

Package ‘caretForecast’

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Title Conformal Time Series Forecasting Using State of Art Machine Learning Algorithms

Version 0.1.3

Description Conformal time series forecasting using the caret infrastructure.
It provides access to state-of-the-art machine learning models for forecasting applications. The hyperparameter of each model is selected based on time series cross-validation, and forecasting is done recursively.

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URL <https://taf-society.github.io/caretForecast/>,
<https://github.com/taf-society/caretForecast>

BugReports <https://github.com/taf-society/caretForecast/issues>

Depends R (>= 3.6)

Imports forecast (>= 8.15), caret (>= 6.0.88), magrittr (>= 2.0.1),
methods (>= 4.1.1), dplyr (>= 1.0.9), generics (>= 0.1.3)

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Author Resul Akay [aut, cre]

Maintainer Resul Akay <resul.akay@taf-society.org>

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ARml

Autoregressive forecasting using various Machine Learning models.

Description

Autoregressive forecasting using various Machine Learning models.

Usage

```
ARml(
  y,
  max_lag = 5,
  xreg = NULL,
  caret_method = "cubist",
  metric = "RMSE",
  pre_process = NULL,
  cv = TRUE,
  cv_horizon = 4,
  initial_window = NULL,
  fixed_window = FALSE,
  verbose = TRUE,
  seasonal = TRUE,
  K = frequency(y)/2,
  tune_grid = NULL,
  lambda = NULL,
  BoxCox_method = c("guerrero", "loglik"),
  BoxCox_lower = -1,
  BoxCox_upper = 2,
  BoxCox_biasadj = FALSE,
  BoxCox_fvar = NULL,
  allow_parallel = FALSE,
  calibrate = TRUE,
  calibration_horizon = NULL,
  n_cal_windows = NULL,
  ...
)
```

Arguments

<code>y</code>	A univariate time series object.
<code>max_lag</code>	Maximum value of lag.
<code>xreg</code>	Optional. A numerical vector or matrix of external regressors, which must have the same number of rows as <code>y</code> . (It should not be a data frame.).
<code>caret_method</code>	A string specifying which classification or regression model to use. Possible values are found using <code>names(getModelInfo())</code> . A list of functions can also be passed for a custom model function. See https://topepo.github.io/caret/ for details.
<code>metric</code>	A string that specifies what summary metric will be used to select the optimal model. See <code>?caret::train</code> .
<code>pre_process</code>	A string vector that defines a pre-processing of the predictor data. Current possibilities are "BoxCox", "YeoJohnson", "expoTrans", "center", "scale", "range", "knnImpute", "bagImpute", "medianImpute", "pca", "ica" and "spatialSign". The default is no pre-processing. See <code>preProcess</code> and <code>trainControl</code> on the procedures and how to adjust them. Pre-processing code is only designed to work when <code>x</code> is a simple matrix or data frame.
<code>cv</code>	Logical, if <code>cv = TRUE</code> model selection will be done via cross-validation. If <code>cv = FALSE</code> user need to provide a specific model via <code>tune_grid</code> argument.
<code>cv_horizon</code>	The number of consecutive values in test set sample.
<code>initial_window</code>	The initial number of consecutive values in each training set sample.
<code>fixed_window</code>	Logical, if <code>FALSE</code> , all training samples start at 1.
<code>verbose</code>	A logical for printing a training log.
<code>seasonal</code>	Boolean. If <code>seasonal = TRUE</code> the fourier terms will be used for modeling seasonality.
<code>K</code>	Maximum order(s) of Fourier terms
<code>tune_grid</code>	A data frame with possible tuning values. The columns are named the same as the tuning parameters. Use <code>getModelInfo</code> to get a list of tuning parameters for each model or see https://topepo.github.io/caret/available-models.html . (NOTE: If given, this argument must be named.)
<code>lambda</code>	BoxCox transformation parameter. If <code>lambda = NULL</code> If <code>lambda = "auto"</code> , then the transformation parameter <code>lambda</code> is chosen using <code>BoxCox.lambda</code> .
<code>BoxCox_method</code>	<code>BoxCox.lambda</code> argument. Choose method to be used in calculating <code>lambda</code> .
<code>BoxCox_lower</code>	<code>BoxCox.lambda</code> argument. Lower limit for possible <code>lambda</code> values.
<code>BoxCox_upper</code>	<code>BoxCox.lambda</code> argument. Upper limit for possible <code>lambda</code> values.
<code>BoxCox_biasadj</code>	<code>InvBoxCox</code> argument. Use adjusted back-transformed mean for Box-Cox transformations. If transformed data is used to produce forecasts and fitted values, a regular back transformation will result in median forecasts. If <code>biasadj</code> is <code>TRUE</code> , an adjustment will be made to produce mean forecasts and fitted values.
<code>BoxCox_fvar</code>	<code>InvBoxCox</code> argument. Optional parameter required if <code>biasadj=TRUE</code> . Can either be the forecast variance, or a list containing the interval level, and the corresponding upper and lower intervals.

<code>allow_parallel</code>	If a parallel backend is loaded and available, should the function use it?
<code>calibrate</code>	Logical. If TRUE, performs rolling-origin calibration to compute horizon-specific conformal prediction intervals. This produces properly calibrated intervals that widen with forecast horizon (trumpet shape). Default is TRUE.
<code>calibration_horizon</code>	Maximum forecast horizon for calibration. If NULL (default), uses $2 * \text{frequency}(y)$ for seasonal data or 10 for non-seasonal data.
<code>n_cal_windows</code>	Number of rolling windows for calibration. If NULL (default), automatically determined based on data length (max 50).
<code>...</code>	Ignored.

Value

A list class of forecast containing the following elements

- `x` : The input time series
- `method` : The name of the forecasting method as a character string
- `mean` : Point forecasts as a time series
- `lower` : Lower limits for prediction intervals
- `upper` : Upper limits for prediction intervals
- `level` : The confidence values associated with the prediction intervals
- `model` : A list containing information about the fitted model
- `newx` : A matrix containing regressors
- `calibration` : Horizon-specific conformal calibration scores (if `calibrate=TRUE`)

Author(s)

Resul Akay

Examples

```
library(caretForecast)

train_data <- window(AirPassengers, end = c(1959, 12))

test <- window(AirPassengers, start = c(1960, 1))

ARml(train_data, caret_method = "lm", max_lag = 12) -> fit

forecast(fit, h = length(test)) -> fc

autoplot(fc) + autolayer(test)

accuracy(fc, test)
```

conformalRegressor	<i>Fit a conformal regressor.</i>
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Description

Fit a conformal regressor.

Usage

```
conformalRegressor(residuals, sigmas = NULL)
```

Arguments

residuals	Model residuals.
sigmas	A vector of difficulty estimates

Value

A conformalRegressor object

Author(s)

Resul Akay

References

Boström, H., 2022. crepes: a Python Package for Generating Conformal Regressors and Predictive Systems. In Conformal and Probabilistic Prediction and Applications. PMLR, 179.

conformalRegressorByHorizon	<i>Fit a horizon-specific conformal regressor for time series forecasting.</i>
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Description

This function creates a conformal regressor that accounts for increasing uncertainty at longer forecast horizons. It uses separate nonconformity score distributions for each horizon $h=1,2,3,\dots$, resulting in prediction intervals that naturally widen as the forecast horizon increases (trumpet-shaped intervals).

Usage

```
conformalRegressorByHorizon(horizon_errors)
```

Arguments

`horizon_errors` A named list where each element contains sorted absolute errors for that horizon. Names should be "h1", "h2", etc. This is typically produced by `calibrate_horizon_scores()`.

Value

A `conformalRegressorByHorizon` object containing:

`alphas_by_horizon` List of sorted nonconformity scores for each horizon

`max_horizon` Maximum calibrated horizon

`n_samples` Number of calibration samples per horizon

Author(s)

Resul Akay

References

Boström, H., 2022. crepes: a Python Package for Generating Conformal Regressors and Predictive Systems. In *Conformal and Probabilistic Prediction and Applications*. PMLR, 179.

Stankeviciute, K., Alaa, A. M., & van der Schaar, M., 2021. Conformal Time-series Forecasting. *NeurIPS 2021*.

forecast.ARml	<i>Forecasting using ARml model</i>
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Description

Forecasting using ARml model

Usage

```
## S3 method for class 'ARml'
forecast(object, h = frequency(object$y), xreg = NULL, level = c(80, 95), ...)
```

Arguments

`object` An object of class "ARml", the result of a call to `ARml`.

`h` forecast horizon

`xreg` Optionally, a numerical vector or matrix of future external regressors

`level` Confidence level for prediction intervals.

`...` Ignored

Value

A list class of forecast containing the following elements

- x : The input time series
- method : The name of the forecasting method as a character string
- mean : Point forecasts as a time series
- lower : Lower limits for prediction intervals
- upper : Upper limits for prediction intervals
- level : The confidence values associated with the prediction intervals
- model : A list containing information about the fitted model
- newxreg : A matrix containing regressors

Author(s)

Resul Akay

Examples

```
library(caretForecast)

train_data <- window(AirPassengers, end = c(1959, 12))

test <- window(AirPassengers, start = c(1960, 1))

ARml(train_data, caret_method = "lm", max_lag = 12) -> fit

forecast(fit, h = length(test), level = c(80,95)) -> fc

autoplot(fc)+ autolayer(test)

accuracy(fc, test)
```

get_var_imp	<i>Variable importance for forecasting model.</i>
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Description

Variable importance for forecasting model.

Usage

```
get_var_imp(object, plot = TRUE)
```

Arguments

object	A list class of ARml or forecast object derived from ARml
plot	Boolean, if TRUE, variable importance will be plotted.

Value

A list class of "varImp.train". See [varImp](#) or a "trellis" plot.

Author(s)

Resul Akay

Examples

```
train <- window(AirPassengers, end = c(1959, 12))

test <- window(AirPassengers, start = c(1960, 1))

ARml(train, caret_method = "lm", max_lag = 12,
pre_process = "center") -> fit

forecast(fit, h = length(test), level = c(80,95)) -> fc

autoplot(fc)+ autolayer(test)

accuracy(fc, test)

get_var_imp(fc, plot = TRUE)
```

`predict.conformalRegressor`*Predict a conformalRegressor*

Description

Predict a conformalRegressor

Usage

```
## S3 method for class 'conformalRegressor'
predict(
  object,
  y_hat = NULL,
  sigmas = NULL,
  confidence = 0.95,
  y_min = -Inf,
  y_max = Inf,
  ...
)
```


Arguments

object	A conformalRegressor object
y_hat	Predicted values
sigmas	Difficulty estimates
confidence	Confidence level
y_min	The minimum value to include in prediction intervals
y_max	The maximum value to include in prediction intervals
...	Ignored

Value

Prediction intervals

Author(s)

Resul Akay

predict.conformalRegressorByHorizon

Predict intervals from a horizon-specific conformal regressor

Description

This function generates prediction intervals that account for increasing uncertainty at longer forecast horizons. Each horizon h uses its own calibrated nonconformity score distribution, resulting in trumpet-shaped prediction intervals.

Usage

```
## S3 method for class 'conformalRegressorByHorizon'
predict(
  object,
  y_hat = NULL,
  confidence = 0.95,
  y_min = -Inf,
  y_max = Inf,
  ...
)
```

Arguments

object	A conformalRegressorByHorizon object
y_hat	Predicted values (one per horizon)
confidence	Confidence level(s) between 0 and 1 (e.g., 0.95 for 95 percent)
y_min	The minimum value to include in prediction intervals
y_max	The maximum value to include in prediction intervals
...	Ignored

Value

A data frame with lower and upper bounds for each confidence level

Author(s)

Resul Akay

retail	<i>Grouped sales data from an Australian Retailer</i>
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Description

A dataset containing 42 products' sales

Usage

retail

Format

A data class of "tbl_df", "tbl", "data.frame" with 13986 rows and 3 columns:

- date** date
- item** products
- value** sales

Source

<https://robjhyndman.com/data/ausretail.csv>

retail_wide	<i>Sales data from an Australian Retailer in time series format</i>
-------------	---

Description

A dataset containing 42 products' sales

Usage

retail_wide

Format

An object of class mts (inherits from ts, matrix) with 333 rows and 43 columns.
This data set is the wide format of [retail](#) data.

Source

<https://robjhyndman.com/data/ausretail.csv>

split_ts	<i>Split a time series into training and testing sets</i>
----------	---

Description

Split a time series into training and testing sets

Usage

```
split_ts(y, test_size = 10)
```

Arguments

y	A univariate time series
test_size	The number of observations to keep in the test set

Value

A list with train and test elements

Author(s)

Resul Akay

Examples

```
dlist <- split_ts(retail_wide[,1], test_size = 12)
```

suggested_methods	<i>Suggested methods for ARml</i>
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Description

Suggested methods for ARml

Usage

```
suggested_methods()
```

Value

A character vector of Suggested methods

Author(s)

Resul Akay

Examples

```
suggested_methods()
```

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