Package ‘kalmanSSM’

September 4, 2023

Title Kalman Filter

Version 0.0.0.9000

Description Functions related to Kalman filters.

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

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

License GPL (>= 3)

Encoding UTF-8

LazyData true

Roxygen list(markdown = TRUE)

VignetteBuilder knitr

Depends R (>= 3.5.0)

LinkingTo Rcpp, RcppArmadillo

Imports Rcpp

Suggests knitr, rmarkdown, testthat

RoxygenNote 7.2.3

NeedsCompilation yes

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R topics documented:

dat_multiv_p1 *Data from a Multivariate State Space Model (p = 1)*

Description

Data from a Multivariate State Space Model (p = 1)

Usage

```
dat_multiv_p1
```

Format

A matrix with 100 rows (time points) and 5 columns (`eta1`, and `eta2` for latent states, `y1`, and `y2` for observed data, and `time` for discrete time from 1 to 100) generated from the state space model given by

$$\begin{pmatrix} y_{1_t} \\ y_{2_t} \end{pmatrix} = \begin{pmatrix} \eta_{1_t} \\ \eta_{2_t} \end{pmatrix} + \begin{pmatrix} \varepsilon 1_t \\ \varepsilon 2_t \end{pmatrix} \quad \text{with} \quad \begin{pmatrix} \varepsilon_{1_t} \\ \varepsilon_{2_t} \end{pmatrix} \sim \mathcal{N} \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0.0 \\ 0.0 & 1 \end{pmatrix} \right)$$

$$\begin{pmatrix} \eta_{1_t} \\ \eta_{2_t} \end{pmatrix} = \begin{pmatrix} 0.8 & 0.0 \\ 0.0 & 0.8 \end{pmatrix} \begin{pmatrix} \eta_{1_{t-1}} \\ \eta_{2_{t-1}} \end{pmatrix} + \begin{pmatrix} \zeta_{1_t} \\ \zeta_{2_t} \end{pmatrix} \quad \text{with} \quad \begin{pmatrix} \zeta 1_t \\ \zeta 2_t \end{pmatrix} \sim \mathcal{N} \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0.0 \\ 0.0 & 1 \end{pmatrix} \right)$$

dat_univ_p1 *Data from a Univariate State Space Model (p = 1)*

Description

Data from a Univariate State Space Model (p = 1)

Usage

```
dat_univ_p1
```

Format

A matrix with 100 rows (time points) and 3 columns (`eta` for the latent state, `y` for the observed data, and `time` for discrete time from 1 to 100) generated from the state space model given by

$$Y_t = \eta_t + \varepsilon_t \quad \text{with} \quad \varepsilon_t \sim \mathcal{N}(0, 1)$$

$$\eta_t = 0.8\eta_{t-1} + \zeta_t \quad \text{with} \quad \zeta_t \sim \mathcal{N}(0, 1) \, .$$

KFilterP1 *Kalman Filter with Lag 1 for State Space Models*

Description

Kalman Filter with Lag 1 for State Space Models

Usage

```
KFilterP1(data, Lambda, mu0, Sigma0, beta, chol_psi, chol_theta)
```

Arguments

`data`	Numeric matrix. `time` by `k` data matrix.
`Lambda`	Numeric matrix. Measurement or observation matrix.
`mu0`	Numeric matrix. Initial state mean vector where `p` is the number of lags.
`Sigma0`	Numeric matrix. Initial state covariance matrix where `p` is the number of lags.
`beta`	Numeric matrix. State transition matrix.
`chol_psi`	Numeric matrix. Cholesky decomposition of the state error covariance matrix Psi.
`chol_theta`	Numeric matrix. Cholesky decomposition of the observation error covariance matrix Theta.

Details

The measurement model is given by

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

where $\mathbf{y}$, $\boldsymbol{\eta}$, and $\boldsymbol{\varepsilon}$ are random variables and $\boldsymbol{\nu}$, $\boldsymbol{\Lambda}$, and $\boldsymbol{\Theta}$ are model parameters. $\mathbf{y}$ is a vector of observed random variables, $\boldsymbol{\eta}$ is a vector of latent random variables, and $\boldsymbol{\varepsilon}$ is a vector of random measurement errors 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

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

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

Value

List of filtered state variables and other Kalman filter results.

Author(s)

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Examples

```
data <- dat_univ_p1[, "y", drop = FALSE]
kalman <- KFilterP1(
  data = data,
  Lambda = matrix(1),
  mu0 = matrix(0),
  Sigma0 = matrix(1),
  beta = matrix(0.8),
  chol_psi = matrix(1),
  chol_theta = matrix(1)
)
str(kalman)

data <- dat_multiv_p1[, c("y1", "y2"), drop = FALSE]
kalman <- KFilterP1(
  data = data,
  Lambda = diag(2),
  mu0 = matrix(data = 0, nrow = 2),
  Sigma0 = diag(2),
  beta = diag(x = 0.8, nrow = 2, ncol = 2),
  chol_psi = chol(diag(2)),
  chol_theta = chol(diag(2))
)
str(kalman)
```

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