

Package ‘multivar’

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Title Penalized Estimation and Forecasting of Multiple Subject Vector Autoregressive (multi-VAR) Models

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Description Functions for simulating, estimating and forecasting stationary Vector Autoregressive (VAR) models for multiple subject data using the penalized multi-VAR framework in Fisher, Kim and Pipiras (2020) <[arXiv:2007.05052](#)>.

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License GPL (>= 2)

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R topics documented:

multivar-package	2
canonical.multivar	2
constructModel	3

cv.multivar	5
dat_multivar_sim	6
multivar-class	7
multivar_sim	8
plot_results	9
plot_sim	10
show.multivar	11

Index 12

multivar-package	<i>Penalized Estimation and Forecasting of Multiple Subject Vector Autoregressive (multi-VAR) Models</i>
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Description

multivar is an R package for simulating, estimating and forecasting stationary Vector Autoregressive (VAR) models for multiple subject data using the penalized multi-VAR framework.

Author(s)

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canonical.multivar	<i>Canonical VAR Fitting Function for multivar</i>
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Description

Canonical VAR Fitting Function for multivar

Usage

```
canonical.multivar(object)
```

Arguments

object multivar object built using ConstructModel.

Details

A function to fit a canonical VAR model to each individual dataset.

Value

A list of results.

See Also

[constructModel](#),

Examples

```
# example 1 (run)
sim1 <- multivar_sim(
  k = 2, # individuals
  d = 3, # number of variables
  n = 20, # number of timepoints
  prop_fill_com = 0.1, # proportion of paths common
  prop_fill_ind = 0.1, # proportion of paths unique
  lb = 0.1, # lower bound on coefficient magnitude
  ub = 0.9, # upper bound on coefficient magnitude
  sigma = diag(1,3) # noise
)

model1 <- constructModel(data = sim1$data, weightest = "ols")
fit1 <- canonical.multivar(model1)
```

constructModel

Construct an object of class multivar

Description

Construct an object of class multivar

Usage

```
constructModel(
  data = NULL,
  lag = 1,
  horizon = 0,
  t1 = NULL,
  t2 = NULL,
  lambda1 = NULL,
  lambda2 = NULL,
  nlambda1 = 30,
  nlambda2 = 30,
  depth = 1000,
  tol = 1e-04,
  window = 1,
```

```

standardize = T,
weightest = "ols",
canonical = FALSE,
threshold = FALSE,
lassotype = "adaptive",
intercept = FALSE,
W = NULL,
ratios = NULL
)

```

Arguments

data	List. A list (length = k) of T by d multivariate time series
lag	Numeric. The VAR order. Default is 1.
horizon	Numeric. Desired forecast horizon. Default is 1. ZF Note: Should probably be zero.
t1	Numeric. Index of time series in which to start cross validation. If NULL, default is floor(nrow(n)/3) where nk is the time series length for individual k.
t2	Numeric. Index of times series in which to end cross validation. If NULL, default is floor(2*nrow(n)/3) where nk is the time series length for individual k.
lambda1	Matrix. Regularization parameter 1. Default is NULL.
lambda2	Matrix. Regularization parameter 2. Default is NULL.
nlambda1	Numeric. Number of lambda1 values to search over. Default is 30.
nlambda2	Numeric. Number of lambda2 values to search over. Default is 30.
depth	Numeric. Depth of grid construction. Default is 1000.
tol	Numeric. Optimization tolerance (default 1e-4).
window	Numeric. Size of rolling window.
standardize	Logical. Default is true. Whether to standardize the individual data.
weightest	Character. Default is "mlr" for multiple linear regression. "sls" for simple linear regression also available. How to estimate the first-stage weights.
canonical	Logical. Default is false. If true, individual datasets are fit to a VAR(1) model.
threshold	Logical. Default is false. If true, and canonical is true, individual transition matrices are thresholded based on significance.
lassotype	Character. Default is "adaptive". Choices are "standard" or "adaptive" lasso.
intercept	Logical. Default is FALSE.
W	Matrix. Default is NULL.
ratios	Numeric vector. Default is NULL.

Examples

```

sim <- multivar_sim(
  k = 2, # individuals

```

```
d = 3, # number of variables
n = 20, # number of timepoints
prop_fill_com = 0.1, # proportion of paths common
prop_fill_ind = 0.1, # proportion of paths unique
lb = 0.1, # lower bound on coefficient magnitude
ub = 0.9, # upper bound on coefficient magnitude
sigma = diag(1,3) # noise
)

plot_sim(sim, plot_type = "common")

model <- constructModel(data = sim$data, weighttest = "ols")
```

cv.multivar

Cross Validation for multivar

Description

Cross Validation for multivar

Usage

```
cv.multivar(object)
```

Arguments

object multivar object built using ConstructModel.

Details

The main function of the multivar package. Performs cross validation to select penalty parameters over a training sample and evaluates them over a test set.

Value

An object of class `multivar.results`.

Examples

```
# example 1 (run)
sim1 <- multivar_sim(
  k = 2, # individuals
  d = 3, # number of variables
  n = 20, # number of timepoints
  prop_fill_com = 0.1, # proportion of paths common
  prop_fill_ind = 0.1, # proportion of paths unique
  lb = 0.1, # lower bound on coefficient magnitude
  ub = 0.9, # upper bound on coefficient magnitude
```

```

    sigma = diag(1,3) # noise
  )

  model1 <- constructModel(data = sim1$data, weighttest = "ols")
  fit1 <- multivar::cv.multivar(model1)

  ## Not run:

  # example 2 (don't run)
  sim2 <- multivar_sim(
    k = 10, # individuals
    d = 10, # number of variables
    n = 100, # number of timepoints
    prop_fill_com = 0.1, # proportion of paths common
    prop_fill_ind = 0.1, # proportion of paths unique
    lb = 0.1, # lower bound on coefficient magnitude
    ub = 0.9, # upper bound on coefficient magnitude
    sigma = diag(1,10) # noise
  )

  model2 <- constructModel(data = sim2$data, weighttest = "ols")
  fit2 <- cv.multivar(model2)

  ## End(Not run)

```

dat_multivar_sim

Simulated multi-VAR data.

Description

This dataset contains multivariate time series data for $k = 9$ individuals with $d = 10$ variables collected at $t = 100$ equidistant time points. The data was generated such that each individual's VAR(1) transition matrix has 20 percent nonzero entries. This means, for example, each individual has 20 nonzero directed relationships in their data generating model. The position of non-zero elements in each individual's transition matrix was selected randomly given the following constraints: 2/3 of each individual's paths are shared by all individuals, and 1/3 are unique to each individual. For each individual, coefficient values between $U(0,1, 0.9)$ were randomly drawn until stability conditions for the VAR model were satisfied.

Usage

```
dat_multivar_sim
```

Format

A list containing

mat_com a common effects transition matrix

mat_ind_unique a list of unique (individual-specific) effect matrices
mat_ind_final a list of total (common + individual-specific) effect matrices
data a list of multivariate time series for all subjects ...

multivar-class	<i>multivar object class</i>
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Description

An object class to be used with `cv.multivar`

Details

To construct an object of class `multivar`, use the function `constructModel`

Slots

k Numeric. The number of subjects (or groupings) in the dataset.
n Numeric Vector. Vector containing the number of timepoints for each dataset.
d Numeric Vector. Vector containing the number of variables for each dataset.
Ak List. A list (length = k) of lagged (T-lag-horizon) by d multivariate time series.
bk List. A list (length = k) of (T-lag-horizon) by d multivariate time series.
Hk List. A list (length = k) of (horizon) by d multivariate time series.
A Matrix. A matrix containing the lagged ((T-lag-horizon)k) by (d+dk) multivariate time series.
b Matrix. A matrix containing the non-lagged ((T-lag-horizon)k) by (d) multivariate time series.
H Matrix. A matrix containing the non-lagged (horizon k) by d multivariate time series.
lag Numeric. The VAR order. Currently only lag 1 is supported.
horizon Numeric. Forecast horizon.
t1 Numeric vector. Index of time series in which to start cross validation for individual k.
t2 Numeric vector. Index of time series in which to end cross validation for individual k.
lambda1 Numeric vector. Regularization parameter 1.
lambda2 Numeric vector. Regularization parameter 2.
nlambda1 Numeric. Number of lambda1 values to search over. Default is 30.
nlambda2 Numeric. Number of lambda2 values to search over. Default is 30.
tol Numeric. Convergence tolerance.
depth Numeric. Depth of grid construction. Default is 1000.
window Numeric. Size of rolling window.
standardize Logical. Default is true. Whether to standardize the individual data.
weightest Character. Default is "mlr" for multiple linear regression. "sls" for simple linear regression also available. How to estimate the first-stage weights.

canonical Logical. Default is false. If true, individual datasets are fit to a VAR(1) model.

threshold Logical. Default is false. If true, and canonical is true, individual transition matrices are thresholded based on significance.

lassotype Character. Default is "adaptive". Choices are "standard" or "adaptive" lasso.

intercept Logical. Default is FALSE.

W Matrix. Default is NULL.

ratios Numeric vector. Default is NULL.

See Also

[constructModel](#)

multivar_sim	<i>Simulate multivar data.</i>
--------------	--------------------------------

Description

Simulate multivar data.

Usage

```
multivar_sim(
  k,
  d,
  n,
  prop_fill_com,
  prop_fill_ind,
  lb,
  ub,
  sigma,
  mat_common = NULL,
  mat_unique = NULL,
  mat_total = NULL
)
```

Arguments

k	Integer. The number of individuals (or datasets) to be generated.
d	Integer. The number of variables per dataset. For now this will be constant across individuals.
n	Integer. The time series length.
prop_fill_com	Numeric. The proportion of nonzero paths in the common transition matrix.
prop_fill_ind	Numeric. The proportion of nonzero unique (not in the common transition matrix or transition matrix of other individuals) paths in each individual transition matrix.

lb	Numeric. The upper bound for individual elements of the transition matrices.
ub	Numeric. The lower bound for individual elements of the transition matrices.
sigma	Matrix. The (population) innovation covariance matrix.
mat_common	Matrix. A common effects transition matrix (if known).
mat_unique	List. A list of unique effects transition matrix (if known).
mat_total	List. A list of total effects transition matrix (if known).

Examples

```

k <- 3
d <- 5
n <- 50
prop_fill_com <- .2
prop_fill_ind <- .2
lb <- 0.1
ub <- 0.7
sigma <- diag(0.1,d)
data <- multivar_sim(k, d, n, prop_fill_com, prop_fill_ind, lb, ub,sigma)$data

```

plot_results *Plot data arising from cv.multivar.*

Description

Plot data arising from cv.multivar.

Usage

```
plot_results(x, plot_type = "common", facet_ncol = 3, datasets = "all")
```

Arguments

x	Object. An object returned by multivar_sim.
plot_type	Character. User can specify "common" to plot the common effects matrix, "unique" to plot the unique effects matrix, or "total" to plot the total effects matrix.
facet_ncol	Numeric. Number of columns to use in the "unique" or "total" effects plot.
datasets	Numeric. A vector containing the index of datasets to plot. Default is "all".

Examples

```

sim1 <- multivar_sim(
  k = 2, # individuals
  d = 3, # number of variables
  n = 20, # number of timepoints
  prop_fill_com = 0.1, # proportion of paths common
  prop_fill_ind = 0.1, # proportion of paths unique
  lb = 0.1, # lower bound on coefficient magnitude
  ub = 0.9, # upper bound on coefficient magnitude
  sigma = diag(1,3) # noise
)

model1 <- constructModel(data = sim1$data, weightest = "ols")
fit1 <- cv.multivar(model1)
plot_results(fit1, plot_type = "common")

```

plot_sim

Plot data arising from multivar_sim.

Description

Plot data arising from multivar_sim.

Usage

```
plot_sim(x, plot_type = "common", facet_ncol = 3, datasets = "all")
```

Arguments

x	Object. An object returned by multivar_sim.
plot_type	Character. User can specify "common" to plot the common effects matrix, "unique" to plot the unique effects matrix, or "total" to plot the total effects matrix.
facet_ncol	Numeric. Number of columns to use in the "unique" or "total" effects plot.
datasets	Numeric. A vector containing the index of datasets to plot. Default is "all".

Examples

```

k <- 3
d <- 5
n <- 50
prop_fill_com <- .2
prop_fill_ind <- .2
lb <- 0.1
ub <- 0.7

```

```
sigma <- diag(0.1,d)
sim <- multivar_sim(k, d, n, prop_fill_com, prop_fill_ind, lb, ub,sigma)
plot_sim(sim, plot_type = "common")
```

show.multivar	<i>Default show method for an object of class multivar</i>
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Description

Default show method for an object of class multivar

Usage

```
## S4 method for signature 'multivar'
show(object)
```

Arguments

object multivar object created from ConstructModel

Value

Displays the following information about the multivar object:

- To do.

See Also

[constructModel](#)

Index

- * **datasets**
 - dat_multivar_sim, 6
- * **multivar**
 - multivar_sim, 8
 - plot_results, 9
 - plot_sim, 10
- * **plot**
 - plot_results, 9
 - plot_sim, 10
- * **simulate**
 - multivar_sim, 8
 - plot_results, 9
 - plot_sim, 10
- * **var**
 - multivar_sim, 8
 - plot_results, 9
 - plot_sim, 10

canonical.multivar, 2
canonical.multivar,multivar-method
 (canonical.multivar), 2
constructModel, 3, 3, 7, 8, 11
cv.multivar, 5
cv.multivar,multivar-method
 (cv.multivar), 5

dat_multivar_sim, 6

multivar (multivar-package), 2
multivar-class, 7
multivar-package, 2
multivar_sim, 8

plot_results, 9
plot_sim, 10

show,multivar-method (show.multivar), 11
show.multivar, 11