

# Package ‘fitOU’

October 30, 2023

**Title** The Ornstein–Uhlenbeck Model

**Version** 0.0.0.9000

**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	<i>Bivariate Ornstein–Uhlenbeck Model Data</i>
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### 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.

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FitOU	<i>Fit the Ornstein–Uhlenbeck Model</i>
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### 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,
  sigma_diag = FALSE,
  center = FALSE,
  lb = NULL,
```

```

    ub = NULL,
    rerun = 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 ( $\mu_{\eta 0}$ ). If mu0 = NULL, a vector of zeros is used.
sigma0	Numeric matrix. Covariance matrix of initial latent variable values ( $\Sigma_{\eta 0}$ ). 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 matrix. 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 matrix. 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 matrix. Starting values of the theta matrix, that is, the measurement error covariance matrix ( $\Theta$ ). If theta_start = NULL, an identity matrix is used.
sigma_diag	Logical. If sigma_diag = TRUE, estimate only the diagonals of $\Sigma$ .
center	Logical. If center = TRUE, mean center by id.
lb	Numeric vector. Optional. The lower bounds for $\Phi$ .
ub	Numeric vector. Optional. The upper bounds for $\Phi$ .
rerun	Positive integer. Number of times to rerun model fitting with a slight change to starting values when exit code is 2 to 6.
...	Additional arguments to pass to <code>dynr::dynr.cook()</code> .

### Details

The measurement model is given by

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

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

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

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  $d\mathbf{W}$  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 ( $\mu_{\eta 0}$ ). If mu0 = NULL, a vector of zeros is used.
sigma0	Numeric matrix. Covariance matrix of initial latent variable values ( $\Sigma_{\eta 0}$ ). 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 matrix. 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 matrix. 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 matrix. Starting values of the theta matrix, that is, the measurement error covariance matrix ( $\Theta$ ). If theta_start = NULL, an identity matrix is used.
...	Additional arguments to pass to <code>dynr::dynr.cook()</code> .
ncores	Positive integer. Number of cores to use.

## Details

The measurement model is given by

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

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

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

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  $d\mathbf{W}$  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: `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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