Package ‘expandFunctions’

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Type Package
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Title Feature Matrix Builder
Version 0.1.0
Imports utils, stats, graphics, plyr, orthopolynom, polynom, glmnet
Description Generates feature matrix outputs from R object inputs using a variety of expansion functions. The generated feature matrices have applications as inputs for a variety of machine learning algorithms. The expansion functions are based on coercing the input to a matrix, treating the columns as features and converting individual columns or combinations into blocks of columns. Currently these include expansion of columns by efficient sparse embedding by vectors of lags, quadratic expansion into squares and unique products, powers by vectors of degree, vectors of orthogonal polynomials functions, and block random affine projection transformations (RAPTs). The transformations are magrittr- and cbind-friendly, and can be used in a building block fashion. For instance, taking the cos() of the output of the RAPT transformation generates a stationary kernel expansion via Bochner's theorem, and this expansion can then be cbind-ed with other features. Additionally, there are utilities for replacing features, removing rows with NAs, creating matrix samples of a given distribution, a simple wrapper for LASSO with CV, a Freeman-Tukey transform, generalizations of the outer function, matrix size-preserving discrete difference by row, plotting, etc.

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Description

Given a model xObj for which coef(xObj) returns a set of coefficients, plot the coefficients.

The plots make it easier to compare which features are large, which are set to zero, and how features change from run to run in a graphical manner.

If the fitting process is linear (e.g. lm, glmnet, etc.) and the original features are appropriately ordered lags, this will generate an impulse response.

Any coefficients that are exactly zero (for instance, set that way by LASSO) will appear as red X’s; non-zero points will be black O’s.
Usage

c coefPlot(xObj, includeIntercept = FALSE, type = "h", main = NULL, ...)

Arguments

xObj Output of a fitting model.
includeIntercept Should the 1st coefficient be plotted? Default is FALSE.
type Graphics type. Default is "h", which results in an impulse-like plot.
main "main" title; default is the relative number of non-zero coefficients, a measure of sparsity.
... Optional additional graphical parameters, for instance to set ylim to a fixed value.

Details

If includeIntercept==TRUE, the intercept of the model will be plotted as index 0.

Changing the type using type="b" will result in a parallel coordinate-like plot rather than an impulse-like plot. It is sometimes easier to see the differences in coefficients with type="b" rather than type="h".

Value

Invisibly returns TRUE. Used for its graphic side effects only.

Examples

set.seed(1)
nObs <- 100
X <- distMat(nObs,6)
A <- cbind(c(1,0,-1,rep(0,3)))  # Y will only depend on X[,1] and X[,3]
Y <- X %*% A + 0.1*runif(nObs)
lassoObj <- easyLASSO(X,Y)
Yhat <- predict(lassoObj,newx=X)
YyHatPlot(Y,Yhat)
coef( lassoObj )  # Sparse coefficients
coefPlot( lassoObj )
coefPlot( lassoObj, includeIntercept=TRUE )
coefPlot( lassoObj, type="b" )
distMat

Make a matrix with coefficients distributed as dist

Description

Generate a pXq matrix with coefficients drawn from the univariate distribution dist with options distOpt.

Usage

distMat(p, q, dist = rnorm, distOpt = NULL)

Arguments

p
Number of rows

q
Number of columns

dist
distribution of coefficients to draw from; default is rnorm.

distOpt
Named list of additional parameters for dist. Always omit the first parameter, n, of the distribution sampling function. Defaults may be omitted if desired (see examples).

Details

The user may provide their own distribution function, but note that the number of values to return, n, must be the first argument, just as with the built-in distributions. The first argument does not have to be named.

Value

A pXq matrix with coefficients distributed as dist with parameters defined in ‘...’

Examples

X <- distMat(10, 2)
X <- distMat(10, 2, distOpt=list(mean=1, sd=2))
X <- distMat(5, 3, rnorm, list(mean=1, sd=2))
X <- distMat(5, 3, rnorm, list(sd=2))
X <- distMat(50, 3, rt, list(df=3))
**easyLASSO**

Select and fit sparse linear model with LASSO

**Description**

The purpose of this function is to make the process of LASSO modelling as simple as possible. This is a simple wrapper on two glmnet functions which, when given input matrix X and response vector y, and a criterion for model selection, will estimate the lambda parameter, and return the LASSO results as a glmnet model. This model can then be used to find coefficients and predictions.

**Usage**

easyLASSO(X, y, criterion = "lambda.1se")

**Arguments**

- **X**
  - Predictor matrix, nXp, with n observations and p features.
- **y**
  - Response vector, or column or row matrix. Must have length n.
- **criterion**
  - String describing which lambda criterion to use in selecting a LASSO model. Choices currently are c("lambda.1se","lambda.min").

**Value**

a glmnet model

**See Also**

glmnet and cv.glmnet

**Examples**

```r
set.seed(1)
noObs <- 100
X <- distMat(noObs,6)
A <- cbind(c(1,0,-1,rep(0,3)))
  # Y will only depend on X[,1] and X[,3]
Y <- X %*% A + 0.1*rnorm(noObs)
lassoObj <- easyLASSO(X=X,y=Y) # LASSO fitting
Yhat <- predict(lassoObj,newx=X)
yyHatPlot(Y,Yhat)
coef( lassoObj ) # Sparse coefficients
typePlot( lassoObj )
```
**eDiff**

*Matrix size-preserving diff function*

**Description**

Returns a matrix, the same size as the input matrix X, containing the back difference.

**Usage**

eDiff(X, pad = NA)

**Arguments**

- **x**
  
  R object coercible to matrix

- **pad**
  
  Pad the first row with this value; the default is NA. 0 would be another value often used in signal processing.

**Value**

Returns a matrix, the same size as the input matrix X, containing the back difference by column. The first row is filled with copies of pad.

**Examples**

eDiff(1:8)
eDiff(as.data.frame(1:8))
eDiff(matrix(1:8, ncol=2))

---

**eLag**

*Convert vector into a matrix of lag columns*

**Description**

Convert vector into a matrix of lag columns

**Usage**

eLag(x, colParamVector, pad = NA)

**Arguments**

- **x**
  
  Data *vector*

- **colParamVector**
  
  Vector of lags for embedding

- **pad**
  
  Scalar for padding embedding
Value

A matrix whose columns are x lagged by the corresponding values in colParamVector.

See Also

embed and embedd, which are related functions.

Examples

```r
eLag(1:6, 0:2)
eLag(1:6, 0:2, pad=0)
```

```
ematrixouter

Extends eOuter to allow a matrix for the first argument
```

Description

Extends eOuter to allow a matrix for the first argument

Usage

```r
eMatrixOuter(X, colParamVector, FUN, ...)
```

Arguments

- **X**: R object coercible to a matrix the columns of this will be the argument of FUN (see below).
- **colParamVector**: Vector input which will be the second argument of FUN (see below).
- **FUN**: Function which will be applied to FUN(X[,i],colParamVector[j],...)
- **...**: Additional arguments to FUN.

Details

This function is a simple extension of eOuter which allows the function eOuter(X[,i],colParamVector,FUN,...) for i in the columns of X.

Value

Returns a matrix with the matrices generated by eOuter for each column column bound together. This means that each row of the returned matrix represents single observations (at least as long as no lags are used).

Examples

```r
A <- matrix(1:6, ncol=2)
temp <- eMatrixOuter(A,0:2,FUN=````)
```
eOuter

Description

Extends outer \{base\} outer(x, y, FUN) to include functions \( \text{FUN}(x, y, \ldots) \) where the first argument of \( \text{FUN} \) is a vector but the second argument must be a scalar.

Usage

eOuter(x, y, FUN, ...)

Arguments

- \textbf{x} Vector, with the same function as in outer \{base\}. Each value will correspond to a row in the return matrix.
- \textbf{y} Vector. Each element in the vector corresponds to a column in the return matrix.
- \textbf{FUN} Function. \( x \) and \( y \) will be the first and second arguments. Unlike outer, however, while a vector can be the first argument, \( \text{FUN} \) might only allow one value as the second argument. This means eOuter can use \text{lagshift}, for instance, as \( \text{FUN} \).
- \textbf{...} Additional parameters for \( \text{FUN} \).

Details

outer has limitations; it only works with functions which can take vector inputs for both the first and second arguments, such as \(^{\wedge}\). As a result, many functions cannot be used for \( \text{FUN} \). The function eOuter gets around this limitation by additionally allowing functions which accept a vector for the first argument, but only scalars for the second argument. It can be used everywhere that outer can be used, but also when \( \text{FUN} \) is limited in this way.

Value

A matrix \( Z \) of size \( \text{length}(x) \times \text{length}(y) \) containing \( Z[i, \cdot] \) with values \( \text{FUN}(x, y[i], \ldots) \).

See Also

\textit{outer} and ePow

Examples

\begin{verbatim}
# This implements a function similar to ePow
# FIXME: change ePow to use eOuter!!!
eOuter(1:6,0:2,FUN = `^`)  
# Other functions of columns
    eOuter(1:10,0:3,FUN = lagshift,lagMax=3,pad=NA)
# FIXME: Make function to allow polynomials to be used:
    eOuter(1:10,1:3,FUN = glaguerre.polynomials, alpha=0.5)
\end{verbatim}
ePow

Convert vector x into a matrix $X_{ij} = x_i^j$

**Description**

Convert vector x into a matrix $X_{ij} = x_i^j$

**Usage**

ePow(x, colParamVector)

**Arguments**

- **x**: Data vector.
- **colParamVector**: Vector of column powers.

**Value**

A matrix $X$ of size length(x) X length(colParamVector)

$$X_{ij} = x_i^j$$

**Examples**

```r
x <- 1:6
ePow(x, 0:2)
```

---

eQuad

Multivariate second order polynomial expansion.

**Description**

Expand matrix columns into linear, square, and unique product columns.

**Usage**

eQuad(X, FUN = `*`, ...)

**Arguments**

- **X**: vector or matrix. If a vector, it will be converted to a column matrix. If it is desired that the squares and products of a vector are computed, pass rbind(X) instead of X, and thereby pass a row matrix.
- **FUN**: Binary function which forms the products of the columns. By default, this is `*`, but other commuting operators or kernels can be used if desired.
- **...**: Options for FUN. Not needed if FUN doesn’t have options.
Details

Form a matrix with columns composed of linear, square, and product columns:

\[ X | FUN(X[, i], X[, j]) \]

where \(i, j\) are the unique combinations of \(i\) and \(j\), including \(i = j\).

By default, the function used to form the squares and products, \(FUN\), is just conventional multiplication = ‘*’, but any commuting binary operator can be used.

This particular expansion is often applied in

- General Method of Data Handling (GMDH).
- Nonlinear Slow Feature Analysis (SFA). Performing a multivariate polynomial of second degree expansion in all the features, then performing linear SFA on the resulting expanded feature matrix, is a very common approach, and in fact is the default method in \texttt{sfa2} \{\texttt{rSFA}\}.

Value

\([X, X^2, \text{uniqueproducts of columns of } X]\). The unique products are in row major upper right triangular order. Thus, for \(X\) with columns 1:3, the order is

\(X[,1]^2, X[,2]^2, X[,3]^2, X[,1] \times X[,2], X[,1] \times X[,3], X[,2] \times X[,3]\)

See Also

\texttt{sfa2}

Examples

```r
# # Examples
# eQuad(1:5)
# eQuad(matrix(1:12, ncol=3, FUN='*'))
```

---

\texttt{eReplace} \hspace{1cm} \textit{Replace values in an R object coercible to a matrix}

Description

Replace values in an R object coercible to a matrix. It is useful for replacing \texttt{NA} with other values, etc., such as with padding values.

Usage

\texttt{eReplace(X, a, b)}
**eTrim**

*Remove padded rows from matrix X*

**Description**

Remove padded rows from matrix X

**Usage**

```
eTrim(X, pad = NA)
```

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>X</code></td>
<td>R object coercible to matrix</td>
</tr>
<tr>
<td><code>pad</code></td>
<td>Value representing padded elements. By default it is NA, but could be any value.</td>
</tr>
</tbody>
</table>

**Value**

A matrix.
expandFunctions

Examples

```r
n <- 10
x <- rnorm(n)     # x vector
X <- eLag(x, 0:1)  # X matrix
t <- 1:n           # time vector
T <- eLag(t, 0:1)  # time matrix; the column corresponding
to 0 is the time for each row,
even after trimming
matplot(X, type="l", lty=1)
X <- eTrim(X)
T <- eTrim(T)
matplot(x=T[,1], y=X, type="l", lty=1,
xlab="Time")
```

expandFunctions: a feature matrix builder

Description

A variety of functions for conversion of vectors and matrices to other matrices to use as features. This allows one to quickly build feature structures and apply various machine learning methods to those features for exploration and pedantic purposes.

Details

The `expandFunctions` package contains functions that can be used to expand feature vectors and matrices into larger feature matrices. These functions include lag embedding, special function univariate expansion, quadratic expansion, and random vector projection.

The general steps for feature generation for time domain data (which subsumes multivariate data via lags) are:

- Preprocess data - remove mean, transform, etc., to a useful vector or matrix.
- If not a matrix, functionally expand vector into a matrix. This is typically done by lag embedding, but may also include STFT, wavelet transforms, etc.
- Functionally expand matrices generated.
- Combine resulting matrices into a single feature matrix.
- Dimensional reduction, feature selection, and/or feature extraction to reduce the number of features.
- Use machine learning method(s) on the resulting feature matrix.

Most of the steps above are well supported in R on CRAN, but the expansion steps tend to be scattered in a variety of packages, poorly represented, or custom built by the user. The `expandFunction` package is intended to collect many of these functions together in one place.

Preprocessing almost always should include centering and scaling the data. However, it may also include a variety of transformations, such as Freeman-Tukey, in order to make the vector fit more closely to a given model (say, a linear model with Gaussian noise).
If the input isn’t a time domain vector, but is instead already in tabular form (for instance, Boston Housing Data), the embedding step can be skipped.

Dimension reduction is outside the scope of this package, but is normally performed to reduce the variables that need handling, reducing the memory used and speeding up the analysis.

The package functions are "magrittr-friendly", that is, built so that they can be directly pipelined since X, the data, is the first argument.

Most functions are prefixed with "e" to help distinguish them from being confused with similarly named functions.

Author(s)

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Examples

```r
## Not run
# Sunspot counts can be somewhat Gaussianized by the
# Freeman-Tukey transform.
x <- freemanTukey(sunspot.month)
par(mfrow=c(1,1)) # just in case multiplots were left over.
plot(x,type="l")

# Embed x using eLag
# Since the base period of sunspots is 11*12 months,
# pick the lags to be fractions of this.
myLags <- seq(from=0,to=200,by=12)
X <- eTrim(eLag(x,myLags))
Y <- X[,+1,drop=FALSE]
X <- X[-1,drop=FALSE]
# matplot(X,type="l",lty=1)

# OLS fitting on the lag feature set
lmObj <- lm(y ~.,data = data.frame(x=X,y=Y))
coefPlot(lmObj,type="b")
summary(lmObj)
Yhat <- predict(lmObj, newdata = data.frame(x=X))
Ydiagnostics(Y,Yhat)

# LASSO fitting on the lag feature set
lassoObj <- easyLASSO(X,Y,criterion="lambda.min")
coefPlot(lassoObj,type="b")
Yhat <- predict(lassoObj,newx = X)
Ydiagnostics(Y,Yhat)

# Reduce the lag feature set using non-zero
# LASSO coefficients
useCoef <- coef(lassoObj)[-1]!=0
myLags <- seq(from=0,to=200,by=12)[c(TRUE,useCoef)]
X <- eTrim(eLag(x,myLags))
Y <- X[,+1,drop=FALSE]
X <- X[-1,drop=FALSE]
```
# OLS fitting on the reduced lag feature set
lmObj <- lm(y ~ ., data = data.frame(x=X, y=Y))
summary(lmObj)
coefPlot(lmObj)
Yhat <- predict(lmObj, newdata = data.frame(x=X))
Ydiagnostics(Y,Yhat)

# 1st nonlinear feature set
# Apply a few Chebyshev functions to the columns of the
# lag matrix. Note these exclude the constant values,
# but include the linear.
chebyFUN <- polywrapper(basePoly=orthopolynom::chebyshev.t.polynomials, kMax=5)
Z <- eMatrixOuter(X,1:5,chebyFUN)

# OLS fitting on the 1st nonlinear feature set
lmObj <- lm(y ~ ., data = data.frame(z=Z, y=Y))
summary(lmObj)
Yhat <- predict(lmObj, newdata = data.frame(z=Z))
Ydiagnostics(Y,Yhat)

# LASSO fitting on the 1st nonlinear feature set
lassoObj <- easyLASSO(Z, Y)
coefPlot(lassoObj)
Yhat <- predict(lassoObj, newx = Z)
Ydiagnostics(Y,Yhat)

# 2nd nonlinear feature set
# Use eQuad as an alternative expansion of the lags
Z <- eQuad(X)

# OLS fitting on the 2nd nonlinear feature set
lmObj <- lm(y ~ ., data = data.frame(z=Z, y=Y))
summary(lmObj)
Yhat <- predict(lmObj, newdata = data.frame(z=Z))
Ydiagnostics(Y,Yhat)

# LASSO fitting on the 2nd nonlinear feature set
lassoObj <- easyLASSO(Z, Y)
coefPlot(lassoObj)
Yhat <- predict(lassoObj, newx = Z)
Ydiagnostics(Y,Yhat)

## End(Not run)
Description
This transform takes Poisson (count) information and makes it more Gaussian, then z-scales (standardizes by centering and scaling to var = 1) the results.

Usage
freemanTukey(x)

Arguments
x Data vector

Value
The transformed vector

References
Taken from https://en.wikipedia.org/wiki/Anscombe_transform

Examples
x <- freemanTukey(sunspot.month)

---

Description
Generates shifted columns.

Usage
lagshift(x, i, lagMax, pad)

Arguments
x Input vector
i Shift (integer)
lagMax Maximum lag that will be needed
pad Scalar used for padding.

Value
vector padded front and back with padding appropriate for generating lag.

Examples
lagshift(1:3,0,1,NA)
**polywrapper**

*Generate special functions using orthonormal functions*

**Description**

Orthopolynom can be used to generate special functions, but for expansion they should be modified. As of this writing, orthopolynom generates polynomials for Chebyshev, Hermite, Legendre and many other functions, their integrals and derivatives, and more.

**Usage**

```r
generate special functions using orthonormal functions
```

**Arguments**

- `basePoly`: A polynomial list from orthopoly
- `kMax`: Integer. The maximum order of the function generated.

**Details**

The function polywrapper does 2 things:

- Generate functions from polynomial coefficients.
- Uses `x` as the 1st argument, and the order as the second; this means the generated functions can be used in `eOuter` and `eMatrixOuter`.

The functions so generated can be used as simple special functions, as well as being useful in feature building.

Since the coefficients from orthopolynom are generated by recursion, an upper limit of the function order needs to be set when calling polywrapper. This is the main limitation of polywrapper. Fortunately, since the functions are compactly stored, `kMax` can be set quite high if desired. Note that usually the `kMax` is known, and is relatively small.

**Value**

Function which is compatible with `eOuter` and `eMatrixOuter`

**Examples**

```r
# Generate a Chebyshev function of the form
# chebyFUN(x,k), where x is the input and k is the order.
# In this case, k must be no more than 5 (since that
# is the value passed to kMax), although it is
# easy to set this to a higher order if desired.
chebyFUN <- polywrapper(basePoly=orthopolynom::chebyshev.t.polynomials,
```
kMax=5)
# Now the function chebyFUN
# can be used as any other function:
x <- seq(-1,+1,0.01)
plot(x,chebyFUN(x,5),type="l")
eOuter(seq(-1,+1,0.01),0:3,chebyFUN)

rapt  Expand an input matrix X using raptObj.

Description

Expand an input matrix X using a Random Affine Projection Transformation (RAPT) object. Such objects use random affine projection transformation to the resulting matrix. This allows RA PT objects serve as a basis for a large number of kinds of expansions. If p are the number of features of X, and q are number of expanded features, the applications fall into two broad categories:

- p > q using the Johnson-Lindenstrauss theorem:
  - Compressed sensing.
  - Manifold learning.
  - Dimension reduction.
  - Graph embedding.
  - ...

- p < q using Bochner's theorem:
  - Approximate kernel projection.
  - Fast approximate SVD.
  - Estimation of dependence.
  - ...

Usage

rapt(X, raptObj)

Arguments

X  Input data matrix
raptObj  raptObj generated by raptMake

Details

Computes

\[ XW + b \]

where

W = raptObj$W
b = raptObj$b
Value

A matrix of randomly (but repeatable) features.

References


See Also

Details of how the rapt object is built are in raptMake.

Examples

# Toy problem
set.seed(1)
nObs <- 100 # Number of observations
X <- matrix(seq(-4,+4,length.out = nObs),ncol=1)
Ytrue <- sin(5*X) + 2*cos(2*X) # True value Ytrue = g(X)
Y <- Ytrue + rnorm(nObs) # Noisy measurement Y

# Standardize X
Xstd <- scale(X)
attributes(Xstd) <- attributes(X)

# Bochner (random Fourier) projection object
nDim <- NCOL(X)
h <- 10 # Estimated by goodness of fit Adj R^2.
# Normally this would be fit by cross validation.
raptObj <- raptMake(nDim,nDim*200,WdistOpt = list(sd=h),
bDistOpt=list(min=-pi,max=+pi))

# Apply raptObj to Xstd to generate features,
# keeping unaltered features Xstd as well.
Xrapt <- cbind( Xstd, cos( rapt(Xstd,raptObj) ) )

# Standardize results
XraptStd <- scale(Xrapt)
attributes(XraptStd) <- attributes(Xrapt)

# A linear fitting of Y to the features XraptStd
lmObj <- lm(Y ~ XraptStd)
summary(lmObj)

# Plot measurements (Y), predictions (Yhat),
# Kernel smoothing with Gaussian kernel and same bandwidth,
# true Y without noise.
Yhat <- predict(lmObj)
plot(X,Y,main="Linear Fitting", ylim=c(-6,10))
lines(X,Yhat,col="red",lty=1,lwd=2)
grid(col="darkgray")
kFit <- ksmooth(X,Y,kernel="normal",bandwidth=1/h)
Define a Random Affine Projection Transformation (RAPT) object
Description
Create a Random Affine Projection Transformation (RAPT) object. Such objects use random affine projection transformation to the resulting matrix. This allows RAPT objects serve as a basis for a large number of kinds of expansions.

Usage
raptMake(p, q, Wdist = rnorm, WdistOpt = NULL, bDist = runif,
           bDistOpt = list(min = 0, max = 0))

Arguments
- `p` Number of input features (columns of `X`).
- `q` Number of output features.
- `Wdist` W distribution function. Coefficients for the random projection matrix W are drawn from this distribution. The default is `rnorm`.
- `WdistOpt` List of optional parameters for Wdist. If this is NULL (default), then only defaults of the distribution are used.
- `bDist` b distribution function. Coefficients for the offset vector b are drawn from this distribution. The default is `runif`.
- `bDistOpt` List of optional parameters for bDist. If this is NULL then only defaults of the distribution are used. The default is `bDistOpt=list(min=0,max=0)`, which results in `b = 0`, with no offset.

Details
This initializes a eRAPTobj, which holds all the parameters needed to perform a random projection transformation expansion (RAPT).
An RAPT of `X` is defined as

\[ XW + b \]

where
- `X` is the input matrix
- `W` is a matrix of coefficients drawn from `Wdist` with options `WdistOpt`
- `b` is a column matrix of coefficients drawn from `bDist` with options `bDistOpt`

If there is a need for multiple `W` or `b` distributions, then make multiple `raptObj`. This makes each `raptObj` fairly simple, while allowing arbitrary complexity through multiple expansion and composition.
A simple way to get a linear feature, in addition to the RAPT features, is to simply `cbind` the original matrix `X` in with the `raptObj` matrix.

Value
An expand object, which defines the following fields: W Input weighting matrix b Input offset matrix
reset.warnings

Examples

raptObj <- raptMake(21,210,bDistOpt=list(min=-pi,max=pi))

reset.warnings

Reset annoyingly persistent warning messages.

Description

Reset annoyingly persistent warning messages.

Usage

reset.warnings()

Value

Returns TRUE invisibly. Used for side effects only.

References

This function is built around the snippet found here: http://stackoverflow.com/questions/5725106/r-how-to-clear-all-warnings

Examples

## reset.warnings()

ydiagnostics

Informative plots for Y and Yhat

Description

This function presents diagnostic plots of estimate Yhat and response Y.

Usage

ydiagnostics(Y, Yhat, ...)

Arguments

Y           R object representing response, coercible to a vector.
Yhat        R object representing estimate, coercible to a vector. The length of Y and Yhat must be equal.
...         Options for cor function. The defaults are use = "everything" and method = "pearson".
Details

The plots shown are:

- Y vs Yhat. Under a perfect noise-free fitting, this would be a straight line with the points lined up on the red line, and the correlation would be 1.0000.
- Y, Yhat and Y-Yhat (residual) time domain plots. The time steps are in samples.
- These show the ACF for the original Y, the residual, and |residual|. The latter helps identify nonlinearity in the residual.

Value

Invisibly returns TRUE; this routine is only used for its graphical side effects described in Details.

See Also

cor

Examples

```r
# The order here looks backwards, but is chosen to
# simulate a typical pair - Yhat will normally have
# a smaller range than Y.
set.seed(2)
nObs <- 100 # Number of observations
x <- stats::filter(rnorm(nObs),c(-0.99),
  method="recursive")
x <- x + (x^2) # Nonlinear component
myLags <- 0:2
X <- eTrim(eLag(x,myLags))
Y <- X[,+1,drop=FALSE]
X <- X[,-1,drop=FALSE]
lmObj <- lm(Y ~ X)
Yhat <- predict(lmObj)
Ydiagnostics(Y,Yhat)
```

```
## yyHatPlot

**Plot y and yHat on the same scale w/reference line**

Description

Plots y and yHat on the same scale as a scatterplot with a 1:1 reference line in red. This is useful for visually comparing actual data y with estimates yHat, determining outliers, etc.

Usage

`yyHatPlot(y, yHat, ...)`
Arguments

- **y**: Vector or matrix coercible to vector. Typically will be the quantity to be predicted.
- **yHat**: Vector or matrix coercible to vector, same length as y. Typically will be the prediction.
- ... Optional additional graph parameters.

Details

Normally only makes sense with vectors, column matrices, or row matrices.

Value

Returns invisibly - only used for graphic side effects.

Examples

```r
set.seed(1)
nObs <- 80
X <- distMat(nObs,2)
A <- cbind(c(1,-1))
Y <- X %*% A + rnorm(nObs) # Response data
lmObj <- lm(Y ~ X)
Yhat <- predict(lmObj) # Estimated response
yyHatPlot(Y,Yhat)
```
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