Package ‘greybox’

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Description Implements functions and instruments for regression model building and its application to forecasting. The main scope of the package is in variables selection and models specification for cases of time series data. This includes promotional modelling, selection between different dynamic regressions with non-standard distributions of errors, selection based on cross validation, solutions to the fat regression model problem and more. Models developed in the package are tailored specifically for forecasting purposes. So as a results there are several methods that allow producing forecasts from these models and visualising them.

License GPL (>= 2)
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**actuals**

Function extracts the actual values from the function

**Description**

This is a simple method that returns the values of the response variable of the model

**Usage**

```r
actuals(object, all = TRUE, ...)
```

## Default S3 method:
actuals(object, all = TRUE, ...)

## S3 method for class 'lm'
actuals(object, all = TRUE, ...)

## S3 method for class 'alm'
actuals(object, all = TRUE, ...)

**Arguments**

- `object` Model estimated using one of the functions of smooth package.
- `all` If FALSE, then in the case of the occurrence model, only demand sizes will be returned.
- `...` Other parameters to pass to the method. Currently nothing is supported here.

**Value**

The vector of the response variable.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>
Examples

```r
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")

ourModel <- stepwise(xreg)
actuals(ourModel)
```

---

### Description

This function extracts AICc / BICc from models. It can be applied to wide variety of models that use `logLik()` and `nobs()` methods (including the popular `lm`, `forecast`, `smooth` classes).

### Usage

```r
AICc(object, ...)
BICc(object, ...)
```

### Arguments

- `object` Time series model.
- `...` Some stuff.

### Details

AICc was proposed by Nariaki Sugiura in 1978 and is used on small samples for the models with normally distributed residuals. BICc was derived in McQuarrie (1999) and is used in similar circumstances.

IMPORTANT NOTE: both of the criteria can only be used for univariate models (regression models, ARIMA, ETS etc) with normally distributed residuals! In case of multivariate models, both criteria need to be modified. See Bedrick & Tsai (1994) for details.

### Value

This function returns numeric value.

### Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>
alm

Augmented Linear Model

Description

Function estimates model based on the selected distribution

Usage

alm(formula, data, subset, na.action, distribution = c("dnorm", "dlaplace", "ds", "dgnorm", "dlogis", "dt", "dalaplace", "dlnorm", "dllaplace", "dls", "dlgnorm", "dbcnorm", "dfnorm", "dinvgauss", "dgamma", "dpois", "dnbinom", "dbeta", "dlogitnorm", "plogis", "pnorm"), loss = c("likelihood", "MSE", "MAE", "HAM", "LASSO", "RIDGE"), occurrence = c("none", "plogis", "pnorm"), scale = NULL, orders = c(0, 0, 0), parameters = NULL, fast = FALSE, ...)

See Also

AIC, BIC

Examples

```r
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")

ourModel <- stepwise(xreg)
AICc(ourModel)
BICc(ourModel)
```

References

Arguments

**formula**
an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. Can also include trend, which would add the global trend.

**data**
a data frame or a matrix, containing the variables in the model.

**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 set by the na.action setting of options, and is na.fail if that is unset. The factory-fresh default is na.omit. Another possible value is NULL, no action. Value na.exclude can be useful.

**distribution**
what density function to use in the process. The full name of the distribution should be provided here. Values with "d" in the beginning of the name refer to the density function, while "p" stands for "probability" (cumulative distribution function). The names align with the names of distribution functions in R. For example, see dnorm.

**loss**
The type of Loss Function used in optimization. loss can be:

- **likelihood** - the model is estimated via the maximisation of the likelihood of the function specified in distribution;
- **MSE** (Mean Squared Error),
- **MAE** (Mean Absolute Error),
- **HAM** (Half Absolute Moment),
- **LASSO** - use LASSO to shrink the parameters of the model;
- **RIDGE** - use RIDGE to shrink the parameters of the model;

In case of LASSO / RIDGE, the variables are not normalised prior to the estimation, but the parameters are divided by the standard deviations of explanatory variables inside the optimisation. As the result the parameters of the final model have the same interpretation as in the case of classical linear regression. Note that the user is expected to provide the parameter lambda.

A user can also provide their own function here as well, making sure that it accepts parameters actual, fitted and B. Here is an example:

```r
lossFunction <- function(actual, fitted, B, xreg) return(mean(abs(actual - fitted)))
loss = lossFunction
```

See vignette("alm","greybox") for some details on losses and distributions.

**occurrence**
what distribution to use for occurrence variable. Can be "none", then nothing happens; "plogis" - then the logistic regression using alm() is estimated for the occurrence part; "pnorm" - then probit is constructed via alm() for the occurrence part. In both of the latter cases, the formula used is the same as the formula for the sizes. Alternatively, you can provide the formula here, and alm will estimate logistic occurrence model with that formula. Finally, an "alm" model can be provided and its estimates will be used in the model construction.

If this is not "none", then the model is estimated in two steps: 1. Occurrence part of the model; 2. Sizes part of the model (excluding zeroes from the data).
scale formula for scale parameter of the model. If NULL, then it is assumed that the scale is constant. This might be useful if you need a model with changing variance (i.e. in case of heteroscedasticity). The log-link is used for the scale (i.e. take exponent of obtained fitted value for the scale, so that it is always positive).

orders the orders of ARIMA to include in the model. Only non-seasonal orders are accepted.

parameters vector of parameters of the linear model. When NULL, it is estimated.

fast if TRUE, then the function won’t check whether the data has variability and whether the regressors are correlated. Might cause trouble, especially in cases of multicollinearity.

additional parameters to pass to distribution functions. This includes:

- alpha - value for Asymmetric Laplace distribution;
- size - the size for the Negative Binomial distribution;
- nu - the number of degrees of freedom for Chi-Squared and Student’s t;
- shape - the shape parameter for Generalised Normal distribution;
- lambda - the meta parameter for LASSO / RIDGE. Should be between 0 and 1, regulating the strength of shrinkage, where 0 means don’t shrink parameters (use MSE) and 1 means shrink everything (ignore MSE);
- lambdaBC - lambda for Box-Cox transform parameter in case of Box-Cox Normal Distribution.
- FI=TRUE will make the function also produce Fisher Information matrix, which then can be used to calculated variances of smoothing parameters and initial states of the model. This is used in the vcov method.

You can also pass parameters to the optimiser:

1. B - the vector of starting values of parameters for the optimiser, should correspond to the explanatory variables. If formula for scale was provided, the parameters for that part should follow the parameters for location;
2. algorithm - the algorithm to use in optimisation ("NLOPT_LN_SBPLX" by default);
3. maxeval - maximum number of evaluations to carry out. Default is 40 per estimated parameter. In case of LASSO / RIDGE the default is 80 per estimated parameter;
4. maxtime - stop, when the optimisation time (in seconds) exceeds this;
5. xtol_rel - the precision of the optimiser (the default is 1E-6);
6. xtol_abs - the absolute precision of the optimiser (the default is 1E-8);
7. ftol_rel - the stopping criterion in case of the relative change in the loss function (the default is 1E-4);
8. ftol_abs - the stopping criterion in case of the absolute change in the loss function (the default is 0 - not used);
9. print_level - the level of output for the optimiser (0 by default). If equal to 41, then the detailed results of the optimisation are returned.

You can read more about these parameters by running the function nloptr.print.options.
Details

This is a function, similar to \texttt{lm}, but using likelihood for the cases of several non-normal distributions. These include:

1. \texttt{dnorm} - Normal distribution,
2. \texttt{dlaplace} - Laplace distribution,
3. \texttt{ds} - S-distribution,
4. \texttt{dgnorm} - Generalised Normal distribution,
5. \texttt{dlogis} - Logistic Distribution,
6. \texttt{dt} - T-distribution,
7. \texttt{dalaplace} - Asymmetric Laplace distribution,
8. \texttt{dlnorm} - Log normal distribution,
9. \texttt{dllaplace} - Log Laplace distribution,
10. \texttt{dls} - Log S-distribution,
11. \texttt{dlgnorm} - Log Generalised Normal distribution,
12. \texttt{dfnorm} - Folded normal distribution,
13. \texttt{dbcnorm} - Box-Cox normal distribution,
14. \texttt{dinvgauss} - Inverse Gaussian distribution,
15. \texttt{dgamma} - Gamma distribution,
16. \texttt{dlogitnorm} - Logit-normal distribution,
17. \texttt{dbeta} - Beta distribution,
18. \texttt{dpois} - Poisson Distribution,
19. \texttt{dnbinom} - Negative Binomial Distribution,
20. \texttt{plogis} - Cumulative Logistic Distribution,
21. \texttt{pnorm} - Cumulative Normal distribution.

This function can be considered as an analogue of \texttt{glm}, but with the focus on time series. This is why, for example, the function has \texttt{orders} parameter for ARIMA and produces time series analysis plots with \texttt{plot(alm(...))}.

This function is slower than \texttt{lm}, because it relies on likelihood estimation of parameters, hessian calculation and matrix multiplication. So think twice when using distribution="dnorm" here.

The estimation is done via the maximisation of likelihood of a selected distribution, so the number of estimated parameters always includes the scale. Thus the number of degrees of freedom of the model in case of \texttt{alm} will typically be lower than in the case of \texttt{lm}.

See more details and examples in the vignette for "ALM": \texttt{vignette("alm","greybox")}.
Value

Function returns model - the final model of the class "alm", which contains:

- coefficients - estimated parameters of the model,
- FI - Fisher Information of parameters of the model. Returned only when FI=TRUE,
- fitted - fitted values,
- residuals - residuals of the model,
- mu - the estimated location parameter of the distribution,
- scale - the estimated scale parameter of the distribution. If a formula was provided for scale, then an object of class "scale" will be returned.
- distribution - distribution used in the estimation,
- logLik - log-likelihood of the model. Only returned, when loss="likelihood" and in several other special cases of distribution and loss combinations (e.g. loss="MSE", distribution="dnorm"),
- loss - the type of the loss function used in the estimation,
- lossFunction - the loss function, if the custom is provided by the user,
- lossValue - the value of the loss function,
- df.residual - number of degrees of freedom of the residuals of the model,
- df - number of degrees of freedom of the model,
- call - how the model was called,
- rank - rank of the model,
- data - data used for the model construction,
- terms - terms of the data. Needed for some additional methods to work,
- occurrence - the occurrence model used in the estimation,
- B - the value of the optimised parameters. Typically, this is a duplicate of coefficients,
- other - the list of all the other parameters either passed to the function or estimated in the process, but not included in the standard output (e.g. alpha for Asymmetric Laplace),
- timeElapsed - the time elapsed for the estimation of the model.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

stepwise, lmCombine, xregTransformer
Examples

### An example with mtcars data and factors

```r
mtcars2 <- within(mtcars, {
  vs <- factor(vs, labels = c("V", "S"))
  am <- factor(am, labels = c("automatic", "manual"))
  cyl <- factor(cyl)
  gear <- factor(gear)
  carb <- factor(carb)
})
```

# The standard model with Log Normal distribution

```r
ourModel <- alm(mpg~., mtcars2[1:30,], distribution="dlnorm")
```

# Produce predictions with the one sided interval (upper bound)

```r
predict(ourModel, mtcars2[-c(1:30),], interval="p", side="u")
```

# Model with heteroscedasticity (scale changes with the change of qsec)

```r
ourModel <- alm(mpg~., mtcars2[1:30,], scales=qsec)
```

### Artificial data for the other examples

```r
xreg <- cbind(rlaplace(100,10,3),rnorm(100,50,5))
```

```r
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rlaplace(100,0,3),xreg,rnorm(100,300,10))
```

### An example with Laplace distribution

```r
ourModel <- alm(y~x1+x2+trend, xreg, subset=c(1:80), distribution="dlaplace")
```

### And another one with Asymmetric Laplace distribution (quantile regression)

# with optimised alpha

```r
ourModel <- alm(y~x1+x2, xreg, subset=c(1:80), distribution="dalaplace")
```

### An example with AR(1) order

```r
ourModel <- alm(y~x1+x2, xreg, subset=c(1:80), distribution="dnorm", orders=c(1,0,0))
```

### Examples with the count data

```r
xreg[,1] <- round(exp(xreg[,1]-70),0)
```

# Negative Binomial distribution

```r
ourModel <- alm(y~x1+x2, xreg, subset=c(1:80), distribution="dnbinom")
```

# Poisson distribution

```r
ourModel <- alm(y~x1+x2, xreg, subset=c(1:80), distribution="dpois")
```
### Examples with binary response variable

```r
xreg[,1] <- round(xreg[,1] / (1 + xreg[,1]),0)
```

# Logistic distribution (logit regression)
```r
ourModel <- alm(y~x1+x2, xreg, subset=c(1:80), distribution="plogis")
summary(ourModel)
plot(predict(ourModel,xreg[-c(1:80),],interval="c"))
```

# Normal distribution (probit regression)
```r
ourModel <- alm(y~x1+x2, xreg, subset=c(1:80), distribution="pnorm")
summary(ourModel)
plot(predict(ourModel,xreg[-c(1:80),],interval="p"))
```

---

### Measures of association

**Description**

Function returns the matrix of measures of association for different types of variables.

**Usage**

```r
association(x, y = NULL, use = c("na.or.complete", "complete.obs",
"everything", "all.obs"), method = c("auto", "pearson", "spearman",
"kendall", "cramer"))
```

**Arguments**

- `x` Either data.frame or a matrix
- `y` The numerical variable.
- `use` What observations to use. See `cor` function for details. The only option that is not available here is "pairwise.complete.obs".
- `method` Which method to use for the calculation of measures of association. By default this is "auto", which means that the function will use: `cor, mcor` or `cramer` depending on the scales of variables. The other options force the function to use one and the same method for all the variables:
  - "pearson" - Pearson’s correlation coefficient using `cor`;
  - "spearman" - Spearman’s correlation coefficient based on `cor`;
  - "kendall" - Kendall’s correlation coefficient via `cor`;
  - "cramer" - Cramer’s V using `cramer`;

Be aware that the wrong usage of measures of association might give misleading results.
Details

The function looks at the types of the variables and calculates different measures depending on the result:

- If both variables are numeric, then Pearson’s correlation is calculated;
- If both variables are categorical, then Cramer’s V is calculated;
- Finally, if one of the variables is categorical, and the other is numeric, then multiple correlation is returned.

After that the measures are wrapped up in a matrix.

Function also calculates the p-values associated with the respective measures (see the return).

See details in the vignette "Marketing analytics with greybox": vignette("maUsingGreybox", "greybox")

assoc() is just a short name for the association().

Value

The following list of values is returned:

- value - Matrix of the coefficients of association;
- p.value - The p-values for the parameters;
- type - The matrix of the types of measures of association.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

table, tableplot, spread, cramer, mcor

Examples

association(mtcars)
Usage

```r
## S3 method for class 'greybox'
coef(object, bootstrap = FALSE, ...)

## S3 method for class 'alm'
confint(object, parm, level = 0.95, bootstrap = FALSE, ...)

## S3 method for class 'scale'
confint(object, parm, level = 0.95, bootstrap = FALSE, ...)

## S3 method for class 'alm'
vcov(object, bootstrap = FALSE, ...)

## S3 method for class 'scale'
vcov(object, bootstrap = FALSE, ...)

## S3 method for class 'alm'
summary(object, level = 0.95, bootstrap = FALSE, ...)
```

Arguments

- `object` - The model estimated using alm or other greybox function.
- `bootstrap` - The logical, which determines, whether to use bootstrap in the process or not.
- `parm` - The parameters passed to `coefbootstrap` function.
- `level` - The confidence level for the construction of the interval.

Details

The `coef()` method returns the vector of parameters of the model. If `bootstrap=TRUE`, then the coefficients are calculated as the mean values of the bootstrapped ones.

The `vcov()` method returns the covariance matrix of parameters. If `bootstrap=TRUE`, then the bootstrap is done using `coefbootstrap` function.

The `confint()` constructs the confidence intervals for parameters. Once again, this can be done using `bootstrap=TRUE`.

Finally, the `summary()` returns the table with parameters, their standard errors, confidence intervals and general information about the model.

Value

Depending on the used method, different values are returned.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>
See Also

`alm, coefbootstrap`

Examples

```r
# An example with ALM
ourModel <- alm(mpg~., mtcars, distribution="dlnorm")
coef(ourModel)
vcov(ourModel)
confint(ourModel)
summary(ourModel)
```

---

`coefbootstrap`  
*Bootstrap for parameters of models*

Description

The function does the bootstrap for parameters of models and returns covariance matrix together with the original bootstrapped data.

Usage

```r
coefbootstrap(object, nsim = 1000, size = floor(0.75 * nobs(object)),
              replace = FALSE, prob = NULL, parallel = FALSE)

## S3 method for class \code{lm}
coefbootstrap(object, nsim = 1000, size = floor(0.75 *
              nobs(object)), replace = FALSE, prob = NULL, parallel = FALSE)

## S3 method for class \code{alm}
coefbootstrap(object, nsim = 1000, size = floor(0.75 *
              nobs(object)), replace = FALSE, prob = NULL, parallel = FALSE)
```

Arguments

- `object`  
The model estimated using either `lm`, or `alm`, or `glm`.
- `nsim`  
A non-negative integer giving the number of items to choose (the sample size), passed to `sample` function in R. If not provided and model contains ARIMA components, this value will be selected at random on each iteration.
- `size`  
A non-negative integer giving the number of items to choose (the sample size), passed to `sample` function in R. If not provided and model contains ARIMA components, this value will be selected at random on each iteration.
- `replace`  
Should sampling be with replacement? Also, passed to `sample` function in R.
- `prob`  
A vector of probability weights for obtaining the elements of the vector being sampled. This is passed to the `sample` as well.
- `parallel`  
Either a logical, specifying whether to do the calculations in parallel, or the number, specifying the number of cores to use for the parallel calculation.
Details
The function applies the same model as in the provided object on a smaller sample in order to get
the estimates of parameters and capture the uncertainty about them. This is a simple implementation
of the case resampling, which assumes that the observations are independent.

Value
Class "bootstrap" is returned, which contains:
- vcov - the covariance matrix of parameters;
- coefficients - the matrix with the bootstrapped coefficients.
- nsim - number of runs done;
- size - the sample size used in the bootstrap;
- replace - whether the sampling was done with replacement;
- prob - a vector of probability weights used in the process;
- parallel - whether the calculations were done in parallel;
- model - the name of the model used (the name of the function);
- timeElapsed - the time that was spend on the calculations.

Author(s)
Ivan Svetunkov, <ivan@svetunkov.ru>

See Also
alm

Examples
# An example with ALM
ourModel <- alm(mpg~., mtcars, distribution="dlnorm", loss="HAM")
# A fast example with 10 iterations. Use at least 1000 to get better results
coefbootstrap(ourModel, nsim=10)

---

**cramer**

**Calculate Cramer’s V for categorical variables**

Description
Function calculates Cramer’s V for two categorical variables based on the table function

Usage

```r
<function> <- cramer(x, y, use = c("na.or.complete", "complete.obs", "everything", "all.obs"))
```
Arguments

x  First categorical variable.
y  Second categorical variable.
use  What observations to use. See cor function for details. The only option that is not available here is "pairwise.complete.obs".

Details

The function calculates Cramer’s V and also returns the associated statistics from Chi-Squared test with the null hypothesis of independence of the two variables.

See details in the vignette "Marketing analytics with greybox": vignette("maUsingGreybox","greybox")

Value

The following list of values is returned:

• valueThe value of Cramer's V;
• statisticThe value of Chi squared statistic associated with the Cramer’s V;
• p.valueThe p-value of Chi squared test associated with the Cramer’s V;
• dfThe number of degrees of freedom from the test.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

table,tableplot,spread,mcor,association

Examples

cramer(mtcars$am, mtcars$gear)

dalaplace  Asymmetric Laplace Distribution

Description

Density, cumulative distribution, quantile functions and random number generation for the Asymmetric Laplace distribution with the location parameter mu, scale and the asymmetry parameter alpha.
**Usage**

dalaplace(q, mu = 0, scale = 1, alpha = 0.5, log = FALSE)

palaplace(q, mu = 0, scale = 1, alpha = 0.5)

qalaplace(p, mu = 0, scale = 1, alpha = 0.5)

ralaplace(n = 1, mu = 0, scale = 1, alpha = 0.5)

**Arguments**

- **q**: vector of quantiles.
- **mu**: vector of location parameters (means).
- **scale**: vector of scale parameters.
- **alpha**: value of asymmetry parameter. Varies from 0 to 1.
- **log**: if TRUE, then probabilities are returned in logarithms.
- **p**: vector of probabilities.
- **n**: number of observations. Should be a single number.

**Details**

When mu=0 and scale=1, the Laplace distribution becomes standardized. The distribution has the following density function:

\[ f(x) = \alpha (1-\alpha) / \text{scale} \exp(-|x-\mu|/\text{scale} (\alpha - I(x<=\mu))) \]

where \( I(.) \) is the indicator function (equal to 1 if the condition is satisfied and zero otherwise).

When alpha=0.5, then the distribution becomes Symmetric Laplace, where scale = 1/2 MAE.

This distribution function aligns with the quantile estimates of parameters (Geraci & Bottai, 2007).

Finally, both palaplace and qalaplace are returned for the lower tail of the distribution.

**Value**

Depending on the function, various things are returned (usually either vector or scalar):

- **dalaplace** returns the density function value for the provided parameters.
- **palaplace** returns the value of the cumulative function for the provided parameters.
- **qalaplace** returns quantiles of the distribution. Depending on what was provided in p, mu and scale, this can be either a vector or a matrix, or an array.
- **ralaplace** returns a vector of random variables generated from the Laplace distribution. Depending on what was provided in mu and scale, this can be either a vector or a matrix or an array.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>
References


Examples

```r
x <- dalaplace(c(-100:100)/10, 0, 1, 0.2)
plot(x, type="l")

x <- palaplace(c(-100:100)/10, 0, 1, 0.2)
plot(x, type="l")

qalaplace(c(0.025,0.975), 0, c(1,2), c(0.2,0.3))

x <- ralaplace(1000, 0, 1, 0.2)
hist(x)
```

dbcnorm

**Box-Cox Normal Distribution**

Description

Density, cumulative distribution, quantile functions and random number generation for the distribution that becomes normal after the Box-Cox transformation. Note that this is based on the original Box-Cox paper.

Usage

```r
dbcnorm(q, mu = 0, sigma = 1, lambda = 0, log = FALSE)
pbcnorm(q, mu = 0, sigma = 1, lambda = 0)
qbcnorm(p, mu = 0, sigma = 1, lambda = 0)
rbcnorm(n = 1, mu = 0, sigma = 1, lambda = 0)
```

Arguments

- `q` vector of quantiles.
- `mu` vector of location parameters (means).
- `sigma` vector of scale parameters.
- `lambda` the value of the Box-Cox transform parameter.


**Details**

The distribution has the following density function:

\[ f(y) = y^{\lambda-1} \frac{1}{\sqrt{2 \pi}} \exp\left(-\frac{(y^{\lambda-1} - \mu)^2}{2 \sigma^2}\right) \]

Both `pbcnorm` and `qbcnorm` are returned for the lower tail of the distribution.

In case of \( \lambda=0 \), the values of the log normal distribution are returned. In case of \( \lambda=1 \), the values of the normal distribution are returned with \( \mu=\mu+1 \).

All the functions are defined for non-negative values only.

**Value**

Depending on the function, various things are returned (usually either vector or scalar):

- `dbcnorm` returns the density function value for the provided parameters.
- `pbcnorm` returns the value of the cumulative function for the provided parameters.
- `qbcnorm` returns quantiles of the distribution. Depending on what was provided in `p`, `mu` and `sigma`, this can be either a vector or a matrix, or an array.
- `rbcnorm` returns a vector of random variables generated from the bcnorm distribution. Depending on what was provided in `mu` and `sigma`, this can be either a vector or a matrix or an array.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**References**


**Examples**

```r
x <- dbcnorm(c(-1000:1000)/200, 0, 1, 1)
plot(c(-1000:1000)/200, x, type="l")

x <- pbcnorm(c(-1000:1000)/200, 0, 1, 1)
plot(c(-1000:1000)/200, x, type="l")

qbcnorm(c(0.025, 0.975), 0, c(1, 2), 1)

x <- rbcnorm(1000, 0, 1, 1)
hist(x)
```
**detectdst**

**DST and Leap year detector functions**

**Description**

Functions to detect, when Daylight Saving Time and leap year start and finish

**Usage**

```r
detectdst(object)
detectleap(object)
```

**Arguments**

- `object` Either a zoo / xts object or a vector of dates / times in POSIXt / Date class. Note that in order for `detectdst()` to work correctly, your data should not have missing observations. Otherwise it might not be possible to locate, when DST happens.

**Details**

The `detectdst` function detects, when the change for the DST starts and ends. It assumes that the frequency of data is not lower than hourly. The `detectleap` function does similar for the leap year, but flagging the 29th of February as a starting and to the 28th of February next year as the ending dates.

In order for the methods to work, the object needs to be of either zoo / xts or POSIXt class and should contain valid dates.

**Value**

List containing:

- `start` - data frame with id (number of observation) and the respective dates, when the DST / leap year start;
- `end` - data frame with id and dates, when DST / leap year end.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**See Also**

`xregExpander`, `temporaldummy`, `outlierdummy`
Examples

# Generate matrix with monthly dummies for a zoo object
x <- as.POSIXct("2004-01-01") + 0: (365*24*8)*60*60
detectdst(x)
detectleap(x)

determination

Coefficients of determination

Description

Function produces coefficients of determination for the provided data

Usage

determination(xreg, bruteforce = TRUE, ...)
determ(object, ...)

Arguments

xreg      Data frame or a matrix, containing the exogenous variables.
bruteforce If TRUE, then all the variables will be used for the regression construction (sink regression). If the number of observations is smaller than the number of series, the function will use stepwise function and select only meaningful variables. So the reported values will be based on stepwise regressions for each variable.
...
object    Other values passed to cor function.

Details

The function calculates coefficients of determination (aka R^2) between all the provided variables. The higher the coefficient for a variable is, the higher the potential multicollinearity effect in the model with the variable will be. Coefficients of determination are connected directly to Variance Inflation Factor (VIF): VIF = 1 / (1 - determination). Arguably it is easier to interpret, because it is restricted with (0, 1) bounds. The multicollinearity can be considered as serious, when determination > 0.9 (which corresponds to VIF > 10).

The method determ can be applied to wide variety of classes, including lm, glm and alm.

See details in the vignette "Marketing analytics with greybox": vignette("maUsingGreybox", "greybox")

Value

Function returns the vector of determination coefficients.
Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

cor, mcor, stepwise

Examples

```r
### Simple example
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("x1","x2","x3","Noise")

determination(xreg)
```

dfnorm

Folded Normal Distribution

Description

Density, cumulative distribution, quantile functions and random number generation for the folded
normal distribution with the location parameter mu and the scale sigma (which corresponds to
standard deviation in normal distribution).

Usage

dfnorm(q, mu = 0, sigma = 1, log = FALSE)
pfnorm(q, mu = 0, sigma = 1)
qfnorm(p, mu = 0, sigma = 1)
rfnorm(n = 1, mu = 0, sigma = 1)

Arguments

q
vector of quantiles.

mu
vector of location parameters (means).

sigma
vector of scale parameters.

log
if TRUE, then probabilities are returned in logarithms.

p
vector of probabilities.

n
number of observations. Should be a single number.
dgnorm

Details
The distribution has the following density function:
\[ f(x) = \frac{1}{\sqrt{2 \pi}} \left( \exp\left(-\frac{(x-\mu)^2}{2 \sigma^2}\right) + \exp\left(-\frac{(x+\mu)^2}{2 \sigma^2}\right) \right) \]
Both `pfnorm` and `qfnorm` are returned for the lower tail of the distribution.

Value
Depending on the function, various things are returned (usually either vector or scalar):
- `dfnorm` returns the density function value for the provided parameters.
- `pfnorm` returns the value of the cumulative function for the provided parameters.
- `qfnorm` returns quantiles of the distribution. Depending on what was provided in \( p, \mu \) and \( \sigma \), this can be either a vector or a matrix, or an array.
- `rfnorm` returns a vector of random variables generated from the fnorm distribution. Depending on what was provided in \( \mu \) and \( \sigma \), this can be either a vector or a matrix or an array.

Author(s)
Ivan Svetunkov, <ivan@svetunkov.ru>

References

Examples
```r
x <- dgnorm(c(-1000:1000)/200, 0, 1)
plot(x, type="l")

x <- pfnorm(c(-1000:1000)/200, 0, 1)
plot(x, type="l")

qfnorm(c(0.025,0.975), 0, c(1,2))

x <- rfnorm(1000, 0, 1)
hist(x)
```

dgnorm

The generalized normal distribution

Description
Density, cumulative distribution, quantile functions and random number generation for the Generalised Normal distribution with the location \( \mu \), a scale and a shape parameters.
Usage

dgnorm(q, mu = 0, scale = 1, shape = 1, log = FALSE)

pgnorm(q, mu = 0, scale = 1, shape = 1, lower.tail = TRUE, log.p = FALSE)

qgnorm(p, mu = 0, scale = 1, shape = 1, lower.tail = TRUE, log.p = FALSE)

rgnorm(n, mu = 0, scale = 1, shape = 1)

Arguments

- **q**: vector of quantiles
- **mu**: location parameter
- **scale**: scale parameter
- **shape**: shape parameter
- **log, log.p**: logical; if TRUE, probabilities p are given as log(p)
- **lower.tail**: logical; if TRUE (default), probabilities are \( P[X \leq x] \), otherwise \( P[X > x] \)
- **p**: vector of probabilities
- **n**: number of observations

Details

A generalized normal random variable \( x \) with parameters location \( \mu \), scale \( s > 0 \) and shape \( \beta > 0 \) has density:

\[
p(x) = \beta \exp\left(-\left|\frac{x - \mu}{s}\right|^\beta\right)/(2s\Gamma(1/\beta)).
\]

The mean and variance of \( x \) are \( \mu \) and \( s^2\Gamma(3/\beta)/\Gamma(1/\beta) \), respectively.

The function are based on the functions from gnorm package of Maryclare Griffin (package has been abandoned since 2018).

The quantile and cumulative functions use uniform approximation for cases \( \text{shape}>100 \). This is needed, because otherwise it is not possible to calculate the values correctly due to \( \text{scale}^\text{shape}=\text{Inf} \) in R.

Author(s)

Maryclare Griffin and Ivan Svetunkov

Source

dgnorm, pgnorm, qgnorm and rgnorm are all parametrized as in Version 1 of the Generalized Normal Distribution Wikipedia page, which uses the parametrization given by in Nadarajah (2005). The same distribution was described much earlier by Subbotin (1923) and named the exponential power distribution by Box and Tiao (1973).
References


Examples

```r
# Density function values for standard normal distribution
x <- dgnorm(seq(-1, 1, length.out = 100), 0, sqrt(2), 2)
plot(x, type="l")

# CDF of standard Laplace
x <- pgnorm(c(-100:100), 0, 1, 1)
plot(x, type="l")

# Quantiles of S distribution
qgnorm(c(0.025,0.975), 0, 1, 0.5)

# Random numbers from a distribution with shape=10000 (approximately uniform)
x <- rgnorm(1000, 0, 1, 1000)
hist(x)
```

dlaplace

### Laplace Distribution

**Description**

Density, cumulative distribution, quantile functions and random number generation for the Laplace distribution with the location parameter mu and the scale parameter (which is equal to Mean Absolute Error, aka Mean Absolute Deviation).

**Usage**

```r
dlaplace(q, mu = 0, scale = 1, log = FALSE)
plaplace(q, mu = 0, scale = 1)
qlaplace(p, mu = 0, scale = 1)
rlaplace(n = 1, mu = 0, scale = 1)
```
Arguments

- \(q\) vector of quantiles.
- \(\mu\) vector of location parameters (means).
- \(scale\) vector of mean absolute errors.
- \(log\) if TRUE, then probabilities are returned in logarithms.
- \(p\) vector of probabilities.
- \(n\) number of observations. Should be a single number.

Details

When \(\mu=0\) and \(scale=1\), the Laplace distribution becomes standardized. The distribution has the following density function:

\[
f(x) = \frac{1}{2 \times scale} \exp(-\text{abs}(x-\mu) / scale)
\]

Both \(plaplace\) and \(qlaplace\) are returned for the lower tail of the distribution.

Value

Depending on the function, various things are returned (usually either vector or scalar):

- \(dlaplace\) returns the density function value for the provided parameters.
- \(plaplace\) returns the value of the cumulative function for the provided parameters.
- \(qlaplace\) returns quantiles of the distribution. Depending on what was provided in \(p, \mu\) and \(scale\), this can be either a vector or a matrix, or an array.
- \(rlaplace\) returns a vector of random variables generated from the Laplace distribution. Depending on what was provided in \(\mu\) and \(scale\), this can be either a vector or a matrix or an array.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

References


Examples

```r
x <- dlaplace(c(-100:100)/10, 0, 1)
plot(x, type="l")

x <- plaplace(c(-100:100)/10, 0, 1)
plot(x, type="l")

qlaplace(c(0.025,0.975), 0, c(1,2))

x <- rlaplace(1000, 0, 1)
hist(x)
```
**dlogitnorm**

---

**Logit Normal Distribution**

**Description**

Density, cumulative distribution, quantile functions and random number generation for the distribution that becomes normal after the Logit transformation.

**Usage**

\[
dlogitnorm(q, \mu = 0, \sigma = 1, \log = \text{FALSE})
\]

\[
plogitnorm(q, \mu = 0, \sigma = 1)
\]

\[
qlogitnorm(p, \mu = 0, \sigma = 1)
\]

\[
rlogitnorm(n = 1, \mu = 0, \sigma = 1)
\]

**Arguments**

- `q` vector of quantiles.
- `mu` vector of location parameters (means).
- `sigma` vector of scale parameters.
- `log` if TRUE, then probabilities are returned in logarithms.
- `p` vector of probabilities.
- `n` number of observations. Should be a single number.

**Details**

The distribution has the following density function:

\[
f(y) = 1/(\sqrt{2 \pi} \ y \ (1-y)) \ \exp(-\logit(y) \cdot \mu)^2 / (2 \ \sigma^2)
\]

where \( y \) is in (0, 1) and \( \logit(y) = \log(y/(1-y)) \).

Both `plogitnorm` and `qlogitnorm` are returned for the lower tail of the distribution.

All the functions are defined for the values between 0 and 1.

**Value**

Depending on the function, various things are returned (usually either vector or scalar):

- `dlogitnorm` returns the density function value for the provided parameters.
- `plogitnorm` returns the value of the cumulative function for the provided parameters.
- `qlogitnorm` returns quantiles of the distribution. Depending on what was provided in `p`, `mu` and `sigma`, this can be either a vector or a matrix, or an array.
- `rlogitnorm` returns a vector of random variables generated from the logitnorm distribution. Depending on what was provided in `mu` and `sigma`, this can be either a vector or a matrix or an array.
Author(s)
Ivan Svetunkov, <ivan@svetunkov.ru>

References


Examples

```r
x <- dlogitnorm(c(-1000:1000)/200, 0, 1)
plot(c(-1000:1000)/200, x, type="l")

x <- plogitnorm(c(-1000:1000)/200, 0, 1)
plot(c(-1000:1000)/200, x, type="l")

qlogitnorm(c(0.025,0.975), 0, c(1,2))

x <- rlogitnorm(1000, 0, 1)
hist(x)
```

---

**S Distribution**

Description

Density, cumulative distribution, quantile functions and random number generation for the S distribution with the location parameter mu and a scaling parameter scale.

Usage

```r
ds(q, mu = 0, scale = 1, log = FALSE)
ps(q, mu = 0, scale = 1)
qs(p, mu = 0, scale = 1)
rn(n = 1, mu = 0, scale = 1)
```

Arguments

- `q` vector of quantiles.
- `mu` vector of location parameters (means).
- `scale` vector of scaling parameter (which are equal to ham/2).
- `log` if TRUE, then probabilities are returned in logarithms.
- `p` vector of probabilities.
- `n` number of observations. Should be a single number.
When $\mu=0$ and $h=2$, the S distribution becomes standardized with $\text{scale}=1$ (this is because $\text{scale}=h/2$). The distribution has the following density function:

$$f(x) = \frac{1}{(4 \text{ scale}^2)} \exp(-\sqrt{\text{abs}(x-\mu)} / \text{scale})$$

The S distribution has fat tails and large excess.

Both $ps$ and $qs$ are returned for the lower tail of the distribution.

**Value**

Depending on the function, various things are returned (usually either vector or scalar):

- $ds$ returns the density function value for the provided parameters.
- $ps$ returns the value of the cumulative function for the provided parameters.
- $qs$ returns quantiles of the distribution. Depending on what was provided in $p$, $\mu$ and $\text{scale}$, this can be either a vector or a matrix, or an array.
- $rs$ returns a vector of random variables generated from the S distribution. Depending on what was provided in $\mu$ and $\text{scale}$, this can be either a vector or a matrix or an array.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**Examples**

```r
x <- ds(c(-1000:1000)/10, 0, 1)
plot(x, type="l")

x <- ps(c(-1000:1000)/10, 0, 1)
plot(x, type="l")

qs(c(0.025,0.975), 0, 1)

x <- rs(1000, 0, 1)
hist(x)
```

**Description**

Density, cumulative distribution, quantile functions and random number generation for the 3 parameter log normal distribution with the location parameter $\mu$, scale $\sigma$ (which corresponds to standard deviation in normal distribution) and shifting parameter $\text{shift}$. 

---

**dtplnorm**

Three Parameter Log Normal Distribution
Usage

dtplnorm(q, mu = 0, sigma = 1, shift = 0, log = FALSE)
ptplnorm(q, mu = 0, sigma = 1, shift = 0)
qtplnorm(p, mu = 0, sigma = 1, shift = 0)
rtplnorm(n = 1, mu = 0, sigma = 1, shift = 0)

Arguments

q vector of quantiles.
mu vector of location parameters (means).
sigma vector of scale parameters.
shift vector of shift parameters.
log if TRUE, then probabilities are returned in logarithms.
p vector of probabilities.
n number of observations. Should be a single number.

Details

The distribution has the following density function:

\[ f(x) = \frac{1}{x-a} \frac{1}{\sqrt{2 \pi}} \exp\left(-\frac{(\log(x-a)-\mu)^2}{2 \sigma^2}\right) \]

Both \text{ptplnorm} and \text{qtplnorm} are returned for the lower tail of the distribution.

The function is based on the lnorm functions from stats package, introducing the shift parameter.

Value

Depending on the function, various things are returned (usually either vector or scalar):

- \text{dtplnorm} returns the density function value for the provided parameters.
- \text{ptplnorm} returns the value of the cumulative function for the provided parameters.
- \text{qtplnorm} returns quantiles of the distribution. Depending on what was provided in \( p, \mu \) and \( \sigma \), this can be either a vector or a matrix, or an array.
- \text{rtplnorm} returns a vector of random variables generated from the tplnorm distribution. Depending on what was provided in \( \mu \) and \( \sigma \), this can be either a vector or a matrix or an array.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

References

### Examples

```r
x <- dtplnorm(c(-100:100)/200, 0, 1, 1)
plot(c(-100:100)/200, x, type="l")

x <- ptplnorm(c(-100:100)/200, 0, 1, 1)
plot(c(-100:100)/200, x, type="l")

qtplnorm(c(0.025,0.975), 0, c(1,2), 1)

x <- rtplnorm(1000, 0, 1, 1)
hist(x)
```

<table>
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<tr>
<th>errorType</th>
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</thead>
<tbody>
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</table>

### Description

This function allows extracting error type from any model.

### Usage

```r
errorType(object, ...)
```

### Arguments

- **object**: Model estimated using one of the functions of smooth package.

- **...**: Currently nothing is accepted via ellipsis.

### Details

`errorType` extracts the type of error from the model (either additive or multiplicative).

### Value

Either "A" for additive error or "M" for multiplicative. All the other functions return strings of character.

### Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>
Examples

```r
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
ourModel <- alm(y~x1+x2,as.data.frame(xreg))
errorType(ourModel)
```

---

**graphmaker**

*Linear graph construction function*

**Description**

The function makes a standard linear graph using the provided actuals and forecasts.

**Usage**

```r
graphmaker(actuals, forecast, fitted = NULL, lower = NULL, upper = NULL, level = NULL, legend = TRUE, cumulative = FALSE, vline = TRUE, parReset = TRUE, ...)
```

**Arguments**

- `actuals`  The vector of actual values
- `forecast` The vector of forecasts. Should be ts object that starts at the end of fitted values.
- `fitted`  The vector of fitted values.
- `lower`  The vector of lower bound values of a prediction interval. Should be ts object that start at the end of fitted values.
- `upper`  The vector of upper bound values of a prediction interval. Should be ts object that start at the end of fitted values.
- `level`  The width of the prediction interval.
- `legend`  If TRUE, the legend is drawn.
- `cumulative` If TRUE, then the forecast is treated as cumulative and value per period is plotted.
- `vline`  Whether to draw the vertical line, splitting the in-sample and the holdout sample.
- `parReset` Whether to reset par() after plotting things or not. If FALSE then you can add elements to the plot (e.g. additional lines).
- `...`  Other parameters passed to `plot()` function.

**Details**

Function uses the provided data to construct a linear graph. It is strongly advised to use ts objects to define the start of each of the vectors. Otherwise the data may be plotted incorrectly.
**greybox**

**Value**

Function does not return anything.

**Author(s)**

Ivan Svetunkov

**See Also**

ts

**Examples**

```r
xreg <- cbind(y=rnorm(100,100,10), x=rnorm(100,10,10))
almModel <- alm(y~x, xreg, subset=c(1:90))
values <- predict(almModel, newdata=xreg[-c(1:90),], interval="prediction")

graphmaker(xreg[,1], values$mean, fitted(values))
graphmaker(xreg[,1], values$mean, fitted(values), legend=FALSE)
graphmaker(xreg[,1], values$mean, fitted(values), legend=FALSE, lower=values$lower, upper=values$upper)

# Produce the necessary ts objects from an arbitrary vectors
actuals <- ts(c(1:10), start=c(2000,1), frequency=4)
forecast <- ts(c(11:15),start=end(actuals)[1]+end(actuals)[2]*deltat(actuals),
               frequency=frequency(actuals))
graphmaker(actuals, forecast)

# This should work as well
graphmaker(c(1:10), c(11:15))

# This way you can add additional elements to the plot
graphmaker(c(1:10), c(11:15), parReset=FALSE)
points(c(1:15))
# But don’t forget to do dev.off() in order to reset the plotting area afterwards
```

---

**greybox**  

*Grey box*

**Description**

Toolbox for working with univariate models for purposes of analysis and forecasting
Details

Package: greybox
Type: Package
Date: 2018-02-13 - Inf
License: GPL-2

The following functions are included in the package:

- **AICc** and **BICc** - AIC / BIC corrected for the sample size.
- **pointLik** - point likelihood of the function.
- **pAIC**, **pAICc**, **pBIC**, **pBICc** - point versions of respective information criteria.
- **determination** - Coefficients of determination between different exogenous variables.
- **temporaldummy** - Matrix with seasonal dummy variables.
- **outlierdummy** - Matrix with dummies for outliers.
- **alm** - Advanced Linear Model - regression, estimated using likelihood with specified distribution (e.g. Laplace or Chi-Squared).
- **sm** - Scale Model - Regression model for scale of distribution (e.g. for Variance of Normal distribution). Requires an lm() or alm() model.
- **stepwise** - Stepwise based on information criteria and partial correlations. Efficient and fast.
- **xregExpander** - Function that expands the provided data into the data with lags and leads.
- **xregTransformer** - Function produces mathematical transformations of the variables, such as taking logarithms, square roots etc.
- **xregMultiplier** - Function produces cross-products of the matrix of the provided variables.
- **lmCombine** - Function combines lm models from the estimated based on information criteria weights.
- **lmDynamic** - Dynamic regression based on point AIC.
- **ro** - Rolling origin evaluation.
- **qalaplace**, **dalaplace**, **palaplace**, **ralaplace** - Asymmetric Laplace distribution and the respective functions.
- **qfnorm**, **dfnorm**, **pfnorm**, **rfnorm** - Folded normal distribution and the respective functions.
- **qs**, **ds**, **ps**, **rs** - S distribution and the respective functions.
- **qtplnorm**, **dtplnorm**, **ptplnorm**, **rtplnorm** - Three parameter log normal distribution and the respective functions.
- **qbcnorm**, **dbcnorm**, **pbcnorm**, **rbcnorm** - Box-Cox normal distribution and the respective functions.
- **qtplnorm**, **dtplnorm**, **ptplnorm**, **rtplnorm** - Three parameter log normal distribution and the respective functions.
- **spread** - function that produces scatterplots / boxplots / tableplots, depending on the types of variables.
- **assoc** - function that calculates measures of association, depending on the types of variables.
hm

Half moment of a distribution and its derivatives.

Description

hm function estimates half moment from some predefined constant C. ham estimates half absolute moment. Finally, asymmetry function returns asymmetry coefficient, while extremity returns the coefficient of excess, both based on hm.

Usage

hm(x, C = mean(x), ...)
ham(x, C = mean(x), ...)
asymmetry(x, C = mean(x), ...)
extremity(x, C = mean(x), ...)

Arguments

x A variable based on which HM is estimated.
C Centring parameter.
... Other parameters passed to mean function.

Details

NA values of x are excluded on the first step of calculation.

Examples

xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
stepwise(xreg)
Value

A complex variable is returned for hm function and real values are returned for asymmetry and ham.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

Examples

```r
x <- rnorm(100, 0, 1)
hm(x)
ham(x)
asymmetry(x)
```

---

is.greybox  
Greybox classes checkers

Description

Functions to check if an object is of the specified class

Usage

```r
is.greybox(x)
is.alm(x)
is.occurrence(x)
is.greyboxC(x)
is.greyboxD(x)
is.rollingOrigin(x)
is.rmc(x)
is.scale(x)
```

Arguments

x  
The object to check.
Details

The list of functions includes:

- `is.greybox()` tests if the object was produced by a greybox function (e.g. `alm` / `stepwise` / `lmCombine` / `lmDynamic`);
- `is.alm()` tests if the object was produced by `alm()` function;
- `is.occurrence()` tests if an occurrence part of the model was produced;
- `is.greyboxC()` tests if the object was produced by `lmCombine()` function;
- `is.greyboxD()` tests if the object was produced by `lmDynamic()` function;
- `is.rmc()` tests if the object was produced by `rmc()` function;
- `is.rollingOrigin()` tests if the object was produced by `ro()` function;
- `is.scale()` tests if the object is of the class "scale" (produced by `alm` in case of heteroscedastic model);

Value

`TRUE` if this is the specified class and `FALSE` otherwise.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

Examples

```r
xreg <- cbind(rlaplace(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rlaplace(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
ourModel <- alm(y~x1+x2, xreg, distribution="dnorm")
is.alm(ourModel)
is.greybox(ourModel)
is.greyboxC(ourModel)
is.greyboxD(ourModel)
```

Description

Function combines parameters of linear regressions of the first variable on all the other provided data.
Usage

```r
lmCombine(data, ic = c("AICc", "AIC", "BIC", "BICc"), bruteforce = FALSE,
          silent = TRUE, distribution = c("dnorm", "dlaplace", "ds", "dgnorm",
                                       "dlogis", "dt", "dalaplace", "dlnorm", "dllaplace", "dlc",
                                       "dlgnorm", "dbcnorm", "dfnorm", "dinvgauss", "dgamma", "dpois",
                                       "dnbinom", "dlogitnorm", "plogis", "pnorm"), parallel = FALSE, ...)
```

Arguments

- **data**: Data frame containing dependent variable in the first column and the others in the rest.
- **ic**: Information criterion to use.
- **bruteforce**: If `TRUE`, then all the possible models are generated and combined. Otherwise the best model is found and then models around that one are produced and then combined.
- **silent**: If `FALSE`, then nothing is silent, everything is printed out. `TRUE` means that nothing is produced.
- **distribution**: Distribution to pass to `alm()`. See `alm` for details.
- **parallel**: If `TRUE`, then the model fitting is done in parallel. WARNING! Packages `foreach` and either `doMC` (Linux and Mac only) or `doParallel` are needed in order to run the function in parallel.
- **...**: Other parameters passed to `alm()`.

Details

The algorithm uses `alm()` to fit different models and then combines the models based on the selected IC. The parameters are combined so that if they are not present in some of models, it is assumed that they are equal to zero. Thus, there is a shrinkage effect in the combination.

Some details and examples of application are also given in the vignette "Greybox": `vignette("greybox","greybox")`

Value

Function returns `model` - the final model of the class "greyboxC". The list of variables:

- `coefficients`: combined parameters of the model,
- `vcov`: combined covariance matrix of the model,
- `fitted`: the fitted values,
- `residuals`: residual of the model,
- `distribution`: distribution used in the estimation,
- `logLik`: combined log-likelihood of the model,
- `IC`: the values of the combined information criterion,
- `ICType`: the type of information criterion used,
- `df.residual`: number of degrees of freedom of the residuals of the combined model,
- `df`: number of degrees of freedom of the combined model,
• importance - importance of the parameters,
• combination - the table, indicating which variables were used in every model construction and what were the weights for each model,
• timeElapsed - the time elapsed for the estimation of the model.

Author(s)
Ivan Svetunkov, <ivan@svetunkov.ru>

References

See Also
step, xregExpander, stepwise

Examples
### Simple example
```r
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
inSample <- xreg[1:80,]
outSample <- xreg[-c(1:80),]
# Combine all the possible models
ourModel <- lmCombine(inSample, bruteforce=TRUE)
predict(ourModel,outSample)
plot(predict(ourModel, outSample))
```

### Fat regression example
```r
xreg <- matrix(rnorm(5000,10,3),50,100)
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(50,0,3),xreg,rnorm(50,300,10))
colnames(xreg) <- c("y",paste0("x",c(1:100)),"Noise")
inSample <- xreg[1:40,]
outSample <- xreg[-c(1:40),]
# Combine only the models close to the optimal
ourModel <- lmCombine(inSample,ic="BICc",bruteforce=FALSE)
summary(ourModel)
plot(predict(ourModel, outSample))
```

# Combine in parallel - should increase speed in case of big data
```r
# Not run: ourModel <- lmCombine(inSample, ic="BICc", bruteforce=TRUE, parallel=TRUE)
summary(ourModel)
predict(ourModel, outSample))
```
lmDynamic

Combine regressions based on point information criteria

Description

Function combines parameters of linear regressions of the first variable on all the other provided data using pAIC weights

Usage

```
lmDynamic(data, ic = c("AICc", "AIC", "BIC", "BICc"), bruteforce = FALSE,
          silent = TRUE, distribution = c("dnorm", "dlaplace", "ds", "dgnorm",
           "dlogis", "dt", "dalaplace", "dlnorm", "dllaplace", "dls", "dlgnorm",
           "dbcnorm", "dfnorm", "dinvgauss", "dgamma", "dpois", "dnbinom", "dlogitnorm",
           "plogis", "pnorm"), parallel = FALSE, ...)
```

Arguments

- `data`: Data frame containing dependent variable in the first column and the others in the rest.
- `ic`: Information criterion to use.
- `bruteforce`: If `TRUE`, then all the possible models are generated and combined. Otherwise the best model is found and then models around that one are produced and then combined.
- `silent`: If `FALSE`, then nothing is silent, everything is printed out. `TRUE` means that nothing is produced.
- `distribution`: Distribution to pass to `alm()`. See `alm` for details.
- `parallel`: If `TRUE`, then the model fitting is done in parallel. WARNING! Packages `foreach` and either `doMC` (Linux and Mac only) or `doParallel` are needed in order to run the function in parallel.
- `...`: Other parameters passed to `alm()`.

Details

The algorithm uses `alm()` to fit different models and then combines the models based on the selected point IC. This is a dynamic counterpart of `lmCombine` function.

Some details and examples of application are also given in the vignette "Greybox": `vignette("greybox", "greybox")`
Value

Function returns `model` - the final model of the class "greyboxD", which includes time varying parameters and dynamic importance of each variable. The list of variables:

- `coefficients` - the mean (over time) parameters of the model,
- `vcov` - the combined covariance matrix of the model,
- `fitted` - the fitted values,
- `residuals` - the residuals of the model,
- `distribution` - the distribution used in the estimation,
- `logLik` - the mean (over time) log-likelihood of the model,
- `IC` - dynamic values of the information criterion (pIC),
- `ICType` - the type of information criterion used,
- `df.residual` - mean number of degrees of freedom of the residuals of the model,
- `df` - mean number of degrees of freedom of the model,
- `importance` - dynamic importance of the parameters,
- `call` - call used in the function,
- `rank` - rank of the combined model,
- `data` - the data used in the model,
- `mu` - the location value of the distribution,
- `scale` - the scale parameter if alm() was used,
- `coefficientsDynamic` - table with parameters of the model, varying over the time,
- `df.residualDynamic` - dynamic df.residual,
- `dfDynamic` - dynamic df,
- `weights` - the dynamic weights for each model under consideration,
- `timeElapsed` - the time elapsed for the estimation of the model.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

References


See Also

`stepwise`, `lmCombine`
### Simple example

```r
xreg <- cbind(rnorm(100,10,3), rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3), xreg, rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
inSample <- xreg[1:80,]
outSample <- xreg[-c(1:80),]
# Combine all the possible models
ourModel <- lmDynamic(inSample, bruteforce=TRUE)
predict(ourModel, outSample)
plot(predict(ourModel, outSample))
```

---

**mcor**

*Multiple correlation*

**Description**

Function calculates multiple correlation between y and x, constructing a linear regression model

**Usage**

```r
mcor(x, y, use = c("na.or.complete", "complete.obs", "everything", "all.obs"))
```

**Arguments**

- `x`  
  Either data.frame or a matrix
- `y`  
  The numerical variable.
- `use`  
  What observations to use. See cor function for details. The only option that is not available here is "pairwise.complete.obs".

**Details**

This is based on the linear regression model with the set of variables in x. The returned value is just a coefficient of multiple correlation from regression, the F-statistics of the model (thus testing the null hypothesis that all the parameters are equal to zero), the associated p-value and the degrees of freedom.

See details in the vignette "Marketing analytics with greybox": vignette("maUsingGreybox", "greybox")

**Value**

The following list of values is returned:

- `value`: The value of the coefficient;
- `statistic`: The value of F-statistics associated with the parameter;
- `p.value`: The p-value of F-statistics associated with the parameter;
- `df.residual`: The number of degrees of freedom for the residuals;
- `df`: The number of degrees of freedom for the data.
ME

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

table, tableplot, spread, cramer, association

Examples

mcor(mtcars$am, mtcars$mpg)

Error measures

Description

Functions allow to calculate different types of errors for point and interval predictions:

1. ME - Mean Error,
2. MAE - Mean Absolute Error,
3. MSE - Mean Squared Error,
4. MRE - Mean Root Error (Kourentzes, 2014),
5. MIS - Mean Interval Score (Gneiting & Raftery, 2007),
6. MPE - Mean Percentage Error,
7. MAPE - Mean Absolute Percentage Error (See Svetunkov, 2017 for the critique),
8. MASE - Mean Absolute Scaled Error (Hyndman & Koehler, 2006),
9. RMSSE - Root Mean Squared Scaled Error (used in M5 Competition),
10. rMAE - Relative Mean Absolute Error (Davydenko & Fildes, 2013),
11. rRMSE - Relative Root Mean Squared Error,
12. rAME - Relative Absolute Mean Error,
13. rMIS - Relative Mean Interval Score,
14. sMSE - Scaled Mean Squared Error (Petropoulos & Kourentzes, 2015),
15. sPIS - Scaled Periods-In-Stock (Wallstrom & Segerstedt, 2010),
16. sCE - Scaled Cumulative Error,
17. sMIS - Scaled Mean Interval Score,
18. GMRAE - Geometric Mean Relative Absolute Error.
Usage

ME(holdout, forecast, na.rm = TRUE)
MAE(holdout, forecast, na.rm = TRUE)
MSE(holdout, forecast, na.rm = TRUE)
MRE(holdout, forecast, na.rm = TRUE)
MIS(holdout, lower, upper, level = 0.95, na.rm = TRUE)
MPE(holdout, forecast, na.rm = TRUE)
MAPE(holdout, forecast, na.rm = TRUE)
MASE(holdout, forecast, scale, na.rm = TRUE)
RMSSE(holdout, forecast, scale, na.rm = TRUE)
rMAE(holdout, forecast, benchmark, na.rm = TRUE)
rRMSE(holdout, forecast, benchmark, na.rm = TRUE)
rAME(holdout, forecast, benchmark, na.rm = TRUE)
rMIS(holdout, lower, upper, benchmarkLower, benchmarkUpper, level = 0.95, na.rm = TRUE)
sMSE(holdout, forecast, scale, na.rm = TRUE)
sPIS(holdout, forecast, scale, na.rm = TRUE)
sCE(holdout, forecast, scale, na.rm = TRUE)
sMIS(holdout, lower, upper, scale, level = 0.95, na.rm = TRUE)
GMRAE(holdout, forecast, benchmark, na.rm = TRUE)

Arguments

holdout The vector or matrix of holdout values.
forecast The vector or matrix of forecasts values.
na.rm Logical, defining whether to remove the NAs from the provided data or not.
lower The lower bound of the prediction interval.
upper The upper bound of the prediction interval.
level The confidence level of the constructed interval.
scale

The value that should be used in the denominator of MASE. Can be anything but advised values are: mean absolute deviation of in-sample one step ahead Naive error or mean absolute value of the in-sample actuals.

benchmark

The vector or matrix of the forecasts of the benchmark model.

benchmarkLower

The lower bound of the prediction interval of the benchmark model.

benchmarkUpper

The upper bound of the prediction interval of the benchmark model.

Details

In case of sMSE, scale needs to be a squared value. Typical one – squared mean value of in-sample actuals.

If all the measures are needed, then measures function can help.

There are several other measures, see details of pinball and hm.

Value

All the functions return the scalar value.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

References


See Also

pinball, hm, measures
Examples

```r
y <- rnorm(100, 10, 2)
testForecast <- rep(mean(y[1:90]), 10)

MAE(y[91:100], testForecast)
MSE(y[91:100], testForecast)
MPE(y[91:100], testForecast)
MAPE(y[91:100], testForecast)

# Measures from Petropoulos & Kourentzes (2015)
MASE(y[91:100], testForecast, mean(abs(y[1:90])))
sMSE(y[91:100], testForecast, mean(abs(y[1:90]))^2)
sPIS(y[91:100], testForecast, mean(abs(y[1:90])))
sCE(y[91:100], testForecast, mean(abs(y[1:90])))

# Original MASE from Hyndman & Koehler (2006)
MASE(y[91:100], testForecast, mean(abs(diff(y[1:90]))))

testForecast2 <- rep(y[91], 10)
# Relative measures, from and inspired by Davydenko & Fildes (2013)
rMAE(y[91:100], testForecast2, testForecast)
rRMSE(y[91:100], testForecast2, testForecast)
rAME(y[91:100], testForecast2, testForecast)
GMRAE(y[91:100], testForecast2, testForecast)

#### Measures for the prediction intervals

# An example with mtcars data
ourModel <- alm(mpg~., mtcars[1:30,], distribution="dnorm")
ourBenchmark <- alm(mpg~1, mtcars[1:30,], distribution="dnorm")

# Produce predictions with the interval
ourForecast <- predict(ourModel, mtcars[-c(1:30),], interval="p")
ourBenchmarkForecast <- predict(ourBenchmark, mtcars[-c(1:30),], interval="p")

MIS(mtcars$mpg[-c(1:30)], ourForecast$lower, ourForecast$upper, 0.95)
sMIS(mtcars$mpg[-c(1:30)], ourForecast$lower, ourForecast$upper, mean(mtcars$mpg[1:30]), 0.95)
rMIS(mtcars$mpg[-c(1:30)], ourForecast$lower, ourForecast$upper,
    ourBenchmarkForecast$lower, ourBenchmarkForecast$upper, 0.95)

### Also, see pinball function for other measures for the intervals
```

measures

Error measures for the provided forecasts
Description

Function calculates several error measures using the provided forecasts and the data for the holdout sample.

Usage

```r
measures(holdout, forecast, actual, digits = NULL, benchmark = c("naive", "mean"))
```

Arguments

- `holdout`: The vector of the holdout values.
- `forecast`: The vector of forecasts produced by a model.
- `actual`: The vector of actual in-sample values.
- `digits`: Number of digits of the output. If `NULL` then no rounding is done.
- `benchmark`: The character variable, defining what to use as benchmark for relative measures. Can be either "naive" or "mean" (arithmetic mean of the whole series). The latter can be useful when dealing with intermittent data.

Value

The functions returns the named vector of errors:

- ME,
- MAE,
- MSE
- MPE,
- MAPE,
- MASE,
- sMAE,
- RMSSE,
- sMSE,
- sCE,
- rMAE,
- rRMSE,
- rAME,
- asymmetry,
- sPIS.

For the details on these errors, see Errors.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>
References


Examples

```r
y <- rnorm(100,10,2)
ourForecast <- rep(mean(y[1:90]),10)
measures(y[91:100],ourForecast,y[1:90],digits=5)
```

<table>
<thead>
<tr>
<th>nparam</th>
<th>Number of parameters and number of variates in the model</th>
</tr>
</thead>
</table>

Description

`nparam()` returns the number of estimated parameters in the model, while `nvariate()` returns number of variates for the response variable.

Usage

```r
nparam(object, ...)
nvariate(object, ...)
```

Arguments

- `object` Time series model.
- `...` Some other parameters passed to the method.
Details

`nparam()` is a very basic and a simple function which does what it says: extracts number of estimated parameters in the model. `nvariate()` returns number of variates (dimensions, columns) for the response variable (1 for the univariate regression).

Value

Both functions return numeric values.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

`nobs`, `logLik`

Examples

```r
### Simple example
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
ourModel <- lm(y~.,data=as.data.frame(xreg))
nparam(ourModel)
nvariate(ourModel)
```

---

**Description**

Function detects outliers and creates a matrix with dummy variables. Only point outliers are considered (no level shifts).

**Usage**

```r
outlierdummy(object, level = 0.999, type = c("rstandard", "rstudent"), ...)
```

**Arguments**

- `object` Model estimated using one of the functions of smooth package.
- `level` Confidence level to use. Everything that is outside the constructed bounds based on that is flagged as outliers.
- `type` Type of residuals to use: either standardised or studentised.
- `...` Other parameters. Not used yet.
Details

The detection is done based on the type of distribution used and confidence level specified by user.

Value

The class "outlierdummy", which contains the list:

- **outliers** - the matrix with the dummy variables, flagging outliers;
- **statistic** - the value of the statistic for the normalised variable;
- **id** - the ids of the outliers (which observations have them);
- **level** - the confidence level used in the process;
- **type** - the type of the residuals used.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

influence.measures

Examples

```r
# Generate the data with S distribution
xreg <- cbind(rnorm(100,10,3), rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rs(100,0,3),xreg)
colnames(xreg) <- c("y", "x1", "x2")

# Fit the normal distribution model
ourModel <- alm(y~x1+x2, xreg, distribution="dnorm")

# Detect outliers
xregOutlierDummy <- outlierdummy(ourModel)
```

---

<table>
<thead>
<tr>
<th>pAIC</th>
<th>Point AIC</th>
</tr>
</thead>
</table>

Description

This function returns a vector of AIC values for the in-sample observations.
pAIC

Usage

pAIC(object, ...)

pAICc(object, ...)

pBIC(object, ...)

pBICc(object, ...)

Arguments

object   Time series model.
...      Some stuff.

Details

This is based on pointLik function. The formula for this is: $pAIC_t = 2 * k - 2 * T * l_t$, where $k$ is
the number of parameters, $T$ is the number of observations and $l_t$ is the point likelihood. This way
we preserve the property that AIC = mean(pAIC).

Value

The function returns the vector of point AIC values.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

pointLik

Examples

xreg <- cbind(rnorm(100,10,3), rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3), xreg, rnorm(100,300,10))
colnames(xreg) <- c("y", "x1", "x2", "Noise")
ourModel <- alm(y~x1+x2, as.data.frame(xreg))

pAICValues <- pAIC(ourModel)

mean(pAICValues)
AIC(ourModel)
**pcor**  

*Partial correlations*

**Description**

Function calculates partial correlations between the provided variables

**Usage**

```r
pcor(x, y = NULL, use = c("na.or.complete", "complete.obs", "everything", "all.obs"), method = c("pearson", "spearman", "kendall"))
```

**Arguments**

- `x`: Either data.frame or a matrix with numeric values.
- `y`: The numerical variable.
- `use`: What observations to use. See cor function for details. The only option that is not available here is "pairwise.complete.obs".
- `method`: Which method to use for the calculation of the partial correlations. This can be either Pearson’s, Spearman’s or Kendall’s coefficient. See cor for details.

**Details**

The calculation is done based on multiple linear regressions. The function calculates them for each pair of variables based on the residuals of linear models of those variables from the other variables in the dataset.

**Value**

The following list of values is returned:

- `value`: Matrix of the coefficients of partial correlations;
- `p.value`: The p-values for the parameters;
- `method`: The method used in the calculations.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**See Also**

mcor, cramer, association

**Examples**

```r
pcor(mtcars)
```
pinball

**Pinball function**

**Description**

The function returns the value from the pinball function for the specified level and the type of loss.

**Usage**

```r
pinball(holdout, forecast, level, loss = 1, na.rm = TRUE)
```

**Arguments**

- `holdout`  The vector or matrix of the holdout values.
- `forecast` The forecast of prediction interval (should be the same length as the holdout).
- `level`    The level of the prediction interval associated with the forecast.
- `loss`     The type of loss to use. The number which corresponds to L1, L2 etc.
- `na.rm`    Logical, defining whether to remove the NAs from the provided data or not.

**Value**

The function returns the scalar value.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**Examples**

```r
# An example with mtcars data
ourModel <- alm(mpg~., mtcars[1:30,], distribution="dnorm")

# Produce predictions with the interval
ourForecast <- predict(ourModel, mtcars[-c(1:30),], interval="p")

# Pinball with the L1 (quantile value)
pinball(mtcars$mpg[-c(1:30)],ourForecast$upper,level=0.975,loss=1)
pinball(mtcars$mpg[-c(1:30)],ourForecast$lower,level=0.025,loss=1)

# Pinball with the L2 (expectile value)
pinball(mtcars$mpg[-c(1:30)],ourForecast$upper,level=0.975,loss=2)
pinball(mtcars$mpg[-c(1:30)],ourForecast$lower,level=0.025,loss=2)
```
plot.greybox  

**Plots of the fit and residuals**

**Description**

The function produces diagnostics plots for a greybox model.

**Usage**

```r
## S3 method for class 'greybox'
plot(x, which = c(1, 2, 4, 6), level = 0.95,
     legend = FALSE, ask = prod(par("mfcol")) < length(which) &&
     dev.interactive(), lowess = TRUE, ...)
```

**Arguments**

- `x`: Estimated greybox model.
- `which`: Which of the plots to produce. The possible options (see details for explanations):
  1. Actuals vs Fitted values;
  2. Standardised residuals vs Fitted;
  3. Studentised residuals vs Fitted;
  4. Absolute residuals vs Fitted;
  5. Squared residuals vs Fitted;
  6. Q-Q plot with the specified distribution;
  7. Fitted over time;
  8. Standardised residuals vs Time;
  9. Studentised residuals vs Time;
  10. ACF of the residuals;
  11. PACF of the residuals;
  12. Cook’s distance over time with 0.5, 0.75 and 0.95 quantile lines from Fisher’s distribution;
  13. Absolute standardised residuals vs Fitted;
- `level`: Confidence level. Defines width of confidence interval. Used in plots (2), (3), (7), (8), (9), (10) and (11).
- `legend`: If TRUE, then the legend is produced on plots (2), (3) and (7).
- `ask`: Logical; if TRUE, the user is asked to press Enter before each plot.
- `lowess`: Logical; if TRUE, LOWESS lines are drawn on scatterplots, see `lowess`.
- `...`: The parameters passed to the plot functions. Recommended to use with separate plots.
Details

The list of produced plots includes:

1. Actuals vs Fitted values. Allows analysing, whether there are any issues in the fit. Does the variability of actuals increase with the increase of fitted values? Is the relation well captured? They grey line on the plot corresponds to the perfect fit of the model.

2. Standardised residuals vs Fitted. Plots the points and the confidence bounds (red lines) for the specified confidence level. Useful for the analysis of outliers;

3. Studentised residuals vs Fitted. This is similar to the previous plot, but with the residuals divided by the scales with the leave-one-out approach. Should be more sensitive to outliers;

4. Absolute residuals vs Fitted. Useful for the analysis of heteroscedasticity;

5. Squared residuals vs Fitted - similar to (3), but with squared values;

6. Q-Q plot with the specified distribution. Can be used in order to see if the residuals follow the assumed distribution. The type of distribution depends on the one used in the estimation (see distribution parameter in alm);

7. Fitted over time. Plots actuals (black line), fitted values (purple line) and prediction interval (red lines) of width level, but only in the case, when there are some values lying outside of it. Can be used in order to make sure that the model did not miss any important events over time;

8. Standardised residuals vs Time. Useful if you want to see, if there is autocorrelation or if there is heteroscedasticity in time. This also shows, when the outliers happen;

9. Studentised residuals vs Time. Similar to previous, but with studentised residuals;

10. ACF of the residuals. Are the residuals autocorrelated? See acf for details;

11. PACF of the residuals. No, really, are they autocorrelated? See pacf for details;

12. Cook’s distance over time. Shows influential observations. If a value is above 0.5, then this means that the observation influences the parameters of the model. This does not work well for non-normal distributions;

13. Absolute standardised residuals vs Fitted. Similar to the previous, but with absolute values. This is more relevant to the models where scale is calculated as an absolute value of something (e.g. Laplace);

14. Squared standardised residuals vs Fitted. This is an additional plot needed to diagnose heteroscedasticity in a model with varying scale. The variance on this plot will be constant if the adequate model for scale was constructed. This is more appropriate for normal and the related distributions.

Which of the plots to produce, is specified via the which parameter. The plots 2, 3, 7, 8 and 9 also use the parameters level, which specifies the confidence level for the intervals.

Value

The function produces the number of plots, specified in the parameter which.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>
Description

This function returns a vector of logarithms of likelihoods for each observation.

Usage

pointLik(object, ...)

Arguments

object      Time series model.
...         Some stuff.

Details

Instead of taking the expected log-likelihood for the whole series, this function calculates the individual value for each separate observation. Note that these values are biased, so you would possibly need to take number of degrees of freedom into account in order to have an unbiased estimator. This value is based on the general likelihood (not its concentrated version), so the sum of these values may slightly differ from the output of logLik.

Value

This function returns a vector.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>
**polyprod**

*This function calculates parameters for the polynomials*

**Description**

The function accepts two vectors with the parameters for the polynomials and returns the vector of parameters after their multiplication. This can be especially useful, when working with ARIMA models.

**Usage**

`polyprod(x, y)`

**Arguments**

- `x` The vector of parameters of the first polynomial.
- `y` The vector of parameters of the second polynomial.

**Value**

The function returns a matrix with one column with the parameters for the polynomial, starting from the 0-order.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>
See Also
  convolve

Examples

polyprod(c(-2,-1),c(1,0.5,0.3))

---

**predict.alm**  
Forecasting using greybox functions

Description

The functions allow producing forecasts based on the provided model and newdata.

Usage

```r
## S3 method for class 'alm'
predict(object, newdata = NULL, interval = c("none", "confidence", "prediction"), level = 0.95, side = c("both", "upper", "lower"), ...)

## S3 method for class 'greybox'
predict(object, newdata = NULL, interval = c("none", "confidence", "prediction"), level = 0.95, side = c("both", "upper", "lower"), ...)

## S3 method for class 'scale'
predict(object, newdata = NULL, interval = c("none", "confidence", "prediction"), level = 0.95, side = c("both", "upper", "lower"), ...)

## S3 method for class 'greybox'
forecast(object, newdata = NULL, h = NULL, ...)

## S3 method for class 'alm'
forecast(object, newdata = NULL, h = NULL, ...)
```

Arguments

- `object`: Time series model for which forecasts are required.
- `newdata`: The new data needed in order to produce forecasts.
- `interval`: Type of intervals to construct: either "confidence" or "prediction". Can be abbreviated.
- `level`: Confidence level. Defines width of prediction interval.
What type of interval to produce: "both" - produces both lower and upper bounds of the interval, "upper" - upper only, "lower" - respectively lower only. In the "both" case the probability is split into two parts: ((1-level)/2, (1+level)/2). When "upper" is specified, then the intervals for (0, level) are constructed. Finally, with "lower" the interval for (1-level, 1) is returned.

... Other arguments passed to vcov function (see coef.alm for details).

h The forecast horizon.

Details

predict produces predictions for the provided model and newdata. If newdata is not provided, then the data from the model is extracted and the fitted values are reproduced. This might be useful when confidence / prediction intervals are needed for the in-sample values.

forecast function produces forecasts for h steps ahead. There are four scenarios in this function:

1. If the newdata is not provided, then it will produce forecasts of the explanatory variables to the horizon h (using es from smooth package or using Naive if smooth is not installed) and use them as newdata.
2. If h and newdata are provided, then the number of rows to use will be regulated by h.
3. If h is NULL, then it is set equal to the number of rows in newdata.
4. If both h and newdata are not provided, then it will use the data from the model itself, reproducing the fitted values.

After forming the newdata the forecast function calls for predict, so you can provide parameters interval, level and side in the call for forecast.

Value

predict.greybox() returns object of class "predict.greybox", which contains:

- model - the estimated model.
- mean - the expected values.
- fitted - fitted values of the model.
- lower - lower bound of prediction / confidence intervals.
- upper - upper bound of prediction / confidence intervals.
- level - confidence level.
- newdata - the data provided in the call to the function.
- variances - conditional variance for the holdout sample. In case of interval="prediction" includes variance of the error.

predict.alm() is based on predict.greybox() and returns object of class "predict.alm", which in addition contains:

- location - the location parameter of the distribution.
- scale - the scale parameter of the distribution.
- distribution - name of the fitted distribution.

forecast() functions return the same "predict.alm" and "predict.greybox" classes, with the same set of output variables.
Description

RMCB stands for "Regression for Multiple Comparison with the Best", referring to the comparison of forecasting methods. This is a regression-based version of the Nemenyi / MCB test relies on the ranks of variables. This test is based on Nemenyi / MCB test (Demsar, 2006). It transforms the data into ranks and then constructs a regression on them of the type:

Usage

```r
rmcb(data, level = 0.95, outplot = c("mcb", "lines", "none"),
     select = NULL, ...)
```

## S3 method for class 'rmcb'
```r
plot(x, outplot = c("mcb", "lines"), select = NULL, ...)
```

Arguments

- `data` Matrix or data frame with observations in rows and variables in columns.
- `level` The width of the confidence interval. Default is 0.95.
What type of plot to use after the calculations. This can be either "MCB" ("mcb"), or "Vertical lines" ("lines"), or nothing ("none"). You can also use plot method on the produced object in order to get the same effect.

What column of data to highlight on the plot. If NULL, then the method with the lowest value is selected.

Other parameters passed to rank function.

The produced rmcb model.

Details

\[ y = b' X + e, \]

where \( y \) is the vector of the ranks of provided data (as.vector(data)), \( X \) is the matrix of dummy variables for each column of the data (forecasting method), \( b \) is the vector of coefficients for the dummies and \( e \) is the error term of the model. Given that the data is ranked, it test the differences in medians between the methods and then produces plots based on that.

There is also a plot() method that allows producing either "mcb" or "lines" style of plot. This can be regulated via plot(x,outplot="lines").

Value

If outplot!="none", then the function plots the results after all the calculations using plot.rmcb() function.

Function returns a list of a class "rmcb", which contains the following variables:

- **mean** Mean values for each method.
- **interval** Confidence intervals for each method.
- **vlines** Coordinates used for outplot="l", marking the groups of methods.
- **groups** The table containing the groups. TRUE - methods are in the same group, FALSE - they are not.
- **methods** Similar to group parameter, but with a slightly different presentation.
- **p.value** p-value for the test of the significance of the model. This is the value from the F test of the linear regression.
- **level** Confidence level.
- **modellm** model produced for the calculation of the intervals.
- **outplot** Style of the plot to produce.
- **select** The selected variable to highlight.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

References

Examples
N <- 50
M <- 4
ourData <- matrix(rnorm(N*M,mean=0,sd=1), N, M)
ourData[,2] <- ourData[,2]+4
ourData[,3] <- ourData[,3]+3
ourData[,4] <- ourData[,4]+2
colnames(ourData) <- c("Method A","Method B","Method C - long name","Method D")
ourTest <- rmcb(ourData, level=0.95)

# See the mean ranks:
ourTest$mean
# The same is for the intervals:
ourTest$interval

# You can also reproduce plots in different styles:
plot(ourTest, outplot="lines")

# Or you can use the default "mcb" style and set additional parameters for the plot():
par(mar=c(2,2,4,0)+0.1)
plot(ourTest, main="Four methods")

---

ro

Rolling Origin

Description
The function does rolling origin for any forecasting function

Usage
ro(data, h = 10, origins = 10, call, value = NULL, ci = FALSE,
co = TRUE, silent = TRUE, parallel = FALSE, ...)

Arguments
data Data vector or ts object with the response variable passed to the function.
h The forecasting horizon.
origins The number of rolling origins.
call The call that is passed to the function. The call must be in quotes. Example: "forecast(ets(data),h)". Here data shows where the data is and h defines where the horizon should be passed in the call. Some hidden parameters can also be specified in the call. For example, parameters counti, counto and countf are used in the inner loop and can be used for the regulation of exogenous variables sizes. See examples for the details.
value: The variable or set of variables returned by the call. For example, mean for functions of forecast package. This can also be a vector of variables. See examples for the details. If the parameter is NULL, then all the values from the call are returned (could be really messy!). Note that if your function returns a list with matrices, then ro will return an array. If your function returns a list, then you will have a list of lists in the end. So it makes sense to understand what you want to get before running the function.

ci: The parameter defines if the in-sample window size should be constant. If TRUE, then with each origin one observation is added at the end of series and another one is removed from the beginning.

c0: The parameter defines whether the holdout sample window size should be constant. If TRUE, the rolling origin will stop when less than h observations are left in the holdout.

silent: If TRUE, nothing is printed out in the console.

parallel: If TRUE, then the model fitting is done in parallel. WARNING! Packages foreach and either doMC (Linux and Mac only) or doParallel are needed in order to run the function in parallel.

Details

This function produces rolling origin forecasts using the data and a call passed as parameters. The function can do all of that either in serial or in parallel, but it needs foreach and either doMC (Linux only) or doParallel packages installed in order to do the latter. This is a dangerous function, so be careful with the call that you pass to it, and make sure that it is well formulated before the execution. Also, do not forget to provide the value that needs to be returned or you might end up with very messy results.

For more details and more examples of usage, please see vignette for the function. In order to do that, just run the command: vignette("ro","greybox")

Value

Function returns the following variables:

- actuals - the data provided to the function.
- holdout - the matrix of actual values corresponding to the produced forecasts from each origin.
- value - the matrices / array / lists with the produced data from each origin. Name of each object corresponds to the names in the parameter value.

Author(s)

Yves Sagaert
Ivan Svetunkov, <ivan@svertovk.ru>
References


Examples

```r
y <- rnorm(100,0,1)
ourCall <- "predict(arima(x=data,order=c(0,1,1)),n.ahead=h)"
# NOTE that the "data" needs to be used in the call, not "y".
# This way we tell the function, where "y" should be used in the call of the function.

# The default call and values
ourValue <- "pred"
ourRO <- ro(y, h=5, origins=5, ourCall, ourValue)

# We can now plot the results of this evaluation:
plot(ourRO)

# You can also use dollar sign
ourValue <- "$pred"
# And you can have constant in-sample size
ro(y, h=5, origins=5, ourCall, ourValue, ci=TRUE)

# You can ask for several values
ourValue <- c("pred","se")
# And you can have constant holdout size
ro(y, h=5, origins=20, ourCall, ourValue, ci=TRUE, co=TRUE)

#### The following code will give exactly the same result as above,
#### but computed in parallel using all but 1 core of CPU:
## Not run: ro(y, h=5, origins=20, ourCall, ourValue, ci=TRUE, co=TRUE, parallel=TRUE)

#### If you want to use functions from forecast package, please note that you need to
#### set the values that need to be returned explicitly. There are two options for this.
# Example 1:
## Not run: ourCall <- "forecast(ets(data), h=h, level=95)"
ourValue <- c("mean", "lower", "upper")
ro(y,h=5,origins=5,ourCall,ourValue)
## End(Not run)

# Example 2:
## Not run: ourCall <- "forecast(ets(data), h=h, level=c(80,95))"
ourValue <- c("mean", "lower[,1]", "upper[,1]", "lower[,2]", "upper[,2]")
ro(y,h=5,origins=5,ourCall,ourValue)
## End(Not run)

#### A more complicated example using the for loop and
#### several time series
x <- matrix(rnorm(120*3,0,1), 120, 3)

# Form an array for the forecasts we will produce
```
## We will have 4 origins with 6-steps ahead forecasts

ourForecasts <- array(NA, c(6, 4, 3))

## Define models that need to be used for each series

ourModels <- list(c(0, 1, 1), c(0, 0, 1), c(0, 1, 0))

## This call uses specific models for each time series

ourCall <- "predict(arima(data, order=ourModels[[i]]), n.ahead=h)"
ourValue <- "pred"

## Start the loop. The important thing here is to use the same variable 'i' as in ourCall.

for(i in 1:3){
  ourData <- x[, i]
  ourForecasts[, , i] <- ro(data=ourData, h=6, origins=4, call=ourCall,
                          value=ourValue, co=TRUE, silent=TRUE)$pred
}

## ourForecasts array now contains rolling origin forecasts from specific models.

##### An example with exogenous variables

x <- rnorm(100, 0, 1)
xreg <- matrix(rnorm(200, 0, 1), 100, 2, dimnames=list(NULL, c("x1", "x2")))

## 'counti' is used to define in-sample size of xreg,
## 'counto' - the size of the holdout sample of xreg

ourCall <- "predict(arima(x=data, order=c(0, 1, 1), xreg=xreg[counti,, drop=FALSE]),
                    n.ahead=h, newxreg=xreg[counto,, drop=FALSE])"
ourValue <- "pred"
ro(x, h=5, origins=5, ourCall, ourValue)

##### Poisson regression with alm

x <- rpois(100, 2)
xreg <- cbind(x, matrix(rnorm(200, 0, 1), 100, 2, dimnames=list(NULL, c("x1", "x2"))))

ourCall <- "predict(alm(x~., data=xreg[counti,, drop=FALSE], distribution="dpois"),
                    newdata=xreg[counto,, drop=FALSE])"
ourValue <- "mean"
testRO <- ro(xreg[, 1], h=5, origins=5, ourCall, ourValue, co=TRUE)
plot(testRO)

## 'countf' is used to take xreg of the size corresponding to the whole sample on each iteration
## This is useful when working with functions from smooth package.
The following call will return the forecasts from es() function of smooth.
## Not run: ourCall <- "es(data=data, h=h, xreg=xreg[countf,, drop=FALSE])"
ourValue <- "forecast"
ro(x, h=5, origins=5, ourCall, ourValue)
## End(Not run)
**sm**

*Scale Model*

**Description**

This method produces a model for scale of distribution for the provided pre-estimated model. The model can be estimated either via `lm` or `alm`.

**Usage**

```r
sm(model, formula = NULL, data = NULL, parameters = NULL, ...)
```

## Default S3 method:

```r
sm(model, formula = NULL, data = NULL, parameters = NULL, ...)
```

## S3 method for class 'lm'

```r
sm(model, formula = NULL, data = NULL, parameters = NULL, ...)
```

## S3 method for class 'alm'

```r
sm(model, formula = NULL, data = NULL, parameters = NULL, ...)
```

**Arguments**

- **model**
  - The pre-estimated alm or lm model.

- **formula**
  - The formula for scale. It should start with ~ and contain all variables that should impact the scale.

- **data**
  - The data, on which the scale model needs to be estimated. If not provided, then the one used in the model is used.

- **parameters**
  - The parameters to use in the model. Only needed if you know the parameters in advance or want to test yours.

- **...**
  - Other parameters to pass to the method, including those explained in alm (e.g. parameters for optimiser).

**Details**

This function is useful, when you suspect a heteroscedasticity in your model and want to fit a model for the scale of the pre-specified distribution. This function is complementary for `lm` or `alm`.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>
Examples

```r
xreg <- cbind(rnorm(100,10,3),rnorm(100,50,5))
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")

# Estimate the location model
ourModel <- alm(y~.,xreg)
# Estimate the scale model
ourScale <- sm(ourModel,formula=~x1+x2)
# Summary of the scale model
summary(ourScale)
```

---

**spread**

*Construct scatterplot / boxplots for the data*

**Description**

Function constructs the plots depending on the types of variables in the provided matrix / data frame.

**Usage**

```r
spread(data, histograms = FALSE, log = FALSE, lowess = FALSE, ...)
```

**Arguments**

- `data` Either matrix or data frame with the data.
- `histograms` If TRUE, then the histograms and barplots are produced on the diagonal of the matrix. Otherwise the names of the variables are written there.
- `log` If TRUE, then the logarithms of all numerical variables are taken.
- `lowess` If TRUE, then LOWESS lines are added to scatterplots and means are connected with lines on boxplots, see lowess for details.
- `...` Other parameters passed to the plot function. Currently only "main" parameter is accepted.

**Details**

If both variables are in metric scale, then the classical scatterplot is constructed. If one of them is either integer (up to 10 values) or categorical (aka 'factor'), then boxplots (with grey dots corresponding to mean values) are constructed. Finally, for the two categorical variables the tableplot is returned (see tableplot function for the details). All of this is packed in a matrix.

See details in the vignette "Marketing analytics with greybox": vignette("maUsingGreybox","greybox")
### Value

Function does not return anything. It just plots things.

### Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

### See Also

plot, table, tableplot

### Examples

```r
### Simple example
spread(mtcars)
spread(mtcars, log=TRUE)
```

---

### Description

Function selects variables that give linear regression with the lowest information criteria. The selection is done stepwise (forward) based on partial correlations. This should be a simpler and faster implementation than `step()` function from `stats` package.

### Usage

```r
stepwise(data, ic = c("AICc", "AIC", "BIC", "BICc"), silent = TRUE,
      df = NULL, method = c("pearson", "kendall", "spearman"),
      distribution = c("dnorm", "dlaplace", "ds", "dgnorm", "dlogis", "dt",
                     "dalaplace", "dlnorm", "dllaplace", "dls", "dlgnorm", "dbcnorm", "dfnorm",
                     "dinvgauss", "dgamma", "dpois", "dnbinom", "dlogtnorm", "plogis", "pnorm"),
      occurrence = c("none", "plogis", "pnorm"), ...)
```

### Arguments

- **data**: Data frame containing dependant variable in the first column and the others in the rest.
- **ic**: Information criterion to use.
- **silent**: If `silent=FALSE`, then nothing is silent, everything is printed out. `silent=TRUE` means that nothing is produced.
- **df**: Number of degrees of freedom to add (should be used if `stepwise` is used on residuals).
Method

Method of correlations calculation. The default is Pearson’s correlation, which should be applicable to a wide range of data in different scales.

distribution

Distribution to pass to \texttt{alm()}. See \texttt{alm} for details.

occurrence

what distribution to use for occurrence part. See \texttt{alm} for details.

... This is temporary and is needed in order to capture “silent” parameter if it is provided.

Details

The algorithm uses \texttt{alm()} to fit different models and \texttt{cor()} to select the next regressor in the sequence.

Some details and examples of application are also given in the vignette “Greybox”: \texttt{vignette(“greybox”, “greybox”)}

Value

Function returns \texttt{model} - the final model of the class "\texttt{alm}". See \texttt{alm} for details of the output.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

References


See Also

\texttt{step, xregExpander, lmCombine}

Examples

```r
### Simple example
xreg <- cbind(rnorm(100,10,3), rnorm(100,50,5))
xreg <- cbind(100 + 0.5 * xreg[,1] - 0.75 * xreg[,2] + rnorm(100,0,3), xreg, rnorm(100,300,10))
colnames(xreg) <- c("y","x1","x2","Noise")
stepwise(xreg)

### Mixture distribution of Log Normal and Cumulative Logit
xreg[,1] <- xreg[,1] * round(exp(xreg[,1]-70) / (1 + exp(xreg[,1]-70)),0)
colnames(xreg) <- c("y","x1","x2","Noise")
ourModel <- stepwise(xreg, distribution="dlnorm",
                      occurrence=stepwise(xreg, distribution="plogis"))
summary(ourModel)
```
### Fat regression example

```r
xreg <- matrix(rnorm(20000,10,3),100,200)
xreg <- cbind(100+0.5*xreg[,1]-0.75*xreg[,2]+rnorm(100,0,3),xreg,rnorm(100,300,10))
colnames(xreg) <- c("y",paste0("x",c(1:200)),"Noise")
ourModel <- stepwise(xreg,ic="AICc")
plot(ourModel$ICs,type="l",ylim=range(min(ourModel$ICs),max(ourModel$ICs)+5))
points(ourModel$ICs)
text(c(1:length(ourModel$ICs))+0.1,ourModel$ICs+5,names(ourModel$ICs))
```

---

**tableplot**

*Construct a plot for categorical variable*

**Description**

Function constructs a plot for two categorical variables based on table function

**Usage**

```r
tableplot(x, y = NULL, labels = TRUE, legend = FALSE, ...)
```

**Arguments**

- `x` First categorical variable. Can be either vector, factor, matrix or a data frame. If `y` is `NULL` and `x` is either matrix of a data frame, then the first two variables of the data will be plotted against each other.
- `y` Second categorical variable. If not provided, then only `x` will be plotted.
- `labels` Whether to print table labels inside the plot or not.
- `legend` If `TRUE`, then the legend for the tableplot is drawn. The plot is then produced on a separate canvas (new `par()`).
- `...` Other parameters passed to the plot function.

**Details**

The function produces the plot of the `table()` function with colour densities corresponding to the respective frequencies of appearance. If the value appears more often than the other (e.g. 0.5 vs 0.15), then it will be darker. The frequency of 0 corresponds to the white colour, the frequency of 1 corresponds to the black.

See details in the vignette "Marketing analytics with greybox": vignette("maUsingGreybox","greybox")

**Value**

Function does not return anything. It just plots things.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>
temporaldummy

See Also

plot, table, spread

Examples

tableplot(mtcars$am, mtcars$gear)

temporaldummy

Dummy variables for provided seasonality type

Description

Function generates the matrix of dummy variables for the months / weeks / days / hours / minutes / seconds of year / month / week / day / hour / minute.

Usage

temporaldummy(object, type = c("month", "quarter", "week", "day", "hour", "halfhour", "minute", "second"), of = c("year", "quarter", "month", "week", "day", "hour", "minute"), factors = FALSE, h = 0)

## Default S3 method:
temporaldummy(object, type = c("month", "quarter", "week", "day", "hour", "halfhour", "minute", "second"), of = c("year", "quarter", "month", "week", "day", "hour", "minute"), factors = FALSE, h = 0)

Arguments

object Either a ts / msts / zoo / xts / tsibble object or a vector of dates.

type Specifies what type of frequency to produce. For example, if type="month", then the matrix with dummies for months of the year will be created.

of Specifies the frequency of what is needed. Used together with type e.g. type="day" and of="month" will produce a matrix with dummies for days of month (31 dummies).

factors If TRUE, the function will return the categorical variable instead of the matrix with dummies.

h If not NULL, then the function will produce dummies for this set of observations ahead as well, binding them to the original matrix.
Details

The function extracts dates from the provided object and returns a matrix with dummy variables for the specified frequency type, with the number of rows equal to the length of the object + the specified horizon. If a numeric vector is provided then it will produce dummies based on typical values (e.g. 30 days in month). So it is recommended to use proper classes with this method.

Several notes on how the dummies are calculated in some special cases:

• In case of weeks of years, the first week is defined according to ISO 8601.

Note that not all the combinations of type and of are supported. For example, there is no such thing as dummies for months of week. Also note that some combinations are not very useful and would take a lot of memory (e.g. minutes of year).

The function will return all the dummy variables. If you want to avoid the dummy variables trap, you will need to exclude one of them manually.

If you want to have a different type of dummy variables, let me know, I will implement it.

Value

One of the two is returned, depending on the value of factors variable:

• factors=FALSE: Class "dgCMatrix" with all the dummy variables is returned in case of numeric variable. Feel free to drop one (making it a reference variable) or convert the object into matrix (this will consume more memory than the returned class). In other cases the object of the same class as the provided is returned.

• factors=TRUE: The categorical variable (factor) containing specific values for each observation.

Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

See Also

xregExpander, xregMultiplier, outlierdummy

Examples

# Generate matrix with dummies for a ts object
x <- ts(rnorm(100,100,1), frequency=12)
temporaldummy(x)

# Generate matrix with monthly dummies for a zoo object
x <- as.Date("2003-01-01")+0:99
temporaldummy(x, type="month", of="year", h=10)
**Description**

Function expands the provided matrix or vector of variables, producing values with lags and leads specified by `lags` variable.

**Usage**

```r
xregExpander(xreg, lags = c(-frequency(xreg):frequency(xreg)),
             silent = TRUE, gaps = c("auto", "NAs", "zero", "naive", "extrapolate"))
```

**Arguments**

- `xreg`: Vector / matrix / data.frame, containing variables that need to be expanded. In case of vector / matrix it is recommended to provide `ts` object, so the frequency of the data is taken into account.
- `lags`: Vector of lags / leads that we need to have. Negative values mean lags, positive ones mean leads.
- `silent`: If `silent=FALSE`, then the progress is printed out. Otherwise the function won’t print anything in the console.
- `gaps`: Defines how to fill in the gaps in the data. "NAs" will leave missing values, "zero" will substitute them by zeroes, "naive" will use the last / the first actual value, while "extrapolate" will use `es` function from smooth package (if present, otherwise - naive) in order to fill in values. Finally, "auto" will let the function select between "extrapolate" and "naive" depending on the length of series.

**Details**

This function could be handy when you want to check if lags and leads of a variable influence the dependent variable. Can be used together with `xregDo="select"` in `es, ces, gum` and `ssarima`. All the missing values in the beginning and at the end of lagged series are substituted by mean forecasts produced using `es`.

**Value**

A `ts` matrix with the expanded variables is returned.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**See Also**

`es`, `stepwise`
### xregMultiplier

**Exogenous variables cross-products**

#### Description

Function generates the cross-products of the provided exogenous variables.

#### Usage

```r
xregMultiplier(xreg, silent = TRUE)
```

#### Arguments

- `xreg`  
  matrix or data.frame, containing variables that need to be expanded. This matrix needs to contain at least two columns.

- `silent`  
  If `silent=False`, then the progress is printed out. Otherwise the function won’t print anything in the console.

#### Details

This function might be useful if you have several variables and want to introduce their cross-products. This might be useful when introducing the interactions between dummy and continuous variables.

#### Value

`ts` matrix with the transformed and the original variables is returned.

#### Author(s)

Ivan Svetunkov, <ivan@svetunkov.ru>

#### See Also

- `es`, `stepwise`, `xregExpander`, `xregTransformer`

#### Examples

```r
# Create matrix of two variables and expand it
x <- cbind(rnorm(100,100,1),rnorm(100,50,3))
x <- ts(x,frequency=12)
xregExpander(x)
```
**xregTransformer**

**Exogenous variables transformer**

**Description**

Function transforms each variable in the provided matrix or vector, producing non-linear values, depending on the selected pool of functions.

**Usage**

```r
xregTransformer(xreg, functions = c("log", "exp", "inv", "sqrt", "square"), silent = TRUE)
```

**Arguments**

- `xreg`: Vector / matrix / data.frame, containing variables that need to be expanded. In case of vector / matrix it is recommended to provide `ts` object, so the frequency of the data is taken into account.
- `functions`: Vector of names for functions used.
- `silent`: If silent=FALSE, then the progress is printed out. Otherwise the function won’t print anything in the console.

**Details**

This function could be useful when you want to automatically select the necessary transformations of the variables. This can be used together with `xregDo="select"` in `es, ces, gum` and `ssarima`. However, this might be dangerous, as it might lead to the overfitting the data. So be reasonable when you produce the transformed variables.

**Value**

`ts` matrix with the transformed and the original variables is returned.

**Author(s)**

Ivan Svetunkov, <ivan@svetunkov.ru>

**See Also**

`es, stepwise, xregExpander`

**Examples**

```r
# Create matrix of two variables and expand it
x <- cbind(rnorm(100,100,1),rnorm(100,50,3))
xregTransformer(x)
```
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