness in the process, and $\mathrm{d}\boldsymbol{W}$ is a Wiener process or Brownian motion, which represents random fluctuations.

Author(s)

Ivan Jacob Agaloos Pesigan

References

Chow, S.-M., Losardo, D., Park, J., & Molenaar, P. C. M. (2023). Continuous-time dynamic models: Connections to structural equation models and other discrete-time models. In R. H. Hoyle (Ed.), Handbook of structural equation modeling (2nd ed.). The Guilford Press.

Ou, L., Hunter, M. D., & Chow, S.-M. (2019). What's for dynr: A package for linear and nonlinear dynamic modeling in R. *The R Journal*, *11*(1), 91. doi:10.32614/rj2019012

Uhlenbeck, G. E., & Ornstein, L. S. (1930). On the theory of the brownian motion. *Physical Review*, *36*(5), 823–841. doi:doi.org/10.1103/physrev.36.823

See Also

Other Fit Ornstein–Uhlenbeck Model Functions: `FitOUID()`

Examples

```
## Not run:
FitOU(
  data = bivariate_ou,
  observed = c("y1", "y2"),
  id = "id",
  time = "time",
  verbose = FALSE
)

## End(Not run)
```

`FitOUID` *Fit the Ornstein–Uhlenbeck Model for Each Individual*

Description

This is a wrapper function that makes fitting the Ornstein–Uhlenbeck model for each individual convenient using the `dynr` package.

Usage

```
FitOUID(
  data,
  observed,
  id,
  time,
  mu0 = NULL,
  sigma0 = NULL,
  mu_start = NULL,
  phi_start = NULL,
  sigma_start = NULL,
  theta_start = NULL,
  ...,
  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), a column indicating subject-specific measurement occasions (i.e., a TIME variable), 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.
`mu0`	Numeric vector. Mean of initial latent variable values ($\boldsymbol{\mu}_{\boldsymbol{\eta} \mid 0}$). If `mu0 = NULL`, a vector of zeros is used.
`sigma0`	Numeric matrix. Covariance matrix of initial latent variable values ($\boldsymbol{\Sigma}_{\boldsymbol{\eta} \mid 0}$). If `sigma0 = NULL`, an identity matrix is used.
`mu_start`	Numeric vector. Starting values of the `mu` vector, that is, the long-term mean or equilibrium level. If `mu_start = NULL`, a vector means of the observed variables is used.
`phi_start`	Numeric matrx. Starting values of the `phi` matrix, that is, the rate of mean reversion, determining how quickly the variable returns to its mean. If `phi_start = NULL`, a matrix of zeros is used.
`sigma_start`	Numeric matrx. Starting values of the `sigma` matrix, that is, the matrix of volatility or randomness in the process. If `sigma_start = NULL`, an identity matrix is used.
`theta_start`	Numeric matrx. Starting values of the `theta` matrix, that is, the measurement error covariance matrix ($\boldsymbol{\Theta}$). If `theta_start = NULL`, an identity matrix is used.
`...`	Additional arguments to pass to `dynr::dynr.cook()`.
`ncores`	Positive integer. Number of cores to use.

Details

The measurement model is given by

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

where $\mathbf{y}_{i,t}$, $\boldsymbol{\eta}_{i,t}$, and $\boldsymbol{\varepsilon}_{i,t}$ are random variables and $\boldsymbol{\nu}$, $\boldsymbol{\Lambda}$, and $\boldsymbol{\Theta}$ are model parameters. $\mathbf{y}_{i,t}$ is a vector of observed random variables at time t and individual i, $\boldsymbol{\eta}_{i,t}$ is a vector of latent random variables at time t and individual i, and $\boldsymbol{\varepsilon}_{i,t}$ is a vector of random measurement errors at time t and individual i, while $\boldsymbol{\nu}$ is a vector of intercept, $\boldsymbol{\Lambda}$ is a matrix of factor loadings, and $\boldsymbol{\Theta}$ is the covariance matrix of $\boldsymbol{\varepsilon}$.

The dynamic structure is given by

$$\mathrm{d}\boldsymbol{\eta}_{i,t} = \boldsymbol{\Phi}\left(\boldsymbol{\mu} - \boldsymbol{\eta}_{i,t}\right)\mathrm{d}t + \boldsymbol{\Sigma}^{\frac{1}{2}}\mathrm{d}\mathbf{W}_{i,t}$$

where $\boldsymbol{\mu}$ is the long-term mean or equilibrium level, $\boldsymbol{\Phi}$ is the rate of mean reversion, determining how quickly the variable returns to its mean, $\boldsymbol{\Sigma}$ is the matrix of volatility or randomness in the process, and $\mathrm{d}\boldsymbol{W}$ is a Wiener process or Brownian motion, which represents random fluctuations.

Author(s)

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References

Chow, S.-M., Losardo, D., Park, J., & Molenaar, P. C. M. (2023). Continuous-time dynamic models: Connections to structural equation models and other discrete-time models. In R. H. Hoyle (Ed.), Handbook of structural equation modeling (2nd ed.). The Guilford Press.

Ou, L., Hunter, M. D., & Chow, S.-M. (2019). What's for dynr: A package for linear and nonlinear dynamic modeling in R. *The R Journal*, *11*(1), 91. doi:10.32614/rj2019012

Uhlenbeck, G. E., & Ornstein, L. S. (1930). On the theory of the brownian motion. *Physical Review*, *36*(5), 823–841. doi:doi.org/10.1103/physrev.36.823

See Also

Other Fit Ornstein–Uhlenbeck Model Functions: `FitOU()`

Examples

```
## Not run:
FitOUID(
  data = bivariate_ou,
  observed = c("y1", "y2"),
  id = "id",
  time = "time",
  verbose = FALSE
)

## End(Not run)
```

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