

Package ‘modeltime.ensemble’

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Type Package

Title Ensemble Algorithms for Time Series Forecasting with Modeltime

Version 0.3.0

Description A 'modeltime' extension that implements time series ensemble forecasting methods including model averaging, weighted averaging, and stacking. These techniques are popular methods to improve forecast accuracy and stability. Refer to papers such as ``Machine-Learning Models for Sales Time Series Forecasting" Pavlyshenko, B.M. (2019) <doi:10.3390>.

URL <https://github.com/business-science/modeltime.ensemble>

BugReports <https://github.com/business-science/modeltime.ensemble/issues>

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LazyData true

Depends modeltime (>= 0.3.0), modeltime.resample (>= 0.1.0), R (>= 3.5)

Imports tune, rsample, yardstick, workflows, parsnip, recipes, dials, timetk (>= 2.5.0), tibble, dplyr (>= 1.0.0), tidyr, purrr, glue, stringr, rlang (>= 0.1.2), cli, crayon, utils, generics, magrittr, glmnet, progressr, tictoc

Suggests roxygen2, testthat, tidymodels, xgboost, tidyverse, lubridate, knitr, rmarkdown, covr, remotes

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ensemble_average	<i>Creates an Ensemble Model using Mean/Median Averaging</i>
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Description

Creates an Ensemble Model using Mean/Median Averaging

Usage

```
ensemble_average(object, type = c("mean", "median"))
```

Arguments

object	A Modeltime Table
type	Specify the type of average ("mean" or "median")

Details

The input to an `ensemble_average()` model is always a Modeltime Table, which contains the models that you will ensemble.

Averaging Methods

The average method uses an un-weighted average using type of either:

- "mean": Performs averaging using `mean(x, na.rm = TRUE)` to aggregate each underlying models forecast at each timestamp
- "median": Performs averaging using `stats::median(x, na.rm = TRUE)` to aggregate each underlying models forecast at each timestamp

Value

A `mdl_time_ensemble` object.

Examples

```
library(tidymodels)
library(modeltime)
library(modeltime.ensemble)
library(tidyverse)
library(timetk)

# Make an ensemble from a Modeltime Table
ensemble_fit <- m750_models %>%
  ensemble_average(type = "mean")

ensemble_fit

# Forecast with the Ensemble
modeltime_table(
  ensemble_fit
) %>%
  modeltime_forecast(
    new_data = testing(m750_splits),
    actual_data = m750
  ) %>%
  plot_modeltime_forecast(
    .interactive = FALSE,
    .conf_interval_show = FALSE
  )
```

ensemble_model_spec *Creates a Stacked Ensemble Model from a Model Spec*

Description

A 2-stage stacking regressor that follows:

1. Stage 1: Sub-Model's are Trained & Predicted using `modeltime.resample::modeltime_fit_resamples()`.
2. Stage 2: A Meta-learner (`model_spec`) is trained on Out-of-Sample Sub-Model Predictions using `ensemble_model_spec()`.

Usage

```
ensemble_model_spec(
  object,
  model_spec,
  kfolds = 5,
  param_info = NULL,
  grid = 6,
  control = control_grid()
)
```

Arguments

object	A Modeltime Table. Used for ensemble sub-models.
model_spec	A model_spec object defining the meta-learner stacking model specification to be used. Can be either: <ol style="list-style-type: none"> 1. A non-tunable model_spec: Parameters are specified and are not optimized via tuning. 2. A tunable model_spec: Contains parameters identified for tuning with <code>tune::tune()</code>
kfolds	K-Fold Cross Validation for tuning the Meta-Learner. Controls the number of folds used in the meta-learner's cross-validation. Gets passed to <code>rsample::vfold_cv()</code> .
param_info	A <code>dials::parameters()</code> object or NULL. If none is given, a parameters set is derived from other arguments. Passing this argument can be useful when parameter ranges need to be customized.
grid	Grid specification or grid size for tuning the Meta Learner. Gets passed to <code>tune::tune_grid()</code> .
control	An object used to modify the tuning process. Uses <code>tune::control_grid()</code> by default. Use <code>control_grid(verbose = TRUE)</code> to follow the training process.

Details**Stacked Ensemble Process**

- Start with a *Modeltime Table* to define your sub-models.
- Step 1: Use `modeltime_fit_resamples()` to perform the submodel resampling procedure.
- Step 2: Use `ensemble_model_spec()` to define and train the meta-learner.

What goes on inside the Meta Learner?

The Meta-Learner Ensembling Process uses the following basic steps:

1. **Make Cross-Validation Predictions.** Cross validation predictions are made for each sub-model with `modeltime_fit_resamples()`. The out-of-sample sub-model predictions contained in `.resample_results` are used as the input to the meta-learner.
2. **Train a Stacked Regressor (Meta-Learner).** The sub-model out-of-sample cross validation predictions are then modeled using a `model_spec` with options:
 - **Tuning:** If the `model_spec` does include tuning parameters via `tune::tune()` then the meta-learner will be hyperparameter tuned using K-Fold Cross Validation. The parameters and grid can adjusted using `kfolds`, `grid`, and `param_info`.
 - **No-Tuning:** If the `model_spec` does *not* include tuning parameters via `tune::tune()` then the meta-learner will not be hyperparameter tuned and will have the model fitted to the sub-model predictions.
3. **Final Model Selection.**
 - **If tuned,** the final model is selected based on RMSE, then retrained on the full set of out of sample predictions.
 - **If not-tuned,** the fitted model from Stage 2 is used.

Progress

The best way to follow the training process and watch progress is to use `control = control_grid(verbose = TRUE)` to see progress.

Parallelize

Portions of the process can be parallelized. To parallelize, set up parallelization using `tune` via one of the backends such as `doFuture`. Then set `control = control_grid(allow_par = TRUE)`

Value

A `mdl_time_ensemble` object.

Examples

```
library(tidymodels)
library(modeltime)
library(modeltime.ensemble)
library(tidyverse)
library(timetk)

# Step 1: Make resample predictions for submodels
resamples_tscv <- training(m750_splits) %>%
  time_series_cv(
    assess = "2 years",
    initial = "5 years",
    skip = "2 years",
    slice_limit = 1
  )

submodel_predictions <- m750_models %>%
  modeltime_fit_resamples(
    resamples = resamples_tscv,
    control = control_resamples(verbose = TRUE)
  )

# Step 2: Metalearner ----

# * No Metalearner Tuning
ensemble_fit_lm <- submodel_predictions %>%
  ensemble_model_spec(
    model_spec = linear_reg() %>% set_engine("lm"),
    control = control_grid(verbose = TRUE)
  )

ensemble_fit_lm

# * With Metalearner Tuning ----
ensemble_fit_glmnet <- submodel_predictions %>%
  ensemble_model_spec(
    model_spec = linear_reg(
      penalty = tune(),
```

```

      mixture = tune()
    ) %>%
      set_engine("glmnet"),
      grid      = 2,
      control   = control_grid(verbose = TRUE)
    )
ensemble_fit_glmnet

```

ensemble_weighted	<i>Creates a Weighted Ensemble Model</i>
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Description

Makes an ensemble by applying loadings to weight sub-model predictions

Usage

```
ensemble_weighted(object, loadings, scale_loadings = TRUE)
```

Arguments

object	A Modeltime Table
loadings	A vector of weights corresponding to the loadings
scale_loadings	If TRUE, divides by the sum of the loadings to proportionally weight the sub-models.

Details

The input to an ensemble_weighted() model is always a Modeltime Table, which contains the models that you will ensemble.

Weighting Method

The weighted method uses uses loadings by applying a *loading x model prediction* for each sub-model.

Value

A mdl_time_ensemble object.

Examples

```
library(tidymodels)
library(modeltime)
library(modeltime.ensemble)
library(tidyverse)
library(timetk)

# Make an ensemble from a Modeltime Table
ensemble_fit <- m750_models %>%
  ensemble_weighted(
    loadings = c(3, 3, 1),
    scale_loadings = TRUE
  )

ensemble_fit

# Forecast with the Ensemble
modeltime_table(
  ensemble_fit
) %>%
  modeltime_forecast(
    new_data = testing(m750_splits),
    actual_data = m750
  ) %>%
  plot_modeltime_forecast(
    .interactive = FALSE,
    .conf_interval_show = FALSE
  )
```

type_sum.mdl_time_ensemble

Succinct summary of Modeltime Tables

Description

type_sum controls how objects are shown when inside tibble columns.

Usage

```
## S3 method for class 'mdl_time_ensemble'
type_sum(x)
```

Arguments

x A mdl_time_ensemble object to summarise.

Value

A character value.

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