Package ‘MAVE’

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## Description

This function returns the basis matrix of CS or CMS of given dimension.

## Usage

```r
## S3 method for class 'mave'
coef(object, dim, ...)

## S3 method for class 'mave.dim'
coef(object, dim = "dim.min", ...)
```

## Arguments

- `object`: the output of `mave` or the output of `mave.dim`
- `dim`: the dimension of CS or CMS. The value of dim should be given when the class of the argument dr is mave. When the class of the argument dr is mave.dim and dim is not given, the function will return the basis matrix of CS or CMS of dimension selected by `mave.dim`
- `...`: no use.

## Value

- `dir`: the matrix of CS or CMS of given dimension

## See Also

- `mave.data` for obtaining the reduced data

## Examples

```r
x <- matrix(rnorm(400),100,4)
y <- x[,1]+x[,2]+as.matrix(rnorm(100))
dr <- mave(y~x)
dir3 <- coef(dr,3)

dr.dim <- mave.dim(dr)
dir3 <- coef(dr.dim,3)
dir.best <- coef(dr.dim)
```
Concrete Compressive Strength Data Set

Description

Concrete strength is very important in civil engineering and is a highly nonlinear function of age and ingredients. This dataset contains 1030 instances and there are 8 features relevant to concrete strength. The description of the variables are given below. The description is from https://archive.ics.uci.edu/ml/datasets/Concrete+Compressive+Strength. Name – Data Type – Measurement – Description

Format

A data frame with 1030 rows and 8 covariate variables and 1 response variable

Details

Cement (component 1) – quantitative – kg in a m3 mixture – Input Variable
Blast Furnace Slag (component 2) – quantitative – kg in a m3 mixture – Input Variable
Fly Ash (component 3) – quantitative – kg in a m3 mixture – Input Variable
Water (component 4) – quantitative – kg in a m3 mixture – Input Variable
Superplasticizer (component 5) – quantitative – kg in a m3 mixture – Input Variable
Coarse Aggregate (component 6) – quantitative – kg in a m3 mixture – Input Variable
Fine Aggregate (component 7) – quantitative – kg in a m3 mixture – Input Variable
Age – quantitative – Day (1~365) – Input Variable
Concrete compressive strength – quantitative – MPa – Output Variable

Source

https://archive.ics.uci.edu/ml/datasets/Concrete+Compressive+Strength

References


Examples

data(Concrete)
train = sample(1:1030)[1:500]
x.train = as.matrix(Concrete[train,1:8])
y.train = as.matrix(Concrete[train,9])
x.test = as.matrix(Concrete[-train,1:8])
y.test = as.matrix(Concrete[-train,9])

dr = mave.compute(x.train,y.train, method='meanopg',max.dim=8)
dr.dim = mave.dim(dr)
y.pred = predict(dr.dim,x.test)
#estimation error
mean((y.pred-y.test)^2)

kc_house_data

House price in King County, USA

Description
A data set contains 21613 observations with 19 features plus house price. The names of the columns are given below.

- id
- date: Date house was sold(String)
- price: Price of the sold house
- bedrooms: Numer of Bedrooms
- bathrooms: Numer of bathrooms
- sqft_living: Square footage of the living room
- sqrt_log: Square footage of the log
- floors: Total floors in the house
- waterfront: Whether the house has a view a waterfront(1: yes, 0: not)
- view: unknown
- condition: Condition of the house
- grade: unknown
- sqft_above: Square footage of house apart from basement
- sqft_basement: Square footage of the basement
- yr_built: Built year
- yr_renovated: Year when the house was renovated
- zipcode: zipcode of the house
- lat: Latitude coordinate
- long Longitude coordinate
- sqrt_lot15: Lot area in 2015(implies some renovations)
- sqrt_lot15: Lot area in 2015(implies some renovations)

Format
A data frame with 21613 rows and 19 variables

Source
https://www.kaggle.com/harlfoxem/housesalesprediction
Examples

data(kc_house_data)
#convert date in string to date in numeric value
kc_house_data[,2]=sapply(kc_house_data[,2],as.double)
train = sample(1:21613)[1:1000]
x.train = as.matrix(kc_house_data[train,c(2,4:21)])  # exclude id, house price
y.train = as.matrix(kc_house_data[train,3])  # house price
x.test = as.matrix(kc_house_data[-train,c(2,4:21)])
y.test = as.matrix(kc_house_data[-train,3])

mave

Dimension reduction

Description

This function provides several methods to estimate the central space or central mean space of \( y \) on \( x \). It returns the matrix of central space or central mean space for different dimensions and contains other information used for dimension selection by `mave.dim`.

Usage

\[
\text{mave(formula, data, method = "CSOPG", max.dim = 10, screen = NULL,}
\text{subset, na.action = na.fail)}
\]

\[
\text{mave.compute(x, y, method = "CSOPG", max.dim = 10,}}
\text{screen = nrow(x)/log(nrow(x)))}
\]

Arguments

- `formula` the model used in regression
- `data` the data
- `method` This parameter specify which method will be used in dimension reduction. It provides five methods, including "csMAVE","csOPG","meanOPG","meanMAVE","KSIR" by default, method = 'csOPG'
  - 'meanOPG' and 'meanMAVE' estimate dimension reduction space for conditional mean
  - 'csMAVE' and 'csOPG' estimate the central dimension reduction space
  - 'KSIR' is a kernel version of sliced inverse regression (Li, 1991). It is fast, but with poor accuracy.
- `max.dim` the maximum dimension of dimension reduction space. The default is 10. In practice, max.dim will be equal to min(max.dim,ncol(x),screen).
- `screen` specify the number of variables retained after screening method. The default is \( n/\log(n) \). When this number is smaller than max.dim, then max.dim will change to the value of screen
- `subset` an optional vector specifying a subset of observations to be used in the fitting process.
na.action  a function which indicates what should happen when the data contain NAs. The
default is na.action, which will stop calculations. If na.action is set to be na.omit,
the incomplete cases will be removed.
x  The n by p design matrix.
y  The n by q respond matrix.

Value

dr is a list which contains:

- dir: dir[[d]] is the central space with d-dimension d = 1, 2, ..., p reduced direction of different
dimensions
- y: the value of response
- idx: the index of variables which survives after screening
- max.dim: the largest dimensions of CS or CMS which have been calculated in mave function
- ky: parameter used for DIM for selection
- x: the original training data

References

Xia Y. A constructive approach to the estimation of dimension reduction directions[J]. The Annals

See Also

mave.dim for dimension selection, predict.mave for prediction using the dimension reduction
space, coef.mave for accessing the basis vectors of dimension reduction space of given dimension,
plot.mave for plot method for mave class

Examples

x <- matrix(rnorm(400*5),400,5)
b1 <- matrix(c(1,1,0,0,0),5,1)
b2 <- matrix(c(0,0,1,1,0),5,1)
eps <- matrix(rnorm(400),400,1)
y <- x%*%b1 + (x%*%b2)*eps

# finding central space based on OPG method
#dr.csopg <- mave.compute(x,y, method = 'csopg')
#or
dr.csopg <- mave(y ~ x, method = 'csopg')
mave.data

The reduced data matrix

Description

The function returns the reduced data matrix of the original data. The reduced data matrix is obtained by the original data multiplied by the dimension reduction directions of given dimension.

Usage

mave.data(dr, x, dim = NULL)

Arguments

- **dr**: the object returned by `mave` or `mave.dim`
- **x**: the original data matrix of p dimensions
- **dim**: the dimension of the reduced data matrix.

See Also

`coef.mave` for obtaining the dimension reduction directions
Examples

```r
x <- matrix(rnorm(400),100,4)
y <- x[,1]+x[,2]+as.matrix(rnorm(100))
dr <- mave(y~x)
x.reduced <- mave.data(dr,x,3)
```

---

### mave.dim

Select best direction using cross-validation

#### Description

This function selects the dimension of the central (mean) space based on the calculation of MAVE using cross-validation method.

#### Usage

```r
mave.dim(dr, max.dim = 10)
```

#### Arguments

- `dr` the result of MAVE function
- `max.dim` the maximum dimension for cross-validation.

#### Value

dr.dim contains all information in dr plus cross-validation values of corresponding direction

- `cv0` : the cross-validation value when the null model is used
- `cv` : the cross-validation value using dimension reduction directions of different dimensions
- `dim.min` : the dimension of minimum cross-validation value. Note that this value can be 0.

#### See Also

- `mave` for computing the dimension reduction space, `predict.mave.dim` for prediction method of mave.dim class

#### Examples

```r
x <- matrix(rnorm(400*5),400,5)
b1 <- matrix(c(1,1,0,0,0),5,1)
b2 <- matrix(c(0,0,1,1,0),5,1)
eps <- matrix(rnorm(400),400,1)
y <- x%*%b1 + (x%*%b2)*eps

# selected dimension of central space
dr.cs <- mave(y~x,method='csmave')
dr.cs.dim <- mave.dim(dr.cs)
```
#selected dimension of central mean space

```
#dr.mean <- mave(y~x, method="meanmave")
#dr.mean.dim <- mave.dim(dr.mean)
```

---

**plot.mave**  

*Plot of mave or mave.dim object*

---

**Description**

Plot the scatterplot of given dimension directions and response variables.

**Usage**

```r
## S3 method for class 'mave'
plot(x, dim = 4, plot.method = pairs, ...)

## S3 method for class 'mave.dim'
plot(x, dim = "dim.min", plot.method = pairs, ...)
```

**Arguments**

- `x`  
  the object returned by `mave`

- `dim`  
  the dimension

- `plot.method`  
  the method for plotting scatter plot. The default is 'pairs'

- `...`  
  arguments passed to the `plot.method`.

**See Also**

- `mave` for computing the dimension reduction space

**Examples**

```r
x = matrix(rnorm(2000),400,5)
beta1 = as.matrix(c(1,1,0,0,0))
beta2 = as.matrix(c(0,0,1,1,0))
err = as.matrix(rnorm(400))
y = (x%*%beta1)^2+x%*%beta2+err
dr = mave(y~x, method = 'meanmave')
dr.dim = mave.dim(dr)
plot(dr, dim=3)
plot(dr.dim)
```
predict.mave  

Make predictions based on the dimension reduction space

Description

This method make predictions based the reduced dimension of data using \texttt{mars} function.

Usage

\begin{verbatim}
## S3 method for class 'mave'
predict(object, newx, dim, ...)

## S3 method for class 'mave.dim'
predict(object, newx, dim = "dim.min", ...)
\end{verbatim}

Arguments

- \texttt{object} the object of class 'mave'
- \texttt{newx} Matrix of the new data to be predicted
- \texttt{dim} the dimension of central space or central mean space. The matrix of the original data will be multiplied by the matrix of dimension reduction directions of given dimension. Then the prediction will be made based on the data of given dimensions. The value of \texttt{dim} should be given when the class of the argument \texttt{dr} is \texttt{mave}. When the class of the argument \texttt{dr} is \texttt{mave.dim} and \texttt{dim} is not given, the function will return the basis matrix of CS or CMS of dimension selected by \texttt{mave.dim}
- \ldots further arguments passed to \texttt{mars} function such as degree.

Value

the prediced response of the new data

See Also

\texttt{mave} for computing the dimension reduction space and \texttt{mave.dim} for estimating the dimension of the dimension reduction space

Examples

\begin{verbatim}
X = matrix(rnorm(10000),1000,10)
beta1 = as.matrix(c(1,1,1,0,0,0,0,0,0,0))
beta2 = as.matrix(c(0,0,0,1,1,1,1,1,0,0))
err = as.matrix(rnorm(1000))
Y = X%*%beta1+X%*%beta2+err

train = sample(1:1000)[1:500]
\end{verbatim}
x.train = X[train,]
y.train = as.matrix(Y[train])
x.test = X[-train,]
y.test = as.matrix(Y[-train])

dr = mave(y.train~x.train, method = 'meanopg')

yp = predict(dr,x.test,dim=3,degree=2)
#mean error
mean((yp-y.test)^2)

dr.dim = mave.dim(dr)

yp = predict(dr.dim,x.test,degree=2)
#mean error
mean((yp-y.test)^2)

---

Description

A dataset containing 4601 record of email with 57 features. These features are the relative frequency of most commonly used phrases and punctuations. The data of these features are recorded 1 to 57 columns of the spam data. The outcome is spam or email which is denoted as 1 or 0, recorded in the 58th column of the data.

Format

A data frame with 4601 rows and 57 variables

Examples

data(spam)
train = sample(1:4601)[1:1000]
x.train <- as.matrix(spam[train,1:57])
y.train <- as.matrix(spam[train,58])
x.test <- as.matrix(spam[-train,1:57])
y.test <- as.matrix(spam[-train,58])
x.train <- sqrt(x.train)
x.test <- sqrt(x.test)
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