Package ‘dynmix’

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Title Estimation of Dynamic Finite Mixtures

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Imports graphics, MASS, Rcpp, stats, utils, zoo

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Description Allows to perform the dynamic mixture estimation with state-space components and normal regression components, and clustering with normal mixture. Quasi-Bayesian estimation, as well as, that based on the Kerridge inaccuracy approximation are implemented. Main references: Nagy and Suzdal-eva (2013) <doi:10.1016/j.apm.2013.05.038>; Nagy et al. (2011) <doi:10.1002/acs.1239>.

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convts

Renames Selected Outcomes of `mixest` and `tvpreg` Objects.

Description

This function renames rows of selected outcomes stored in `mixest` and `tvpreg` objects. It can be useful in generating better looking plots.

Usage

```r
convts(x, ind=NULL, ...)
```

Arguments

- `x` : object of class `mixest` or `tvpreg`
- `ind` : optional, `character` consisting of names of time points, should have the same length as the forecasted time-series
- `...` : optional, alternatively, instead of providing `ind`, arguments of `seq.Date` can be specified

Value

object of the same class as `x` but with renamed rownames of selected outcomes

Examples

```r
data(oil)
t1 <- tvp.reg(y=oil[,1,drop=FALSE], x=oil[,-1,drop=FALSE], lambda=0.99, V=100, W=100)
plot(t1)

t1a <- convts(x=t1, from=as.Date("1990-02-15"), by="month", length.out=nrow(oil[,1,drop=FALSE]))
plot(t1a)

ml <- mixest1(y=oil[,1,drop=FALSE], x=oil[,-1,drop=FALSE], ftype=1, V=100, W=100)
```
Computes LDL' Matrix Decomposition.

Description
This function decomposes matrix $V$ into $V = LDL'$, where $L$ is a lower triangular matrix with unit diagonal and $D$ is a diagonal matrix with non-negative terms.

Usage

```r
ldlt(A)
```

Arguments

- `A`: symmetric positive-definite matrix

Value

- list of
  - $L$: matrix $L$
  - $D$: matrix $D$

References


Examples

```r
A <- matrix(c(5,1,1,3),2,2)
V <- ldlt(A)
V$L
V$D
V$L %*% V$D %*% t(V$L)
A
```
ltdl

Computes L’DL Matrix Decomposition.

Description

This function decomposes matrix $V$ into $V = L'DL$, where $L$ is a lower triangular matrix with unit diagonal and $D$ is a diagonal matrix with non-negative terms.

Usage

ltdl(A)

Arguments

A symmetric positive-definite matrix

Value

list of

$L$ matrix $L$

$D$ matrix $D$

References


Examples

A <- matrix(c(5, 1, 1, 3), 2, 2)
v <- ltdl(A)
v$L
v$D
t(v$L) %*% v$D %*% v$L
A
**Description**

This function estimates recursively mixtures with state-space components with a dynamic model of switching. The components are normal linear models. Suppose there are available $k$ potentially important predictors of $y$, i.e., $x_1, \ldots, x_k$. Then up to $2^k$ linear models including constant term can be created by including or not including each of these predictors in the individual model, i.e., component of the mixture.

**Usage**

```
mixest1(y, x, mods = NULL, ftype = NULL, lambda = NULL, kappa = NULL, V = NULL, W = NULL, atype = NULL)
```

**Arguments**

- **y**: one column matrix of forecasted time-series, observations inserted rowwise
- **x**: matrix of independent time-series (predictors), observations inserted rowwise
- **mods**: optional, matrix indicating which models should be used as components, the first column indicates inclusion of a constant in a component model, by default all possible models with a constant are used, inclusion of a variable is indicated by 1, omitting by 0, component models are indexed by rows, variables (time-series) are indexed by columns
- **ftype**: optional, numeric indicating type of forecasting, 0 represents forecasting based on coefficients derived from the estimated mixture, 1 represents averaging forecasts from all components by the estimated weights, 2 represents selecting the forecast given by the model with the highest weight, 3 represents selecting the forecast from the so-called median probability model (Barbieri and Berger, 2004), by default ftype=0 is taken
- **lambda**: optional, numeric between 0 and 1, a forgetting factor in covariance estimation method described by Raftery et al. (2010), by default the method of Nagy and Suzdaleva (2013) is used
- **kappa**: optional, numeric between 0 and 1, a parameter for the exponentially weighted moving average estimation of components variances, described for example by Koop and Korobilis (2012), if lambda is specified but kappa is not, then the method of recursive moments described by Raftery et al. (2010) is used, by default the method of Nagy and Suzdaleva (2013) is used
- **V**: optional, numeric initial variance for all components (output equation), by default $V=1$ is taken
- **W**: optional, numeric initial value to be put in the diagonal matrix representing the covariance matrices (state equation), by default $W=1$ is taken
- **atype**: optional, numeric indicating approximation of pdf, 0 represents quasi-Bayesian approach, 1 represents minimization of the Kerridge inaccuracy (where suitable optimization is done with the Gauss-Newton method, still this increases the computation time greatly), by default atype=0 is taken
Mixest1

Value

object of class mixest, i.e., list of

$y.hat vector of predictions

$rvi matrix of relative variable importances

$coef matrix of regression coefficients corresponding to ftype method chosen

$weights matrix of estimated weights of component models

$V vector of updated variances from the selected models, consistent with ftype chosen

$R matrix of updated diagonal of covariances corresponding to independent variables in regressions, consistent with ftype chosen

$components matrix of mods

$parameters character of parameters used in the model

Source


References


See Also

mixest2

Examples

data(oil)
m1 <- mixest1(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],ftype=1,V=100,W=100)

# Models with only one variable
mods <- diag(1,nrow=ncol(oil[,-1,drop=FALSE]),ncol=ncol(oil[,-1,drop=FALSE]))
mods <- cbind(1,mods)
m2 <- mixest1(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],mods=mods,ftype=1,V=100,W=100)
Computes Mixture Estimation with Normal Regression Components.

Description

This function estimates recursively mixtures with normal regression components with a dynamic model of switching.

Usage

mixest2(y, x, mods=NULL, ftype=NULL, V=NULL, W=NULL, atype=NULL, Tvar=NULL)

Arguments

- **y**: one column matrix of forecasted time-series, observations inserted rowwise
- **x**: matrix of independent time-series (predictors), observations inserted rowwise
- **mods**: see mixest1
- **ftype**: optional, numeric indicating type of forecasting. 1 represents averaging forecasts from all components by the estimated weights (i.e., forecasting based on coefficients derived from the estimated mixture), 2 represents selecting the forecast given by the model with the highest weight, 3 represents selecting the forecast from the so-called median probability model (Barbieri and Berger, 2004), by default ftype=1 is taken
- **V**: optional, numeric initial variance, the same for all components, by default V=1 is taken
- **W**: optional, numeric initial value to be put in the diagonal matrix representing the covariance matrices for regression coefficients, the same for all components, by default W=1 is taken
- **atype**: optional, numeric indicating approximation of pdfs, 0 represents quasi-Bayesian approach, 1 represents minimization of the Kerridge inaccuracy, by default atype=0 is taken
- **Tvar**: optional, numeric indicating the number of first observations, when variance and covariance updating will not be performed, i.e., the initial values will be kept fixed, by default Tvar=30 is taken

Value

object of class mixest, i.e., list of

- **$y.hat**: vector of predictions
- **$rvi**: matrix of relative variable importances
- **$coef**: matrix of regression coefficients corresponding to ftype method chosen
- **$weights**: matrix of estimated weights of component models
$V$ vector of updated variances from the selected models, consistent with ftype chosen

$R$ matrix of updated diagonal of covariances corresponding to independent variables in regressions, consistent with ftype chosen

$\text{components}$ matrix of mods

$\text{parameters}$ character of parameters used in the model

Source


References


See Also

`mixest1`

Examples

```r
data(oil)
m1 <- mixest2(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],ftype=1,V=100,W=100)
```

oil

Crude Oil Data.

Description

Selected data from oil market.

Usage

data(oil)
Format

oil is matrix object such that columnwise are

- WTI – WTI spot price in USD per barrel
- MSCI – MSCI World Index
- TB3MS – U.S. 3-month treasury bill secondary market rate
- TWEXM – Trade weighted U.S. dollar index (Mar, 1973 = 100)
- PROD – U.S. product supplied for crude oil and petroleum products in thousands of barrels

Details

The data are in monthly frequency. They cover the period between Feb, 1990 and Dec, 2016. MSCI, TB3MS, TWEXM and PROD are lagged one period back.

Source

The data are provided by Federal Reserve Bank of St. Louis, MSCI and U.S. Energy Information Administration.

https://www.eia.gov
https://fred.stlouisfed.org
https://www.msci.com/end-of-day-data-search

Examples

data(oil)

plot.mixest

Plots Selected Outcomes from mixest Object.

Description

The function plots selected outcomes from mixest object.

Usage

## S3 method for class 'mixest'
plot(x, ...)

Arguments

x an object of mixest class
... not used
The function plots a few outcomes from `mixest` object. First, the estimated regression coefficients are plotted separately for each variable. Credible intervals of 90% are added. Next, if averaging was chosen for forecasting, then relative variable importances are plotted, i.e., sum of weights of models containing the given variable. If selection procedure was chosen for forecasting, it is plotted whether the given variable is included in the selected model at the given time. Finally weights from all component models are presented in one plot.

### See Also

`convts`

### Examples

```r
data(oil)
m1 <- mixest1(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],ftype=2,V=100,W=100)
plot(m1)
```

---

**plot.qbnmix**

Plots Selected Outcomes from `qbnmix` Object.

### Description

The function plots selected outcomes from `qbnmix` object.

### Usage

```r
## S3 method for class 'qbnmix'
plot(x, ...)
```

### Arguments

- `x` an object of `qbnmix` class
- `...` not used

### Details

The function plots a few outcomes from `qbnmix` object. First, it plots means for each cluster. Then, it plots posterior probabilities for each cluster. Finally, estimates of mixing weights for each cluster.
Examples

```r
R <- list(matrix(c(1,0.3,0,
    0.3,0.3,0,
    0,0,0.15),3,3),
    matrix(c(1,0,0,
    0,0.5,0,
    0,0.2),3,3))
data <- rbind(MASS::mvrnorm(n=180,c(5,2,3),R[[1]]),
    MASS::mvrnorm(n=20,c(1,2,3),R[[2]]))
data <- data[sample(nrow(data)),]
mu0 <- list(matrix(c(4.8689,1.9417,3.0175),nrow=1,ncol=3),
    matrix(c(1.0182,1.9903,2.8847),nrow=1,ncol=3))
est <- qbnmix(y=data,mu0=mu0)
plot(est)
```

plot.tvpreg  

Plots Selected Outcomes from tvpreg Object.

Description

The function plots selected outcomes from tvpreg object.

Usage

```r
## S3 method for class 'tvpreg'
plot(x, ...)
```

Arguments

- **x**: an object of tvpreg class
- **...**: not used

Details

The function plots the estimated regression coefficients, separately for each variable. 90% credible intervals are added.

See Also

convts

Examples

```r
data(oil)
t1<- tvp.reg(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],lambda=0.99,V=100,W=100)
plot(t1)
```
print.mixest

*Prints mixest Object.*

---

**Description**

The function prints selected outcomes obtained from object *mixest*.

**Usage**

```r
## S3 method for class 'mixest'
print(x, ...)
```

**Arguments**

- `x` an object of *mixest* class
- `...` not used

**Details**

The function prints the general structure of the model, i.e., names of predictors. It also prints the number of observations (length of time-series) and the number of component models used in estimations (mixing). Additionally it prints the model’s parameters (i.e., forecasting method, values of the initial parameters, etc.).

**Examples**

```r
data(oil)
m1 <- mixest1(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],ftype=2,V=100,W=100)
print(m1)
```

---

print.qbnmix

*Prints qbnmix Object.*

---

**Description**

The function prints selected outcomes obtained from *qbnmix*.

**Usage**

```r
## S3 method for class 'qbnmix'
print(x, ...)
```
Arguments

  x  an object of qbnmix class
  ... not used

Details

  The function prints estimated means and covariance matrices from the last step.

Examples

```r
R <- list(matrix(c(1,0.3,0,
                   0.3,0.3,0,
                   0,0.0.15),3,3),
          matrix(c(1,0,0,
                   0.5,0,
                   0,0.2),3,3))
data <- rbind(MASS::mvrnorm(n=180,c(5,2,3),R[[1]]),
               MASS::mvrnorm(n=20,c(1,2,3),R[[2]]))
data <- data[sample(nrow(data)),]
mu0 <- list(matrix(c(4.8689,1.9417,3.0175),nrow=1,ncol=3),
            matrix(c(1.0182,1.9903,2.8847),nrow=1,ncol=3))
est <- qbnmix(y=data,mu0=mu0)
print(est)
```

print.tvpreg

`print.tvpreg` prints `tvpreg` object.

Description

  The function prints selected outcomes obtained from object `tvpreg`.

Usage

```r
# S3 method for class 'tvpreg'
print(x, ...)  
```

Arguments

  x  an object of `tvpreg` class
  ... not used

Details

  The function prints the general structure of the model, i.e., names of predictors. It also prints the number of observations (length of time-series) and the regression coefficients as estimated in the last period.
Examples

data(oil)
t1<- tvp.reg(y=oil[,1,drop=FALSE],x=oil[,-1,drop=FALSE],lambda=0.99,V=100,W=100)
print(t1)

qbnmix

Estimates Normal Mixtures.

Description

This function performs a recursive clustering for normal mixtures. Quasi-Bayesian approximation is performed.

Usage

qbnmix(y,m=2,mu0=NULL,R0=NULL)

Arguments

y
matrix of observations, rows correspond to observations, columns correspond to tuples

m
numeric specifying the number of components (clusters), by default m=2 is taken

mu0
optional, initial means, should be a list of m matrices, each of them having one row and ncol(y) columns, if not specified random values are taken

R0
optional, initial covariance matrices, should be a list of m matrices, each of them having ncol(y) rows and ncol(y) columns, if not specified identity matrices are taken

Value

object of class qbnmix, i.e., list of

$mu
list of estimated means

$R
list of estimated covariance matrices (from last step only)

$alpha
matrix of estimates of mixing weights (components columnwise)

$w
matrix of posterior probabilities (components columnwise)

$mu0
list of initial means matrices

$R0
list of initial covariance matrices

Source

Examples

R <- list(matrix(c(1,0.3,0,  
0.3,0.3,0,  
0,0,0.15),3,3),  
matrix(c(1,0,0,  
0,0.5,0,  
0,0,0.2),3,3))
data <- rbind(MASS::mvrnorm(n=180,c(5,2,3),R[[1]]),  
MASS::mvrnorm(n=20,c(1,2,3),R[[2]]))
data <- data[sample(nrow(data)),]
mu0 <- list(matrix(c(4.8689,1.9417,3.0175),nrow=1,ncol=3),  
matrix(c(1.0182,1.9903,2.8847),nrow=1,ncol=3))
est <- qbnmix(y=data,mu0=mu0)

sqrtmat

Computes the Square Root of a Matrix.

Description

This function computes the square root of a matrix.

Usage

sqrtmat(A)

Arguments

A symmetric positive-definite matrix

Value

matrix B such that BB' = A

References


Examples

A <- matrix(c(5,1,1,3),2,2)  
B <- sqrtmat(A)  
B %*% t(B)  
A
Computes Time-Varying Parameters Regression.

Description
This function estimates Time-Varying Parameters regression.

Usage
`tvp.reg(y, x, lambda=NULL, kappa=NULL, V=NULL, W=NULL)`

Arguments
- `y`: one column matrix of forecasted time-series, observations inserted rowwise
- `x`: matrix of independent time-series (predictors), observations inserted rowwise
- `lambda`: optional, see `mixest1`
- `kappa`: optional, see `mixest1`
- `V`: optional, numeric initial variance, by default `V=1` is taken
- `W`: optional, numeric initial value to be put on diagonal of covariance matrix, by default `W=1` is taken

Details
If `lambda` is specified, then the method described by Raftery et al. (2010) is used, with possible extension to the one described by Koop and Korobilis (2012). Otherwise, the Kalman filter described as by Nagy and Suzdaleva (2013) is used.

Value
object of class `tvpreg`, i.e., `list` of
- `$y.hat`: vector of predictions
- `$coef`: matrix of regression coefficients
- `$R`: matrix of diagonals of covariances corresponding to independent variables in regressions
- `$V`: vector of outcome variances

References


Examples

data(oil)
t1 <- tvp.reg(y=oil[,1,drop=FALSE], x=oil[,-1,drop=FALSE], lambda=0.99, V=100, W=100)
t2 <- tvp.reg(y=oil[,1,drop=FALSE], x=oil[,-1,drop=FALSE], V=100, W=100)
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