Package ‘VMDML’

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Type Package

Title Variational Mode Decomposition Based Machine Learning Models

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Description Application of Variational Mode Decomposition based different Machine Learning models for univariate time series forecasting. For method details see (i) K. Dragomiretskiy and D. Zosso (2014) <doi:10.1109/TSP.2013.2288675>; (ii) Pankaj Das (2020) <http://krishi.icar.gov.in/jspui/handle/123456789/44138>.

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Contents

VMDARIMA *Variational Mode Decomposition Based Autoregressive Moving Average Model*

Description

The VMDARIMA function helps to fit the Variational Mode Decomposition Based Autoregressive Moving Average Model. It will also provide you with accuracy measures along with an option to select the proportion of training and testing data sets. Users can choose among the available choices of parameters of Variational Mode Decomposition for fitting the Autoregressive Moving Average Model. In this package we have modelled the dependency of the study variable assuming first order autocorrelation. This package will help the researchers working in the area of hybrid machine learning models.

Usage

```
VMDARIMA(data,k,alpha,tau,K,DC,init,tol)
```

Arguments

`data`	input univariate time series data.
`k`	partition value for spliting the data set into training and testing.
`alpha`	a numeric value specifying the balancing parameter of the data-fidelity constraint.
`tau`	a numeric value specifying the time-step of the dual ascent (pick 0 for noiseslack).
`K`	a numeric value specifying the number of modes to be recovered.
`DC`	a boolean. If true the first mode is put and kept at DC (0-freq).
`init`	a numeric value. This parameter differs depending on the input data parameter (1-dimensional and 2-dimensional).
`tol`	a numeric value specifying the tolerance of convergence criterion (typically this parameter is around 1e-6 for the 1-dimensional and 1e-7 for the 2-dimensional data).

Details

Variational mode decomposition (VMD) is one of the latest signal decomposition techniques, similar to EMD, first proposed by Dragomiretskiy and Zosso (2014). This is a an entirely non-recursive variational mode decomposition model,where the modes are extracted concurrently. The algorithm generates an ensemble of modes and their respective center frequencies, such that the modes collectively reproduce the input signal. Further Autoregressive Moving Average(ARIMA) model applied to each decomposed items to forecast them. Finally all forecasted values are aggregated to produce final forecast value (Das et al., 2020, 2019).

Value

`Total_No_IMF` Total number of IMFs after decomposition by VMD method.

`Prediction_Accuracy_VMDARIMA`
List of performance measures of the fitted VMDSVR model.

`Final_Prediction_VMDARIMA`
Final forecasted value of the VMD based ARIMA model. It is obtained by combining the forecasted value of all individual IMF and fresidue.

Author(s)

Pankaj Das, Girish Kumar Jha, Tauqueer Ahmad and Achal Lama

References

Dragomiretskiy, K. and Zosso, D.(2014). Variational Mode Decomposition. IEEE Transactions on Signal Processing, 62(3):531-544. (doi: 10.1109/TSP.2013.2288675).

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Das, P., Jha, G. K. and Lama, A. (2023). Empirical Mode Decomposition Based Ensemble Hybrid Machine Learning Models for Agricultural Commodity Price Forecasting. Statistics and Applications, 21(1), 99-112.(http://krishi.icar.gov.in/jspui/handle/123456789/77772).

Das, P. (2019). Study On Machine Learning Techniques Based Hybrid Model for Forecasting in Agriculture. Published Ph.D. Thesis.

Choudhury, K., Jha, G. K., Das, P. and Chaturvedi, K. K. (2019). Forecasting Potato Price using Ensemble Artificial Neural Networks. Indian Journal of Extension Education, 55(1): 71-77. (http://krishi.icar.gov.in/jspui/handle/123456789/44873).

See Also

VMDARIMA, ARIMA, VMD, VMDecomp

Examples

```
set.seed(6)
data=rnorm(300,6.6,.36)
alpha = 2000
tau = 0
K= 3
DC = FALSE
init = 1
tol = 1e-6
VMDARIMA(data,.8,alpha,tau,K,DC,init,tol)
```

`VMDELM` *Variational Mode Decomposition Based Extreme Learning Machine Model*

Description

The VMDELM function helps to fit the Variational Mode Decomposition based Extreme Learning Machine Model. It will also provide you with accuracy measures along with an option to select the proportion of training and testing data sets. Users can choose among the available choices of parameters of regresion model for fitting the Variational Mode Decomposition based Extreme Learning Machine Model. In this package we have modelled the dependency of the study variable assuming first order autocorrelation. This package will help the researchers working in the area of hybrid machine learning models.

Usage

```
VMDELM(data,k,alpha,tau,K,DC,init,tol)
```

Arguments

`data`	Input univariate time series data.
`k`	Partition value for spliting the data set into training and testing.
`alpha`	a numeric value specifying the balancing parameter of the data-fidelity constraint.
`tau`	a numeric value specifying the time-step of the dual ascent (pick 0 for noiseslack)
`K`	a numeric value specifying the number of modes to be recovered
`DC`	a boolean. If true the first mode is put and kept at DC (0-freq)
`init`	a numeric value. This parameter differs depending on the input 'data' parameter (1-dimensional and 2-dimensional)
`tol`	a numeric value specifying the tolerance of convergence criterion (typically this parameter is around 1e-6 for the 1-dimensional and 1e-7 for the 2-dimensional data)

Details

Variational mode decomposition (VMD) is one of the latest signal decomposition techniques, similar to EMD, first proposed by Dragomiretskiy and Zosso (2014). This is a an entirely non-recursive variational mode decomposition model,where the modes are extracted concurrently. The algorithm generates an ensemble of modes and their respective center frequencies, such that the modes collectively reproduce the input signal. Further Extreme Learning Machine (ELM) model applied to each decomposed items to forecast them. Finally all forecasted values are aggregated to produce final forecast value (Das et al, 2020,2019,2022).

Value

`Total_No_IMF` Total number of IMFs after decomposition by VMD method.

`Prediction_Accuracy_VMDELM`
List of performance measures of the fitted VMDELM model.

`Final_Prediction_VMDELM`
Final forecasted value of the VMD based ELM model. It is obtained by combining the forecasted value of all individual IMF and fresidue.

Author(s)

Pankaj Das, Girish Kumar Jha, Tauqueer Ahmad and Achal Lama

References

Dragomiretskiy, K. and Zosso, D.(2014). Variational Mode Decomposition. IEEE Transactions on Signal Processing, 62(3):531-544. (doi: 10.1109/TSP.2013.2288675).

Das,P., Jha,G. K.,Lama,A., Parsad, R. and Mishra, D. (2020). Empirical Mode Decomposition based Support Vector Regression for Agricultural Price Forecasting. Indian Journal of Extension Education, 56(2): 7-12. (http://krishi.icar.gov.in/jspui/handle/123456789/44138).

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Choudhury, K., Jha, G. K., Das, P. and Chaturvedi, K. K. (2019). Forecasting Potato Price using Ensemble Artificial Neural Networks. Indian Journal of Extension Education, 55(1):71-77. (http://krishi.icar.gov.in/jspui/handle/123456789/44873).

See Also

ELM,VMD,VMDecomp,VMDELM

Examples

```
set.seed(6)
data3=rnorm(300,6.6,.36)
alpha = 2000
tau = 0
K= 3
DC = FALSE
init = 1
tol = 1e-6
#VMDELM(data3,0.8,alpha,tau,K,DC,init,tol)
```

VMDRF *Variational Mode Decomposition Based Random Forest Model*

Description

The VMDRF function helps to fit the Variational Mode Decomposition based Random Forest Model. It will also provide you with accuracy measures along with an option to select the proportion of training and testing data sets. Users can choose among the available choices of parameters for fitting the Variational Mode Decomposition based Random forest model. In this package we have modelled the dependency of the study variable assuming first order autocorrelation. This package will help the researchers working in the area of hybrid machine learning models.

Usage

```
VMDRF(data,k,alpha,tau,K,DC,init,tol,m,n)
```

Arguments

`data`	input univariate time series data.
`k`	partition value for spliting the data set into training and testing.
`alpha`	a numeric value specifying the balancing parameter of the data-fidelity constraint.
`tau`	a numeric value specifying the time-step of the dual ascent (pick 0 for noiseslack).
`K`	a numeric value specifying the number of modes to be recovered.
`DC`	a boolean. If true the first mode is put and kept at DC (0-freq).
`init`	a numeric value. This parameter differs depending on the input data parameter (1-dimensional and 2-dimensional).
`tol`	a numeric value specifying the tolerance of convergence criterion (typically this parameter is around 1e-6 for the 1-dimensional and 1e-7 for the 2-dimensional data).
`m`	number of predictors sampled for spliting at each node.
`n`	number of trees grown.

Details

Variational mode decomposition (VMD) is one of the latest signal decomposition techniques, similar to EMD, first proposed by Dragomiretskiy and Zosso (2014). This is a an entirely non-recursive variational mode decomposition model,where the modes are extracted concurrently. The algorithm generates an ensemble of modes and their respective center frequencies, such that the modes collectively reproduce the input signal. Further Random Forest (RF) model applied to each decomposed items to forecast them. Finally all forecasted values are aggregated to produce final forecast value (Das et al., 2019, 2020, 2022).

Value

`Total_No_IMF` Total number of IMFs after decomposition by VMD method.

`Prediction_Accuracy_VMDRF`
List of performance measures of the fitted VMDRF model.

`Final_Prediction_VMDRF`
Final forecasted value of the VMD based RF model. It is obtained by combining the forecasted value of all individual IMF and fresidue.

Author(s)

Pankaj Das, Girish Kumar Jha, Tauqueer Ahmad and Achal Lama

References

Dragomiretskiy, K. and Zosso, D.(2014). Variational Mode Decomposition. IEEE Transactions on Signal Processing, 62(3):531-544. (doi: 10.1109/TSP.2013.2288675).

Das,P., Jha, G. K.,Lama,A., Parsad, R. and Mishra, D. (2020). Empirical Mode Decomposition based Support Vector Regression for Agricultural Price Forecasting. Indian Journal of Extension Education, 56(2): 7-12. (http://krishi.icar.gov.in/jspui/handle/123456789/44138).

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See Also

randomForest, VMDRF, VMD, VMDecomp

Examples

```
set.seed(6)
data3=rnorm(300,6.6,.36)
alpha = 2000
tau = 0
k=0.8
K= 3
DC = FALSE
init = 1
tol = 1e-6
m=3
n=5
```

```
VMDRF(data3,k,alpha,tau,K,DC,init,tol,m,n)
```

VMDSVR *Variational Mode Decomposition Based Support Vector Regression Model*

Description

The VMDSVR function helps to fit the Variational Mode Decomposition based Support Vector Regression Model. It will also provide you with accuracy measures along with an option to select the proportion of training and testing data sets. Users can choose among the available choices of kernel and types of regresion model for fitting the Support Vector Regression model. In this package we have modelled the dependency of the study variable assuming first order autocorrelation. This package will help the researchers working in the area of hybrid machine learning models.

Usage

```
VMDSVR(data,k,alpha,tau,K,DC,init,tol, ker.funct="",svm.type="")
```

Arguments

`data`	input univariate time series data.
`k`	partition value for spliting the data set into training and testing.
`alpha`	a numeric value specifying the balancing parameter of the data-fidelity constraint.
`tau`	a numeric value specifying the time-step of the dual ascent (pick 0 for noiseslack).
`K`	a numeric value specifying the number of modes to be recovered.
`DC`	a boolean. If true the first mode is put and kept at DC (0-freq).
`init`	a numeric value. This parameter differs depending on the input data parameter (1-dimensional and 2-dimensional)
`tol`	a numeric value specifying the tolerance of convergence criterion (typically this parameter is around 1e-6 for the 1-dimensional and 1e-7 for the 2-dimensional data).
`ker.funct`	The available choices of kernel functions like radial basis, linear, polynomial and sigmoidfor fitting Support Vector Regression. By default radial basis function works.
`svm.type`	SVM can be used as a regression machine. User can apply eps-regression or nu-regression. By default the VMDSVR uses eps-regression.

Details

Variational mode decomposition (VMD) is one of the latest signal decomposition techniques, similar to EMD, first proposed by Dragomiretskiy and Zosso (2014). This is a an entirely non-recursive variational mode decomposition model,where the modes are extracted concurrently. The algorithm generates an ensemble of modes and their respective center frequencies, such that the modes collectively reproduce the input signal. Further Support Vector Regression (SVR) model applied to each decomposed items to forecast them. Finally all forecasted values are aggregated to produce final forecast value (Das et al., 2019, 2020, 2022).

Value

`Total_No_IMF` Total number of IMFs after decomposition by VMD method.

`Prediction_Accuracy_VMDSVR`
List of performance measures of the fitted VMDSVR model.

`Final_Prediction_VMDSVR`
Final forecasted value of the VMD based SVR model. It is obtained by combining the forecasted value of all individual IMF.

Author(s)

Pankaj Das, Girish Kumar Jha, Tauqueer Ahmad and Achal Lama

References

Dragomiretskiy, K. and Zosso, D.(2014). Variational Mode Decomposition. IEEE Transactions on Signal Processing, 62(3):531-544. (doi: 10.1109/TSP.2013.2288675).

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Choudhury, K., Jha, G. K., Das, P. and Chaturvedi, K. K. (2019). Forecasting Potato Price using Ensemble Artificial Neural Networks. Indian Journal of Extension Education, 55(1):71-77. (http://krishi.icar.gov.in/jspui/handle/123456789/44873).

See Also

EMDSVRhybrid, EEMDSVR, VMD, VMDecomp, VMDSVR

Examples

```
set.seed(6)
data3=rnorm(300,6.6,.36)
alpha = 2000
tau = 0
K= 3
DC = FALSE
init = 1
tol = 1e-6
VMDSVR(data3,.8,alpha,tau,K,DC,init,tol,"radial","nu-regression")
```

VMDTDNN *Variational Mode Decomposition Based Time Delay Neural Network Model*

Description

The VMDTDNN function helps to fit the Variational Mode Decomposition based Time Delay Neural Network Model. It will also provide you with accuracy measures along with an option to select the proportion of training and testing data sets. Users can choose among the available choices of paarameters of Variational Mode Decomposition based Time Delay Neural Network Model. In this package we have modelled the dependency of the study variable assuming first order autocorrelation. This package will help the researchers working in the area of hybrid machine learning models.

Usage

```
VMDTDNN(data,k,alpha,tau,K,DC,init,tol,l,n,r,m)
```

Arguments

`data`	input univariate time series data.
`k`	partition value for spliting the data set into training and testing.
`alpha`	a numeric value specifying the balancing parameter of the data-fidelity constraint.
`tau`	a numeric value specifying the time-step of the dual ascent (pick 0 for noiseslack).
`K`	a numeric value specifying the number of modes to be recovered.
`DC`	a boolean. If true the first mode is put and kept at DC (0-freq).
`init`	a numeric value. This parameter differs depending on the input data parameter (1-dimensional and 2-dimensional).
`tol`	a numeric value specifying the tolerance of convergence criterion (typically this parameter is around 1e-6 for the 1-dimensional and 1e-7 for the 2-dimensional data).
`l`	The lag length for fitting neural network model.

`n`	Size of the hidden node for fitting neural network model.
`r`	Number of networks to fit with different random starting weights.
`m`	Maximum number of iterations for fitting neural network model.

Details

Variational mode decomposition (VMD) is one of the latest signal decomposition techniques, similar to EMD, first proposed by Dragomiretskiy and Zosso (2014). This is a an entirely non-recursive variational mode decomposition model,where the modes are extracted concurrently. The algorithm generates an ensemble of modes and their respective center frequencies, such that the modes collectively reproduce the input signal. Further Time Delay Neural Network (TDNN) model applied to each decomposed items to forecast them. Finally all forecasted values are aggregated to produce final forecast value (Choudhury et al., 2019).

Value

`Total_No_IMF` Total number of IMFs after decomposition by VMD method.

`Prediction_Accuracy_VMDTDNN`
List of performance measures of the fitted VMDTDNN model.

`Final_Prediction_VMDTDNN`
Final forecasted value of the VMD based TDNN model. It is obtained by combining the forecasted value of all individual IMF and fresidue.

Author(s)

Pankaj Das, Girish Kumar Jha, Tauqueer Ahmad, Achal Lama and Lampros Mouselimis

References

Dragomiretskiy, K. and Zosso, D.(2014). Variational Mode Decomposition. IEEE Transactions on Signal Processing, 62(3):531-544. (doi: 10.1109/TSP.2013.2288675).

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Choudhury, K., Jha, G. K., Das, P. and Chaturvedi, K. K. (2019). Forecasting Potato Price using Ensemble Artificial Neural Networks. Indian Journal of Extension Education, 55(1):71-77. (http://krishi.icar.gov.in/jspui/handle/123456789/44873).

See Also

VMDTDNN, TDNN, VMD, VMDecomp

Examples

```
set.seed(6)
data=rnorm(300,6.6,.36)
alpha = 2000
tau = 0
K= 3
DC = FALSE
init = 1
tol = 1e-6
#VMDTDNN(data,.8,alpha,tau,K,DC,init,tol,1,5,20,100)
```

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