

# Package ‘modeltime’

October 18, 2021

**Title** The Tidymodels Extension for Time Series Modeling

**Version** 1.1.0

**Description** The time series forecasting framework for use with the 'tidymodels' ecosystem. Models include ARIMA, Exponential Smoothing, and additional time series models from the 'forecast' and 'prophet' packages. Refer to ``Forecasting Principles & Practice, Second edition''

(<https://otexts.com/fpp2/>).

Refer to ``Prophet: forecasting at scale''

(<https://research.fb.com/blog/2017/02/prophet-forecasting-at-scale/>).

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

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

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*.prepare\_transform*      *Prepare Recursive Transformations*

---

**Description**

Prepare Recursive Transformations

**Usage**

```
.prepare_transform(.transform)
.prepare_panel_transform(.transform)
```

**Arguments**

*.transform*      A transformation function

**Value**

A function that applies a recursive transformation

adam\_fit\_impl

*Low-Level ADAM function for translating modeltime to forecast***Description**

Low-Level ADAM function for translating modeltime to forecast

**Usage**

```
adam_fit_impl(
  x,
  y,
  period = "auto",
  p = 0,
  d = 0,
  q = 0,
  P = 0,
  D = 0,
  Q = 0,
  model = "ZXZ",
  constant = FALSE,
  regressors = c("use", "select", "adapt"),
  outliers = c("ignore", "use", "select"),
  level = 0.99,
  occurrence = c("none", "auto", "fixed", "general", "odds-ratio",
    "inverse-odds-ratio", "direct"),
  distribution = c("default", "dnorm", "dlaplace", "ds", "dgnorm", "dlnorm",
    "dinvgauss", "dgamma"),
  loss = c("likelihood", "MSE", "MAE", "HAM", "LASSO", "RIDGE", "MSEh", "TMSE",
    "GTMSE", "MSCE"),
  ic = c("AICc", "AIC", "BIC", "BICc"),
  select_order = FALSE,
  ...
)
```

**Arguments**

x	A data.frame of predictors
y	A vector with outcome
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
p	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.
d	The order of integration for non-seasonal differencing. Often denoted "d" in pdq-notation.

q	The order of the non-seasonal moving average (MA) terms. Often denoted "q" in pdq-notation.
P	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
D	The order of integration for seasonal differencing. Often denoted "D" in PDQ-notation.
Q	The order of the seasonal moving average (SMA) terms. Often denoted "Q" in PDQ-notation.
model	The type of ETS model.
constant	Logical, determining, whether the constant is needed in the model or not.
regressors	The variable defines what to do with the provided explanatory variables.
outliers	Defines what to do with outliers.
level	What confidence level to use for detection of outliers.
occurrence	The type of model used in probability estimation.
distribution	what density function to assume for the error term.
loss	The type of Loss Function used in optimization.
ic	The information criterion to use in the model selection / combination procedure.
select_order	If TRUE, then the function will select the most appropriate order using a mechanism similar to auto.msarima(), but implemented in auto.adam(). The values list(ar=...,i=...,ma=...) specify the maximum orders to check in this case
...	Additional arguments passed to smooth: : adam

---

adam\_params

*Tuning Parameters for ADAM Models*


---

## Description

Tuning Parameters for ADAM Models

## Usage

```

use_constant(values = c(FALSE, TRUE))

regressors_treatment(values = c("use", "select", "adapt"))

outliers_treatment(values = c("ignore", "use", "select"))

probability_model(
  values = c("none", "auto", "fixed", "general", "odds-ratio", "inverse-odds-ratio",
            "direct")
)

distribution(

```

```

  values = c("default", "dnorm", "dlaplace", "ds", "dgnorm", "dlnorm", "dinvgauss",
            "dgamma")
)

information_criteria(values = c("AICc", "AIC", "BICc", "BIC"))

select_order(values = c(FALSE, TRUE))

```

### Arguments

values            A character string of possible values.

### Details

The main parameters for ADAM models are:

- non\_seasonal\_ar: The order of the non-seasonal auto-regressive (AR) terms.
- non\_seasonal\_differences: The order of integration for non-seasonal differencing.
- non\_seasonal\_ma: The order of the non-seasonal moving average (MA) terms.
- seasonal\_ar: The order of the seasonal auto-regressive (SAR) terms.
- seasonal\_differences: The order of integration for seasonal differencing.
- seasonal\_ma: The order of the seasonal moving average (SMA) terms.
- use\_constant: Logical, determining, whether the constant is needed in the model or not.
- regressors\_treatment: The variable defines what to do with the provided explanatory variables.
- outliers\_treatment: Defines what to do with outliers.
- probability\_model: The type of model used in probability estimation.
- distribution: What density function to assume for the error term.
- information\_criteria: The information criterion to use in the model selection / combination procedure.
- select\_order: If TRUE, then the function will select the most appropriate order.

### Value

A dials parameter

A parameter

A parameter

A parameter

A parameter

A parameter

A parameter

A parameter

**Examples**

```

use_constant()

regressors_treatment()

distribution()

```

---

Adam_predict_impl	<i>Bridge prediction function for ADAM models</i>
-------------------	---

---

**Description**

Bridge prediction function for ADAM models

**Usage**

```
Adam_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>smooth::adam()</code>

---

adam_reg	<i>General Interface for ADAM Regression Models</i>
----------	---

---

**Description**

`adam_reg()` is a way to generate a *specification* of an ADAM model before fitting and allows the model to be created using different packages. Currently the only package is `smooth`.

**Usage**

```

adam_reg(
  mode = "regression",
  ets_model = NULL,
  non_seasonal_ar = NULL,
  non_seasonal_differences = NULL,
  non_seasonal_ma = NULL,
  seasonal_ar = NULL,
  seasonal_differences = NULL,
  seasonal_ma = NULL,

```



```

    use_constant = NULL,
    regressors_treatment = NULL,
    outliers_treatment = NULL,
    outliers_ci = NULL,
    probability_model = NULL,
    distribution = NULL,
    loss = NULL,
    information_criteria = NULL,
    seasonal_period = NULL,
    select_order = NULL
)

```

### Arguments

mode	A single character string for the type of model. The only possible value for this model is "regression".
ets_model	The type of ETS model. The first letter stands for the type of the error term ("A" or "M"), the second (and sometimes the third as well) is for the trend ("N", "A", "Ad", "M" or "Md"), and the last one is for the type of seasonality ("N", "A" or "M").
non_seasonal_ar	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.
non_seasonal_differences	The order of integration for non-seasonal differencing. Often denoted "d" in pdq-notation.
non_seasonal_ma	The order of the non-seasonal moving average (MA) terms. Often denoted "q" in pdq-notation.
seasonal_ar	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
seasonal_differences	The order of integration for seasonal differencing. Often denoted "D" in PDQ-notation.
seasonal_ma	The order of the seasonal moving average (SMA) terms. Often denoted "Q" in PDQ-notation.
use_constant	Logical, determining, whether the constant is needed in the model or not. This is mainly needed for ARIMA part of the model, but can be used for ETS as well.
regressors_treatment	The variable defines what to do with the provided explanatory variables: "use" means that all of the data should be used, while "select" means that a selection using ic should be done, "adapt" will trigger the mechanism of time varying parameters for the explanatory variables.
outliers_treatment	Defines what to do with outliers: "ignore", so just returning the model, "detect" outliers based on specified level and include dummies for them in the model, or detect and "select" those of them that reduce ic value.

outliers_ci	What confidence level to use for detection of outliers. Default is 99%.
probability_model	The type of model used in probability estimation. Can be "none" - none, "fixed" - constant probability, "general" - the general Beta model with two parameters, "odds-ratio" - the Odds-ratio model with $b=1$ in Beta distribution, "inverse-odds-ratio" - the model with $a=1$ in Beta distribution, "direct" - the TSB-like (Teunter et al., 2011) probability update mechanism $a+b=1$ , "auto" - the automatically selected type of occurrence model.
distribution	what density function to assume for the error term. The full name of the distribution should be provided, starting with the letter "d" - "density".
loss	The type of Loss Function used in optimization.
information_criteria	The information criterion to use in the model selection / combination procedure.
seasonal_period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.
select_order	If TRUE, then the function will select the most appropriate order. The values <code>list(ar=...,i=...,ma=...)</code> specify the maximum orders to check in this case.

## Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `adam_reg()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "auto\_adam" (default) - Connects to `smooth::auto.adam()`
- "adam" - Connects to `smooth::adam()`

## Main Arguments

The main arguments (tuning parameters) for the model are:

- `seasonal_period`: The periodic nature of the seasonality. Uses "auto" by default.
- `non_seasonal_ar`: The order of the non-seasonal auto-regressive (AR) terms.
- `non_seasonal_differences`: The order of integration for non-seasonal differencing.
- `non_seasonal_ma`: The order of the non-seasonal moving average (MA) terms.
- `seasonal_ar`: The order of the seasonal auto-regressive (SAR) terms.
- `seasonal_differences`: The order of integration for seasonal differencing.
- `seasonal_ma`: The order of the seasonal moving average (SMA) terms.
- `ets_model`: The type of ETS model.
- `use_constant`: Logical, determining, whether the constant is needed in the model or not.
- `regressors_treatment`: The variable defines what to do with the provided explanatory variables.
- `outliers_treatment`: Defines what to do with outliers.

- `probability_model`: The type of model used in probability estimation.
- `distribution`: what density function to assume for the error term.
- `loss`: The type of Loss Function used in optimization.
- `information_criteria`: The information criterion to use in the model selection / combination procedure.

These arguments are converted to their specific names at the time that the model is fit.

Other options and argument can be set using `set_engine()` (See Engine Details below).

If parameters need to be modified, `update()` can be used in lieu of recreating the object from scratch.

### **auto\_adam (default engine)**

The engine uses `smooth::auto.adam()`.

Function Parameters:

```
## Registered S3 method overwritten by 'greybox':
##   method      from
##   print.pcor lava

## function (data, model = "ZXZ", lags = c(frequency(data)), orders = list(ar = c(0),
##   i = c(0), ma = c(0), select = FALSE), formula = NULL, outliers = c("ignore",
##   "use", "select"), level = 0.99, distribution = c("dnorm", "dlaplace",
##   "ds", "dgnorm", "dlnorm", "dinvgauss", "dgamma"), h = 0, holdout = FALSE,
##   persistence = NULL, phi = NULL, initial = c("optimal", "backcasting"),
##   arma = NULL, occurrence = c("none", "auto", "fixed", "general", "odds-ratio",
##   "inverse-odds-ratio", "direct"), ic = c("AICc", "AIC", "BIC", "BICc"),
##   bounds = c("usual", "admissible", "none"), regressors = c("use", "select",
##   "adapt"), silent = TRUE, parallel = FALSE, ...)
```

The *MAXIMUM* nonseasonal ARIMA terms (`max.p`, `max.d`, `max.q`) and seasonal ARIMA terms (`max.P`, `max.D`, `max.Q`) are provided to `forecast::auto.arima()` via `arma_reg()` parameters. Other options and argument can be set using `set_engine()`.

Parameter Notes:

- All values of nonseasonal `pdq` and seasonal `PDQ` are maximums. The `smooth::auto.adam()` model will select a value using these as an upper limit.
- `xreg` - This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).

### **adam**

The engine uses `smooth::adam()`.

Function Parameters:

```
## function (data, model = "ZXZ", lags = c(frequency(data)), orders = list(ar = c(0),
##   i = c(0), ma = c(0), select = FALSE), constant = FALSE, formula = NULL,
##   regressors = c("use", "select", "adapt"), outliers = c("ignore", "use",
##   "select"), level = 0.99, occurrence = c("none", "auto", "fixed",
```

```
##      "general", "odds-ratio", "inverse-odds-ratio", "direct"), distribution = c("default",
##      "dnorm", "dlaplace", "ds", "dgnorm", "dlnorm", "dinvgauss", "dgamma"),
##      loss = c("likelihood", "MSE", "MAE", "HAM", "LASSO", "RIDGE", "MSEh",
##      "TMSE", "GTMSE", "MSCE"), h = 0, holdout = FALSE, persistence = NULL,
##      phi = NULL, initial = c("optimal", "backcasting"), arma = NULL, ic = c("AICc",
##      "AIC", "BIC", "BICc"), bounds = c("usual", "admissible", "none"),
##      silent = TRUE, ...)
```

The nonseasonal ARIMA terms (orders) and seasonal ARIMA terms (orders) are provided to `smooth::adam()` via `adam_reg()` parameters. Other options and argument can be set using `set_engine()`.

Parameter Notes:

- `xreg` - This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### Seasonal Period Specification

The period can be non-seasonal (`seasonal_period = 1` or "none") or yearly seasonal (e.g. For monthly time stamps, `seasonal_period = 12`, `seasonal_period = "12 months"`, or `seasonal_period = "yearly"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A seasonal period is selected based on the periodicity of the data (e.g. 12 if monthly)
2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

### Univariate (No xregs, Exogenous Regressors):

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.

### Multivariate (xregs, Exogenous Regressors)

The `xreg` parameter is populated using the `fit()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)

2. date (time stamp),
3. month.lbl (labeled month as a ordered factor).

The month.lbl is an exogenous regressor that can be passed to the `arima_reg()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass month.lbl on as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
## Not run:
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)
library(smooth)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- AUTO ADAM ----

# Model Spec
model_spec <- adam_reg() %>%
  set_engine("auto_adam")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- STANDARD ADAM ----

# Model Spec
model_spec <- adam_reg(
  seasonal_period      = 12,
  non_seasonal_ar      = 3,
  non_seasonal_differences = 1,
  non_seasonal_ma      = 3,
  seasonal_ar          = 1,
  seasonal_differences  = 0,
  seasonal_ma          = 1
```

```

) %>%
  set_engine("adam")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

## End(Not run)

```

---

add\_modeltime\_model *Add a Model into a Modeltime Table*

---

## Description

Add a Model into a Modeltime Table

## Usage

```
add_modeltime_model(object, model, location = "bottom")
```

## Arguments

object	Multiple Modeltime Tables (class mdl_time_tbl)
model	A model of class model_fit or a fitted workflow object
location	Where to add the model. Either "top" or "bottom". Default: "bottom".

## See Also

- [combine\\_modeltime\\_tables\(\)](#): Combine 2 or more Modeltime Tables together
- [add\\_modeltime\\_model\(\)](#): Adds a new row with a new model to a Modeltime Table
- [update\\_modeltime\\_description\(\)](#): Updates a description for a model inside a Modeltime Table
- [update\\_modeltime\\_model\(\)](#): Updates a model inside a Modeltime Table
- [pull\\_modeltime\\_model\(\)](#): Extracts a model from a Modeltime Table

## Examples

```

library(tidymodels)

model_fit_ets <- exp_smoothing() %>%
  set_engine("ets") %>%
  fit(value ~ date, training(m750_splits))

m750_models %>%

```

```
add_modeltime_model(model_fit_ets)
```

---

arima\_boost

*General Interface for "Boosted" ARIMA Regression Models*


---

## Description

arima\_boost() is a way to generate a *specification* of a time series model that uses boosting to improve modeling errors (residuals) on Exogenous Regressors. It works with both "automated" ARIMA (auto.arima) and standard ARIMA (arima). The main algorithms are:

- Auto ARIMA + XGBoost Errors (engine = auto\_arima\_xgboost, default)
- ARIMA + XGBoost Errors (engine = arima\_xgboost)

## Usage

```
arima_boost(
  mode = "regression",
  seasonal_period = NULL,
  non_seasonal_ar = NULL,
  non_seasonal_differences = NULL,
  non_seasonal_ma = NULL,
  seasonal_ar = NULL,
  seasonal_differences = NULL,
  seasonal_ma = NULL,
  mtry = NULL,
  trees = NULL,
  min_n = NULL,
  tree_depth = NULL,
  learn_rate = NULL,
  loss_reduction = NULL,
  sample_size = NULL,
  stop_iter = NULL
)
```

## Arguments

mode	A single character string for the type of model. The only possible value for this model is "regression".
seasonal_period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.
non_seasonal_ar	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.

non_seasonal_differences	The order of integration for non-seasonal differencing. Often denoted "d" in pdq-notation.
non_seasonal_ma	The order of the non-seasonal moving average (MA) terms. Often denoted "q" in pdq-notation.
seasonal_ar	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
seasonal_differences	The order of integration for seasonal differencing. Often denoted "D" in PDQ-notation.
seasonal_ma	The order of the seasonal moving average (SMA) terms. Often denoted "Q" in PDQ-notation.
mtry	A number for the number (or proportion) of predictors that will be randomly sampled at each split when creating the tree models (specific engines only)
trees	An integer for the number of trees contained in the ensemble.
min_n	An integer for the minimum number of data points in a node that is required for the node to be split further.
tree_depth	An integer for the maximum depth of the tree (i.e. number of splits) (specific engines only).
learn_rate	A number for the rate at which the boosting algorithm adapts from iteration-to-iteration (specific engines only).
loss_reduction	A number for the reduction in the loss function required to split further (specific engines only).
sample_size	number for the number (or proportion) of data that is exposed to the fitting routine.
stop_iter	The number of iterations without improvement before stopping (xgboost only).

## Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `arima_boost()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "auto\_arima\_xgboost" (default) - Connects to `forecast::auto.arima()` and `xgboost::xgb.train`
- "arima\_xgboost" - Connects to `forecast::Arima()` and `xgboost::xgb.train`

## Main Arguments

The main arguments (tuning parameters) for the **ARIMA model** are:

- `seasonal_period`: The periodic nature of the seasonality. Uses "auto" by default.
- `non_seasonal_ar`: The order of the non-seasonal auto-regressive (AR) terms.
- `non_seasonal_differences`: The order of integration for non-seasonal differencing.
- `non_seasonal_ma`: The order of the non-seasonal moving average (MA) terms.



- seasonal\_ar: The order of the seasonal auto-regressive (SAR) terms.
- seasonal\_differences: The order of integration for seasonal differencing.
- seasonal\_ma: The order of the seasonal moving average (SMA) terms.

The main arguments (tuning parameters) for the model **XGBoost model** are:

- mtry: The number of predictors that will be randomly sampled at each split when creating the tree models.
- trees: The number of trees contained in the ensemble.
- min\_n: The minimum number of data points in a node that are required for the node to be split further.
- tree\_depth: The maximum depth of the tree (i.e. number of splits).
- learn\_rate: The rate at which the boosting algorithm adapts from iteration-to-iteration.
- loss\_reduction: The reduction in the loss function required to split further.
- sample\_size: The amount of data exposed to the fitting routine.
- stop\_iter: The number of iterations without improvement before stopping.

These arguments are converted to their specific names at the time that the model is fit.

Other options and argument can be set using `set_engine()` (See Engine Details below).

If parameters need to be modified, `update()` can be used in lieu of recreating the object from scratch.

### Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

Model 1: ARIMA:

modeltime	forecast::auto.arima	forecast::Arima
seasonal_period	ts(frequency)	ts(frequency)
non_seasonal_ar, non_seasonal_differences, non_seasonal_ma	max.p(5), max.d(2), max.q(5)	order = c(p(0), d(0), q(0))
seasonal_ar, seasonal_differences, seasonal_ma	max.P(2), max.D(1), max.Q(2)	seasonal = c(P(0), D(0), Q(0))

Model 2: XGBoost:

modeltime	xgboost::xgb.train
tree_depth	max_depth (6)
trees	nrounds (15)
learn_rate	eta (0.3)
mtry	colsample_bynode (1)
min_n	min_child_weight (1)
loss_reduction	gamma (0)
sample_size	subsample (1)
stop_iter	early_stop

Other options can be set using `set_engine()`.

### **auto\_arima\_xgboost (default engine)**

Model 1: Auto ARIMA (`forecast::auto.arima`):

```
## function (y, d = NA, D = NA, max.p = 5, max.q = 5, max.P = 2, max.Q = 2,
##   max.order = 5, max.d = 2, max.D = 1, start.p = 2, start.q = 2, start.P = 1,
##   start.Q = 1, stationary = FALSE, seasonal = TRUE, ic = c("aicc", "aic",
##     "bic"), stepwise = TRUE, nmodels = 94, trace = FALSE, approximation = (length(x) >
##     150 | frequency(x) > 12), method = NULL, truncate = NULL, xreg = NULL,
##   test = c("kpss", "adf", "pp"), test.args = list(), seasonal.test = c("seas",
##     "ocsb", "hegy", "ch"), seasonal.test.args = list(), allowdrift = TRUE,
##   allowmean = TRUE, lambda = NULL, biasadj = FALSE, parallel = FALSE,
##   num.cores = 2, x = y, ...)
```

Parameter Notes:

- All values of nonseasonal pdq and seasonal PDQ are maximums. The `auto.arima` will select a value using these as an upper limit.
- `xreg` - This should not be used since XGBoost will be doing the regression

Model 2: XGBoost (`xgboost::xgb.train`):

```
## function (params = list(), data, nrounds, watchlist = list(), obj = NULL,
##   feval = NULL, verbose = 1, print_every_n = 1L, early_stopping_rounds = NULL,
##   maximize = NULL, save_period = NULL, save_name = "xgboost.model", xgb_model = NULL,
##   callbacks = list(), ...)
```

Parameter Notes:

- XGBoost uses a `params = list()` to capture. Parsnip / Modeltime automatically sends any args provided as ... inside of `set_engine()` to the `params = list(...)`.

## **Fit Details**

### **Date and Date-Time Variable**

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### *Seasonal Period Specification*

The period can be non-seasonal (`seasonal_period = 1`) or seasonal (e.g. `seasonal_period = 12` or `seasonal_period = "12 months"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A period is selected based on the periodicity of the data (e.g. 12 if monthly)
2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

**Univariate (No xregs, Exogenous Regressors):**

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

**Multivariate (xregs, Exogenous Regressors)**

The `xreg` parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `month.lbl` (labeled month as a ordered factor).

The `month.lbl` is an exogenous regressor that can be passed to the `arima_boost()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass `month.lbl` on as an exogenous regressor.
- `fit_xy(data[, c("date", "month.lbl")], y = data$y)` will pass `x`, where `x` is a data frame containing `month.lbl` and the date feature. Only `month.lbl` will be used as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

**See Also**

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

**Examples**

```
library(tidyverse)
library(lubridate)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# MODEL SPEC ----

# Set engine and boosting parameters
```

```

model_spec <- arima_boost(

  # ARIMA args
  seasonal_period = 12,
  non_seasonal_ar = 0,
  non_seasonal_differences = 1,
  non_seasonal_ma = 1,
  seasonal_ar      = 0,
  seasonal_differences = 1,
  seasonal_ma      = 1,

  # XGBoost Args
  tree_depth = 6,
  learn_rate = 0.1
) %>%
  set_engine(engine = "arima_xgboost")

# FIT ----

## Not run:
# Boosting - Happens by adding numeric date and month features
model_fit_boosted <- model_spec %>%
  fit(value ~ date + as.numeric(date) + month(date, label = TRUE),
      data = training(splits))

model_fit_boosted

## End(Not run)

```

---

Arima\_fit\_impl

*Low-Level ARIMA function for translating modeltime to forecast*


---

## Description

Low-Level ARIMA function for translating modeltime to forecast

## Usage

```

Arima_fit_impl(
  x,
  y,
  period = "auto",
  p = 0,
  d = 0,
  q = 0,
  P = 0,
  D = 0,

```

```

    Q = 0,
    ...
)

```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
p	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.
d	The order of integration for non-seasonal differencing. Often denoted "d" in pdq-notation.
q	The order of the non-seasonal moving average (MA) terms. Often denoted "q" in pdq-notation.
P	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
D	The order of integration for seasonal differencing. Often denoted "D" in PDQ-notation.
Q	The order of the seasonal moving average (SMA) terms. Often denoted "Q" in PDQ-notation.
...	Additional arguments passed to <code>forecast::Arima</code>

---

arima\_params

*Tuning Parameters for ARIMA Models*


---

### Description

Tuning Parameters for ARIMA Models

### Usage

```
non_seasonal_ar(range = c(0L, 5L), trans = NULL)
```

```
non_seasonal_differences(range = c(0L, 2L), trans = NULL)
```

```
non_seasonal_ma(range = c(0L, 5L), trans = NULL)
```

```
seasonal_ar(range = c(0L, 2L), trans = NULL)
```

```
seasonal_differences(range = c(0L, 1L), trans = NULL)
```

```
seasonal_ma(range = c(0L, 2L), trans = NULL)
```

**Arguments**

range	A two-element vector holding the <i>defaults</i> for the smallest and largest possible values, respectively.
trans	A trans object from the scales package, such as scales::log10_trans() or scales::reciprocal_trans(). If not provided, the default is used which matches the units used in range. If no transformation, NULL.

**Details**

The main parameters for ARIMA models are:

- non\_seasonal\_ar: The order of the non-seasonal auto-regressive (AR) terms.
- non\_seasonal\_differences: The order of integration for non-seasonal differencing.
- non\_seasonal\_ma: The order of the non-seasonal moving average (MA) terms.
- seasonal\_ar: The order of the seasonal auto-regressive (SAR) terms.
- seasonal\_differences: The order of integration for seasonal differencing.
- seasonal\_ma: The order of the seasonal moving average (SMA) terms.

**Examples**

```
non_seasonal_ar()
```

```
non_seasonal_differences()
```

```
non_seasonal_ma()
```

---

Arima\_predict\_impl     *Bridge prediction function for ARIMA models*

---

**Description**

Bridge prediction function for ARIMA models

**Usage**

```
Arima_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class model_fit
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to forecast::Arima()

---

arima\_reg

*General Interface for ARIMA Regression Models*


---

### Description

arima\_reg() is a way to generate a *specification* of an ARIMA model before fitting and allows the model to be created using different packages. Currently the only package is forecast.

### Usage

```
arima_reg(
  mode = "regression",
  seasonal_period = NULL,
  non_seasonal_ar = NULL,
  non_seasonal_differences = NULL,
  non_seasonal_ma = NULL,
  seasonal_ar = NULL,
  seasonal_differences = NULL,
  seasonal_ma = NULL
)
```

### Arguments

mode	A single character string for the type of model. The only possible value for this model is "regression".
seasonal_period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.
non_seasonal_ar	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.
non_seasonal_differences	The order of integration for non-seasonal differencing. Often denoted "d" in pdq-notation.
non_seasonal_ma	The order of the non-seasonal moving average (MA) terms. Often denoted "q" in pdq-notation.
seasonal_ar	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
seasonal_differences	The order of integration for seasonal differencing. Often denoted "D" in PDQ-notation.
seasonal_ma	The order of the seasonal moving average (SMA) terms. Often denoted "Q" in PDQ-notation.

## Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `arima_reg()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "auto\_arima" (default) - Connects to `forecast::auto.arima()`
- "arima" - Connects to `forecast::Arima()`

## Main Arguments

The main arguments (tuning parameters) for the model are:

- `seasonal_period`: The periodic nature of the seasonality. Uses "auto" by default.
- `non_seasonal_ar`: The order of the non-seasonal auto-regressive (AR) terms.
- `non_seasonal_differences`: The order of integration for non-seasonal differencing.
- `non_seasonal_ma`: The order of the non-seasonal moving average (MA) terms.
- `seasonal_ar`: The order of the seasonal auto-regressive (SAR) terms.
- `seasonal_differences`: The order of integration for seasonal differencing.
- `seasonal_ma`: The order of the seasonal moving average (SMA) terms.

These arguments are converted to their specific names at the time that the model is fit.

Other options and argument can be set using `set_engine()` (See Engine Details below).

If parameters need to be modified, `update()` can be used in lieu of recreating the object from scratch.

## Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

<code>modeltime</code>	<code>forecast::auto.arima</code>	<code>forecast::Arima</code>
<code>seasonal_period</code>	<code>ts(frequency)</code>	<code>ts(frequency)</code>
<code>non_seasonal_ar, non_seasonal_differences, non_seasonal_ma</code>	<code>max.p(5), max.d(2), max.q(5)</code>	<code>order = c(p(0), d(0), q(0))</code>
<code>seasonal_ar, seasonal_differences, seasonal_ma</code>	<code>max.P(2), max.D(1), max.Q(2)</code>	<code>seasonal = c(P(0), D(0), Q(0))</code>

Other options can be set using `set_engine()`.

### **auto\_arima (default engine)**

The engine uses `forecast::auto.arima()`.

Function Parameters:

```
## function (y, d = NA, D = NA, max.p = 5, max.q = 5, max.P = 2, max.Q = 2,
##   max.order = 5, max.d = 2, max.D = 1, start.p = 2, start.q = 2, start.P = 1,
##   start.Q = 1, stationary = FALSE, seasonal = TRUE, ic = c("aicc", "aic",
##     "bic"), stepwise = TRUE, nmodels = 94, trace = FALSE, approximation = (length(x) >
##     150 | frequency(x) > 12), method = NULL, truncate = NULL, xreg = NULL,
```



```
## test = c("kpss", "adf", "pp"), test.args = list(), seasonal.test = c("seas",
## "ocsb", "hegy", "ch"), seasonal.test.args = list(), allowdrift = TRUE,
## allowmean = TRUE, lambda = NULL, biasadj = FALSE, parallel = FALSE,
## num.cores = 2, x = y, ...)
```

The *MAXIMUM* nonseasonal ARIMA terms (max.p, max.d, max.q) and seasonal ARIMA terms (max.P, max.D, max.Q) are provided to `forecast::auto.arima()` via `arima_reg()` parameters. Other options and argument can be set using `set_engine()`.

Parameter Notes:

- All values of nonseasonal pdq and seasonal PDQ are maximums. The `forecast::auto.arima()` model will select a value using these as an upper limit.
- `xreg` - This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).

### arima

The engine uses `forecast::Arima()`.

Function Parameters:

```
## function (y, order = c(0, 0, 0), seasonal = c(0, 0, 0), xreg = NULL, include.mean = TRUE,
## include.drift = FALSE, include.constant, lambda = model$lambda, biasadj = FALSE,
## method = c("CSS-ML", "ML", "CSS"), model = NULL, x = y, ...)
```

The nonseasonal ARIMA terms (`order`) and seasonal ARIMA terms (`seasonal`) are provided to `forecast::Arima()` via `arima_reg()` parameters. Other options and argument can be set using `set_engine()`.

Parameter Notes:

- `xreg` - This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).
- `method` - The default is set to "ML" (Maximum Likelihood). This method is more robust at the expense of speed and possible selections may fail unit root inversion testing. Alternatively, you can add `method = "CSS-ML"` to evaluate Conditional Sum of Squares for starting values, then Maximum Likelihood.

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### Seasonal Period Specification

The period can be non-seasonal (`seasonal_period = 1` or "none") or yearly seasonal (e.g. For monthly time stamps, `seasonal_period = 12`, `seasonal_period = "12 months"`, or `seasonal_period = "yearly"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A seasonal period is selected based on the periodicity of the data (e.g. 12 if monthly)
2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

### Univariate (No xregs, Exogenous Regressors):

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

### Multivariate (xregs, Exogenous Regressors)

The `xreg` parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `month.lbl` (labeled month as a ordered factor).

The `month.lbl` is an exogenous regressor that can be passed to the `arima_reg()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass `month.lbl` on as an exogenous regressor.
- `fit_xy(data[, c("date", "month.lbl")], y = data$y)` will pass `x`, where `x` is a data frame containing `month.lbl` and the date feature. Only `month.lbl` will be used as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750
```

```

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- AUTO ARIMA ----

# Model Spec
model_spec <- arima_reg() %>%
  set_engine("auto_arima")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- STANDARD ARIMA ----

# Model Spec
model_spec <- arima_reg(
  seasonal_period      = 12,
  non_seasonal_ar      = 3,
  non_seasonal_differences = 1,
  non_seasonal_ma      = 3,
  seasonal_ar          = 1,
  seasonal_differences  = 0,
  seasonal_ma          = 1
) %>%
  set_engine("arima")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

```

---

arima\_xgboost\_fit\_impl

*Bridge ARIMA-XGBoost Modeling function*


---

## Description

Bridge ARIMA-XGBoost Modeling function

## Usage

```

arima_xgboost_fit_impl(
  x,
  y,
  period = "auto",
  p = 0,

```

```

d = 0,
q = 0,
P = 0,
D = 0,
Q = 0,
include.mean = TRUE,
include.drift = FALSE,
include.constant,
lambda = model$lambda,
biasadj = FALSE,
method = c("CSS-ML", "ML", "CSS"),
model = NULL,
max_depth = 6,
nrounds = 15,
eta = 0.3,
colsample_bytree = NULL,
colsample_bynode = NULL,
min_child_weight = 1,
gamma = 0,
subsample = 1,
validation = 0,
early_stop = NULL,
...
)

```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
p	The order of the non-seasonal auto-regressive (AR) terms.
d	The order of integration for non-seasonal differencing.
q	The order of the non-seasonal moving average (MA) terms.
P	The order of the seasonal auto-regressive (SAR) terms.
D	The order of integration for seasonal differencing.
Q	The order of the seasonal moving average (SMA) terms.
include.mean	Should the ARIMA model include a mean term? The default is TRUE for undifferenced series, FALSE for differenced ones (where a mean would not affect the fit nor predictions).
include.drift	Should the ARIMA model include a linear drift term? (i.e., a linear regression with ARIMA errors is fitted.) The default is FALSE.
include.constant	If TRUE, then include.mean is set to be TRUE for undifferenced series and include.drift is set to be TRUE for differenced series. Note that if there is

	more than one difference taken, no constant is included regardless of the value of this argument. This is deliberate as otherwise quadratic and higher order polynomial trends would be induced.
lambda	Box-Cox transformation parameter. If lambda="auto", then a transformation is automatically selected using BoxCox.lambda. The transformation is ignored if NULL. Otherwise, data transformed before model is estimated.
biasadj	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 biasadj is TRUE, an adjustment will be made to produce mean forecasts and fitted values.
method	Fitting method: maximum likelihood or minimize conditional sum-of-squares. The default (unless there are missing values) is to use conditional-sum-of-squares to find starting values, then maximum likelihood.
model	Output from a previous call to Arima. If model is passed, this same model is fitted to y without re-estimating any parameters.
max_depth	An integer for the maximum depth of the tree.
nrounds	An integer for the number of boosting iterations.
eta	A numeric value between zero and one to control the learning rate.
colsample_bytree	Subsampling proportion of columns.
colsample_bynode	Subsampling proportion of columns for each node within each tree. See the counts argument below. The default uses all columns.
min_child_weight	A numeric value for the minimum sum of instance weights needed in a child to continue to split.
gamma	A number for the minimum loss reduction required to make a further partition on a leaf node of the tree
subsample	Subsampling proportion of rows.
validation	A positive number. If on [0, 1) the value, validation is a random proportion of data in x and y that are used for performance assessment and potential early stopping. If 1 or greater, it is the <i>number</i> of training set samples use for these purposes.
early_stop	An integer or NULL. If not NULL, it is the number of training iterations without improvement before stopping. If validation is used, performance is base on the validation set; otherwise the training set is used.
...	Additional arguments passed to xgboost::xgb.train

---

```
arima_xgboost_predict_impl
```

*Bridge prediction Function for ARIMA-XGBoost Models*

---

### Description

Bridge prediction Function for ARIMA-XGBoost Models

### Usage

```
arima_xgboost_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>predict.xgb.Booster()</code>

---

```
auto_adam_fit_impl
```

*Low-Level ADAM function for translating modeltime to forecast*

---

### Description

Low-Level ADAM function for translating modeltime to forecast

### Usage

```
auto_adam_fit_impl(
  x,
  y,
  period = "auto",
  p = 0,
  d = 0,
  q = 0,
  P = 0,
  D = 0,
  Q = 0,
  model = "ZXZ",
  constant = FALSE,
  regressors = c("use", "select", "adapt"),
  outliers = c("ignore", "use", "select"),
  level = 0.99,
  occurrence = c("none", "auto", "fixed", "general", "odds-ratio",
    "inverse-odds-ratio", "direct"),
  distribution = c("default", "dnorm", "dlaplace", "ds", "dgnorm", "dlnorm",
```

```

    "dinvgauss", "dgamma"),
  loss = c("likelihood", "MSE", "MAE", "HAM", "LASSO", "RIDGE", "MSEh", "TMSE",
    "GTMSE", "MSCE"),
  ic = c("AICc", "AIC", "BIC", "BICc"),
  select_order = FALSE,
  ...
)

```

## Arguments

x	A data.frame of predictors
y	A vector with outcome
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
p	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.
d	The order of integration for non-seasonal differencing. Often denoted "d" in pdq-notation.
q	The order of the non-seasonal moving average (MA) terms. Often denoted "q" in pdq-notation.
P	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
D	The order of integration for seasonal differencing. Often denoted "D" in PDQ-notation.
Q	The order of the seasonal moving average (SMA) terms. Often denoted "Q" in PDQ-notation.
model	The type of ETS model.
constant	Logical, determining, whether the constant is needed in the model or not.
regressors	The variable defines what to do with the provided explanatory variables.
outliers	Defines what to do with outliers.
level	What confidence level to use for detection of outliers.
occurrence	The type of model used in probability estimation.
distribution	what density function to assume for the error term.
loss	The type of Loss Function used in optimization.
ic	The information criterion to use in the model selection / combination procedure.
select_order	If TRUE, then the function will select the most appropriate order using a mechanism similar to auto.msarima(), but implemented in auto.adam(). The values list(ar=...,i=...,ma=...) specify the maximum orders to check in this case.
...	Additional arguments passed to smooth::auto.adam

---

 Auto\_adam\_predict\_impl

*Bridge prediction function for AUTO ADAM models*


---

### Description

Bridge prediction function for AUTO ADAM models

### Usage

```
Auto_adam_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>smooth::auto.adam()</code>

---

 auto\_arima\_fit\_impl

*Low-Level ARIMA function for translating modeltime to forecast*


---

### Description

Low-Level ARIMA function for translating modeltime to forecast

### Usage

```
auto_arima_fit_impl(
  x,
  y,
  period = "auto",
  max.p = 5,
  max.d = 2,
  max.q = 5,
  max.P = 2,
  max.D = 1,
  max.Q = 2,
  ...
)
```



**Arguments**

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
max.p	The maximum order of the non-seasonal auto-regressive (AR) terms.
max.d	The maximum order of integration for non-seasonal differencing.
max.q	The maximum order of the non-seasonal moving average (MA) terms.
max.P	The maximum order of the seasonal auto-regressive (SAR) terms.
max.D	The maximum order of integration for seasonal differencing.
max.Q	The maximum order of the seasonal moving average (SMA) terms.
...	Additional arguments passed to <code>forecast::auto.arma</code>

---

 auto\_arma\_xgboost\_fit\_impl

*Bridge ARIMA-XGBoost Modeling function*


---

**Description**

Bridge ARIMA-XGBoost Modeling function

**Usage**

```

auto_arma_xgboost_fit_impl(
  x,
  y,
  period = "auto",
  max.p = 5,
  max.d = 2,
  max.q = 5,
  max.P = 2,
  max.D = 1,
  max.Q = 2,
  max.order = 5,
  d = NA,
  D = NA,
  start.p = 2,
  start.q = 2,
  start.P = 1,
  start.Q = 1,
  stationary = FALSE,
  seasonal = TRUE,

```

```

ic = c("aicc", "aic", "bic"),
stepwise = TRUE,
nmodels = 94,
trace = FALSE,
approximation = (length(x) > 150 | frequency(x) > 12),
method = NULL,
truncate = NULL,
test = c("kpss", "adf", "pp"),
test.args = list(),
seasonal.test = c("seas", "ocsb", "hegy", "ch"),
seasonal.test.args = list(),
allowdrift = TRUE,
allowmean = TRUE,
lambda = NULL,
biasadj = FALSE,
max_depth = 6,
nrounds = 15,
eta = 0.3,
colsample_bytree = NULL,
colsample_bynode = NULL,
min_child_weight = 1,
gamma = 0,
subsample = 1,
validation = 0,
early_stop = NULL,
...
)

```

### Arguments

<code>x</code>	A dataframe of xreg (exogenous regressors)
<code>y</code>	A numeric vector of values to fit
<code>period</code>	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
<code>max.p</code>	The maximum order of the non-seasonal auto-regressive (AR) terms.
<code>max.d</code>	The maximum order of integration for non-seasonal differencing.
<code>max.q</code>	The maximum order of the non-seasonal moving average (MA) terms.
<code>max.P</code>	The maximum order of the seasonal auto-regressive (SAR) terms.
<code>max.D</code>	The maximum order of integration for seasonal differencing.
<code>max.Q</code>	The maximum order of the seasonal moving average (SMA) terms.
<code>max.order</code>	Maximum value of $p+q+P+Q$ if model selection is not stepwise.
<code>d</code>	Order of first-differencing. If missing, will choose a value based on <code>test</code> .
<code>D</code>	Order of seasonal-differencing. If missing, will choose a value based on <code>season.test</code> .
<code>start.p</code>	Starting value of <code>p</code> in stepwise procedure.

start.q	Starting value of q in stepwise procedure.
start.P	Starting value of P in stepwise procedure.
start.Q	Starting value of Q in stepwise procedure.
stationary	If TRUE, restricts search to stationary models.
seasonal	If FALSE, restricts search to non-seasonal models.
ic	Information criterion to be used in model selection.
stepwise	If TRUE, will do stepwise selection (faster). Otherwise, it searches over all models. Non-stepwise selection can be very slow, especially for seasonal models.
nmodels	Maximum number of models considered in the stepwise search.
trace	If TRUE, the list of ARIMA models considered will be reported.
approximation	If TRUE, estimation is via conditional sums of squares and the information criteria used for model selection are approximated. The final model is still computed using maximum likelihood estimation. Approximation should be used for long time series or a high seasonal period to avoid excessive computation times.
method	fitting method: maximum likelihood or minimize conditional sum-of-squares. The default (unless there are missing values) is to use conditional-sum-of-squares to find starting values, then maximum likelihood. Can be abbreviated.
truncate	An integer value indicating how many observations to use in model selection. The last truncate values of the series are used to select a model when truncate is not NULL and approximation=TRUE. All observations are used if either truncate=NULL or approximation=FALSE.
test	Type of unit root test to use. See <a href="#">ndiffs</a> for details.
test.args	Additional arguments to be passed to the unit root test.
seasonal.test	This determines which method is used to select the number of seasonal differences. The default method is to use a measure of seasonal strength computed from an STL decomposition. Other possibilities involve seasonal unit root tests.
seasonal.test.args	Additional arguments to be passed to the seasonal unit root test. See <a href="#">nsdiffs</a> for details.
allowdrift	If TRUE, models with drift terms are considered.
allowmean	If TRUE, models with a non-zero mean are considered.
lambda	Box-Cox transformation parameter. If lambda="auto", then a transformation is automatically selected using <code>BoxCox.lambda</code> . The transformation is ignored if NULL. Otherwise, data transformed before model is estimated.
biasadj	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 biasadj is TRUE, an adjustment will be made to produce mean forecasts and fitted values.
max_depth	An integer for the maximum depth of the tree.
nrounds	An integer for the number of boosting iterations.
eta	A numeric value between zero and one to control the learning rate.

colsample_bytree	Subsampling proportion of columns.
colsample_bynode	Subsampling proportion of columns for each node within each tree. See the counts argument below. The default uses all columns.
min_child_weight	A numeric value for the minimum sum of instance weights needed in a child to continue to split.
gamma	A number for the minimum loss reduction required to make a further partition on a leaf node of the tree
subsample	Subsampling proportion of rows.
validation	A positive number. If on [0, 1) the value, validation is a random proportion of data in x and y that are used for performance assessment and potential early stopping. If 1 or greater, it is the <i>number</i> of training set samples use for these purposes.
early_stop	An integer or NULL. If not NULL, it is the number of training iterations without improvement before stopping. If validation is used, performance is base on the validation set; otherwise the training set is used.
...	Additional arguments passed to <code>xgboost::xgb.train</code>

---

combine\_modeltime\_tables

*Combine multiple Modeltime Tables into a single Modeltime Table*

---

## Description

Combine multiple Modeltime Tables into a single Modeltime Table

## Usage

```
combine_modeltime_tables(...)
```

## Arguments

... Multiple Modeltime Tables (class `mdl_time_tbl`)

## Details

This function combines multiple Modeltime Tables.

- The `.model_id` will automatically be renumbered to ensure each model has a unique ID.
- Only the `.model_id`, `.model`, and `.model_desc` columns will be returned.

### Re-Training Models on the Same Datasets

One issue can arise if your models are trained on different datasets. If your models have been trained on different datasets, you can run `modeltime_refit()` to train all models on the same data.

### Re-Calibrating Models

If your data has been calibrated using `modeltime_calibrate()`, the `.test` and `.calibration_data` columns will be removed. To re-calibrate, simply run `modeltime_calibrate()` on the newly combined Modeltime Table.

### See Also

- `combine_modeltime_tables()`: Combine 2 or more Modeltime Tables together
- `add_modeltime_model()`: Adds a new row with a new model to a Modeltime Table
- `update_modeltime_description()`: Updates a description for a model inside a Modeltime Table
- `update_modeltime_model()`: Updates a model inside a Modeltime Table
- `pull_modeltime_model()`: Extracts a model from a Modeltime Table

### Examples

```
library(modeltime)
library(tidymodels)
library(tidyverse)
library(timetk)
library(lubridate)

# Setup
m750 <- m4_monthly %>% filter(id == "M750")

splits <- time_series_split(m750, assess = "3 years", cumulative = TRUE)

model_fit_arma <- arima_reg() %>%
  set_engine("auto_arma") %>%
  fit(value ~ date, training(splits))

model_fit_prophet <- prophet_reg() %>%
  set_engine("prophet") %>%
  fit(value ~ date, training(splits))

# Multiple Modeltime Tables
model_tbl_1 <- modeltime_table(model_fit_arma)
model_tbl_2 <- modeltime_table(model_fit_prophet)

# Combine
combine_modeltime_tables(model_tbl_1, model_tbl_2)
```

---

control\_modeltime      *Control aspects of the training process*

---

## Description

These functions are matched to the associated training functions:

- `control_refit()`: Used with `modeltime_refit()`
- `control_fit_workflowset()`: Used with `modeltime_fit_workflowset()`
- `control_nested_fit()`: Used with `modeltime_nested_fit()`
- `control_nested_refit()`: Used with `modeltime_nested_refit()`
- `control_nested_forecast()`: Used with `modeltime_nested_forecast()`

## Usage

```
control_refit(verbose = FALSE, allow_par = FALSE, cores = -1, packages = NULL)
```

```
control_fit_workflowset(  
  verbose = FALSE,  
  allow_par = FALSE,  
  cores = -1,  
  packages = NULL  
)
```

```
control_nested_fit(  
  verbose = FALSE,  
  allow_par = FALSE,  
  cores = -1,  
  packages = NULL  
)
```

```
control_nested_refit(  
  verbose = FALSE,  
  allow_par = FALSE,  
  cores = -1,  
  packages = NULL  
)
```

```
control_nested_forecast(  
  verbose = FALSE,  
  allow_par = FALSE,  
  cores = -1,  
  packages = NULL  
)
```

**Arguments**

verbose	Logical to control printing.
allow_par	Logical to allow parallel computation. Default: FALSE (single threaded).
cores	Number of cores for computation. If -1, uses all available physical cores. Default: -1.
packages	An optional character string of additional R package names that should be loaded during parallel processing. <ul style="list-style-type: none"> <li>• Packages in your namespace are loaded by default</li> <li>• Key Packages are loaded by default: tidymodels, parsnip, modeltime, dplyr, stats, lubridate and timetk.</li> </ul>

**Value**

A List with the control settings.

**See Also**

- Setting Up Parallel Processing: [parallel\\_start\(\)](#), [[parallel\\_stop\(\)](#)]
- Training Functions: [[modeltime\\_refit\(\)](#)], [[modeltime\\_fit\\_workflowset\(\)](#)], [[modeltime\\_nested\\_fit\(\)](#)], [[modeltime\\_nested\\_refit\(\)](#)]

[[parallel\\_stop\(\)](#)]: R:parallel\_stop() [[modeltime\\_refit\(\)](#)]: R:modeltime\_refit() [[modeltime\\_fit\\_workflowset\(\)](#)]: R:modeltime\_fit\_workflowset() [[modeltime\\_nested\\_fit\(\)](#)]: R:modeltime\_nested\_fit() [[modeltime\\_nested\\_refit\(\)](#)]: R:modeltime\_nested\_refit()

**Examples**

```
# No parallel processing by default
control_refit()

# Allow parallel processing
control_refit(allow_par = TRUE)

# Set verbosity to show additional training information
control_refit(verbose = TRUE)

# Add additional packages used during modeling in parallel processing
# - This is useful if your namespace does not load all needed packages
#   to run models.
# - An example is if I use `temporal_hierarchy()`, which depends on the `thief` package
control_refit(allow_par = TRUE, packages = "thief")
```

---

create\_model\_grid      *Helper to make parsnip model specs from a dials parameter grid*

---

### Description

Helper to make parsnip model specs from a dials parameter grid

### Usage

```
create_model_grid(grid, f_model_spec, engine_name, ..., engine_params = list())
```

### Arguments

grid	A tibble that forms a grid of parameters to adjust
f_model_spec	A function name (quoted or unquoted) that specifies a parsnip model specification function
engine_name	A name of an engine to use. Gets passed to <code>parsnip::set_engine()</code> .
...	Static parameters that get passed to the <code>f_model_spec</code>
engine_params	A list of additional parameters that can be passed to the engine via <code>parsnip::set_engine(...)</code> .

### Details

This is a helper function that combines dials grids with parsnip model specifications. The intent is to make it easier to generate workflowset objects for forecast evaluations with `modeltime_fit_workflowset()`.

The process follows:

1. Generate a grid (hyperparameter combination)
2. Use `create_model_grid()` to apply the parameter combinations to a parsnip model spec and engine.

The output contains ".model" column that can be used as a list of models inside the `workflow_set()` function.

### Value

Tibble with a new column named `.models`

### See Also

- [dials::grid\\_regular\(\)](#): For making parameter grids.
- [workflowsets::workflow\\_set\(\)](#): For creating a workflowset from the `.models` list stored in the ".models" column.
- [modeltime\\_fit\\_workflowset\(\)](#): For fitting a workflowset to forecast data.



## Examples

```
library(tidymodels)
library(modeltime)

# Parameters that get optimized
grid_tbl <- grid_regular(
  learn_rate(),
  levels = 3
)

# Generate model specs
grid_tbl %>%
  create_model_grid(
    f_model_spec = boost_tree,
    engine_name = "xgboost",
    # Static boost_tree() args
    mode = "regression",
    # Static set_engine() args
    engine_params = list(
      max_depth = 5
    )
  )
```

---

create\_xreg\_recipe      *Developer Tools for preparing XREGS (Regressors)*

---

## Description

These functions are designed to assist developers in extending the modeltime package. `create_xregs_recipe()` makes it simple to automate conversion of raw un-encoded features to machine-learning ready features.

## Usage

```
create_xreg_recipe(
  data,
  prepare = TRUE,
  clean_names = TRUE,
  dummy_encode = TRUE,
  one_hot = FALSE
)
```

## Arguments

<code>data</code>	A data frame
<code>prepare</code>	Whether or not to run <code>recipes::prep()</code> on the final recipe. Default is to prepare. User can set this to <code>FALSE</code> to return an un prepared recipe.

<code>clean_names</code>	Uses <code>janitor::clean_names()</code> to process the names and improve robustness to failure during dummy (one-hot) encoding step.
<code>dummy_encode</code>	Should factors (categorical data) be
<code>one_hot</code>	If <code>dummy_encode = TRUE</code> , should the encoding return one column for each feature or one less column than each feature. Default is <code>FALSE</code> .

## Details

The default recipe contains steps to:

1. Remove date features
2. Clean the column names removing spaces and bad characters
3. Convert ordered factors to regular factors
4. Convert factors to dummy variables
5. Remove any variables that have zero variance

## Value

A recipe in either prepared or un-prepared format.

## Examples

```
library(dplyr)
library(timetk)
library(recipes)
library(lubridate)

predictors <- m4_monthly %>%
  filter(id == "M750") %>%
  select(-value) %>%
  mutate(month = month(date, label = TRUE))
predictors

# Create default recipe
xreg_recipe_spec <- create_xreg_recipe(predictors, prepare = TRUE)

# Extracts the preprocessed training data from the recipe (used in your fit function)
juice_xreg_recipe(xreg_recipe_spec)

# Applies the prepared recipe to new data (used in your predict function)
bake_xreg_recipe(xreg_recipe_spec, new_data = predictors)
```

---

croston_fit_impl	<i>Low-Level Exponential Smoothing function for translating modeltime to forecast</i>
------------------	---

---

**Description**

Low-Level Exponential Smoothing function for translating modeltime to forecast

**Usage**

```
croston_fit_impl(x, y, alpha = 0.1, ...)
```

**Arguments**

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
alpha	Value of alpha. Default value is 0.1.
...	Additional arguments passed to forecast::ets

---

croston_predict_impl	<i>Bridge prediction function for CROSTON models</i>
----------------------	--

---

**Description**

Bridge prediction function for CROSTON models

**Usage**

```
croston_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class model_fit
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to stats::predict()

---

ets_fit_impl	<i>Low-Level Exponential Smoothing function for translating modeltime to forecast</i>
--------------	---

---

### Description

Low-Level Exponential Smoothing function for translating modeltime to forecast

### Usage

```
ets_fit_impl(
  x,
  y,
  period = "auto",
  error = "auto",
  trend = "auto",
  season = "auto",
  damping = "auto",
  alpha = NULL,
  beta = NULL,
  gamma = NULL,
  ...
)
```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
error	The form of the error term: "auto", "additive", or "multiplicative". If the error is multiplicative, the data must be non-negative.
trend	The form of the trend term: "auto", "additive", "multiplicative" or "none".
season	The form of the seasonal term: "auto", "additive", "multiplicative" or "none".
damping	Apply damping to a trend: "auto", "damped", or "none".
alpha	Value of alpha. If NULL, it is estimated.
beta	Value of beta. If NULL, it is estimated.
gamma	Value of gamma. If NULL, it is estimated.
...	Additional arguments passed to forecast::ets

---

ets_predict_impl	<i>Bridge prediction function for Exponential Smoothing models</i>
------------------	--

---

**Description**

Bridge prediction function for Exponential Smoothing models

**Usage**

```
ets_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>forecast::ets()</code>

---

exp_smoothing	<i>General Interface for Exponential Smoothing State Space Models</i>
---------------	---

---

**Description**

`exp_smoothing()` is a way to generate a *specification* of an Exponential Smoothing model before fitting and allows the model to be created using different packages. Currently the only package is `forecast`. Several algorithms are implemented:

- ETS - Automated Exponential Smoothing
- CROSTON - Croston's forecast is a special case of Exponential Smoothing for intermittent demand
- Theta - A special case of Exponential Smoothing with Drift that performed well in the M3 Competition

**Usage**

```
exp_smoothing(
  mode = "regression",
  seasonal_period = NULL,
  error = NULL,
  trend = NULL,
  season = NULL,
  damping = NULL,
  smooth_level = NULL,
  smooth_trend = NULL,
  smooth_seasonal = NULL
)
```

**Arguments**

mode	A single character string for the type of model. The only possible value for this model is "regression".
seasonal_period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.
error	The form of the error term: "auto", "additive", or "multiplicative". If the error is multiplicative, the data must be non-negative.
trend	The form of the trend term: "auto", "additive", "multiplicative" or "none".
season	The form of the seasonal term: "auto", "additive", "multiplicative" or "none".
damping	Apply damping to a trend: "auto", "damped", or "none".
smooth_level	This is often called the "alpha" parameter used as the base level smoothing factor for exponential smoothing models.
smooth_trend	This is often called the "beta" parameter used as the trend smoothing factor for exponential smoothing models.
smooth_seasonal	This is often called the "gamma" parameter used as the seasonal smoothing factor for exponential smoothing models.

**Details**

Models can be created using the following *engines*:

- "ets" (default) - Connects to `forecast::ets()`
- "croston" - Connects to `forecast::croston()`
- "theta" - Connects to `forecast::thetaf()`
- "smooth\_es" - Connects to `smooth::es()`

**Engine Details**

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

<code>modeltime</code>	<code>forecast::ets</code>	<code>forecast::croston()</code>	<code>forecast::thetaf()</code>	<code>smooth::es()</code>
<code>seasonal_period()</code>	<code>ts(frequency)</code>	<code>ts(frequency)</code>	<code>ts(frequency)</code>	<code>ts(frequency)</code>
<code>error(), trend(), season()</code>	<code>model('ZZZ')</code>	NA	NA	<code>model('ZZZ')</code>
<code>damping()</code>	<code>damped (NULL)</code>	NA	NA	<code>phi</code>
<code>smooth_level()</code>	<code>alpha (NULL)</code>	<code>alpha (0.1)</code>	NA	<code>persistence(alpha)</code>
<code>smooth_trend()</code>	<code>beta (NULL)</code>	NA	NA	<code>persistence(beta)</code>
<code>smooth_seasonal()</code>	<code>gamma (NULL)</code>	NA	NA	<code>persistence(gamma)</code>

Other options can be set using `set_engine()`.

**ets (default engine)**

The engine uses `forecast::ets()`.

Function Parameters:

```
## function (y, model = "ZZZ", damped = NULL, alpha = NULL, beta = NULL, gamma = NULL,
##   phi = NULL, additive.only = FALSE, lambda = NULL, biasadj = FALSE,
##   lower = c(rep(1e-04, 3), 0.8), upper = c(rep(0.9999, 3), 0.98), opt.crit = c("lik",
##     "amse", "mse", "sigma", "mae"), nmse = 3, bounds = c("both", "usual",
##     "admissible"), ic = c("aicc", "aic", "bic"), restrict = TRUE, allow.multiplicative.trend = FALSE,
##   use.initial.values = FALSE, na.action = c("na.contiguous", "na.interp",
##     "na.fail"), ...)
```

The main arguments are `model` and `damped` are defined using:

- `error()` = "auto", "additive", and "multiplicative" are converted to "Z", "A", and "M"
- `trend()` = "auto", "additive", "multiplicative", and "none" are converted to "Z","A","M" and "N"
- `season()` = "auto", "additive", "multiplicative", and "none" are converted to "Z","A","M" and "N"
- `damping()` - "auto", "damped", "none" are converted to NULL, TRUE, FALSE
- `smooth_level()`, `smooth_trend()`, and `smooth_seasonal()` are automatically determined if not provided. They are mapped to "alpha", "beta" and "gamma", respectively.

By default, all arguments are set to "auto" to perform automated Exponential Smoothing using *in-sample data* following the underlying `forecast::ets()` automation routine.

Other options and argument can be set using `set_engine()`.

Parameter Notes:

- `xreg` - This model is not set up to use exogenous regressors. Only univariate models will be fit.

### **croston**

The engine uses `forecast::croston()`.

Function Parameters:

```
## function (y, h = 10, alpha = 0.1, x = y)
```

The main arguments are defined using:

- `smooth_level()`: The "alpha" parameter

Parameter Notes:

- `xreg` - This model is not set up to use exogenous regressors. Only univariate models will be fit.

### **theta**

The engine uses `forecast::thetaf()`

Parameter Notes:

- `xreg` - This model is not set up to use exogenous regressors. Only univariate models will be fit.

### **smooth\_es**

The engine uses `smooth::es()`.

Function Parameters:

```
## function (y, model = "ZZZ", persistence = NULL, phi = NULL, initial = c("optimal",
##   "backcasting"), initialSeason = NULL, ic = c("AICc", "AIC", "BIC",
##   "BICc"), loss = c("likelihood", "MSE", "MAE", "HAM", "MSEh", "TMSE",
##   "GTMSE", "MSCE"), h = 10, holdout = FALSE, cumulative = FALSE, interval = c("none",
##   "parametric", "likelihood", "semiparametric", "nonparametric"), level = 0.95,
##   bounds = c("usual", "admissible", "none"), silent = c("all", "graph",
##   "legend", "output", "none"), xreg = NULL, xregDo = c("use", "select"),
##   initialX = NULL, ...)
```

The main arguments `model` and `phi` are defined using:

- `error()` = "auto", "additive" and "multiplicative" are converted to "Z", "A" and "M"
- `trend()` = "auto", "additive", "multiplicative", "additive\_damped", "multiplicative\_damped" and "none" are converted to "Z", "A", "M", "Ad", "Md" and "N".
- `season()` = "auto", "additive", "multiplicative", and "none" are converted "Z", "A", "M" and "N"
- `damping()` - Value of damping parameter. If `NULL`, then it is estimated.
- `smooth_level()`, `smooth_trend()`, and `smooth_seasonal()` are automatically determined if not provided. They are mapped to "persistence" ("alpha", "beta" and "gamma", respectively).

By default, all arguments are set to "auto" to perform automated Exponential Smoothing using *in-sample data* following the underlying `smooth::es()` automation routine.

Other options and argument can be set using `set_engine()`.

Parameter Notes:

- `xreg` - This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).

## **Fit Details**

### **Date and Date-Time Variable**

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### *Seasonal Period Specification*

The period can be non-seasonal (`seasonal_period = 1` or "none") or seasonal (e.g. `seasonal_period = 12` or `seasonal_period = "12 months"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A period is selected based on the periodicity of the data (e.g. 12 if monthly)



2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

### Univariate:

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

### Multivariate (xregs, Exogenous Regressors)

Just for smooth engine.

The `xreg` parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `month.lbl` (labeled month as a ordered factor).

The `month.lbl` is an exogenous regressor that can be passed to the `arima_reg()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass `month.lbl` on as an exogenous regressor.
- `fit_xy(data[, c("date", "month.lbl")], y = data$y)` will pass `x`, where `x` is a data frame containing `month.lbl` and the date feature. Only `month.lbl` will be used as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

### See Also

`fit.model_spec()`, `set_engine()`

### Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)
library(smooth)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750
```

```
# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- AUTO ETS ----

# Model Spec - The default parameters are all set
# to "auto" if none are provided
model_spec <- exp_smoothing() %>%
  set_engine("ets")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- STANDARD ETS ----

# Model Spec
model_spec <- exp_smoothing(
  seasonal_period = 12,
  error           = "multiplicative",
  trend           = "additive",
  season         = "multiplicative"
) %>%
  set_engine("ets")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- CROSTON ----

# Model Spec
model_spec <- exp_smoothing(
  smooth_level = 0.2
) %>%
  set_engine("croston")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- THETA ----

# # Model Spec
model_spec <- exp_smoothing() %>%
```

```

      set_engine("theta")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

#' # ---- SMOOTH ----

#' # Model Spec
model_spec <- exp_smoothing(
  seasonal_period = 12,
  error           = "multiplicative",
  trend           = "additive_damped",
  season          = "additive"
) %>%
  set_engine("smooth_es")

# Fit Spec
model_fit <- model_spec %>%
  fit(value ~ date, data = training(splits))
model_fit

```

---

exp\_smoothing\_params *Tuning Parameters for Exponential Smoothing Models*

---

## Description

Tuning Parameters for Exponential Smoothing Models

## Usage

```

error(values = c("additive", "multiplicative"))

trend(values = c("additive", "multiplicative", "none"))

trend_smooth(
  values = c("additive", "multiplicative", "none", "additive_damped",
            "multiplicative_damped")
)

season(values = c("additive", "multiplicative", "none"))

```

```
damping(values = c("damped", "none"))
damping_smooth(range = c(0, 2), trans = NULL)
smooth_level(range = c(0, 1), trans = NULL)
smooth_trend(range = c(0, 1), trans = NULL)
smooth_seasonal(range = c(0, 1), trans = NULL)
```

### Arguments

values	A character string of possible values.
range	A two-element vector holding the <i>defaults</i> for the smallest and largest possible values, respectively.
trans	A trans object from the scales package, such as <code>scales::log10_trans()</code> or <code>scales::reciprocal_trans()</code> . If not provided, the default is used which matches the units used in range. If no transformation, NULL.

### Details

The main parameters for Exponential Smoothing models are:

- `error`: The form of the error term: "additive", or "multiplicative". If the error is multiplicative, the data must be non-negative.
- `trend`: The form of the trend term: "additive", "multiplicative" or "none".
- `season`: The form of the seasonal term: "additive", "multiplicative" or "none"..
- `damping`: Apply damping to a trend: "damped", or "none".
- `smooth_level`: This is often called the "alpha" parameter used as the base level smoothing factor for exponential smoothing models.
- `smooth_trend`: This is often called the "beta" parameter used as the trend smoothing factor for exponential smoothing models.
- `smooth_seasonal`: This is often called the "gamma" parameter used as the seasonal smoothing factor for exponential smoothing models.

### Examples

```
error()
trend()
season()
```

---

get\_arma\_description *Get model descriptions for Arima objects*

---

**Description**

Get model descriptions for Arima objects

**Usage**

```
get_arma_description(object, padding = FALSE)
```

**Arguments**

object	Objects of class Arima
padding	Whether or not to include padding

**Source**

- Forecast R Package, forecast:::arma.string()

**Examples**

```
library(forecast)

arma_fit <- forecast::Arima(1:10)

get_arma_description(arma_fit)
```

---

get\_model\_description *Get model descriptions for parsnip, workflows & modeltime objects*

---

**Description**

Get model descriptions for parsnip, workflows & modeltime objects

**Usage**

```
get_model_description(object, indicate_training = FALSE, upper_case = TRUE)
```

**Arguments**

object	Parsnip or workflow objects
indicate_training	Whether or not to indicate if the model has been trained
upper_case	Whether to return upper or lower case model descriptions

**Examples**

```
library(dplyr)
library(timetk)
library(parsnip)
library(modeltime)

# Model Specification ----

arima_spec <- arima_reg() %>%
  set_engine("auto_arima")

get_model_description(arima_spec, indicate_training = TRUE)

# Fitted Model ----

m750 <- m4_monthly %>% filter(id == "M750")

arima_fit <- arima_spec %>%
  fit(value ~ date, data = m750)

get_model_description(arima_fit, indicate_training = TRUE)
```

---

get\_tbats\_description *Get model descriptions for TBATS objects*

---

**Description**

Get model descriptions for TBATS objects

**Usage**

```
get_tbats_description(object)
```

**Arguments**

object            Objects of class tbats

**Source**

- Forecast R Package, `forecast:::as.character.tbats()`

---

is_calibrated	<i>Test if a Modeltime Table has been calibrated</i>
---------------	--

---

**Description**

This function returns TRUE for objects that contains columns ".type" and ".calibration\_data"

**Usage**

```
is_calibrated(object)
```

**Arguments**

object	An object to detect if is a Calibrated Modeltime Table
--------	--

---

is_modeltime_model	<i>Test if object contains a fitted modeltime model</i>
--------------------	---

---

**Description**

This function returns TRUE for trained workflows and parsnip objects that contain modeltime models

**Usage**

```
is_modeltime_model(object)
```

**Arguments**

object	An object to detect if contains a fitted modeltime model
--------	--

---

is_modeltime_table	<i>Test if object is a Modeltime Table</i>
--------------------	--

---

**Description**

This function returns TRUE for objects that contain class mdl\_time\_tbl

**Usage**

```
is_modeltime_table(object)
```

**Arguments**

object	An object to detect if is a Modeltime Table
--------	---

---

is_residuals	<i>Test if a table contains residuals.</i>
--------------	--

---

**Description**

This function returns TRUE for objects that contains the column name '.residuals'.

**Usage**

```
is_residuals(object)
```

**Arguments**

object            An object to detect if it provides from `modeltime::modeltime_residuals()`.

---

load_namespace	<i>These are not intended for use by the general public.</i>
----------------	--

---

**Description**

These are not intended for use by the general public.

**Usage**

```
load_namespace(x, full_load)
```

**Arguments**

x                    A vector  
full\_load            A vector

**Value**

Control information



## Description

Extract logged information calculated during the `modeltime_nested_fit()`, `modeltime_nested_select_best()`, and `modeltime_nested_refit()` processes.

## Usage

```
extract_nested_test_accuracy(object)

extract_nested_test_forecast(object, .include_actual = TRUE, .id_subset = NULL)

extract_nested_error_report(object)

extract_nested_best_model_report(object)

extract_nested_future_forecast(
  object,
  .include_actual = TRUE,
  .id_subset = NULL
)

extract_nested_modeltime_table(object, .row_id = 1)

extract_nested_train_split(object, .row_id = 1)

extract_nested_test_split(object, .row_id = 1)
```

## Arguments

<code>object</code>	A nested modeltime table
<code>.include_actual</code>	Whether or not to include the actual data in the extracted forecast. Default: TRUE.
<code>.id_subset</code>	Can supply a vector of id's to extract forecasts for one or more id's, rather than extracting all forecasts. If NULL, extracts forecasts for all id's.
<code>.row_id</code>	The row number to extract from the nested data.

---

`m750`*The 750th Monthly Time Series used in the M4 Competition*

---

**Description**

The 750th Monthly Time Series used in the M4 Competition

**Usage**`m750`**Format**

A tibble with 306 rows and 3 variables:

- `id` Factor. Unique series identifier
- `date` Date. Timestamp information. Monthly format.
- `value` Numeric. Value at the corresponding timestamp.

**Source**

- [M4 Competition Website](#)

**Examples**`m750`

---

`m750_models`*Three (3) Models trained on the M750 Data (Training Set)*

---

**Description**

Three (3) Models trained on the M750 Data (Training Set)

**Usage**`m750_models`**Format**

An `time_series_cv` object with 6 slices of Time Series Cross Validation resamples made on the `training(m750_splits)`

**Details**

```
library(modeltime)
m750_models <- modeltime_table(
  wflw_fit_arima,
  wflw_fit_prophet,
  wflw_fit_glmnet
)
```

**Examples**

```
library(modeltime)

m750_models
```

---

m750\_splits

*The results of train/test splitting the M750 Data*

---

**Description**

The results of train/test splitting the M750 Data

**Usage**

```
m750_splits
```

**Format**

An rsplit object split into approximately 23.5-years of training data and 2-years of testing data

**Details**

```
library(timetk)
m750_splits <- time_series_split(m750, assess = "2 years", cumulative = TRUE)
```

**Examples**

```
library(rsample)

m750_splits

training(m750_splits)
```

m750\_training\_resamples

*The Time Series Cross Validation Resamples the M750 Data (Training Set)*

---

### **Description**

The Time Series Cross Validation Resamples the M750 Data (Training Set)

### **Usage**

```
m750_training_resamples
```

### **Format**

An `time_series_cv` object with 6 slices of Time Series Cross Validation resamples made on the `training(m750_splits)`

### **Details**

```
library(timetk)
m750_training_resamples <- time_series_cv(
  data      = training(m750_splits),
  assess    = "2 years",
  skip      = "2 years",
  cumulative = TRUE,
  slice_limit = 6
)
```

### **Examples**

```
library(rsample)

m750_training_resamples
```

---

maape

*Mean Arctangent Absolute Percentage Error*

---

### **Description**

Useful when MAPE returns Inf typically due to intermittent data containing zeros. This is a wrapper to the function of `TSrepr::maape()`.

**Usage**

```
maape(data, ...)
```

**Arguments**

data	A data.frame containing the truth and estimate columns.
...	Not currently in use.

---

maape.data.frame	<i>Mean Arctangent Absolute Percentage Error</i>
------------------	--

---

**Description**

This is basically a wrapper to the function of TSrepr::maape().

**Usage**

```
## S3 method for class 'data.frame'
maape(data, truth, estimate, na_rm = TRUE, ...)
```

**Arguments**

data	A data.frame containing the truth and estimate columns.
truth	The column identifier for the true results (that is numeric).
estimate	The column identifier for the predicted results (that is also numeric).
na_rm	Not in use...NA values managed by TSrepr::maape
...	Not currently in use

---

maape_vec	<i>Mean Arctangent Absolute Percentage Error</i>
-----------	--

---

**Description**

This is basically a wrapper to the function of TSrepr::maape().

**Usage**

```
maape_vec(truth, estimate, na_rm = TRUE, ...)
```

**Arguments**

truth	The column identifier for the true results (that is numeric).
estimate	The column identifier for the predicted results (that is also numeric).
na_rm	Not in use...NA values managed by TSrepr::maape
...	Not currently in use

---

make_ts_splits	<i>Generate a Time Series Train/Test Split Indices</i>
----------------	--

---

**Description**

Makes fast train/test split indices for time series.

**Usage**

```
make_ts_splits(.data, .length_test, .length_train = NULL)
```

**Arguments**

.data	A data frame containing ordered time series data (ascending)
.length_test	The number of rows to include in the test set
.length_train	Optional. The number of rows to include in the training set. If NULL, returns all remaining row indices.

**Value**

A list containing train\_idx and test\_idx

---

metric_sets	<i>Forecast Accuracy Metrics Sets</i>
-------------	---------------------------------------

---

**Description**

This is a wrapper for [metric\\_set\(\)](#) with several common forecast / regression accuracy metrics included. These are the default time series accuracy metrics used with [modeltime\\_accuracy\(\)](#).

**Usage**

```
default_forecast_accuracy_metric_set(...)
extended_forecast_accuracy_metric_set(...)
```

**Arguments**

...	Add additional yardstick metrics
-----	----------------------------------

### Default Forecast Accuracy Metric Set

The primary purpose is to use the default accuracy metrics to calculate the following forecast accuracy metrics using `modeltime_accuracy()`:

- MAE - Mean absolute error, `mae()`
- MAPE - Mean absolute percentage error, `mape()`
- MASE - Mean absolute scaled error, `mase()`
- SMAPE - Symmetric mean absolute percentage error, `smape()`
- RMSE - Root mean squared error, `rmse()`
- RSQ - R-squared, `rsq()`

Adding additional metrics is possible via . . . .

### Extended Forecast Accuracy Metric Set

Extends the default metric set by adding:

- MAAPE - Mean Arctangent Absolute Percentage Error, `maape()`. MAAPE is designed for intermittent data where MAPE returns Inf.

### See Also

- `yardstick::metric_tweak()` - For modifying yardstick metrics

### Examples

```
library(tibble)
library(dplyr)
library(timetk)
library(yardstick)

fake_data <- tibble(
  y = c(1:12, 2*1:12),
  yhat = c(1 + 1:12, 2*1:12 - 1)
)

# ---- HOW IT WORKS ----

# Default Forecast Accuracy Metric Specification
default_forecast_accuracy_metric_set()

# Create a metric summarizer function from the metric set
calc_default_metrics <- default_forecast_accuracy_metric_set()

# Apply the metric summarizer to new data
calc_default_metrics(fake_data, y, yhat)

# ---- ADD MORE PARAMETERS ----

# Can create a version of mase() with seasonality = 12 (monthly)
```

```

mase12 <- metric_tweak(.name = "mase12", .fn = mase, m = 12)

# Add it to the default metric set
my_metric_set <- default_forecast_accuracy_metric_set(mase12)
my_metric_set

# Apply the newly created metric set
my_metric_set(fake_data, y, yhat)

```

---

modeltime\_accuracy      *Calculate Accuracy Metrics*

---

### Description

This is a wrapper for `yardstick` that simplifies time series regression accuracy metric calculations from a fitted workflow (trained workflow) or `model_fit` (trained `parsnip` model).

### Usage

```

modeltime_accuracy(
  object,
  new_data = NULL,
  metric_set = default_forecast_accuracy_metric_set(),
  acc_by_id = FALSE,
  quiet = TRUE,
  ...
)

```

### Arguments

<code>object</code>	A Modeltime Table
<code>new_data</code>	A tibble to predict and calculate residuals on. If provided, overrides any calibration data.
<code>metric_set</code>	A <code>yardstick::metric_set()</code> that is used to summarize one or more forecast accuracy (regression) metrics.
<code>acc_by_id</code>	Should a global or local model accuracy be produced? (Default: FALSE) <ul style="list-style-type: none"> <li>• When FALSE, a global model accuracy is provided.</li> <li>• If TRUE, a local accuracy is provided group-wise for each time series ID. To enable local accuracy, an id must be provided during <code>modeltime_calibrate()</code>.</li> </ul>
<code>quiet</code>	Hide errors (TRUE, the default), or display them as they occur?
<code>...</code>	If <code>new_data</code> is provided, these parameters are passed to <code>modeltime_calibrate()</code>



## Details

The following accuracy metrics are included by default via `default_forecast_accuracy_metric_set()`:

- MAE - Mean absolute error, `mae()`
- MAPE - Mean absolute percentage error, `mape()`
- MASE - Mean absolute scaled error, `mase()`
- SMAPE - Symmetric mean absolute percentage error, `smape()`
- RMSE - Root mean squared error, `rmse()`
- RSQ - R-squared, `rsq()`

## Value

A tibble with accuracy estimates.

## Examples

```
library(tidymodels)
library(tidyverse)
library(lubridate)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- ACCURACY ----

models_tbl %>%
  modeltime_calibrate(new_data = testing(splits)) %>%
  modeltime_accuracy(
    metric_set = metric_set(mae, rmse, rsq)
  )
```

---

modeltime\_calibrate    *Preparation for forecasting*

---

### Description

Calibration sets the stage for accuracy and forecast confidence by computing predictions and residuals from out of sample data.

### Usage

```
modeltime_calibrate(object, new_data, id = NULL, quiet = TRUE, ...)
```

### Arguments

object	A fitted model object that is either: <ol style="list-style-type: none"> <li>1. A modeltime table that has been created using <code>modeltime_table()</code></li> <li>2. A workflow that has been fit by <code>fit.workflow()</code> or</li> <li>3. A parsnip model that has been fit using <code>fit.model_spec()</code></li> </ol>
new_data	A test data set tibble containing future information (timestamps and actual values).
id	A quoted column name containing an identifier column identifying time series that are grouped.
quiet	Hide errors (TRUE, the default), or display them as they occur?
...	Additional arguments passed to <code>modeltime_forecast()</code> .

### Details

The results of calibration are used for:

- **Forecast Confidence Interval Estimation:** The out of sample residual data is used to calculate the confidence interval. Refer to `modeltime_forecast()`.
- **Accuracy Calculations:** The out of sample actual and prediction values are used to calculate performance metrics. Refer to `modeltime_accuracy()`

The calibration steps include:

1. If not a Modeltime Table, objects are converted to Modeltime Tables internally
2. Two Columns are added:
  - `.type`: Indicates the sample type. This is:
    - "Test" if predicted, or
    - "Fitted" if residuals were stored during modeling.
  - `.calibration_data`:
    - Contains a tibble with Timestamps, Actual Values, Predictions and Residuals calculated from `new_data` (Test Data)
    - If `id` is provided, will contain a 5th column that is the identifier variable.

**Value**

A Modeltime Table (mdl\_time\_tbl) with nested .calibration\_data added

**Examples**

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- CALIBRATE ----

calibration_tbl <- models_tbl %>%
  modeltime_calibrate(
    new_data = testing(splits)
  )

# ---- ACCURACY ----

calibration_tbl %>%
  modeltime_accuracy()

# ---- FORECAST ----

calibration_tbl %>%
  modeltime_forecast(
    new_data = testing(splits),
    actual_data = m750
  )
```

---

`modeltime_fit_workflowset`*Fit a workflowset object to one or multiple time series*

---

## Description

This is a wrapper for `fit()` that takes a `workflowset` object and fits each model on one or multiple time series either sequentially or in parallel.

## Usage

```
modeltime_fit_workflowset(  
  object,  
  data,  
  ...,  
  control = control_fit_workflowset()  
)
```

## Arguments

<code>object</code>	A <code>workflow_set</code> object, generated with the <code>workflowsets::workflow_set</code> function.
<code>data</code>	A tibble that contains data to fit the models.
<code>...</code>	Not currently used.
<code>control</code>	An object used to modify the fitting process. See <a href="#">control_fit_workflowset()</a> .

## Value

A Modeltime Table containing one or more fitted models.

## See Also

[control\\_fit\\_workflowset\(\)](#)

## Examples

```
library(tidymodels)  
library(modeltime)  
library(workflowsets)  
library(tidyverse)  
library(lubridate)  
library(timetk)  
  
data_set <- m4_monthly  
  
# SETUP WORKFLOWSETS
```

```

rec1 <- recipe(value ~ date + id, data_set) %>%
  step_mutate(date_num = as.numeric(date)) %>%
  step_mutate(month_lbl = lubridate::month(date, label = TRUE)) %>%
  step_dummy(all_nominal(), one_hot = TRUE)

mod1 <- linear_reg() %>% set_engine("lm")

mod2 <- prophet_reg() %>% set_engine("prophet")

wfsets <- workflowsets::workflow_set(
  preproc = list(rec1 = rec1),
  models = list(
    mod1 = mod1,
    mod2 = mod2
  ),
  cross = TRUE
)

# FIT WORKFLOWSETS
# - Returns a Modeltime Table with fitted workflowsets

wfsets %>% modeltime_fit_workflowset(data_set)

```

---

modeltime\_forecast      *Forecast future data*

---

## Description

The goal of `modeltime_forecast()` is to simplify the process of forecasting future data.

## Usage

```

modeltime_forecast(
  object,
  new_data = NULL,
  h = NULL,
  actual_data = NULL,
  conf_interval = 0.95,
  conf_by_id = FALSE,
  keep_data = FALSE,
  arrange_index = FALSE,
  ...
)

```

## Arguments

`object`            A Modeltime Table

new_data	A tibble containing future information to forecast. If NULL, forecasts the calibration data.
h	The forecast horizon (can be used instead of new_data for time series with no exogenous regressors). Extends the calibration data h periods into the future.
actual_data	Reference data that is combined with the output tibble and given a .key = "actual"
conf_interval	An estimated confidence interval based on the calibration data. This is designed to estimate future confidence from <i>out-of-sample prediction error</i> .
conf_by_id	Whether or not to produce confidence interval estimates by an ID feature. <ul style="list-style-type: none"> <li>• When FALSE, a global model confidence interval is provided.</li> <li>• If TRUE, a local confidence interval is provided group-wise for each time series ID. To enable local confidence interval, an id must be provided during modeltime_calibrate().</li> </ul>
keep_data	Whether or not to keep the new_data and actual_data as extra columns in the results. This can be useful if there is an important feature in the new_data and actual_data needed when forecasting. Default: FALSE.
arrange_index	Whether or not to sort the index in rowwise chronological order (oldest to newest) or to keep the original order of the data. Default: FALSE.
...	Not currently used

## Details

The `modeltime_forecast()` function prepares a forecast for visualization with `plot_modeltime_forecast()`. The forecast is controlled by `new_data` or `h`, which can be combined with existing data (controlled by `actual_data`). Confidence intervals are included if the incoming Modeltime Table has been calibrated using `modeltime_calibrate()`. Otherwise confidence intervals are not estimated.

### New Data

When forecasting you can specify future data using `new_data`. This is a future tibble with date column and columns for xregs extending the trained dates and exogenous regressors (xregs) if used.

- **Forecasting Evaluation Data:** By default, the `new_data` will use the `.calibration_data` if `new_data` is not provided. This is the equivalent of using `rsample::testing()` for getting test data sets.
- **Forecasting Future Data:** See `timetk::future_frame()` for creating future tibbles.
- **Xregs:** Can be used with this method

### H (Horizon)

When forecasting, you can specify `h`. This is a phrase like "1 year", which extends the `.calibration_data` (1st priority) or the `actual_data` (2nd priority) into the future.

- **Forecasting Future Data:** All forecasts using `h` are **extended after the calibration data or actual\_data**.
- Extending `.calibration_data` - Calibration data is given 1st priority, which is desirable *after refitting* with `modeltime_refit()`. Internally, a call is made to `timetk::future_frame()` to expedite creating new data using the date feature.

- Extending `actual_data` - If `h` is provided, and the `modeltime` table has not been calibrated, the "actual\_data" will be extended into the future. This is useful in situations where you want to go directly from `modeltime_table()` to `modeltime_forecast()` without calibrating or refitting.
- **Xregs**: Cannot be used because future data must include new xregs. If xregs are desired, build a future data frame and use `new_data`.

### Actual Data

This is reference data that contains the true values of the time-stamp data. It helps in visualizing the performance of the forecast vs the actual data.

When `h` is used and the `Modeltime Table` has *not been calibrated*, then the actual data is extended into the future periods that are defined by `h`.

### Confidence Interval Estimation

Confidence intervals (`.conf_lo`, `.conf_hi`) are estimated based on the normal estimation of the testing errors (out of sample) from `modeltime_calibrate()`. The out-of-sample error estimates are then carried through and applied to any future forecasts.

The confidence interval can be adjusted with the `conf_interval` parameter. An 80% confidence interval estimates a normal (Gaussian distribution) that assumes that 80% of the future data will fall within the upper and lower confidence limits.

The confidence interval is *mean-adjusted*, meaning that if the mean of the residuals is non-zero, the confidence interval is adjusted to widen the interval to capture the difference in means.

Refitting has no effect on the confidence interval since this is calculated independently of the refitted model (on data with a smaller sample size). New observations typically improve future accuracy, which in most cases makes the out-of-sample confidence intervals conservative.

### Keep Data

Include the new data (and actual data) as extra columns with the results of the model forecasts. This can be helpful when the new data includes information useful to the forecasts. An example is when forecasting *Panel Data* and the new data contains ID features related to the time series group that the forecast belongs to.

### Arrange Index

By default, `modeltime_forecast()` keeps the original order of the data. If desired, the user can sort the output by `.key`, `.model_id` and `.index`.

### Value

A tibble with predictions and time-stamp data. For ease of plotting and calculations, the column names are transformed to:

- `.key`: Values labeled either "prediction" or "actual"
- `.index`: The timestamp index.
- `.value`: The value being forecasted.

Additionally, if the `Modeltime Table` has been previously calibrated using `modeltime_calibrate()`, you will gain confidence intervals.

- `.conf_lo`: The lower limit of the confidence interval.

- `.conf_hi`: The upper limit of the confidence interval.

Additional descriptive columns are included:

- `.model_id`: Model ID from the Modeltime Table
- `.model_desc`: Model Description from the Modeltime Table

Unnecessary columns are *dropped* to save space:

- `.model`
- `.calibration_data`

### Examples

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- CALIBRATE ----

calibration_tbl <- models_tbl %>%
  modeltime_calibrate(new_data = testing(splits))

# ---- ACCURACY ----

calibration_tbl %>%
  modeltime_accuracy()

# ---- FUTURE FORECAST ----
```



```

calibration_tbl %>%
  modeltime_forecast(
    new_data = testing(splits),
    actual_data = m750
  )

# ---- ALTERNATIVE: FORECAST WITHOUT CONFIDENCE INTERVALS ----
# Skips Calibration Step, No Confidence Intervals

models_tbl %>%
  modeltime_forecast(
    new_data = testing(splits),
    actual_data = m750
  )

# ---- KEEP NEW DATA WITH FORECAST ----
# Keeps the new data. Useful if new data has information
# like ID features that should be kept with the forecast data

calibration_tbl %>%
  modeltime_forecast(
    new_data = testing(splits),
    keep_data = TRUE
  )

```

---

modeltime\_nested\_fit *Fit Tidymodels Workflows to Nested Time Series*

---

## Description

Fits one or more tidymodels workflow objects to nested time series data using the following process:

1. Models are iteratively fit to training splits.
2. Accuracy is calculated on testing splits and is logged. Accuracy results can be retrieved with [extract\\_nested\\_test\\_accuracy\(\)](#)
3. Any model that returns an error is logged. Error logs can be retrieved with [extract\\_nested\\_error\\_report\(\)](#)
4. Forecast is predicted on testing splits and is logged. Forecast results can be retrieved with [extract\\_nested\\_test\\_forecast\(\)](#)

## Usage

```

modeltime_nested_fit(
  nested_data,
  ...,
  model_list = NULL,
  metric_set = default_forecast_accuracy_metric_set(),

```

```

  conf_interval = 0.95,
  control = control_nested_fit()
)

```

### Arguments

nested_data	Nested time series data
...	Tidymodels workflow objects that will be fit to the nested time series data.
model_list	Optionally, a <code>list()</code> of Tidymodels workflow objects can be provided
metric_set	A <code>yardstick::metric_set()</code> that is used to summarize one or more forecast accuracy (regression) metrics.
conf_interval	An estimated confidence interval based on the calibration data. This is designed to estimate future confidence from <i>out-of-sample prediction error</i> .
control	Used to control verbosity and parallel processing. See <code>control_nested_fit()</code> .

### Details

#### Preparing Data for Nested Forecasting:

Use `extend_timeseries()`, `nest_timeseries()`, and `split_nested_timeseries()` for preparing data for Nested Forecasting. The structure must be a nested data frame, which is supplied in `modeltime_nested_fit(nested_data)`.

#### Fitting Models:

Models must be in the form of tidymodels workflow objects. The models can be provided in two ways:

1. Using `...` (dots): The workflow objects can be provided as dots.
2. Using `model_list` parameter: You can supply one or more workflow objects that are wrapped in a `list()`.

#### Controlling the fitting process:

A control object can be provided during fitting to adjust the verbosity and parallel processing. See `control_nested_fit()`.

---

modeltime\_nested\_forecast

*Modeltime Nested Forecast*

---

### Description

Make a new forecast from a Nested Modeltime Table.

**Usage**

```

modeltime_nested_forecast(
  object,
  h = NULL,
  include_actual = TRUE,
  conf_interval = 0.95,
  id_subset = NULL,
  control = control_nested_forecast()
)

```

**Arguments**

object	A Nested Modeltime Table
h	The forecast horizon. Extends the "trained on" data "h" periods into the future.
include_actual	Whether or not to include the ".actual_data" as part of the forecast. If FALSE, just returns the forecast predictions.
conf_interval	An estimated confidence interval based on the calibration data. This is designed to estimate future confidence from <i>out-of-sample prediction error</i> .
id_subset	A sequence of ID's from the modeltime table to subset the forecasting process. This can speed forecasts up.
control	Used to control verbosity and parallel processing. See <a href="#">control_nested_forecast()</a> .

**Details**

This function is designed to help users that want to make new forecasts other than those that are created during the logging process as part of the Nested Modeltime Workflow.

**Logged Forecasts:**

The logged forecasts can be extracted using:

- [extract\\_nested\\_future\\_forecast\(\)](#): Extracts the future forecast created after refitting with `modeltime_nested_refit()`.
- [extract\\_nested\\_test\\_forecast\(\)](#): Extracts the test forecast created after initial fitting with `modeltime_nested_fit()`.

The problem is that these forecasts are static. The user would need to redo the fitting, model selection, and refitting process to obtain new forecasts. This is why `modeltime_nested_forecast()` exists. So you can create a new forecast without retraining any models.

**Nested Forecasts:**

The main arguments is h, which is a horizon that specifies how far into the future to make the new forecast.

- If h = NULL, a logged forecast will be returned
- If h = 12, a new forecast will be generated that extends each series 12-periods into the future.
- If h = "2 years", a new forecast will be generated that extends each series 2-years into the future.

Use the `id_subset` to filter the Nested Modeltime Table object to just the time series of interest. Use the `conf_interval` to override the logged confidence interval. Note that this will have no effect if `h = NULL` as logged forecasts are returned. So be sure to provide `h` if you want to update the confidence interval.

Use the `control` argument to apply verbosity during the forecasting process and to run forecasts in parallel. Generally, `parallel` is better if many forecasts are being generated.

---

`modeltime_nested_refit`

*Refits a Nested Modeltime Table*

---

### Description

Refits a Nested Modeltime Table to actual data using the following process:

1. Models are iteratively refit to `.actual_data`.
2. Any model that returns an error is logged. Errors can be retrieved with [extract\\_nested\\_error\\_report\(\)](#)
3. Forecast is predicted on `future_data` and is logged. Forecast can be retrieved with [extract\\_nested\\_future\\_forecast\(\)](#)

### Usage

```
modeltime_nested_refit(object, control = control_nested_refit())
```

### Arguments

<code>object</code>	A Nested Modeltime Table
<code>control</code>	Used to control verbosity and parallel processing. See <a href="#">control_nested_refit()</a> .

---

`modeltime_nested_select_best`

*Select the Best Models from Nested Modeltime Table*

---

### Description

Finds the best models for each time series group in a Nested Modeltime Table using a metric that the user specifies.

- Logs the best results, which can be accessed with [extract\\_nested\\_best\\_model\\_report\(\)](#)
- If `filter_test_forecasts = TRUE`, updates the test forecast log, which can be accessed [extract\\_nested\\_test\\_forecast\(\)](#)

**Usage**

```
modeltime_nested_select_best(
  object,
  metric = "rmse",
  minimize = TRUE,
  filter_test_forecasts = TRUE
)
```

**Arguments**

object	A Nested Modeltime Table
metric	A metric to minimize or maximize. By default available metrics are: <ul style="list-style-type: none"> <li>• "rmse" (default)</li> <li>• "mae"</li> <li>• "mape"</li> <li>• "mase"</li> <li>• "smape"</li> <li>• "rsq"</li> </ul>
minimize	Whether to minimize or maximize. Default: TRUE (minimize).
filter_test_forecasts	Whether or not to update the test forecast log to filter only the best forecasts. Default: TRUE.

---

modeltime_refit	<i>Refit one or more trained models to new data</i>
-----------------	---

---

**Description**

This is a wrapper for fit() that takes a Modeltime Table and retrains each model on *new data* re-using the parameters and preprocessing steps used during the training process.

**Usage**

```
modeltime_refit(object, data, ..., control = control_refit())
```

**Arguments**

object	A Modeltime Table
data	A tibble that contains data to retrain the model(s) using.
...	Additional arguments to control refitting.
	<b>Ensemble Model Spec</b> (modeltime.ensemble): When making a meta-learner with modeltime.ensemble::ensemble_model_spec(), used to pass resamples argument containing results from modeltime.resample::modeltime_fit_resa
control	Used to control verbosity and parallel processing. See <a href="#">control_refit()</a> .

## Details

Refitting is an important step prior to forecasting time series models. The `modeltime_refit()` function makes it easy to recycle models, retraining on new data.

### Recycling Parameters

Parameters are recycled during retraining using the following criteria:

- **Automated models** (e.g. "auto arima") will have parameters recalculated.
- **Non-automated models** (e.g. "arima") will have parameters preserved.
- All preprocessing steps will be reused on the data

### Refit

The `modeltime_refit()` function is used to retrain models trained with `fit()`.

### Refit XY

The XY format is not supported at this time.

## Value

A Modeltime Table containing one or more re-trained models.

## See Also

[control\\_refit\(\)](#)

## Examples

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
```

```
)  
  
# ---- CALIBRATE ----  
# - Calibrate on training data set  
  
calibration_tbl <- models_tbl %>%  
  modeltime_calibrate(new_data = testing(splits))  
  
# ---- REFIT ----  
# - Refit on full data set  
  
refit_tbl <- calibration_tbl %>%  
  modeltime_refit(m750)
```

---

modeltime\_residuals    *Extract Residuals Information*

---

## Description

This is a convenience function to unnest model residuals

## Usage

```
modeltime_residuals(object, new_data = NULL, quiet = TRUE, ...)
```

## Arguments

object	A Modeltime Table
new_data	A tibble to predict and calculate residuals on. If provided, overrides any calibration data.
quiet	Hide errors (TRUE, the default), or display them as they occur?
...	Not currently used.

## Value

A tibble with residuals.

## Examples

```
library(tidyverse)  
library(lubridate)  
library(timetk)  
library(parsnip)  
library(rsample)
```

```

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- RESIDUALS ----

# In-Sample
models_tbl %>%
  modeltime_calibrate(new_data = training(splits)) %>%
  modeltime_residuals() %>%
  plot_modeltime_residuals(.interactive = FALSE)

# Out-of-Sample
models_tbl %>%
  modeltime_calibrate(new_data = testing(splits)) %>%
  modeltime_residuals() %>%
  plot_modeltime_residuals(.interactive = FALSE)

```

---

```
modeltime_residuals_test
```

*Apply Statistical Tests to Residuals*

---

## Description

This is a convenience function to calculate some statistical tests on the residuals models. Currently, the following statistics are calculated: the shapiro.test to check the normality of the residuals, the box-pierce and ljung-box tests and the durbin watson test to check the autocorrelation of the residuals. In all cases the p-values are returned.

## Usage

```
modeltime_residuals_test(object, new_data = NULL, lag = 1, fitdf = 0, ...)
```



**Arguments**

<code>object</code>	A tibble extracted from <code>modeltime::modeltime_residuals()</code> .
<code>new_data</code>	A tibble to predict and calculate residuals on. If provided, overrides any calibration data.
<code>lag</code>	The statistic will be based on lag autocorrelation coefficients. Default: 1 (Applies to Box-Pierce, Ljung-Box, and Durbin-Watson Tests)
<code>fitdf</code>	Number of degrees of freedom to be subtracted. Default: 0 (Applies Box-Pierce and Ljung-Box Tests)
<code>...</code>	Not currently used

**Details****Shapiro-Wilk Test**

The Shapiro-Wilk tests the Normality of the residuals. The Null Hypothesis is that the residuals are normally distributed. A low P-Value below a given significance level indicates the values are NOT Normally Distributed.

If the **p-value > 0.05 (good)**, this implies that the distribution of the data are not significantly different from normal distribution. In other words, we can assume the normality.

**Box-Pierce and Ljung-Box Tests Tests**

The Ljung-Box and Box-Pierce tests are methods that test for the absence of autocorrelation in residuals. A low p-value below a given significance level indicates the values are autocorrelated.

If the **p-value > 0.05 (good)**, this implies that the residuals of the data are independent. In other words, we can assume the residuals are not autocorrelated.

For more information about the parameters associated with the Box Pierce and Ljung Box tests check `?Box.Test`

**Durbin-Watson Test**

The Durbin-Watson test is a method that tests for the absence of autocorrelation in residuals. The Durbin Watson test reports a test statistic, with a value from 0 to 4, where:

- **2 is no autocorrelation (good)**
- From 0 to <2 is positive autocorrelation (common in time series data)
- From >2 to 4 is negative autocorrelation (less common in time series data)

**Value**

A tibble with with the p-values of the calculated statistical tests.

**See Also**

[stats::shapiro.test\(\)](#), [stats::Box.test\(\)](#)

**Examples**

```

library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- RESIDUALS ----

# In-Sample
models_tbl %>%
  modeltime_calibrate(new_data = training(splits)) %>%
  modeltime_residuals() %>%
  modeltime_residuals_test()

# Out-of-Sample
models_tbl %>%
  modeltime_calibrate(new_data = testing(splits)) %>%
  modeltime_residuals() %>%
  modeltime_residuals_test()

```

---

modeltime\_table

*Scale forecast analysis with a Modeltime Table*


---

**Description**

Designed to perform forecasts at scale using models created with `modeltime`, `parsnip`, `workflows`, and regression modeling extensions in the `tidymodels` ecosystem.

**Usage**

```
modeltime_table(...)

as_modeltime_table(.l)
```

**Arguments**

```
...      Fitted parsnip model or workflow objects
.l       A list containing fitted parsnip model or workflow objects
```

**Details**

modeltime\_table():

1. Creates a table of models
2. Validates that all objects are models (parsnip or workflows objects) and all models have been fitted (trained)
3. Provides an ID and Description of the models

as\_modeltime\_table():

Converts a list of models to a modeltime table. Useful if programatically creating Modeltime Tables from models stored in a list.

**Examples**

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

# Make a Modeltime Table
models_tbl <- modeltime_table(
```

```

    model_fit_prophet
  )

# Can also convert a list of models
list(model_fit_prophet) %>%
  as_modeltime_table()

# ---- CALIBRATE ----

calibration_tbl <- models_tbl %>%
  modeltime_calibrate(new_data = testing(splits))

# ---- ACCURACY ----

calibration_tbl %>%
  modeltime_accuracy()

# ---- FORECAST ----

calibration_tbl %>%
  modeltime_forecast(
    new_data = testing(splits),
    actual_data = m750
  )

```

---

naive_fit_impl	<i>Low-Level NAIVE Forecast</i>
----------------	---------------------------------

---

## Description

Low-Level NAIVE Forecast

## Usage

```
naive_fit_impl(x, y, id = NULL, seasonal_period = "auto", ...)
```

## Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
id	An optional ID feature to identify different time series. Should be a quoted name.
seasonal_period	Not used for NAIVE forecast but here for consistency with SNAIVE
...	Not currently used

---

naive_predict_impl	<i>Bridge prediction function for NAIVE Models</i>
--------------------	--

---

**Description**

Bridge prediction function for NAIVE Models

**Usage**

```
naive_predict_impl(object, new_data)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.

---

naive_reg	<i>General Interface for NAIVE Forecast Models</i>
-----------	--

---

**Description**

`naive_reg()` is a way to generate a *specification* of an NAIVE or SNAIVE model before fitting and allows the model to be created using different packages.

**Usage**

```
naive_reg(mode = "regression", id = NULL, seasonal_period = NULL)
```

**Arguments**

mode	A single character string for the type of model. The only possible value for this model is "regression".
id	An optional quoted column name (e.g. "id") for identifying multiple time series (i.e. panel data).
seasonal_period	SNAIVE only. A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.

**Details**

The data given to the function are not saved and are only used to determine the *mode* of the model. For `naive_reg()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "naive" (default) - Performs a NAIVE forecast
- "snaive" - Performs a Seasonal NAIVE forecast

## Engine Details

### naive (default engine)

- The engine uses `naive_fit_impl()`
- The NAIVE implementation uses the last observation and forecasts this value forward.
- The `id` can be used to distinguish multiple time series contained in the data
- The `seasonal_period` is not used but provided for consistency with the SNAIVE implementation

### snaive (default engine)

- The engine uses `snaive_fit_impl()`
- The SNAIVE implementation uses the last seasonal series in the data and forecasts this sequence of observations forward
- The `id` can be used to distinguish multiple time series contained in the data
- The `seasonal_period` is used to determine how far back to define the repeated series. This can be a numeric value (e.g. 28) or a period (e.g. "1 month")

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### ID features (Multiple Time Series, Panel Data)

The `id` parameter is populated using the `fit()` or `fit_xy()` function:

*ID Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `series_id` (a unique identifier that identifies each time series in your data).

The `series_id` can be passed to the `naive_reg()` using `fit()`:

- `naive_reg(id = "series_id")` specifies that the `series_id` column should be used to identify each time series.
- `fit(y ~ date + series_id)` will pass `series_id` on to the underlying naive or snaive functions.

### Seasonal Period Specification (snaive)

The period can be non-seasonal (`seasonal_period = 1` or `"none"`) or yearly seasonal (e.g. For monthly time stamps, `seasonal_period = 12`, `seasonal_period = "12 months"`, or `seasonal_period = "yearly"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A seasonal period is selected based on the periodicity of the data (e.g. 12 if monthly)

2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

### External Regressors (Xregs)

These models are univariate. No xregs are used in the modeling process.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- NAIVE ----

# Model Spec
model_spec <- naive_reg() %>%
  set_engine("naive")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- SEASONAL NAIVE ----

# Model Spec
model_spec <- naive_reg(
  id = "id",
  seasonal_period = 12
) %>%
  set_engine("snaive")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date + id, data = training(splits))
model_fit
```

---

new\_modeltime\_bridge *Constructor for creating modeltime models*

---

## Description

These functions are used to construct new modeltime bridge functions that connect the tidymodels infrastructure to time-series models containing date or date-time features.

## Usage

```
new_modeltime_bridge(class, models, data, extras = NULL, desc = NULL)
```

## Arguments

class	A class name that is used for creating custom printing messages
models	A list containing one or more models
data	A data frame (or tibble) containing 4 columns: (date column with name that matches input data), .actual, .fitted, and .residuals.
extras	An optional list that is typically used for transferring preprocessing recipes to the predict method.
desc	An optional model description to appear when printing your modeltime objects

## Examples

```
library(stats)
library(tidyverse)
library(lubridate)
library(timetk)

lm_model <- lm(value ~ as.numeric(date) + hour(date) + wday(date, label = TRUE),
              data = taylor_30_min)

data = tibble(
  date      = taylor_30_min$date, # Important - The column name must match the modeled data
  # These are standardized names: .actual, .fitted, .residuals
  .actual   = taylor_30_min$value,
  .fitted   = lm_model$fitted.values %>% as.numeric(),
  .residuals = lm_model$residuals %>% as.numeric()
)

new_modeltime_bridge(
  class = "lm_time_series_impl",
  models = list(model_1 = lm_model),
  data = data,
  extras = NULL
)
```



---

nnetar\_fit\_impl      *Low-Level NNETAR function for translating modeltime to forecast*

---

### Description

Low-Level NNETAR function for translating modeltime to forecast

### Usage

```
nnetar_fit_impl(
  x,
  y,
  period = "auto",
  p = 1,
  P = 1,
  size = 10,
  repeats = 20,
  decay = 0,
  maxit = 100,
  ...
)
```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
p	Embedding dimension for non-seasonal time series. Number of non-seasonal lags used as inputs. For non-seasonal time series, the default is the optimal number of lags (according to the AIC) for a linear AR(p) model. For seasonal time series, the same method is used but applied to seasonally adjusted data (from an stl decomposition).
P	Number of seasonal lags used as inputs.
size	Number of nodes in the hidden layer. Default is half of the number of input nodes (including external regressors, if given) plus 1.
repeats	Number of networks to fit with different random starting weights. These are then averaged when producing forecasts.
decay	Parameter for weight decay. Default 0.
maxit	Maximum number of iterations. Default 100.
...	Additional arguments passed to forecast::nnetar

---

nnetar\_params

*Tuning Parameters for NNETAR Models*


---

**Description**

Tuning Parameters for NNETAR Models

**Usage**

```
num_networks(range = c(1L, 100L), trans = NULL)
```

**Arguments**

range	A two-element vector holding the <i>defaults</i> for the smallest and largest possible values, respectively.
trans	A trans object from the scales package, such as <code>scales::log10_trans()</code> or <code>scales::reciprocal_trans()</code> . If not provided, the default is used which matches the units used in range. If no transformation, NULL.

**Details**

The main parameters for NNETAR models are:

- `non_seasonal_ar`: Number of non-seasonal auto-regressive (AR) lags. Often denoted "p" in pdq-notation.
- `seasonal_ar`: Number of seasonal auto-regressive (SAR) lags. Often denoted "P" in PDQ-notation.
- `hidden_units`: An integer for the number of units in the hidden model.
- `num_networks`: Number of networks to fit with different random starting weights. These are then averaged when producing forecasts.
- `penalty`: A non-negative numeric value for the amount of weight decay.
- `epochs`: An integer for the number of training iterations.

**See Also**

[non\\_seasonal\\_ar\(\)](#), [seasonal\\_ar\(\)](#), [dials::hidden\\_units\(\)](#), [dials::penalty\(\)](#), [dials::epochs\(\)](#)

**Examples**

```
num_networks()
```

---

nnetar\_predict\_impl     *Bridge prediction function for ARIMA models*

---

### Description

Bridge prediction function for ARIMA models

### Usage

```
nnetar_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>forecast::forecast()</code>

---

nnetar\_reg                 *General Interface for NNETAR Regression Models*

---

### Description

`nnetar_reg()` is a way to generate a *specification* of an NNETAR model before fitting and allows the model to be created using different packages. Currently the only package is `forecast`.

### Usage

```
nnetar_reg(
  mode = "regression",
  seasonal_period = NULL,
  non_seasonal_ar = NULL,
  seasonal_ar = NULL,
  hidden_units = NULL,
  num_networks = NULL,
  penalty = NULL,
  epochs = NULL
)
```

### Arguments

mode	A single character string for the type of model. The only possible value for this model is "regression".
seasonal_period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.

non_seasonal_ar	The order of the non-seasonal auto-regressive (AR) terms. Often denoted "p" in pdq-notation.
seasonal_ar	The order of the seasonal auto-regressive (SAR) terms. Often denoted "P" in PDQ-notation.
hidden_units	An integer for the number of units in the hidden model.
num_networks	Number of networks to fit with different random starting weights. These are then averaged when producing forecasts.
penalty	A non-negative numeric value for the amount of weight decay.
epochs	An integer for the number of training iterations.

### Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `nnetar_reg()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "nnetar" (default) - Connects to [forecast::nnetar\(\)](#)

### Main Arguments

The main arguments (tuning parameters) for the model are the parameters in `nnetar_reg()` function. These arguments are converted to their specific names at the time that the model is fit.

Other options and argument can be set using `set_engine()` (See Engine Details below).

If parameters need to be modified, `update()` can be used in lieu of recreating the object from scratch.

### Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

<code>modeltime</code>	<code>forecast::nnetar</code>
<code>seasonal_period</code>	<code>ts(frequency)</code>
<code>non_seasonal_ar</code>	<code>p (1)</code>
<code>seasonal_ar</code>	<code>P (1)</code>
<code>hidden_units</code>	<code>size (10)</code>
<code>num_networks</code>	<code>repeats (20)</code>
<code>epochs</code>	<code>maxit (100)</code>
<code>penalty</code>	<code>decay (0)</code>

Other options can be set using `set_engine()`.

### nnetar

The engine uses [forecast::nnetar\(\)](#).

Function Parameters:

```
## function (y, p, P = 1, size, repeats = 20, xreg = NULL, lambda = NULL,
##       model = NULL, subset = NULL, scale.inputs = TRUE, x = y, ...)
```

Parameter Notes:

- `xreg` - This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).
- `size` - Is set to 10 by default. This differs from the forecast implementation
- `p` and `P` - Are set to 1 by default.
- `maxit` and `decay` are `nnet::nnet` parameters that are exposed in the `nnetar_reg()` interface. These are key tuning parameters.

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### Seasonal Period Specification

The period can be non-seasonal (`seasonal_period = 1` or "none") or yearly seasonal (e.g. For monthly time stamps, `seasonal_period = 12`, `seasonal_period = "12 months"`, or `seasonal_period = "yearly"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A seasonal period is selected based on the periodicity of the data (e.g. 12 if monthly)
2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

### Univariate (No xregs, Exogenous Regressors):

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

### Multivariate (xregs, Exogenous Regressors)

The `xreg` parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),

3. month.lbl (labeled month as a ordered factor).

The month.lbl is an exogenous regressor that can be passed to the nnetar\_reg() using fit():

- fit(y ~ date + month.lbl) will pass month.lbl on as an exogenous regressor.
- fit\_xy(data[,c("date", "month.lbl")], y = data\$y) will pass x, where x is a data frame containing month.lbl and the date feature. Only month.lbl will be used as an exogenous regressor.

Note that date or date-time class values are excluded from xreg.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- NNETAR ----

# Model Spec
model_spec <- nnetar_reg() %>%
  set_engine("nnetar")

# Fit Spec
set.seed(123)
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit
```

---

panel\_tail

*Filter the last N rows (Tail) for multiple time series*

---

### Description

Filter the last N rows (Tail) for multiple time series

**Usage**

```
panel_tail(data, id, n)
```

**Arguments**

data	A data frame
id	An "id" feature indicating which column differentiates the time series panels
n	The number of rows to filter

**Value**

A data frame

**See Also**

- [recursive\(\)](#) - used to generate recursive autoregressive models

**Examples**

```
library(timetk)

# Get the last 6 observations from each group
m4_monthly %>%
  panel_tail(id = id, n = 6)
```

---

parallel_start	<i>Start parallel clusters using parallel package</i>
----------------	---

---

**Description**

Start parallel clusters using parallel package

**Usage**

```
parallel_start(..., .method = c("parallel", "spark"))

parallel_stop()
```

**Arguments**

...	Parameters passed to underlying functions (See Details Section)
.method	The method to create the parallel backend. Supports: <ul style="list-style-type: none"> <li>• "parallel" - Uses the parallel and doParallel packages</li> <li>• "spark" - Uses the sparklyr package</li> </ul>

**Parallel (.method = "parallel")**

Performs 3 Steps:

1. Makes clusters using `parallel::makeCluster(...)`. The `parallel_start(...)` are passed to `parallel::makeCluster(...)`.
2. Registers clusters using `doParallel::registerDoParallel()`.
3. Adds `.libPaths()` using `parallel::clusterCall()`.

**Spark (.method = "spark")**

- Important, make sure to create a spark connection using `sparklyr::spark_connect()`.
- Pass the connection object as the first argument. For example, `parallel_start(sc, .method = "spark")`.
- The `parallel_start(...)` are passed to `sparklyr::registerDoSpark(...)`.

**Examples**

```
# Starts 2 clusters
parallel_start(2)

# Returns to sequential processing
parallel_stop()
```

---

parse\_index

*Developer Tools for parsing date and date-time information*

---

**Description**

These functions are designed to assist developers in extending the `modeltime` package.

**Usage**

```
parse_index_from_data(data)

parse_period_from_index(data, period)
```

**Arguments**

<code>data</code>	A data frame
<code>period</code>	A period to calculate from the time index. Numeric values are returned as-is. "auto" guesses a numeric value from the index. A time-based phrase (e.g. "7 days") calculates the number of timestamps that typically occur within the time-based phrase.



**Value**

- `parse_index_from_data()`: Returns a tibble containing the date or date-time column.
- `parse_period_from_index()`: Returns the numeric period from a tibble containing the index.

**Examples**

```
library(dplyr)
library(timetk)

predictors <- m4_monthly %>%
  filter(id == "M750") %>%
  select(-value)

index_tbl <- parse_index_from_data(predictors)
index_tbl

period <- parse_period_from_index(index_tbl, period = "1 year")
period
```

---

`plot_modeltime_forecast`*Interactive Forecast Visualization*

---

**Description**

This is a wrapper for `plot_time_series()` that generates an interactive (plotly) or static (ggplot2) plot with the forecasted data.

**Usage**

```
plot_modeltime_forecast(
  .data,
  .conf_interval_show = TRUE,
  .conf_interval_fill = "grey20",
  .conf_interval_alpha = 0.2,
  .smooth = FALSE,
  .legend_show = TRUE,
  .legend_max_width = 40,
  .title = "Forecast Plot",
  .x_lab = "",
  .y_lab = "",
  .color_lab = "Legend",
  .interactive = TRUE,
  .plotly_slider = FALSE,
  ...
)
```

**Arguments**

<code>.data</code>	A tibble that is the output of <code>modeltime_forecast()</code>
<code>.conf_interval_show</code>	Logical. Whether or not to include the confidence interval as a ribbon.
<code>.conf_interval_fill</code>	Fill color for the confidence interval
<code>.conf_interval_alpha</code>	Fill opacity for the confidence interval. Range (0, 1).
<code>.smooth</code>	Logical - Whether or not to include a trendline smoother. Uses See <code>smooth_vec()</code> to apply a LOESS smoother.
<code>.legend_show</code>	Logical. Whether or not to show the legend. Can save space with long model descriptions.
<code>.legend_max_width</code>	Numeric. The width of truncation to apply to the legend text.
<code>.title</code>	Title for the plot
<code>.x_lab</code>	X-axis label for the plot
<code>.y_lab</code>	Y-axis label for the plot
<code>.color_lab</code>	Legend label if a <code>color_var</code> is used.
<code>.interactive</code>	Returns either a static (ggplot2) visualization or an interactive (plotly) visualization
<code>.plotly_slider</code>	If TRUE, returns a plotly date range slider.
<code>...</code>	Additional arguments passed to <code>timetk::plot_time_series()</code> .

**Value**

A static ggplot2 plot or an interactive plotly plot containing a forecast

**Examples**

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
```

```

    set_engine(engine = "prophet") %>%
    fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- FORECAST ----

models_tbl %>%
  modeltime_calibrate(new_data = testing(splits)) %>%
  modeltime_forecast(
    new_data = testing(splits),
    actual_data = m750
  ) %>%
  plot_modeltime_forecast(.interactive = FALSE)

```

---

plot\_modeltime\_residuals

*Interactive Residuals Visualization*


---

## Description

This is a wrapper for examining residuals using:

- Time Plot: [plot\\_time\\_series\(\)](#)
- ACF Plot: [plot\\_acf\\_diagnostics\(\)](#)
- Seasonality Plot: [plot\\_seasonal\\_diagnostics\(\)](#)

## Usage

```

plot_modeltime_residuals(
  .data,
  .type = c("timeplot", "acf", "seasonality"),
  .smooth = FALSE,
  .legend_show = TRUE,
  .legend_max_width = 40,
  .title = "Residuals Plot",
  .x_lab = "",
  .y_lab = "",
  .color_lab = "Legend",
  .interactive = TRUE,
  ...
)

```

**Arguments**

.data	A tibble that is the output of <code>modeltime_residuals()</code>
.type	One of "timeplot", "acf", or "seasonality". The default is "timeplot".
.smooth	Logical - Whether or not to include a trendline smoother. Uses See <code>smooth_vec()</code> to apply a LOESS smoother.
.legend_show	Logical. Whether or not to show the legend. Can save space with long model descriptions.
.legend_max_width	Numeric. The width of truncation to apply to the legend text.
.title	Title for the plot
.x_lab	X-axis label for the plot
.y_lab	Y-axis label for the plot
.color_lab	Legend label if a <code>color_var</code> is used.
.interactive	Returns either a static (ggplot2) visualization or an interactive (plotly) visualization
...	Additional arguments passed to: <ul style="list-style-type: none"> <li>• Time Plot: <code>plot_time_series()</code></li> <li>• ACF Plot: <code>plot_acf_diagnostics()</code></li> <li>• Seasonality Plot: <code>plot_seasonal_diagnostics()</code></li> </ul>

**Value**

A static ggplot2 plot or an interactive plotly plot containing residuals vs time

**Examples**

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))
```

```

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- RESIDUALS ----

residuals_tbl <- models_tbl %>%
  modeltime_calibrate(new_data = testing(splits)) %>%
  modeltime_residuals()

residuals_tbl %>%
  plot_modeltime_residuals(
    .type = "timeplot",
    .interactive = FALSE
  )

```

---

pluck\_modeltime\_model *Extract model by model id in a Modeltime Table*

---

## Description

The `pull_modeltime_model()` and `pluck_modeltime_model()` functions are synonyms.

## Usage

```
pluck_modeltime_model(object, .model_id)
```

```
## S3 method for class 'mdl_time_tbl'
pluck_modeltime_model(object, .model_id)
```

```
pull_modeltime_model(object, .model_id)
```

## Arguments

<code>object</code>	A Modeltime Table
<code>.model_id</code>	A numeric value matching the <code>.model_id</code> that you want to update

## See Also

- [combine\\_modeltime\\_tables\(\)](#): Combine 2 or more Modeltime Tables together
- [add\\_modeltime\\_model\(\)](#): Adds a new row with a new model to a Modeltime Table
- [update\\_modeltime\\_description\(\)](#): Updates a description for a model inside a Modeltime Table
- [update\\_modeltime\\_model\(\)](#): Updates a model inside a Modeltime Table
- [pull\\_modeltime\\_model\(\)](#): Extracts a model from a Modeltime Table

## Examples

```
m750_models %>%
  pluck_modeltime_model(2)
```

---

predict.recursive      *Recursive Model Predictions*

---

## Description

Make predictions from a recursive model.

## Usage

```
## S3 method for class 'recursive'
predict(object, new_data, type = NULL, opts = list(), ...)
```

## Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
type	A single character value or NULL. Possible values are "numeric", "class", "prob", "conf_int", "pred_int", "quantile", "time", "hazard", "survival", or "raw". When NULL, <code>predict()</code> will choose an appropriate value based on the model's mode.
opts	A list of optional arguments to the underlying predict function that will be used when <code>type = "raw"</code> . The list should not include options for the model object or the new data being predicted.
...	Arguments to the underlying model's prediction function cannot be passed here (see <code>opts</code> ). There are some <code>parsnip</code> related options that can be passed, depending on the value of <code>type</code> . Possible arguments are: <ul style="list-style-type: none"> <li><code>level</code>: for types of "conf_int" and "pred_int" this is the parameter for the tail area of the intervals (e.g. confidence level for confidence intervals). Default value is 0.95.</li> <li><code>std_error</code>: add the standard error of fit or prediction (on the scale of the linear predictors) for types of "conf_int" and "pred_int". Default value is FALSE.</li> <li><code>quantile</code>: the quantile(s) for quantile regression (not implemented yet)</li> <li><code>time</code>: the time(s) for hazard and survival probability estimates.</li> </ul>

## Details

Refer to [recursive\(\)](#) for further details and examples.

## Value

Numeric values for the recursive panel prediction

---

`predict.recursive_panel`*Recursive Model Predictions*

---

## Description

Make predictions from a recursive model.

## Usage

```
## S3 method for class 'recursive_panel'  
predict(object, new_data, type = NULL, opts = list(), ...)
```

## Arguments

<code>object</code>	An object of class <code>model_fit</code>
<code>new_data</code>	A rectangular data object, such as a data frame.
<code>type</code>	A single character value or NULL. Possible values are "numeric", "class", "prob", "conf_int", "pred_int", "quantile", "time", "hazard", "survival", or "raw". When NULL, <code>predict()</code> will choose an appropriate value based on the model's mode.
<code>opts</code>	A list of optional arguments to the underlying predict function that will be used when <code>type = "raw"</code> . The list should not include options for the model object or the new data being predicted.
<code>...</code>	Arguments to the underlying model's prediction function cannot be passed here (see <code>opts</code> ). There are some <code>parSNIP</code> related options that can be passed, depending on the value of <code>type</code> . Possible arguments are: <ul style="list-style-type: none"><li>• <code>level</code>: for types of "conf_int" and "pred_int" this is the parameter for the tail area of the intervals (e.g. confidence level for confidence intervals). Default value is 0.95.</li><li>• <code>std_error</code>: add the standard error of fit or prediction (on the scale of the linear predictors) for types of "conf_int" and "pred_int". Default value is FALSE.</li><li>• <code>quantile</code>: the quantile(s) for quantile regression (not implemented yet)</li><li>• <code>time</code>: the time(s) for hazard and survival probability estimates.</li></ul>

## Details

Refer to [recursive\(\)](#) for further details and examples.

## Value

Numeric values for the recursive panel prediction

---

```
prep_nested           Prepared Nested Modeltime Data
```

---

### Description

A set of functions to simplify preparation of nested data for iterative (nested) forecasting with Nested Modeltime Tables.

### Usage

```
extend_timeseries(.data, .id_var, .date_var, .length_future, ...)
nest_timeseries(.data, .id_var, .length_future, .length_actual = NULL)
split_nested_timeseries(.data, .length_test, .length_train = NULL, ...)
```

### Arguments

<code>.data</code>	A data frame or tibble containing time series data. The data should have: <ul style="list-style-type: none"> <li>• identifier (<code>.id_var</code>): Identifying one or more time series groups</li> <li>• date variable (<code>.date_var</code>): A date or date time column</li> <li>• target variable (<code>.value</code>): A column containing numeric values that is to be forecasted</li> </ul>
<code>.id_var</code>	An id column
<code>.date_var</code>	A date or datetime column
<code>.length_future</code>	Varies based on the function: <ul style="list-style-type: none"> <li>• <code>extend_timeseries()</code>: Defines how far into the future to extend the time series by each time series group.</li> <li>• <code>nest_timeseries()</code>: Defines which observations should be split into the <code>.future_data</code>.</li> </ul>
<code>...</code>	Additional arguments passed to the helper function. See details.
<code>.length_actual</code>	Can be used to slice the <code>.actual_data</code> to a most recent number of observations.
<code>.length_test</code>	Defines the length of the test split for evaluation.
<code>.length_train</code>	Defines the length of the training split for evaluation.

### Details

Preparation of nested time series follows a 3-Step Process:

#### Step 1: Extend the Time Series:

`extend_timeseries()`: A wrapper for `timetk::future_frame()` that extends a time series group-wise into the future.

- The group column is specified by `.id_var`.
- The date column is specified by `.date_var`.



- The length into the future is specified with `.length_future`.
- The `...` are additional parameters that can be passed to `timetk::future_frame()`

### Step 2: Nest the Time Series:

`nest_timeseries()`: A helper for nesting your data into `.actual_data` and `.future_data`.

- The group column is specified by `.id_var`
- The `.length_future` defines the length of the `.future_data`.
- The remaining data is converted to the `.actual_data`.
- The `.length_actual` can be used to slice the `.actual_data` to a most recent number of observations.

The result is a "nested data frame".

### Step 3: Split the Actual Data into Train/Test Splits:

`split_nested_timeseries()`: A wrapper for `timetk::time_series_split()` that generates training/testing splits from the `.actual_data` column.

- The `.length_test` is the primary argument that identifies the size of the testing sample. This is typically the same size as the `.future_data`.
- The `.length_train` is an optional size of the training data.
- The `...` (dots) are additional arguments that can be passed to `timetk::time_series_split()`.

### Helpers:

`extract_nested_train_split()` and `extract_nested_test_split()` are used to simplify extracting the training and testing data from the actual data. This can be helpful when making preprocessing recipes using the recipes package.

### Examples

```
library(tidyverse)
library(timetk)
library(modeltime)

nested_data_tbl <- walmart_sales_weekly %>%
  select(id, Date, Weekly_Sales) %>%
  set_names(c("id", "date", "value")) %>%

  # Step 1: Extends the time series by id
  extend_timeseries(
    .id_var = id,
    .date_var = date,
    .length_future = 52
  ) %>%

  # Step 2: Nests the time series into .actual_data and .future_data
  nest_timeseries(
    .id_var = id,
    .length_future = 52
  ) %>%
```

```

# Step 3: Adds a column .splits that contains training/testing indicies
split_nested_timeseries(
  .length_test = 52
)

nested_data_tbl

# Helpers: Getting the Train/Test Sets
extract_nested_train_split(nested_data_tbl, .row_id = 1)

```

---

prophet\_boost

*General Interface for Boosted PROPHET Time Series Models*


---

## Description

prophet\_boost() is a way to generate a *specification* of a Boosted PROPHET model before fitting and allows the model to be created using different packages. Currently the only package is prophet.

## Usage

```

prophet_boost(
  mode = "regression",
  growth = NULL,
  changepoint_num = NULL,
  changepoint_range = NULL,
  seasonality_yearly = NULL,
  seasonality_weekly = NULL,
  seasonality_daily = NULL,
  season = NULL,
  prior_scale_changepoints = NULL,
  prior_scale_seasonality = NULL,
  prior_scale_holidays = NULL,
  logistic_cap = NULL,
  logistic_floor = NULL,
  mtry = NULL,
  trees = NULL,
  min_n = NULL,
  tree_depth = NULL,
  learn_rate = NULL,
  loss_reduction = NULL,
  sample_size = NULL,
  stop_iter = NULL
)

```

**Arguments**

mode	A single character string for the type of model. The only possible value for this model is "regression".
growth	String 'linear' or 'logistic' to specify a linear or logistic trend.
changepoint_num	Number of potential changepoints to include for modeling trend.
changepoint_range	Adjusts the flexibility of the trend component by limiting to a percentage of data before the end of the time series. 0.80 means that a changepoint cannot exist after the first 80% of the data.
seasonality_yearly	One of "auto", TRUE or FALSE. Toggles on/off a seasonal component that models year-over-year seasonality.
seasonality_weekly	One of "auto", TRUE or FALSE. Toggles on/off a seasonal component that models week-over-week seasonality.
seasonality_daily	One of "auto", TRUE or FALSE. Toggles on/off a seasonal component that models day-over-day seasonality.
season	'additive' (default) or 'multiplicative'.
prior_scale_changepoints	Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.
prior_scale_seasonality	Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality.
prior_scale_holidays	Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.
logistic_cap	When growth is logistic, the upper-bound for "saturation".
logistic_floor	When growth is logistic, the lower-bound for "saturation".
mtry	A number for the number (or proportion) of predictors that will be randomly sampled at each split when creating the tree models (specific engines only)
trees	An integer for the number of trees contained in the ensemble.
min_n	An integer for the minimum number of data points in a node that is required for the node to be split further.
tree_depth	An integer for the maximum depth of the tree (i.e. number of splits) (specific engines only).
learn_rate	A number for the rate at which the boosting algorithm adapts from iteration-to-iteration (specific engines only).
loss_reduction	A number for the reduction in the loss function required to split further (specific engines only).

sample_size	number for the number (or proportion) of data that is exposed to the fitting routine.
stop_iter	The number of iterations without improvement before stopping (xgboost only).

### Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `prophet_boost()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "prophet\_xgboost" (default) - Connects to `prophet::prophet()` and `xgboost::xgb.train()`

### Main Arguments

The main arguments (tuning parameters) for the **PROPHET** model are:

- `growth`: String 'linear' or 'logistic' to specify a linear or logistic trend.
- `changepoint_num`: Number of potential changepoints to include for modeling trend.
- `changepoint_range`: Range changepoints that adjusts how close to the end the last changepoint can be located.
- `season`: 'additive' (default) or 'multiplicative'.
- `prior_scale_changepoints`: Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.
- `prior_scale_seasonality`: Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality.
- `prior_scale_holidays`: Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.
- `logistic_cap`: When growth is logistic, the upper-bound for "saturation".
- `logistic_floor`: When growth is logistic, the lower-bound for "saturation".

The main arguments (tuning parameters) for the model **XGBoost model** are:

- `mtry`: The number of predictors that will be randomly sampled at each split when creating the tree models.
- `trees`: The number of trees contained in the ensemble.
- `min_n`: The minimum number of data points in a node that are required for the node to be split further.
- `tree_depth`: The maximum depth of the tree (i.e. number of splits).
- `learn_rate`: The rate at which the boosting algorithm adapts from iteration-to-iteration.
- `loss_reduction`: The reduction in the loss function required to split further.
- `sample_size`: The amount of data exposed to the fitting routine.
- `stop_iter`: The number of iterations without improvement before stopping.

These arguments are converted to their specific names at the time that the model is fit.

Other options and argument can be set using `set_engine()` (See Engine Details below).

If parameters need to be modified, `update()` can be used in lieu of recreating the object from scratch.

## Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

Model 1: PROPHET:

<code>modeltime</code>	<code>prophet</code>
<code>growth</code>	<code>growth ('linear')</code>
<code>changepoint_num</code>	<code>n.changepoints (25)</code>
<code>changepoint_range</code>	<code>changepoints.range (0.8)</code>
<code>seasonality_yearly</code>	<code>yearly.seasonality ('auto')</code>
<code>seasonality_weekly</code>	<code>weekly.seasonality ('auto')</code>
<code>seasonality_daily</code>	<code>daily.seasonality ('auto')</code>
<code>season</code>	<code>seasonality.mode ('additive')</code>
<code>prior_scale_changepoints</code>	<code>changepoint.prior.scale (0.05)</code>
<code>prior_scale_seasonality</code>	<code>seasonality.prior.scale (10)</code>
<code>prior_scale_holidays</code>	<code>holidays.prior.scale (10)</code>
<code>logistic_cap</code>	<code>df\$cap (NULL)</code>
<code>logistic_floor</code>	<code>df\$floor (NULL)</code>

Model 2: XGBoost:

<code>modeltime</code>	<code>xgboost::xgb.train</code>
<code>tree_depth</code>	<code>max_depth (6)</code>
<code>trees</code>	<code>nrounds (15)</code>
<code>learn_rate</code>	<code>eta (0.3)</code>
<code>mtry</code>	<code>colsample_bynode (1)</code>
<code>min_n</code>	<code>min_child_weight (1)</code>
<code>loss_reduction</code>	<code>gamma (0)</code>
<code>sample_size</code>	<code>subsample (1)</code>
<code>stop_iter</code>	<code>early_stop</code>

Other options can be set using `set_engine()`.

### **prophet\_xgboost**

Model 1: PROPHET (`prophet::prophet`):

```
## function (df = NULL, growth = "linear", changepoints = NULL, n.changepoints = 25,
##   changepoint.range = 0.8, yearly.seasonality = "auto", weekly.seasonality = "auto",
##   daily.seasonality = "auto", holidays = NULL, seasonality.mode = "additive",
##   seasonality.prior.scale = 10, holidays.prior.scale = 10, changepoint.prior.scale = 0.05,
##   mcmc.samples = 0, interval.width = 0.8, uncertainty.samples = 1000,
##   fit = TRUE, ...)
```

Parameter Notes:

- `df`: This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).

- `holidays`: A data.frame of holidays can be supplied via `set_engine()`
- `uncertainty.samples`: The default is set to 0 because the prophet uncertainty intervals are not used as part of the Modeltime Workflow. You can override this setting if you plan to use prophet's uncertainty tools.

#### Logistic Growth and Saturation Levels:

- For `growth = "logistic"`, simply add numeric values for `logistic_cap` and/or `logistic_floor`. There is *no need* to add additional columns for "cap" and "floor" to your data frame.

#### Limitations:

- `prophet::add_seasonality()` is not currently implemented. It's used to specify non-standard seasonalities using fourier series. An alternative is to use `step_fourier()` and supply custom seasonalities as Extra Regressors.

#### Model 2: XGBoost (`xgboost::xgb.train`):

```
## function (params = list(), data, nrounds, watchlist = list(), obj = NULL,
##   feval = NULL, verbose = 1, print_every_n = 1L, early_stopping_rounds = NULL,
##   maximize = NULL, save_period = NULL, save_name = "xgboost.model", xgb_model = NULL,
##   callbacks = list(), ...)
```

#### Parameter Notes:

- XGBoost uses a `params = list()` to capture. Parsnip / Modeltime automatically sends any args provided as ... inside of `set_engine()` to the `params = list(...)`.

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### Univariate (No Extra Regressors):

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

### Multivariate (Extra Regressors)

Extra Regressors parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `month.lbl` (labeled month as a ordered factor).

The `month.lbl` is an exogenous regressor that can be passed to the `arima_reg()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass `month.lbl` on as an exogenous regressor.
- `fit_xy(data[,c("date", "month.lbl")], y = data$y)` will pass `x`, where `x` is a data frame containing `month.lbl` and the date feature. Only `month.lbl` will be used as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
library(dplyr)
library(lubridate)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- PROPHET ----

# Model Spec
model_spec <- prophet_boost(
  learn_rate = 0.1
) %>%
  set_engine("prophet_xgboost")

# Fit Spec
## Not run:
model_fit <- model_spec %>%
  fit(log(value) ~ date + as.numeric(date) + month(date, label = TRUE),
      data = training(splits))
model_fit

## End(Not run)
```

---

prophet\_fit\_impl      *Low-Level PROPHET function for translating modeltime to PROPHET*

---

### Description

Low-Level PROPHET function for translating modeltime to PROPHET

### Usage

```
prophet_fit_impl(
  x,
  y,
  growth = "linear",
  n.changepoints = 25,
  changepoint.range = 0.8,
  yearly.seasonality = "auto",
  weekly.seasonality = "auto",
  daily.seasonality = "auto",
  seasonality.mode = "additive",
  changepoint.prior.scale = 0.05,
  seasonality.prior.scale = 10,
  holidays.prior.scale = 10,
  regressors.prior.scale = 10000,
  regressors.standardize = "auto",
  regressors.mode = NULL,
  logistic_cap = NULL,
  logistic_floor = NULL,
  ...
)
```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
growth	String 'linear', 'logistic', or 'flat' to specify a linear, logistic or flat trend.
n.changepoints	Number of potential changepoints to include. Not used if input 'changepoints' is supplied. If 'changepoints' is not supplied, then n.changepoints potential changepoints are selected uniformly from the first 'changepoint.range' proportion of df\$ds.
changepoint.range	Proportion of history in which trend changepoints will be estimated. Defaults to 0.8 for the first 80 'changepoints' is specified.
yearly.seasonality	Fit yearly seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.



weekly.seasonality	Fit weekly seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.
daily.seasonality	Fit daily seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.
seasonality.mode	'additive' (default) or 'multiplicative'.
changepoint.prior.scale	Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.
seasonality.prior.scale	Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality. Can be specified for individual seasonalities using add_seasonality.
holidays.prior.scale	Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.
regressors.prior.scale	Float scale for the normal prior. Default is 10,000. Gets passed to prophet::add_regressor(prior.scale)
regressors.standardize	Bool, specify whether this regressor will be standardized prior to fitting. Can be 'auto' (standardize if not binary), True, or False. Gets passed to prophet::add_regressor(standardize)
regressors.mode	Optional, 'additive' or 'multiplicative'. Defaults to seasonality.mode.
logistic_cap	When growth is logistic, the upper-bound for "saturation".
logistic_floor	When growth is logistic, the lower-bound for "saturation".
...	Additional arguments passed to prophet::prophet

---

 prophet\_params

*Tuning Parameters for Prophet Models*


---

## Description

Tuning Parameters for Prophet Models

## Usage

```
growth(values = c("linear", "logistic"))
```

```
changepoint_num(range = c(0L, 50L), trans = NULL)
```

```
changepoint_range(range = c(0.6, 0.9), trans = NULL)
```

```

seasonality_yearly(values = c(TRUE, FALSE))
seasonality_weekly(values = c(TRUE, FALSE))
seasonality_daily(values = c(TRUE, FALSE))
prior_scale_changepoints(range = c(-3, 2), trans = log10_trans())
prior_scale_seasonality(range = c(-3, 2), trans = log10_trans())
prior_scale_holidays(range = c(-3, 2), trans = log10_trans())

```

### Arguments

values	A character string of possible values.
range	A two-element vector holding the <i>defaults</i> for the smallest and largest possible values, respectively.
trans	A trans object from the scales package, such as <code>scales::log10_trans()</code> or <code>scales::reciprocal_trans()</code> . If not provided, the default is used which matches the units used in range. If no transformation, NULL.

### Details

The main parameters for Prophet models are:

- growth: The form of the trend: "linear", or "logistic".
- changepoint\_num: The maximum number of trend changepoints allowed when modeling the trend
- changepoint\_range: The range affects how close the changepoints can go to the end of the time series. The larger the value, the more flexible the trend.
- Yearly, Weekly, and Daily Seasonality:
  - *Yearly*: seasonality\_yearly - Useful when seasonal patterns appear year-over-year
  - *Weekly*: seasonality\_weekly - Useful when seasonal patterns appear week-over-week (e.g. daily data)
  - *Daily*: seasonality\_daily - Useful when seasonal patterns appear day-over-day (e.g. hourly data)
- season:
  - The form of the seasonal term: "additive" or "multiplicative".
  - See [season\(\)](#).
- "Prior Scale": Controls flexibility of
  - *Changepoints*: prior\_scale\_changepoints
  - *Seasonality*: prior\_scale\_seasonality
  - *Holidays*: prior\_scale\_holidays
  - The `log10_trans()` converts priors to a scale from 0.001 to 100, which effectively weights lower values more heavily than larger values.

**Examples**

```

growth()

changepoint_num()

season()

prior_scale_changepoints()

```

---

prophet\_predict\_impl    *Bridge prediction function for PROPHET models*

---

**Description**

Bridge prediction function for PROPHET models

**Usage**

```
prophet_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>prophet::predict()</code>

---

prophet\_reg                    *General Interface for PROPHET Time Series Models*

---

**Description**

`prophet_reg()` is a way to generate a *specification* of a PROPHET model before fitting and allows the model to be created using different packages. Currently the only package is `prophet`.

**Usage**

```

prophet_reg(
  mode = "regression",
  growth = NULL,
  changepoint_num = NULL,
  changepoint_range = NULL,
  seasonality_yearly = NULL,
  seasonality_weekly = NULL,

```

```

seasonality_daily = NULL,
season = NULL,
prior_scale_changepoints = NULL,
prior_scale_seasonality = NULL,
prior_scale_holidays = NULL,
logistic_cap = NULL,
logistic_floor = NULL
)

```

### Arguments

mode	A single character string for the type of model. The only possible value for this model is "regression".
growth	String 'linear' or 'logistic' to specify a linear or logistic trend.
changepoint_num	Number of potential changepoints to include for modeling trend.
changepoint_range	Adjusts the flexibility of the trend component by limiting to a percentage of data before the end of the time series. 0.80 means that a changepoint cannot exist after the first 80% of the data.
seasonality_yearly	One of "auto", TRUE or FALSE. Toggles on/off a seasonal component that models year-over-year seasonality.
seasonality_weekly	One of "auto", TRUE or FALSE. Toggles on/off a seasonal component that models week-over-week seasonality.
seasonality_daily	One of "auto", TRUE or FALSE. Toggles on/off a seasonal component that models day-over-day seasonality.
season	'additive' (default) or 'multiplicative'.
prior_scale_changepoints	Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.
prior_scale_seasonality	Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality.
prior_scale_holidays	Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.
logistic_cap	When growth is logistic, the upper-bound for "saturation".
logistic_floor	When growth is logistic, the lower-bound for "saturation".

## Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `prophet_reg()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "prophet" (default) - Connects to `prophet::prophet()`

## Main Arguments

The main arguments (tuning parameters) for the model are:

- `growth`: String 'linear' or 'logistic' to specify a linear or logistic trend.
- `changepoint_num`: Number of potential changepoints to include for modeling trend.
- `changepoint_range`: Range changepoints that adjusts how close to the end the last changepoint can be located.
- `season`: 'additive' (default) or 'multiplicative'.
- `prior_scale_changepoints`: Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.
- `prior_scale_seasonality`: Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality.
- `prior_scale_holidays`: Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.
- `logistic_cap`: When growth is logistic, the upper-bound for "saturation".
- `logistic_floor`: When growth is logistic, the lower-bound for "saturation".

These arguments are converted to their specific names at the time that the model is fit.

Other options and argument can be set using `set_engine()` (See Engine Details below).

If parameters need to be modified, `update()` can be used in lieu of recreating the object from scratch.

## Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

<code>modeltime</code>	<code>prophet</code>
<code>growth</code>	<code>growth ('linear')</code>
<code>changepoint_num</code>	<code>n.changepoints (25)</code>
<code>changepoint_range</code>	<code>changepoints.range (0.8)</code>
<code>seasonality_yearly</code>	<code>yearly.seasonality ('auto')</code>
<code>seasonality_weekly</code>	<code>weekly.seasonality ('auto')</code>
<code>seasonality_daily</code>	<code>daily.seasonality ('auto')</code>
<code>season</code>	<code>seasonality.mode ('additive')</code>
<code>prior_scale_changepoints</code>	<code>changepoint.prior.scale (0.05)</code>
<code>prior_scale_seasonality</code>	<code>seasonality.prior.scale (10)</code>

prior_scale_holidays	holidays.prior.scale (10)
logistic_cap	df\$cap (NULL)
logistic_floor	df\$floor (NULL)

Other options can be set using `set_engine()`.

### prophet

The engine uses `prophet::prophet()`.

Function Parameters:

```
## function (df = NULL, growth = "linear", changepoints = NULL, n.changepoints = 25,
##   changepoint.range = 0.8, yearly.seasonality = "auto", weekly.seasonality = "auto",
##   daily.seasonality = "auto", holidays = NULL, seasonality.mode = "additive",
##   seasonality.prior.scale = 10, holidays.prior.scale = 10, changepoint.prior.scale = 0.05,
##   mcmc.samples = 0, interval.width = 0.8, uncertainty.samples = 1000,
##   fit = TRUE, ...)
```

Parameter Notes:

- `df`: This is supplied via the `parsnip / modeltime fit()` interface (so don't provide this manually). See Fit Details (below).
- `holidays`: A `data.frame` of holidays can be supplied via `set_engine()`
- `uncertainty.samples`: The default is set to 0 because the prophet uncertainty intervals are not used as part of the Modeltime Workflow. You can override this setting if you plan to use prophet's uncertainty tools.

Regressors:

- Regressors are provided via the `fit()` or `recipes` interface, which passes regressors to `prophet::add_regressor()`
- Parameters can be controlled in `set_engine()` via: `regressors.prior.scale`, `regressors.standardize`, and `regressors.mode`
- The regressor prior scale implementation default is `regressors.prior.scale = 1e4`, which deviates from the prophet implementation (defaults to `holidays.prior.scale`)

Logistic Growth and Saturation Levels:

- For `growth = "logistic"`, simply add numeric values for `logistic_cap` and/or `logistic_floor`. There is *no need* to add additional columns for "cap" and "floor" to your data frame.

Limitations:

- `prophet::add_seasonality()` is not currently implemented. It's used to specify non-standard seasonalities using fourier series. An alternative is to use `step_fourier()` and supply custom seasonalities as Extra Regressors.

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### Univariate (No Extra Regressors):

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

### Multivariate (Extra Regressors)

Extra Regressors parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`.
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `month.lbl` (labeled month as a ordered factor).

The `month.lbl` is an exogenous regressor that can be passed to the `arima_reg()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass `month.lbl` on as an exogenous regressor.
- `fit_xy(data[, c("date", "month.lbl")], y = data$y)` will pass `x`, where `x` is a data frame containing `month.lbl` and the date feature. Only `month.lbl` will be used as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

## See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

## Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750
```

```
# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- PROPHET ----

# Model Spec
model_spec <- prophet_reg() %>%
  set_engine("prophet")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit
```

---

prophet\_xgboost\_fit\_impl

*Low-Level PROPHET function for translating modeltime to Boosted PROPHET*

---

## Description

Low-Level PROPHET function for translating modeltime to Boosted PROPHET

## Usage

```
prophet_xgboost_fit_impl(
  x,
  y,
  df = NULL,
  growth = "linear",
  changepoints = NULL,
  n.changepoints = 25,
  changepoint.range = 0.8,
  yearly.seasonality = "auto",
  weekly.seasonality = "auto",
  daily.seasonality = "auto",
  holidays = NULL,
  seasonality.mode = "additive",
  seasonality.prior.scale = 10,
  holidays.prior.scale = 10,
  changepoint.prior.scale = 0.05,
  logistic_cap = NULL,
  logistic_floor = NULL,
  mcmc.samples = 0,
  interval.width = 0.8,
```



```

uncertainty.samples = 1000,
fit = TRUE,
max_depth = 6,
nrounds = 15,
eta = 0.3,
colsample_bytree = NULL,
colsample_bynode = NULL,
min_child_weight = 1,
gamma = 0,
subsample = 1,
validation = 0,
early_stop = NULL,
...
)

```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
df	(optional) Dataframe containing the history. Must have columns ds (date type) and y, the time series. If growth is logistic, then df must also have a column cap that specifies the capacity at each ds. If not provided, then the model object will be instantiated but not fit; use <code>fit.prophet(m, df)</code> to fit the model.
growth	String 'linear', 'logistic', or 'flat' to specify a linear, logistic or flat trend.
changepoints	Vector of dates at which to include potential changepoints. If not specified, potential changepoints are selected automatically.
n.changepoints	Number of potential changepoints to include. Not used if input 'changepoints' is supplied. If 'changepoints' is not supplied, then n.changepoints potential changepoints are selected uniformly from the first 'changepoint.range' proportion of df\$ds.
changepoint.range	Proportion of history in which trend changepoints will be estimated. Defaults to 0.8 for the first 80 'changepoints' is specified.
yearly.seasonality	Fit yearly seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.
weekly.seasonality	Fit weekly seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.
daily.seasonality	Fit daily seasonality. Can be 'auto', TRUE, FALSE, or a number of Fourier terms to generate.
holidays	data frame with columns holiday (character) and ds (date type)and optionally columns lower_window and upper_window which specify a range of days around the date to be included as holidays. lower_window=-2 will include 2 days prior to the date as holidays. Also optionally can have a column prior_scale specifying the prior scale for each holiday.

seasonality.mode	'additive' (default) or 'multiplicative'.
seasonality.prior.scale	Parameter modulating the strength of the seasonality model. Larger values allow the model to fit larger seasonal fluctuations, smaller values dampen the seasonality. Can be specified for individual seasonalities using add_seasonality.
holidays.prior.scale	Parameter modulating the strength of the holiday components model, unless overridden in the holidays input.
changepoint.prior.scale	Parameter modulating the flexibility of the automatic changepoint selection. Large values will allow many changepoints, small values will allow few changepoints.
logistic_cap	When growth is logistic, the upper-bound for "saturation".
logistic_floor	When growth is logistic, the lower-bound for "saturation".
mcmc.samples	Integer, if greater than 0, will do full Bayesian inference with the specified number of MCMC samples. If 0, will do MAP estimation.
interval.width	Numeric, width of the uncertainty intervals provided for the forecast. If mcmc.samples=0, this will be only the uncertainty in the trend using the MAP estimate of the extrapolated generative model. If mcmc.samples>0, this will be integrated over all model parameters, which will include uncertainty in seasonality.
uncertainty.samples	Number of simulated draws used to estimate uncertainty intervals. Settings this value to 0 or False will disable uncertainty estimation and speed up the calculation.
fit	Boolean, if FALSE the model is initialized but not fit.
max_depth	An integer for the maximum depth of the tree.
nrounds	An integer for the number of boosting iterations.
eta	A numeric value between zero and one to control the learning rate.
colsample_bytree	Subsampling proportion of columns.
colsample_bynode	Subsampling proportion of columns for each node within each tree. See the counts argument below. The default uses all columns.
min_child_weight	A numeric value for the minimum sum of instance weights needed in a child to continue to split.
gamma	A number for the minimum loss reduction required to make a further partition on a leaf node of the tree
subsample	Subsampling proportion of rows.
validation	A positive number. If on [0, 1) the value, validation is a random proportion of data in x and y that are used for performance assessment and potential early stopping. If 1 or greater, it is the <i>number</i> of training set samples use for these purposes.

early_stop	An integer or NULL. If not NULL, it is the number of training iterations without improvement before stopping. If validation is used, performance is base on the validation set; otherwise the training set is used.
...	Additional arguments passed to <code>xgboost::xgb.train</code>

---

 prophet\_xgboost\_predict\_impl

*Bridge prediction function for Boosted PROPHET models*

---

### Description

Bridge prediction function for Boosted PROPHET models

### Usage

```
prophet_xgboost_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>prophet::predict()</code>

---

 pull\_modeltime\_residuals

*Extracts modeltime residuals data from a Modeltime Model*

---

### Description

If a modeltime model contains data with residuals information, this function will extract the data frame.

### Usage

```
pull_modeltime_residuals(object)
```

### Arguments

object	A fitted parsnip / modeltime model or workflow
--------	--

### Value

A tibble containing the model timestamp, actual, fitted, and residuals data

---

pull\_parsnip\_preprocessor

*Pulls the Formula from a Fitted Parsnip Model Object*

---

### Description

Pulls the Formula from a Fitted Parsnip Model Object

### Usage

```
pull_parsnip_preprocessor(object)
```

### Arguments

object            A fitted parsnip model `model_fit` object

### Value

A formula using `stats::formula()`

---

recipe\_helpers

*Developer Tools for processing XREGS (Regressors)*

---

### Description

Wrappers for using `recipes::bake` and `recipes::juice` to process data returning data in either data frame or matrix format (Common formats needed for machine learning algorithms).

### Usage

```
juice_xreg_recipe(recipe, format = c("tbl", "matrix"))
```

```
bake_xreg_recipe(recipe, new_data, format = c("tbl", "matrix"))
```

### Arguments

recipe            A prepared recipe

format            One of:

- `tbl`: Returns a tibble (`data.frame`)
- `matrix`: Returns a matrix

new\_data          Data to be processed by a recipe

### Value

Data in either the `tbl` (`data.frame`) or `matrix` formats

**Examples**

```

library(dplyr)
library(timetk)
library(recipes)
library(lubridate)

predictors <- m4_monthly %>%
  filter(id == "M750") %>%
  select(-value) %>%
  mutate(month = month(date, label = TRUE))
predictors

# Create default recipe
xreg_recipe_spec <- create_xreg_recipe(predictors, prepare = TRUE)

# Extracts the preprocessed training data from the recipe (used in your fit function)
juice_xreg_recipe(xreg_recipe_spec)

# Applies the prepared recipe to new data (used in your predict function)
bake_xreg_recipe(xreg_recipe_spec, new_data = predictors)

```

---

recursive	<i>Create a Recursive Time Series Model from a Parsnip or Workflow Regression Model</i>
-----------	---

---

**Description**

Create a Recursive Time Series Model from a Parsnip or Workflow Regression Model

**Usage**

```
recursive(object, transform, train_tail, id = NULL, ...)
```

**Arguments**

object	An object of <code>model_fit</code> or a fitted workflow class
transform	A transformation performed on <code>new_data</code> after each step of recursive algorithm. <ul style="list-style-type: none"> <li>• <b>Transformation Function:</b> Must have one argument <code>data</code> (see examples)</li> </ul>
train_tail	A tibble with tail of training data set. In most cases it'll be required to create some variables based on dependent variable.
id	(Optional) An identifier that can be provided to perform a panel forecast. A single quoted column name (e.g. <code>id = "id"</code> ).
...	Not currently used.

## Details

### What is a Recursive Model?

A *recursive model* uses predictions to generate new values for independent features. These features are typically lags used in autoregressive models. It's important to understand that a recursive model is only needed when the **Lag Size < Forecast Horizon**.

### Why is Recursive needed for Autoregressive Models with Lag Size < Forecast Horizon?

When the lag length is less than the forecast horizon, a problem exists where missing values (NA) are generated in the future data. A solution that `recursive()` implements is to iteratively fill these missing values in with values generated from predictions.

### Recursive Process

When producing forecast, the following steps are performed:

1. Computing forecast for first row of new data. The first row cannot contain NA in any required column.
2. Filling *i*-th place of the dependent variable column with already computed forecast.
3. Computing missing features for next step, based on already calculated prediction. These features are computed with on a tibble object made from binded `train_tail` (i.e. tail of training data set) and `new_data` (which is an argument of `predict` function).
4. Jumping into point 2., and repeating rest of steps till the for-loop is ended.

### Recursion for Panel Data

Panel data is time series data with multiple groups identified by an ID column. The `recursive()` function can be used for Panel Data with the following modifications:

1. Supply an `id` column as a quoted column name
2. Replace `tail()` with `panel_tail()` to use tails for each time series group.

## Value

An object with added recursive class

## See Also

- `panel_tail()` - Used to generate tails for multiple time series groups.

## Examples

```
# Libraries & Setup ----
library(modeltime)
library(tidymodels)
library(tidyverse)
library(lubridate)
library(timetk)
library/slider)
```

```

# ---- SINGLE TIME SERIES (NON-PANEL) ----

m750

FORECAST_HORIZON <- 24

m750_extended <- m750 %>%
  group_by(id) %>%
  future_frame(
    .length_out = FORECAST_HORIZON,
    .bind_data = TRUE
  ) %>%
  ungroup()

# TRANSFORM FUNCTION ----
# - Function runs recursively that updates the forecasted dataset
lag_roll_transformer <- function(data){
  data %>%
    # Lags
    tk_augment_lags(value, .lags = 1:12) %>%
    # Rolling Features
    mutate(rolling_mean_12 = lag(slide_dbl(
      value, .f = mean, .before = 12, .complete = FALSE
    ), 1))
}

# Data Preparation
m750_rolling <- m750_extended %>%
  lag_roll_transformer() %>%
  select(-id)

train_data <- m750_rolling %>%
  drop_na()

future_data <- m750_rolling %>%
  filter(is.na(value))

# Modeling

# Straight-Line Forecast
model_fit_lm <- linear_reg() %>%
  set_engine("lm") %>%
  # Use only date feature as regressor
  fit(value ~ date, data = train_data)

# Autoregressive Forecast
model_fit_lm_recursive <- linear_reg() %>%
  set_engine("lm") %>%
  # Use date plus all lagged features
  fit(value ~ ., data = train_data) %>%
  # Add recursive() w/ transformer and train_tail
  recursive(
    transform = lag_roll_transformer,

```

```

        train_tail = tail(train_data, FORECAST_HORIZON)
      )

model_fit_lm_recursive

# Forecasting
modeltime_table(
  model_fit_lm,
  model_fit_lm_recursive
) %>%
  update_model_description(2, "LM - Lag Roll") %>%
  modeltime_forecast(
    new_data = future_data,
    actual_data = m750
  ) %>%
  plot_modeltime_forecast(
    .interactive = FALSE,
    .conf_interval_show = FALSE
  )

# MULTIPLE TIME SERIES (PANEL DATA) -----

m4_monthly

FORECAST_HORIZON <- 24

m4_extended <- m4_monthly %>%
  group_by(id) %>%
  future_frame(
    .length_out = FORECAST_HORIZON,
    .bind_data = TRUE
  ) %>%
  ungroup()

# TRANSFORM FUNCTION ----
# - NOTE - We create lags by group
lag_transformer_grouped <- function(data){
  data %>%
    group_by(id) %>%
    tk_augment_lags(value, .lags = 1:FORECAST_HORIZON) %>%
    ungroup()
}

m4_lags <- m4_extended %>%
  lag_transformer_grouped()

train_data <- m4_lags %>%
  drop_na()

future_data <- m4_lags %>%
  filter(is.na(value))

# Modeling Autoregressive Panel Data

```



```

model_fit_lm_recursive <- linear_reg() %>%
  set_engine("lm") %>%
  fit(value ~ ., data = train_data) %>%
  recursive(
    id       = "id", # We add an id = "id" to specify the groups
    transform = lag_transformer_grouped,
    # We use panel_tail() to grab tail by groups
    train_tail = panel_tail(train_data, id, FORECAST_HORIZON)
  )

modeltime_table(
  model_fit_lm_recursive
) %>%
  modeltime_forecast(
    new_data      = future_data,
    actual_data   = m4_monthly,
    keep_data     = TRUE
  ) %>%
  group_by(id) %>%
  plot_modeltime_forecast(
    .interactive = FALSE,
    .conf_interval_show = FALSE
  )

```

---

seasonal\_reg

*General Interface for Multiple Seasonality Regression Models  
(TBATS, STLM)*


---

## Description

`seasonal_reg()` is a way to generate a *specification* of an Seasonal Decomposition model before fitting and allows the model to be created using different packages. Currently the only package is forecast.

## Usage

```

seasonal_reg(
  mode = "regression",
  seasonal_period_1 = NULL,
  seasonal_period_2 = NULL,
  seasonal_period_3 = NULL
)

```

## Arguments

`mode` A single character string for the type of model. The only possible value for this model is "regression".

seasonal\_period\_1

(required) The primary seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.

seasonal\_period\_2

(optional) A second seasonal frequency. Is NULL by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.

seasonal\_period\_3

(optional) A third seasonal frequency. Is NULL by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.

## Details

The data given to the function are not saved and are only used to determine the *mode* of the model. For `seasonal_reg()`, the mode will always be "regression".

The model can be created using the `fit()` function using the following *engines*:

- "tbats" - Connects to `forecast::tbats()`
- "stlm\_ets" - Connects to `forecast::stlm()`, `method = "ets"`
- "stlm\_arima" - Connects to `forecast::stlm()`, `method = "arima"`

## Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

modeltime	forecast::stlm	forecast::tbats
seasonal_period_1, seasonal_period_2, seasonal_period_3	msts(seasonal.periods)	msts(seasonal.periods)

Other options can be set using `set_engine()`.

The engines use `forecast::stlm()`.

Function Parameters:

```
## function (y, s.window = 7 + 4 * seq(6), robust = FALSE, method = c("ets",
##   "arima"), modelfunction = NULL, model = NULL, etsmodel = "ZZN", lambda = NULL,
##   biasadj = FALSE, xreg = NULL, allow.multiplicative.trend = FALSE, x = y,
##   ...)
```

### tbats

- **Method:** Uses `method = "tbats"`, which by default is auto-TBATS.
- **Xregs:** Univariate. Cannot accept Exogenous Regressors (`xregs`). `Xregs` are ignored.

### stlm\_ets

- **Method:** Uses method = "stlm\_ets", which by default is auto-ETS.
- **Xregs:** Univariate. Cannot accept Exogenous Regressors (xregs). Xregs are ignored.

#### stlm\_arima

- **Method:** Uses method = "stlm\_arima", which by default is auto-ARIMA.
- **Xregs:** Multivariate. Can accept Exogenous Regressors (xregs).

### Fit Details

#### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

#### Seasonal Period Specification

The period can be non-seasonal (`seasonal_period = 1` or "none") or yearly seasonal (e.g. For monthly time stamps, `seasonal_period = 12`, `seasonal_period = "12 months"`, or `seasonal_period = "yearly"`). There are 3 ways to specify:

1. `seasonal_period = "auto"`: A seasonal period is selected based on the periodicity of the data (e.g. 12 if monthly)
2. `seasonal_period = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `seasonal_period = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

#### Univariate (No xregs, Exogenous Regressors):

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

#### Multivariate (xregs, Exogenous Regressors)

- The `tbats` engine *cannot* accept Xregs.
- The `stlm_ets` engine *cannot* accept Xregs.
- The `stlm_arima` engine *can* accept Xregs

The `xreg` parameter is populated using the `fit()` or `fit_xy()` function:

- Only factor, ordered factor, and numeric data will be used as `xregs`.
- Date and Date-time variables are not used as `xregs`
- character data should be converted to factor.

*Xreg Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),

3. `month.lbl` (labeled month as a ordered factor).

The `month.lbl` is an exogenous regressor that can be passed to the `seasonal_reg()` using `fit()`:

- `fit(y ~ date + month.lbl)` will pass `month.lbl` on as an exogenous regressor.
- `fit_xy(data[,c("date", "month.lbl")], y = data$y)` will pass `x`, where `x` is a data frame containing `month.lbl` and the date feature. Only `month.lbl` will be used as an exogenous regressor.

Note that date or date-time class values are excluded from `xreg`.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
taylor_30_min

# Split Data 80/20
splits <- initial_time_split(taylor_30_min, prop = 0.8)

# ---- STLM ETS ----

# Model Spec
model_spec <- seasonal_reg() %>%
  set_engine("stlm_ets")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# ---- STLM ARIMA ----

# Model Spec
model_spec <- seasonal_reg() %>%
  set_engine("stlm_arima")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit
```

---

smooth_fit_impl	<i>Low-Level Exponential Smoothing function for translating modeltime to forecast</i>
-----------------	---

---

### Description

Low-Level Exponential Smoothing function for translating modeltime to forecast

### Usage

```
smooth_fit_impl(
  x,
  y,
  period = "auto",
  error = "auto",
  trend = "auto",
  season = "auto",
  damping = NULL,
  alpha = NULL,
  beta = NULL,
  gamma = NULL,
  ...
)
```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
error	The form of the error term: "auto", "additive", or "multiplicative". If the error is multiplicative, the data must be non-negative.
trend	The form of the trend term: "auto", "additive", "multiplicative" or "none".
season	The form of the seasonal term: "auto", "additive", "multiplicative" or "none".
damping	Apply damping to a trend: "auto", "damped", or "none".
alpha	Value of alpha. If NULL, it is estimated.
beta	Value of beta. If NULL, it is estimated.
gamma	Value of gamma. If NULL, it is estimated.
...	Additional arguments passed to smooth: :es

---

smooth\_predict\_impl     *Bridge prediction function for Exponential Smoothing models*

---

### Description

Bridge prediction function for Exponential Smoothing models

### Usage

```
smooth_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>smooth::es()</code>

---

snaive\_fit\_impl     *Low-Level SNAIVE Forecast*

---

### Description

Low-Level SNAIVE Forecast

### Usage

```
snaive_fit_impl(x, y, id = NULL, seasonal_period = "auto", ...)
```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
id	An optional ID feature to identify different time series. Should be a quoted name.
seasonal_period	The seasonal period to forecast into the future
...	Not currently used

---

snaive\_predict\_impl    *Bridge prediction function for SNAIVE Models*

---

**Description**

Bridge prediction function for SNAIVE Models

**Usage**

```
snaive_predict_impl(object, new_data)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.

---

stlm\_arima\_fit\_impl    *Low-Level stlm function for translating modeltime to forecast*

---

**Description**

Low-Level stlm function for translating modeltime to forecast

**Usage**

```
stlm_arima_fit_impl(
  x,
  y,
  period_1 = "auto",
  period_2 = NULL,
  period_3 = NULL,
  ...
)
```

**Arguments**

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period_1	(required) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
period_2	(optional) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.

period_3	(optional) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
...	Additional arguments passed to <code>forecast::stlm()</code>

---

`stlm_arima_predict_impl`

*Bridge prediction function for ARIMA models*

---

### Description

Bridge prediction function for ARIMA models

### Usage

```
stlm_arima_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>forecast::forecast()</code>

---

`stlm_ets_fit_impl`

*Low-Level stlm function for translating modeltime to forecast*

---

### Description

Low-Level stlm function for translating modeltime to forecast

### Usage

```
stlm_ets_fit_impl(
  x,
  y,
  period_1 = "auto",
  period_2 = NULL,
  period_3 = NULL,
  ...
)
```



**Arguments**

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period_1	(required) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
period_2	(optional) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
period_3	(optional) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
...	Additional arguments passed to <code>forecast::stlm()</code>

---

stlm\_ets\_predict\_impl *Bridge prediction function for ARIMA models*

---

**Description**

Bridge prediction function for ARIMA models

**Usage**

```
stlm_ets_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>forecast::forecast()</code>

---

summarize\_accuracy\_metrics

*Summarize Accuracy Metrics*

---

**Description**

This is an internal function used by `modeltime_accuracy()`.

**Usage**

```
summarize_accuracy_metrics(data, truth, estimate, metric_set)
```

**Arguments**

data	A data.frame containing the truth and estimate columns.
truth	The column identifier for the true results (that is numeric).
estimate	The column identifier for the predicted results (that is also numeric).
metric_set	A yardstick::metric_set() that is used to summarize one or more forecast accuracy (regression) metrics.

**Examples**

```
library(tibble)
library(dplyr)

predictions_tbl <- tibble(
  group = c("model 1", "model 1", "model 1",
            "model 2", "model 2", "model 2"),
  truth = c(1, 2, 3,
            1, 2, 3),
  estimate = c(1.2, 2.0, 2.5,
              0.9, 1.9, 3.3)
)

predictions_tbl %>%
  group_by(group) %>%
  summarize_accuracy_metrics(
    truth, estimate,
    metric_set = default_forecast_accuracy_metric_set()
  )
```

---

table\_modeltime\_accuracy

*Interactive Accuracy Tables*

---

**Description**

Converts results from `modeltime_accuracy()` into either interactive (reactable) or static (gt) tables.

**Usage**

```
table_modeltime_accuracy(
  .data,
  .round_digits = 2,
  .sortable = TRUE,
  .show_sortable = TRUE,
  .searchable = TRUE,
  .filterable = FALSE,
```

```

    .expand_groups = TRUE,
    .title = "Accuracy Table",
    .interactive = TRUE,
    ...
  )

```

## Arguments

<code>.data</code>	A tibble that is the output of <code>modeltime_accuracy()</code>
<code>.round_digits</code>	Rounds accuracy metrics to a specified number of digits. If NULL, rounding is not performed.
<code>.sortable</code>	Allows sorting by columns. Only applied to reactable tables. Passed to <code>reactable(sortable)</code> .
<code>.show_sortable</code>	Shows sorting. Only applied to reactable tables. Passed to <code>reactable(showSortable)</code> .
<code>.searchable</code>	Adds search input. Only applied to reactable tables. Passed to <code>reactable(searchable)</code> .
<code>.filterable</code>	Adds filters to table columns. Only applied to reactable tables. Passed to <code>reactable(filterable)</code> .
<code>.expand_groups</code>	Expands groups dropdowns. Only applied to reactable tables. Passed to <code>reactable(defaultExpanded)</code> .
<code>.title</code>	A title for static (gt) tables.
<code>.interactive</code>	Return interactive or static tables. If TRUE, returns reactable table. If FALSE, returns static gt table.
<code>...</code>	Additional arguments passed to <code>reactable::reactable()</code> or <code>gt::gt()</code> (depending on <code>.interactive</code> selection).

## Details

### Groups

The function respects `dplyr::group_by()` groups and thus scales with multiple groups.

### Reactable Output

A `reactable()` table is an interactive format that enables live searching and sorting. When `.interactive = TRUE`, a call is made to `reactable::reactable()`.

`table_modeltime_accuracy()` includes several common options like toggles for sorting and searching. Additional arguments can be passed to `reactable::reactable()` via `...`

### GT Output

A `gt` table is an HTML-based table that is "static" (e.g. non-searchable, non-sortable). It's commonly used in PDF and Word documents that does not support interactive content.

When `.interactive = FALSE`, a call is made to `gt::gt()`. Arguments can be passed via `...`

Table customization is implemented using a piping workflow (`%>%`). For more information, refer to the [GT Documentation](#).

## Value

A static `gt` table or an interactive `reactable` table containing the accuracy information.

## Examples

```
library(tidyverse)
library(lubridate)
library(timetk)
library(parsnip)
library(rsample)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.9)

# --- MODELS ---

# Model 1: prophet ----
model_fit_prophet <- prophet_reg() %>%
  set_engine(engine = "prophet") %>%
  fit(value ~ date, data = training(splits))

# ---- MODELTIME TABLE ----

models_tbl <- modeltime_table(
  model_fit_prophet
)

# ---- ACCURACY ----

models_tbl %>%
  modeltime_calibrate(new_data = testing(splits)) %>%
  modeltime_accuracy() %>%
  table_modeltime_accuracy()
```

---

tbats\_fit\_impl

*Low-Level tbats function for translating modeltime to forecast*

---

## Description

Low-Level tbats function for translating modeltime to forecast

## Usage

```
tbats_fit_impl(
  x,
  y,
```

```

    period_1 = "auto",
    period_2 = NULL,
    period_3 = NULL,
    use.parallel = length(y) > 1000,
    ...
  )

```

### Arguments

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period_1	(required) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
period_2	(optional) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
period_3	(optional) First seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
use.parallel	TRUE/FALSE indicates whether or not to use parallel processing.
...	Additional arguments passed to <code>forecast::tbats()</code>

---

tbats\_predict\_impl     *Bridge prediction function for ARIMA models*

---

### Description

Bridge prediction function for ARIMA models

### Usage

```
tbats_predict_impl(object, new_data, ...)
```

### Arguments

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>forecast::forecast()</code>

---

temporal_hierarchy	<i>General Interface for Temporal Hierarchical Forecasting (THIEF) Models</i>
--------------------	---

---

### Description

temporal\_hierarchy() is a way to generate a *specification* of an Temporal Hierarchical Forecasting model before fitting and allows the model to be created using different packages. Currently the only package is thief. Note this function requires the thief package to be installed.

### Usage

```
temporal_hierarchy(
  mode = "regression",
  seasonal_period = NULL,
  combination_method = NULL,
  use_model = NULL
)
```

### Arguments

- |                    |  |
|--------------------|--|
| mode               | A single character string for the type of model. The only possible value for this model is "regression".   |
| seasonal_period    | A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided. See Fit Details below.   |
| combination_method | Combination method of temporal hierarchies, taking one of the following values: <ul style="list-style-type: none"> <li>• "struc" - Structural scaling: weights from temporal hierarchy</li> <li>• "mse" - Variance scaling: weights from in-sample MSE</li> <li>• "ols" - Unscaled OLS combination weights</li> <li>• "bu" - Bottom-up combination – i.e., all aggregate forecasts are ignored.</li> <li>• "shr" - GLS using a shrinkage (to block diagonal) estimate of residuals</li> <li>• "sam" - GLS using sample covariance matrix of residuals</li> </ul> |
| use_model          | Model used for forecasting each aggregation level: <ul style="list-style-type: none"> <li>• "ets" - exponential smoothing</li> <li>• "arima" - arima</li> <li>• "theta" - theta</li> <li>• "naive" - random walk forecasts</li> <li>• "snaive" - seasonal naive forecasts, based on the last year of observed data</li> </ul>  |

## Details

Models can be created using the following *engines*:

- "thief" (default) - Connects to `thief::thief()`

## Engine Details

The standardized parameter names in `modeltime` can be mapped to their original names in each engine:

<code>modeltime</code>	<code>thief::thief()</code>
<code>combination_method</code>	<code>comb</code>
<code>use_model</code>	<code>usemodel</code>

Other options can be set using `set_engine()`.

### **thief (default engine)**

The engine uses `thief::thief()`.

Function Parameters:

```
## function (y, m = frequency(y), h = m * 2, comb = c("struc", "mse", "ols",
##      "bu", "shr", "sam"), usemodel = c("ets", "arima", "theta", "naive",
##      "snaive"), forecastfunction = NULL, aggregatelist = NULL, ...)
```

Other options and argument can be set using `set_engine()`.

Parameter Notes:

- `xreg` - This model is not set up to use exogenous regressors. Only univariate models will be fit.

## Fit Details

### **Date and Date-Time Variable**

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### **Univariate:**

For univariate analysis, you must include a date or date-time feature. Simply use:

- Formula Interface (recommended): `fit(y ~ date)` will ignore `xreg`'s.
- XY Interface: `fit_xy(x = data[, "date"], y = data$y)` will ignore `xreg`'s.

### **Multivariate (xregs, Exogenous Regressors)**

This model is not set up for use with exogenous regressors.

## References

- For forecasting with temporal hierarchies see: Athanasopoulos G., Hyndman R.J., Kourentzes N., Petropoulos F. (2017) Forecasting with Temporal Hierarchies. *European Journal of Operational research*, **262**(1), 60-74.
- For combination operators see: Kourentzes N., Barrow B.K., Crone S.F. (2014) Neural network ensemble operators for time series forecasting. *Expert Systems with Applications*, **41**(9), 4235-4244.

## See Also

`fit.model_spec()`, `set_engine()`

## Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)
library(thief)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- HIERARCHICAL ----

# Model Spec - The default parameters are all set
# to "auto" if none are provided
model_spec <- temporal_hierarchy() %>%
  set_engine("thief")

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit
```



**Description**

Tuning Parameters for TEMPORAL HIERARCHICAL Models

**Usage**

```
combination_method()
```

```
use_model()
```

**Details**

The main parameters for Temporal Hierarchical models are:

- `combination_method`: Combination method of temporal hierarchies.
- `use_model`: Model used for forecasting each aggregation level.

**Examples**

```
combination_method()
```

```
use_model()
```

---

```
temporal_hier_fit_impl
```

*Low-Level Temporal Hierarchical function for translating model-time to forecast*

---

**Description**

Low-Level Temporal Hierarchical function for translating modeltime to forecast

**Usage**

```
temporal_hier_fit_impl(  
  x,  
  y,  
  period = "auto",  
  comb = c("struc", "mse", "ols", "bu", "shr", "sam"),  
  usemodel = c("ets", "arima", "theta", "naive", "snaive"),  
  ...  
)
```

**Arguments**

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
period	A seasonal frequency. Uses "auto" by default. A character phrase of "auto" or time-based phrase of "2 weeks" can be used if a date or date-time variable is provided.
comb	Combination method of temporal hierarchies
usemodel	Model used for forecasting each aggregation level
...	Additional arguments passed to forecast::ets

---

temporal\_hier\_predict\_impl

*Bridge prediction function for TEMPORAL HIERARCHICAL models*


---

**Description**

Bridge prediction function for TEMPORAL HIERARCHICAL models

**Usage**

```
temporal_hier_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class model_fit
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to stats::predict()

---

theta\_fit\_impl

*Low-Level Exponential Smoothing function for translating modeltime to forecast*


---

**Description**

Low-Level Exponential Smoothing function for translating modeltime to forecast

**Usage**

```
theta_fit_impl(x, y, ...)
```

**Arguments**

x	A dataframe of xreg (exogenous regressors)
y	A numeric vector of values to fit
...	Additional arguments passed to forecast::ets

---

theta_predict_impl	<i>Bridge prediction function for THETA models</i>
--------------------	--

---

**Description**

Bridge prediction function for THETA models

**Usage**

```
theta_predict_impl(object, new_data, ...)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.
...	Additional arguments passed to <code>stats::predict()</code>

---

time_series_params	<i>Tuning Parameters for Time Series (ts-class) Models</i>
--------------------	--

---

**Description**

Tuning Parameters for Time Series (ts-class) Models

**Usage**

```
seasonal_period(values = c("none", "daily", "weekly", "yearly"))
```

**Arguments**

values	A time-based phrase
--------	---------------------

**Details**

Time series models (e.g. `Arima()` and `ets()`) use `stats::ts()` or `forecast::msts()` to apply seasonality. We can do the same process using the following general time series parameter:

- `period`: The periodic nature of the seasonality.

It's usually best practice to *not* tune this parameter, but rather set to obvious values based on the seasonality of the data:

- **Daily Seasonality**: Often used with **hourly data** (e.g. 24 hourly timestamps per day)
- **Weekly Seasonality**: Often used with **daily data** (e.g. 7 daily timestamps per week)
- **Yearly Seasonality**: Often used with **weekly, monthly, and quarterly data** (e.g. 12 monthly observations per year).

However, in the event that users want to experiment with period tuning, you can do so with `seasonal_period()`.

**Examples**

```
seasonal_period()
```

---

```
type_sum.mdl_time_tbl Succinct summary of Modeltime Tables
```

---

**Description**

type\_sum controls how objects are shown when inside tibble columns.

**Usage**

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

**Arguments**

x                    A mdl\_time\_tbl object to summarise.

**Value**

A character value.

---

```
update_modeltime_model
Update the model by model id in a Modeltime Table
```

---

**Description**

Update the model by model id in a Modeltime Table

**Usage**

```
update_modeltime_model(object, .model_id, .new_model)
```

**Arguments**

object                A Modeltime Table  
.model\_id             A numeric value matching the .model\_id that you want to update  
.new\_model            A fitted workflow, model\_fit, or mdl\_time\_ensmble object

**See Also**

- `combine_modeltime_tables()`: Combine 2 or more Modeltime Tables together
- `add_modeltime_model()`: Adds a new row with a new model to a Modeltime Table
- `update_modeltime_description()`: Updates a description for a model inside a Modeltime Table
- `update_modeltime_model()`: Updates a model inside a Modeltime Table
- `pull_modeltime_model()`: Extracts a model from a Modeltime Table

**Examples**

```
library(tidymodels)

model_fit_ets <- exp_smoothing() %>%
  set_engine("ets") %>%
  fit(value ~ date, training(m750_splits))

m750_models %>%
  update_modeltime_model(1, model_fit_ets)
```

---

update\_model\_description

*Update the model description by model id in a Modeltime Table*

---

**Description**

The `update_model_description()` and `update_modeltime_description()` functions are synonyms.

**Usage**

```
update_model_description(object, .model_id, .new_model_desc)
```

```
update_modeltime_description(object, .model_id, .new_model_desc)
```

**Arguments**

<code>object</code>	A Modeltime Table
<code>.model_id</code>	A numeric value matching the <code>.model_id</code> that you want to update
<code>.new_model_desc</code>	Text describing the new model description

**See Also**

- `combine_modeltime_tables()`: Combine 2 or more Modeltime Tables together
- `add_modeltime_model()`: Adds a new row with a new model to a Modeltime Table
- `update_modeltime_description()`: Updates a description for a model inside a Modeltime Table
- `update_modeltime_model()`: Updates a model inside a Modeltime Table
- `pull_modeltime_model()`: Extracts a model from a Modeltime Table

**Examples**

```
m750_models %>%
  update_modeltime_description(2, "PROPHET - No Regressors")
```

---

```
window_function_fit_impl
```

*Low-Level Window Forecast*

---

**Description**

Low-Level Window Forecast

**Usage**

```
window_function_fit_impl(
  x,
  y,
  id = NULL,
  window_size = "all",
  window_function = NULL,
  ...
)
```

**Arguments**

<code>x</code>	A dataframe of xreg (exogenous regressors)
<code>y</code>	A numeric vector of values to fit
<code>id</code>	An optional ID feature to identify different time series. Should be a quoted name.
<code>window_size</code>	The period to apply the window function to
<code>window_function</code>	A function to apply to the window. The default is <code>mean()</code> .
<code>...</code>	Additional arguments for the <code>window_function</code> . For example, it's common to pass <code>na.rm = TRUE</code> for the mean forecast.

---

window\_function\_predict\_impl  
*Bridge prediction function for window Models*

---

**Description**

Bridge prediction function for window Models

**Usage**

```
window_function_predict_impl(object, new_data)
```

**Arguments**

object	An object of class <code>model_fit</code>
new_data	A rectangular data object, such as a data frame.

---

window\_reg                      *General Interface for Window Forecast Models*

---

**Description**

`window_reg()` is a way to generate a *specification* of a window model before fitting and allows the model to be created using different backends.

**Usage**

```
window_reg(mode = "regression", id = NULL, window_size = NULL)
```

**Arguments**

mode	A single character string for the type of model. The only possible value for this model is "regression".
id	An optional quoted column name (e.g. "id") for identifying multiple time series (i.e. panel data).
window_size	A window to apply the window function. By default, the window uses the full data set, which is rarely the best choice.

**Details**

A time series window regression is derived using `window_reg()`. The model can be created using the `fit()` function using the following *engines*:

- **"window\_function" (default)** - Performs a Window Forecast applying a `window_function` (engine parameter) to a window of size defined by `window_size`

## Engine Details

### function (default engine)

The engine uses `window_function_fit_impl()`. A time series window function applies a `window_function` to a window of the data (last N observations).

- The function can return a scalar (single value) or multiple values that are repeated for each window
- Common use cases:
  - **Moving Average Forecasts:** Forecast forward a 20-day average
  - **Weighted Average Forecasts:** Exponentially weighting the most recent observations
  - **Median Forecasts:** Forecasting forward a 20-day median
  - **Repeating Forecasts:** Simulating a Seasonal Naive Forecast by broadcasting the last 12 observations of a monthly dataset into the future

The key engine parameter is the `window_function`. A function / formula:

- If a function, e.g. `mean`, the function is used with any additional arguments, ... in `set_engine()`.
- If a formula, e.g. `~ mean(. , na.rm = TRUE)`, it is converted to a function.

This syntax allows you to create very compact anonymous functions.

## Fit Details

### Date and Date-Time Variable

It's a requirement to have a date or date-time variable as a predictor. The `fit()` interface accepts date and date-time features and handles them internally.

- `fit(y ~ date)`

### ID features (Multiple Time Series, Panel Data)

The `id` parameter is populated using the `fit()` or `fit_xy()` function:

*ID Example:* Suppose you have 3 features:

1. `y` (target)
2. `date` (time stamp),
3. `series_id` (a unique identifier that identifies each time series in your data).

The `series_id` can be passed to the `window_reg()` using `fit()`:

- `window_reg(id = "series_id")` specifies that the `series_id` column should be used to identify each time series.
- `fit(y ~ date + series_id)` will pass `series_id` on to the underlying functions.

### Window Function Specification (window\_function)

You can specify a function / formula using `purrr` syntax.

- If a function, e.g. `mean`, the function is used with any additional arguments, ... in `set_engine()`.
- If a formula, e.g. `~ mean(. , na.rm = TRUE)`, it is converted to a function.



This syntax allows you to create very compact anonymous functions.

### Window Size Specification (`window_size`)

The period can be non-seasonal (`window_size = 1` or `"none"`) or yearly seasonal (e.g. For monthly time stamps, `window_size = 12`, `window_size = "12 months"`, or `window_size = "yearly"`). There are 3 ways to specify:

1. `window_size = "all"`: A seasonal period is selected based on the periodicity of the data (e.g. 12 if monthly)
2. `window_size = 12`: A numeric frequency. For example, 12 is common for monthly data
3. `window_size = "1 year"`: A time-based phrase. For example, "1 year" would convert to 12 for monthly data.

### External Regressors (`Xregs`)

These models are univariate. No `xregs` are used in the modeling process.

### See Also

[fit.model\\_spec\(\)](#), [set\\_engine\(\)](#)

### Examples

```
library(dplyr)
library(parsnip)
library(rsample)
library(timetk)
library(modeltime)

# Data
m750 <- m4_monthly %>% filter(id == "M750")
m750

# Split Data 80/20
splits <- initial_time_split(m750, prop = 0.8)

# ---- WINDOW FUNCTION ----

# Used to make:
# - Mean/Median forecasts
# - Simple repeating forecasts

# Median Forecast ----

# Model Spec
model_spec <- window_reg(
  window_size = 12
) %>%
# Extra parameters passed as: set_engine(...)
set_engine(
  engine = "window_function",
  window_function = median,
  na.rm = TRUE
```

```

)

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date, data = training(splits))
model_fit

# Predict
# - The 12-month median repeats going forward
predict(model_fit, testing(splits))

# ---- PANEL FORECAST - WINDOW FUNCTION ----

# Weighted Average Forecast
model_spec <- window_reg(
  # Specify the ID column for Panel Data
  id = "id",
  window_size = 12
) %>%
  set_engine(
    engine = "window_function",
    # Create a Weighted Average
    window_function = ~ sum(tail(.x, 3) * c(0.1, 0.3, 0.6)),
  )

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date + id, data = training(splits))
model_fit

# Predict: The weighted average (scalar) repeats going forward
predict(model_fit, testing(splits))

# ---- BROADCASTING PANELS (REPEATING) ----

# Simulating a Seasonal Naive Forecast by
# broadcasting model the last 12 observations into the future
model_spec <- window_reg(
  id = "id",
  window_size = Inf
) %>%
  set_engine(
    engine = "window_function",
    window_function = ~ tail(.x, 12),
  )

# Fit Spec
model_fit <- model_spec %>%
  fit(log(value) ~ date + id, data = training(splits))
model_fit

# Predict: The sequence is broadcasted (repeated) during prediction

```

```
predict(model_fit, testing(splits))
```

---

```
xgboost_impl
```

```
Wrapper for parsnip::xgb_train
```

---

## Description

Wrapper for `parsnip::xgb_train`

## Usage

```
xgboost_impl(
  x,
  y,
  max_depth = 6,
  nrounds = 15,
  eta = 0.3,
  colsample_bynode = NULL,
  colsample_bytree = NULL,
  min_child_weight = 1,
  gamma = 0,
  subsample = 1,
  validation = 0,
  early_stop = NULL,
  objective = NULL,
  counts = TRUE,
  event_level = c("first", "second"),
  ...
)
```

## Arguments

<code>x</code>	A data frame or matrix of predictors
<code>y</code>	A vector (factor or numeric) or matrix (numeric) of outcome data.
<code>max_depth</code>	An integer for the maximum depth of the tree.
<code>nrounds</code>	An integer for the number of boosting iterations.
<code>eta</code>	A numeric value between zero and one to control the learning rate.
<code>colsample_bynode</code>	Subsampling proportion of columns for each node within each tree. See the <code>counts</code> argument below. The default uses all columns.
<code>colsample_bytree</code>	Subsampling proportion of columns for each tree. See the <code>counts</code> argument below. The default uses all columns.

min_child_weight	A numeric value for the minimum sum of instance weights needed in a child to continue to split.
gamma	A number for the minimum loss reduction required to make a further partition on a leaf node of the tree
subsample	Subsampling proportion of rows. By default, all of the training data are used.
validation	A positive number. If on [0, 1) the value, validation is a random proportion of data in x and y that are used for performance assessment and potential early stopping. If 1 or greater, it is the <i>number</i> of training set samples use for these purposes.
early_stop	An integer or NULL. If not NULL, it is the number of training iterations without improvement before stopping. If validation is used, performance is base on the validation set; otherwise the training set is used.
objective	A single string (or NULL) that defines the loss function that xgboost uses to create trees. See <code>xgboost::xgb.train()</code> for options. If left NULL, an appropriate loss function is chosen.
counts	A logical. If FALSE, <code>colsample_bynode</code> and <code>colsample_bytree</code> are both assumed to be <i>proportions</i> of the proportion of columns affects (instead of counts).
event_level	For binary classification, this is a single string of either "first" or "second" to pass along describing which level of the outcome should be considered the "event".
...	Other options to pass to <code>xgb.train</code> .

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xgboost_predict	<i>Wrapper for xgboost::predict</i>
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## Description

Wrapper for `xgboost::predict`

## Usage

```
xgboost_predict(object, newdata, ...)
```

## Arguments

object	a model object for which prediction is desired.
newdata	New data to be predicted
...	additional arguments affecting the predictions produced.

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