Package 'tscv'

October 21, 2026

Title Functions and Utilities for Tidy Time Series Forecasting and Time Series Cross-Validation

Version 1.0.2

Description Functions and tools for tidy time series analysis and forecasting as well as time series cross-validation. This is mainly a set of wrapper and helper functions as well as some extensions for the packages 'tsibble', 'fable', and 'fabletools'.

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URL https://github.com/ahaeusser/tscv, https://ahaeusser.github.io/tscv/

BugReports https://github.com/ahaeusser/tscv/issues

Depends R (>= 4.1.0)

Imports rlang, dplyr, ggplot2, grDevices, tidyr, tidyselect, tibble, slider, lubridate, purrr, tsibble, forecast, fabletools, stats, qqplotr, scales, distributional, tidytext

Encoding UTF-8

LazyData true

Suggests knitr, rmarkdown, tidyverse, fable, feasts, testthat (>= 3.0.0), covr

VignetteBuilder knitr

Config/testthat/edition 3

Config/roxygen2/version 8.1.1

NeedsCompilation no

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Repository CRAN

Date/Publication 2026-10-21 11:40:02 UTC

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`acf_vec` *Estimate autocorrelations of a numeric vector*

Description

Estimate the sample autocorrelation function of a numeric vector.

Usage

```
acf_vec(x, lag_max = 24, ...)
```

Arguments

x	Numeric vector.
lag_max	Integer. Maximum lag for which the autocorrelation is estimated.
...	Further arguments passed to stats::acf().

Details

acf_vec() is a small wrapper around stats::acf(). It returns the sample autocorrelations as a numeric vector and removes lag 0 from the output, because lag 0 is always equal to 1 and is usually not needed for diagnostics.

Value

A numeric vector containing the sample autocorrelations for lags 1 to lag_max.

See Also

Other data analysis: estimate_acf(), estimate_kurtosis(), estimate_mode(), estimate_pacf(), estimate_skewness(), pacf_vec(), summarise_data(), summarise_split(), summarise_stats()

Examples

```
library(dplyr)

x <- M4_monthly_data |>
  filter(series == first(series)) |>
  pull(value)

acf_vec(
  x = x,
  lag_max = 12
)
```

---

check_data *Check and prepare tsibble data*

Description

Check that the input data is a valid regular and ordered tsibble, fill implicit gaps if requested, and convert wide data to long format.

Usage

```
check_data(data, fill_missing = TRUE)
```

Arguments

`data`	A `tsibble` in long or wide format.
`fill_missing`	Logical value. If `TRUE`, implicit missing values are turned into explicit missing values with `fill_gaps()`.

Details

`check_data()` is a data preparation helper for time series workflows. It performs three tasks:

- checks that `data` is a `tsibble`;
- checks that the time index is regular and ordered by key and index;
- optionally turns implicit missing values into explicit missing values using `fill_gaps()`.

If the input data has no key variables, it is treated as wide data and is converted to long format. The resulting output contains the original index column, a `variable` column containing the former column names, and a `value` column containing the corresponding observations.

Existing explicit missing values are not changed.

Value

A `tsibble` prepared for downstream use. Wide data is returned in long format with one measurement variable named `value`.

See Also

Other data preparation: `interpolate_missing()`, `smooth_outlier()`

Examples

```
library(dplyr)
library(tsibble)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395")) |>
  as_tsibble(
    index = index,
    key = series
  )

check_data(data)

wide_data <- data |>
  as_tibble() |>
  select(index, series, value) |>
  tidyr::pivot_wider(
    names_from = series,
    values_from = value
  ) |>
  as_tsibble(index = index)

check_data(wide_data)
```

DSHW *Double Seasonal Holt-Winters model*

Description

Specify a Double Seasonal Holt-Winters model for use with `fabletools::model()`.

Usage

```
DSHW(formula, ...)
```

Arguments

`formula`	A model formula specifying the response variable, for example `value`.
`...`	Further arguments passed to `forecast::dshw()`, including `periods`.

Details

`DSHW()` is a model specification wrapper around `forecast::dshw()` for the `fable`, `tsibble`, and `fabletools` ecosystem.

The model is useful for time series with two important seasonal patterns, such as hourly data with daily and weekly seasonality.

The seasonal periods must be supplied through the `periods` argument.

Value

A model definition that can be used inside `fabletools::model()`.

See Also

Other DSHW: `fitted.DSHW()`, `forecast.DSHW()`, `model_sum.DSHW()`, `residuals.DSHW()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_load |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 28) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("DSHW" = DSHW(value, periods = c(24, 168)))

model_frame
```

elec_load *Hourly electricity load (actual values and forecasts)*

Description

Hourly tibble with actual electricity loads and load forecasts from the ENTSO-E Transparency Platform. The data set contains time series data from 2019-01-01 00:00:00 to 2019-12-31 23:00:00 for 8 bidding zones within Europe (DE, DK1, ES, FI, FR, NL, NO1, SE1). The original data are on a quarter-hourly basis (15-minutes interval), but aggregated to hourly data.

Usage

```
data(elec_load)
```

Format

A time series object of class `tibble` with 140.160 rows and 5 columns:

- `time`: Date and time index
- `item`: Time series name
- `unit`: Measured unit
- `bidding_zone`: Bidding zone
- `value`: Measurement variable

Source

ENTSO-E Transparency Platform

Examples

```
data(elec_load)
```

elec_price *Hourly day-ahead electricity spot prices*

Description

Hourly tibble with day-ahead electricity spot prices from the ENTSO-E Transparency Platform. The data set contains time series data from 2019-01-01 00:00:00 to 2020-12-31 23:00:00 for 8 bidding zones within Europe (DE, DK1, ES, FI, FR, NL, NO1, SE1).

Usage

```
data(elec_price)
```

Format

A time series object of class `tibble` with 140.352 rows and 5 columns:

- `time`: Date and time index
- `item`: Time series name
- `unit`: Measured unit
- `bidding_zone`: Bidding zone
- `value`: Measurement variable

Source

ENTSO-E Transparency Platform

Examples

```
data(elec_price)
```

`estimate_acf` *Estimate autocorrelations by time series*

Description

Estimate the sample autocorrelation function for one or more time series in a `tibble`.

Usage

```
estimate_acf(.data, context, lag_max = 24, level = 0.9, ...)
```

Arguments

`.data`	A `tibble` containing the time series data.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.
`lag_max`	Integer. Maximum lag for which the autocorrelation is estimated.
`level`	Numeric value. Confidence level used to calculate the approximate significance bound.
`...`	Further arguments passed to `stats::acf()`.

Details

`estimate_acf()` groups the input data by the series identifier supplied in `context` and estimates the sample autocorrelation function for each time series separately.

The output contains one row per series and lag. The column bound contains an approximate significance threshold based on the selected confidence level. The logical column `sign` indicates whether the absolute autocorrelation is larger than this threshold.

Value

A tibble with the series identifier and the columns type, lag, value, bound, and sign.

See Also

Other data analysis: acf_vec(), estimate_kurtosis(), estimate_mode(), estimate_pacf(), estimate_skewness(), pacf_vec(), summarise_data(), summarise_split(), summarise_stats()

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

estimate_acf(
  .data = data,
  context = context,
  lag_max = 12
)
```

---

estimate_kurtosis *Estimate kurtosis*

Description

Estimate the kurtosis of a numeric distribution.

Usage

```
estimate_kurtosis(x, na_rm = TRUE)
```

Arguments

x	Numeric vector.
na_rm	Logical value. If TRUE, missing values are removed before estimation.

Details

The function computes the moment-based kurtosis

$$\frac{n \sum_i (x_i - \bar{x})^4}{\left(\sum_i (x_i - \bar{x})^2\right)^2}$$

Missing values are removed by default.

This returns the usual kurtosis, not excess kurtosis. A normal distribution has kurtosis close to 3.

Value

A numeric value giving the estimated kurtosis.

See Also

Other data analysis: `acf_vec()`, `estimate_acf()`, `estimate_mode()`, `estimate_pacf()`, `estimate_skewness()`, `pacf_vec()`, `summarise_data()`, `summarise_split()`, `summarise_stats()`

Examples

```
x <- c(1, 2, 3, 4, 5, NA)

estimate_kurtosis(x)
estimate_kurtosis(x, na_rm = TRUE)

set.seed(123)
y <- rnorm(100)
estimate_kurtosis(y)
```

---

estimate_mode *Estimate the mode of a distribution*

Description

Estimate the mode of a numeric distribution using kernel density estimation.

Usage

```
estimate_mode(x, na_rm = TRUE, ...)
```

Arguments

`x`	Numeric vector.
`na_rm`	Logical value. If `TRUE`, missing values are removed before estimation.
`...`	Further arguments passed to `stats::density()`.

Details

The function computes a kernel density estimate with `stats::density()` and returns the value of `x` at which the estimated density is largest.

Missing values are removed by default. Additional arguments are passed to `stats::density()`, for example `bw`, `kernel`, or `n`.

Value

A numeric value giving the estimated mode of the distribution.

See Also

Other data analysis: `acf_vec()`, `estimate_acf()`, `estimate_kurtosis()`, `estimate_pacf()`, `estimate_skewness()`, `pacf_vec()`, `summarise_data()`, `summarise_split()`, `summarise_stats()`

Examples

```
x <- c(1, 1, 2, 2, 2, 3, 4, NA)

estimate_mode(x)
estimate_mode(x, na_rm = TRUE)
estimate_mode(x, bw = "nrd0")

set.seed(123)
y <- rnorm(100, mean = 5)
estimate_mode(y)
```

`estimate_pacf` *Estimate partial autocorrelations by time series*

Description

Estimate the sample partial autocorrelation function for one or more time series in a `tibble`.

Usage

```
estimate_pacf(.data, context, lag_max = 24, level = 0.9, ...)
```

Arguments

`.data`	A `tibble` containing the time series data.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.
`lag_max`	Integer. Maximum lag for which the partial autocorrelation is estimated.
`level`	Numeric value. Confidence level used to calculate the approximate significance bound.
`...`	Further arguments passed to `stats::pacf()`.

Details

`estimate_pacf()` groups the input data by the series identifier supplied in `context` and estimates the sample partial autocorrelation function for each time series separately.

The output contains one row per series and lag. The column bound contains an approximate significance threshold based on the selected confidence level. The logical column `sign` indicates whether the absolute partial autocorrelation is larger than this threshold.

Value

A `tibble` with the series identifier and the columns `type`, `lag`, `value`, `bound`, and `sign`.

See Also

Other data analysis: `acf_vec()`, `estimate_acf()`, `estimate_kurtosis()`, `estimate_mode()`, `estimate_skewness()`, `pacf_vec()`, `summarise_data()`, `summarise_split()`, `summarise_stats()`

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

estimate_pacf(
  .data = data,
  context = context,
  lag_max = 12
)
```

`estimate_skewness` *Estimate skewness*

Description

Estimate the skewness of a numeric distribution.

Usage

```
estimate_skewness(x, na_rm = TRUE)
```

Arguments

x	Numeric vector.
na_rm	Logical value. If TRUE, missing values are removed before estimation.

Details

The function computes the moment-based skewness

$$\frac{\frac{1}{n}\sum_i (x_i - \bar{x})^3}{\left(\frac{1}{n}\sum_i (x_i - \bar{x})^2\right)^{3/2}}$$

Missing values are removed by default. Positive values indicate a distribution with a longer or heavier right tail; negative values indicate a distribution with a longer or heavier left tail.

Value

A numeric value giving the estimated skewness.

See Also

Other data analysis: acf_vec(), estimate_acf(), estimate_kurtosis(), estimate_mode(), estimate_pacf(), pacf_vec(), summarise_data(), summarise_split(), summarise_stats()

Examples

```
x <- c(1, 2, 3, 4, 10, NA)

estimate_skewness(x)
estimate_skewness(x, na_rm = TRUE)

set.seed(123)
y <- rexp(100)
estimate_skewness(y)
```

---

fitted.DSHW *Extract fitted values from a DSHW model*

Description

Extract fitted values from a fitted DSHW model.

Usage

```
## S3 method for class 'DSHW'
fitted(object, ...)
```

Arguments

object	A fitted DSHW model object.
...	Additional arguments. Currently not used.

Value

Fitted values.

See Also

Other DSHW: DSHW(), forecast.DSHW(), model_sum.DSHW(), residuals.DSHW()

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_load |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 28) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("DSHW" = DSHW(value, periods = c(24, 168)))

fitted(model_frame)
```

---

fitted.MEDIAN *Extract fitted values from a median model*

Description

Extract fitted values from a fitted MEDIAN model.

Usage

```
## S3 method for class 'MEDIAN'
fitted(object, ...)
```

Arguments

object	A fitted MEDIAN model object.
...	Additional arguments. Currently not used.

Value

Fitted values.

See Also

Other MEDIAN: MEDIAN(), forecast.MEDIAN(), model_sum.MEDIAN(), residuals.MEDIAN()

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("MEDIAN" = MEDIAN(value ~ window()))

fitted(model_frame)
```

---

fitted.NAIVE2 *Extract fitted values from a Naive2 model*

Description

Extract fitted values from a fitted NAIVE2 model.

Usage

```
## S3 method for class 'NAIVE2'
fitted(object, ...)
```

Arguments

object	A fitted NAIVE2 model object.
...	Additional arguments. Currently not used.

Value

Fitted values.

See Also

Other NAIVE2: NAIVE2(), forecast.NAIVE2(), model_sum.NAIVE2(), residuals.NAIVE2()

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("NAIVE2" = NAIVE2(value ~ season(12)))

fitted(model_frame)
```

`fitted.SMEAN` *Extract fitted values from a seasonal mean model*

Description

Extract fitted values from a fitted `SMEAN` model.

Usage

```
## S3 method for class 'SMEAN'
fitted(object, ...)
```

Arguments

`object`	A fitted `SMEAN` model object.
`...`	Additional arguments. Currently not used.

Value

Fitted values.

See Also

Other SMEAN: `SMEAN()`, `forecast.SMEAN()`, `model_sum.SMEAN()`, `residuals.SMEAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)
```

```
model_frame <- train_frame |>
  model("SMEAN" = SMEAN(value ~ lag("year")))

fitted(model_frame)
```

`fitted.SMEDIAN` *Extract fitted values from a seasonal median model*

Description

Extract fitted values from a fitted `SMEDIAN` model.

Usage

```
## S3 method for class 'SMEDIAN'
fitted(object, ...)
```

Arguments

`object`	A fitted `SMEDIAN` model object.
`...`	Additional arguments. Currently not used.

Value

Fitted values.

See Also

Other SMEDIAN: `SMEDIAN()`, `forecast.SMEDIAN()`, `model_sum.SMEDIAN()`, `residuals.SMEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SMEDIAN" = SMEDIAN(value ~ lag("week")))

fitted(model_frame)
```

`fitted.SNAIVE2` *Extract fitted values from a SNAIVE2 model*

Description

Extract fitted values from a fitted `SNAIVE2` model.

Usage

```
## S3 method for class 'SNAIVE2'
fitted(object, ...)
```

Arguments

`object`	A fitted `SNAIVE2` model object.
`...`	Additional arguments. Currently not used.

Value

Fitted values.

See Also

Other SNAIVE2: `SNAIVE2()`, `forecast.SNAIVE2()`, `model_sum.SNAIVE2()`, `residuals.SNAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SNAIVE2" = SNAIVE2(value))

fitted(model_frame)
```

`fitted.TBATS` *Extract fitted values from a TBATS model*

Description

Extract fitted values from a fitted `TBATS` model.

Usage

```
## S3 method for class 'TBATS'
fitted(object, ...)
```

Arguments

`object`	A fitted `TBATS` model object.
`...`	Additional arguments. Currently not used.

Details

This method is used by `fitted()` when extracting fitted values from a mable containing a `TBATS` model.

Value

Fitted values.

See Also

Other TBATS: `TBATS()`, `forecast.TBATS()`, `model_sum.TBATS()`, `residuals.TBATS()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("TBATS" = TBATS(value, periods = c(24, 168)))

fitted(model_frame)
```

`forecast.DSHW` *Forecast a DSHW model*

Description

Forecast a fitted `DSHW` model.

Usage

```
## S3 method for class 'DSHW'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted `DSHW` model object.
`new_data`	A `tsibble` containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Value

A vector of forecast distributions.

See Also

Other DSHW: `DSHW()`, `fitted.DSHW()`, `model_sum.DSHW()`, `residuals.DSHW()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_load |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 28) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("DSHW" = DSHW(value, periods = c(24, 168)))

forecast(model_frame, h = 24)
```

`forecast.MEDIAN` *Forecast a median model*

Description

Forecast a fitted `MEDIAN` model.

Usage

```
## S3 method for class 'MEDIAN'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted `MEDIAN` model object.
`new_data`	A `tsibble` containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Value

A vector of forecast distributions.

See Also

Other MEDIAN: `MEDIAN()`, `fitted.MEDIAN()`, `model_sum.MEDIAN()`, `residuals.MEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("MEDIAN" = MEDIAN(value ~ window()))

forecast(model_frame, h = 12)
```

`forecast.NAIVE2` *Forecast a Naive2 model*

Description

Forecast a fitted `NAIVE2` model.

Usage

```
## S3 method for class 'NAIVE2'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted `NAIVE2` model object.
`new_data`	A `tsibble` containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Details

Point forecasts are calculated using `naive2()`. Forecast distributions use a normal approximation based on a random walk applied to the seasonally adjusted response. These forecast distributions are not part of the original M4 Naive2 specification.

Value

A vector of forecast distributions.

See Also

Other NAIVE2: `NAIVE2()`, `fitted.NAIVE2()`, `model_sum.NAIVE2()`, `residuals.NAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("NAIVE2" = NAIVE2(value ~ season(12)))

forecast(model_frame, h = 18)
```

`forecast.SMEAN` *Forecast a seasonal mean model*

Description

Forecast a fitted `SMEAN` model.

Usage

```
## S3 method for class 'SMEAN'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted `SMEAN` model object.
`new_data`	A `tsibble` containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Value

A vector of forecast distributions.

See Also

Other SMEAN: `SMEAN()`, `fitted.SMEAN()`, `model_sum.SMEAN()`, `residuals.SMEAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("SMEAN" = SMEAN(value ~ lag("year")))

forecast(model_frame, h = 12)
```

`forecast.SMEDIAN` *Forecast a seasonal median model*

Description

Forecast a fitted `SMEDIAN` model.

Usage

```
## S3 method for class 'SMEDIAN'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted `SMEDIAN` model object.
`new_data`	A `tsibble` containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Value

A vector of forecast distributions.

See Also

Other SMEDIAN: `SMEDIAN()`, `fitted.SMEDIAN()`, `model_sum.SMEDIAN()`, `residuals.SMEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SMEDIAN" = SMEDIAN(value ~ lag("week")))

forecast(model_frame, h = 24)
```

`forecast.SNAIVE2` *Forecast a SNAIVE2 model*

Description

Forecast a fitted `SNAIVE2` model.

Usage

```
## S3 method for class 'SNAIVE2'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted `SNAIVE2` model object.
`new_data`	A `tsibble` containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Value

A vector of forecast distributions.

See Also

Other SNAIVE2: `SNAIVE2()`, `fitted.SNAIVE2()`, `model_sum.SNAIVE2()`, `residuals.SNAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SNAIVE2" = SNAIVE2(value))

forecast(model_frame, h = 24)
```

`forecast.TBATS` *Forecast a TBATS model*

Description

Forecast a fitted TBATS model.

Usage

```
## S3 method for class 'TBATS'
forecast(object, new_data, specials = NULL, ...)
```

Arguments

`object`	A fitted TBATS model object.
`new_data`	A tsibble containing future time points.
`specials`	Parsed specials. Currently not used.
`...`	Additional arguments. Currently not used.

Details

This method is used by `forecast()` when forecasting a mable containing a TBATS model.

Value

A vector of forecast distributions.

See Also

Other TBATS: `TBATS()`, `fitted.TBATS()`, `model_sum.TBATS()`, `residuals.TBATS()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("TBATS" = TBATS(value, periods = c(24, 168)))

forecast(model_frame, h = 24)
```

`forecast_naive2` *Forecast a time series using the Naive2 method*

Description

Produces forecasts using the Naive2 benchmark from the M4 forecasting competition. The function first applies `test_seasonality()` at the specified frequency. If seasonality is not detected, the final observation is repeated for the complete forecast horizon.

If seasonality is detected, the series is adjusted using classical multiplicative decomposition. A naive forecast is then produced from the seasonally adjusted series and reseasonalized using the estimated seasonal factors.

Usage

```
forecast_naive2(x, freq, n_ahead)
```

Arguments

`x`	A numeric vector containing the observed time series.
`freq`	Integer value. A positive whole number specifying the seasonal frequency, such as ‘12‘ for monthly data or ‘4‘ for quarterly data.
`n_ahead`	Integer value. A positive whole number specifying the number of future observations to forecast.

Value

A numeric vector of length ‘n_ahead‘ containing the point forecasts.

Examples

```
x <- as.numeric(AirPassengers)

forecast_naive2(
  x = x,
  freq = 12,
  n_ahead = 18
)
```

`interpolate_missing` *Interpolate missing values*

Description

Interpolate missing values in a numeric time series.

Usage

```
interpolate_missing(x, periods, ...)
```

Arguments

`x`	Numeric vector containing the time series observations.
`periods`	Numeric vector giving the seasonal periods of the time series, for example `12` for monthly data with yearly seasonality or `c(24, 168)` for hourly data with daily and weekly seasonality.
`...`	Further arguments passed to `forecast::msts()` or `forecast::na.interp()`.

Details

`interpolate_missing()` is a small wrapper around `forecast::na.interp()`. The input vector is first converted to an `msts` object using the seasonal periods supplied in `periods`.

For non-seasonal time series, missing values are replaced using linear interpolation. For seasonal time series, `forecast::na.interp()` uses an STL-based approach: the series is decomposed, the seasonally adjusted series is interpolated, and the seasonal component is added back.

The function returns a plain numeric vector with the same length as the input.

Value

A numeric vector with missing values interpolated.

See Also

Other data preparation: `check_data()`, `smooth_outlier()`

Examples

```
library(dplyr)

x <- M4_monthly_data |>
  filter(series == first(series)) |>
  pull(value)

x_missing <- x
x_missing[c(10, 20, 30)] <- NA
```

```
x_interpolated <- interpolate_missing(
  x = x_missing,
  periods = 12
)

anyNA(x_missing)
anyNA(x_interpolated)

hourly <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 14) |>
  pull(value)

hourly_missing <- hourly
hourly_missing[c(24, 48, 72)] <- NA

interpolate_missing(
  x = hourly_missing,
  periods = c(24, 168)
)
```

`M4_monthly_data` *Monthly time series data from the M4 Competition*

Description

The data set contains 30 selected time series on a monthly basis from the M4 Competition.

Usage

```
data(M4_monthly_data)
```

Format

A time series object of class `tibble` with 7881 rows and 4 columns:

- `index`: Date and time index
- `series`: Time series ID from M4 forecasting competition
- `category`: Category from M4 forecasting competition
- `value`: Measurement variable

Source

M4 Competition

Examples

```
data(M4_monthly_data)
```

M4_quarterly_data *Quarterly time series data from the M4 Competition*

Description

The data set contains 30 selected time series on a quarterly basis from the M4 Competition.

Usage

```
data(M4_quarterly_data)
```

Format

A time series object of class `tibble` with 2818 rows and 4 columns:

- `index`: Date and time index
- `series`: Time series ID from M4 forecasting competition
- `category`: Category from M4 forecasting competition
- `value`: Measurement variable

Source

M4 Competition

Examples

```
data(M4_quarterly_data)
```

mae_vec *Calculate the mean absolute error*

Description

Calculate the mean absolute error of a numeric vector.

Usage

```
mae_vec(truth, estimate, na_rm = TRUE)
```

Arguments

`truth`	Numeric vector containing the actual values.
`estimate`	Numeric vector containing the forecasts.
`na_rm`	Logical value. If `TRUE`, missing values are removed.

Details

`mae_vec()` computes the average absolute forecast error `abs(truth - estimate)`. The metric is reported in the same units as the original data.

Value

A numeric value.

See Also

Other accuracy functions: `make_accuracy()`, `make_errors()`, `mape_vec()`, `me_vec()`, `mpe_vec()`, `mse_vec()`, `rmse_vec()`, `smape_vec()`

Examples

```
truth <- c(10, 20, 30)
estimate <- c(8, 22, 25)

mae_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
mae_vec(truth_na, estimate_na)
```

---

make_accuracy *Estimate point forecast accuracy*

Description

Estimate accuracy metrics for point forecasts generated from rolling-origin time series cross-validation.

Usage

```
make_accuracy(
  future_frame,
  main_frame,
  context,
  dimension = "split",
  benchmark = NULL
)
```

Arguments

`future_frame`	A `tibble` containing point forecasts. It must contain the columns specified by `context`, as well as `model`, `split`, `horizon`, and `point`.
`main_frame`	A `tibble` containing the observed values. It must contain the series identifier, time index, and value column specified by `context`.

context	A named list with the identifiers for series_id, value_id, and index_id.
dimension	Character value. Determines the dimension over which accuracy is summarized. Common choices are "split" and "horizon".
benchmark	Optional character value giving the model name used as the benchmark for the relative mean absolute error rMAE.

Details

make_accuracy() compares point forecasts in future_frame with the observed values in main_frame. The two data sets are joined using the series identifier and time index defined in context.

Accuracy can be summarized along different cross-validation dimensions:

- dimension = "split" summarizes accuracy separately for each test split.
- dimension = "horizon" summarizes accuracy separately for each forecast horizon.

The following point forecast accuracy metrics are returned:

- ME: mean error.
- MAE: mean absolute error.
- MSE: mean squared error.
- RMSE: root mean squared error.
- MAPE: mean absolute percentage error.
- sMAPE: symmetric mean absolute percentage error.
- MPE: mean percentage error.

If benchmark is supplied, the function also computes the relative mean absolute error rMAE. The rMAE is calculated as the model's MAE divided by the MAE of the benchmark model for the same series and selected dimension.

Value

A tibble containing the forecast accuracy metrics. The output contains the series identifier, model name, selected dimension, dimension value n, metric name, and metric value.

See Also

Other accuracy functions: mae_vec(), make_errors(), mape_vec(), me_vec(), mpe_vec(), mse_vec(), rmse_vec(), smape_vec()

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)
library(fable)

context <- list(
  series_id = "series",
```

```
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

split_frame <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

train_frame <- slice_train(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
) |>
  as_tsibble(
    index = index,
    key = c(series, split)
  )

model_frame <- train_frame |>
  model(
    "SNAIVE" = SNAIVE(value ~ lag("year"))
  )

fable_frame <- model_frame |>
  forecast(h = 18)

future_frame <- make_future(
  fable = fable_frame,
  context = context
)

accuracy_horizon <- make_accuracy(
  future_frame = future_frame,
  main_frame = main_frame,
  context = context,
  dimension = "horizon"
)

accuracy_horizon

accuracy_split <- make_accuracy(
  future_frame = future_frame,
```

```
  main_frame = main_frame,
  context = context,
  dimension = "split"
)

accuracy_split
```

---

make_errors *Calculate forecast errors and percentage errors*

Description

Calculate forecast errors and percentage forecast errors for point forecasts.

Usage

```
make_errors(future_frame, main_frame, context)
```

Arguments

future_frame	A tibble containing the forecasts. It must contain the columns specified by context, as well as model, split, horizon, and point.
main_frame	A tibble containing the observed values. It must contain the series identifier, time index, and value column specified by context.
context	A named list with the identifiers for series_id, value_id, and index_id.

Details

make_errors() compares point forecasts in future_frame with the observed values in main_frame. The two data sets are joined by the series identifier and time index specified in context.

The forecast error is calculated as error = actual - point. The percentage forecast error is calculated as pct_error = (actual -point / point) * 100.

Positive errors indicate that the forecast is below the observed value. Negative errors indicate that the forecast is above the observed value.

The returned data contains:

- series_id: Unique identifier for the time series as specified in context.
- model: Forecasting model name.
- split: Train-test split identifier.
- horizon: Forecast horizon.
- error: Forecast error.
- pct_error: Percentage forecast error.

Value

A tibble containing forecast errors and percentage forecast errors.

See Also

Other accuracy functions: mae_vec(), make_accuracy(), mape_vec(), me_vec(), mpe_vec(), mse_vec(), rmse_vec(), smape_vec()

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)
library(fable)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

split_frame <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

train_frame <- slice_train(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
) |>
  as_tsibble(
    index = index,
    key = c(series, split)
  )

model_frame <- train_frame |>
  model(
    "SNAIVE" = SNAIVE(value ~ lag("year"))
  )

fable_frame <- model_frame |>
  forecast(h = 18)

future_frame <- make_future(
  fable = fable_frame,
```

```
  context = context
)

error_frame <- make_errors(
  future_frame = future_frame,
  main_frame = main_frame,
  context = context
)

error_frame
```

`make_future` *Convert forecasts to a future frame*

Description

Convert forecasts from a `fable` object to a standardized forecast table.

Usage

```
make_future(fable, context)
```

Arguments

`fable`	A `fable` created with `forecast()`.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.

Details

`make_future()` converts the output of `forecast()` into a `tibble` with a consistent structure for downstream evaluation, plotting, and accuracy calculation.

The returned `future_frame` contains one row per forecasted observation, time series, split, and model. It includes the following columns:

- the time index column specified by `context$index_id`;
- the series identifier column specified by `context$series_id`;
- `model`: the forecasting model name;
- `split`: the train-test split identifier;
- `horizon`: the forecast horizon within each series, split, and model;
- `point`: the point forecast, taken from the `.mean` column of the `fable`.

This format is used by functions such as `make_accuracy()` and `make_errors()`.

Value

A `tibble` containing forecasts in standardized `future_frame` format.

See Also

Other time series cross-validation: make_split(), make_tsibble(), slice_test(), slice_train(), split_index()

Examples

```
library(dplyr)
library(tsibble)
library(fable)
library(fabletools)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

split_frame <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

train_frame <- slice_train(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
) |>
  as_tsibble(
    index = index,
    key = c(series, split)
  )

model_frame <- train_frame |>
  model(
    "SNAIVE" = SNAIVE(value ~ lag("year"))
  )

fable_frame <- model_frame |>
  forecast(h = 18)

future_frame <- make_future(
  fable = fable_frame,
```

```
  context = context
)

future_frame
```

---

make_split *Create train-test splits for time series cross-validation*

Description

Create a split frame with train and test indices for one or more time series.

Usage

```
make_split(
  main_frame,
  context,
  type,
  value,
  n_ahead,
  n_skip = 0,
  n_lag = 0,
  mode = "slide",
  exceed = TRUE
)
```

Arguments

main_frame	A tibble containing the time series data.
context	A named list with the identifiers for series_id, value_id, and index_id.
type	Character value. The type of initial split. Possible values are "first", "last", and "prob".
value	Numeric value specifying the initial split.
n_ahead	Integer. The forecast horizon, i.e. the number of observations in each test window.
n_skip	Integer. The number of observations to skip between split origins. The default is 0.
n_lag	Integer. The number of lagged observations to include before the test window. This is useful if lagged predictors are required when constructing test features. The default is 0.
mode	Character value. Either "slide" for a fixed-window approach or "stretch" for an expanding-window approach.
exceed	Logical value. If TRUE, out-of-sample splits exceeding the original sample size are created.

Details

`make_split()` creates rolling-origin train-test splits for time series cross-validation. The output is used by functions such as `slice_train()` and `slice_test()` to extract the corresponding training and testing samples from `main_frame`.

The function supports two training-window modes:

- `mode = "slide"` creates a fixed-window approach. The training window has constant length and moves forward over time.
- `mode = "stretch"` creates an expanding-window approach. The training window starts at the first observation and grows over time.

The initial training window is controlled by `type` and `value`:

- `type = "first"` uses the first `value` observations as the initial training window.
- `type = "last"` keeps the last `value` observations for testing and derives the initial training window from the remaining sample.
- `type = "prob"` uses `floor(value * n_total)` observations as the initial training window.

The argument `n_skip` controls how far the rolling origin moves between consecutive splits. For non-overlapping test windows, use `n_skip = n_ahead - 1`.

Value

A `tibble` containing the split plan. The output has one row per time series and split, with list-columns `train` and `test` containing integer row positions.

See Also

Other time series cross-validation: `make_future()`, `make_tsibble()`, `slice_test()`, `slice_train()`, `split_index()`

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series == "M23100")

# Fixed-window split plan
fixed_split <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
```

```
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "slide",
  exceed = FALSE
)

fixed_split

# Expanding-window split plan
expanding_split <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

expanding_split
```

`make_tsibble` *Convert data to a tsibble*

Description

Convert a `tibble` containing time series data to a `tsibble`.

Usage

```
make_tsibble(main_frame, context)
```

Arguments

`main_frame`	A `tibble` containing the time series data.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.

Details

`make_tsibble()` is a small helper for time series cross-validation workflows. It uses the time index and series identifier supplied in `context` to create a regular `tsibble`.

The input data must contain the columns specified by `context$index_id` and `context$series_id`. The column specified by `context$index_id` is used as the time index, and the column specified by `context$series_id` is used as the key.

Value

A `tsibble` with the same columns as `main_frame`, using the index and key defined in `context`.

See Also

Other time series cross-validation: `make_future()`, `make_split()`, `slice_test()`, `slice_train()`, `split_index()`

Examples

```
library(dplyr)
library(tsibble)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

tsibble_frame <- make_tsibble(
  main_frame = main_frame,
  context = context
)

tsibble_frame
```

---

mape_vec *Calculate the mean absolute percentage error*

Description

Calculate the mean absolute percentage error of a numeric vector.

Usage

```
mape_vec(truth, estimate, na_rm = TRUE)
```

Arguments

`truth`	Numeric vector containing the actual values.
`estimate`	Numeric vector containing the forecasts.
`na_rm`	Logical value. If `TRUE`, missing values are removed.

Details

mape_vec() computes the average absolute percentage forecast error: abs((truth - estimate) / truth) * 100.

This metric is undefined when truth is zero and may return Inf or NaN in such cases.

Value

A numeric value.

See Also

Other accuracy functions: mae_vec(), make_accuracy(), make_errors(), me_vec(), mpe_vec(), mse_vec(), rmse_vec(), smape_vec()

Examples

```
truth <- c(10, 20, 40)
estimate <- c(8, 22, 30)

mape_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
mape_vec(truth_na, estimate_na)
```

MEDIAN *Median model*

Description

Specify a median benchmark model for use with fabletools::model().

Usage

```
MEDIAN(formula, ...)
```

Arguments

formula	A model formula specifying the response and optional window() special, for example value ~ window().
...	Further arguments.

Details

MEDIAN() forecasts future values using the median of the observed response. The window() special controls whether the median is estimated using all observations, a fixed trailing window, or a rolling window.

Value

A model definition that can be used inside `fabletools::model()`.

See Also

Other MEDIAN: `fitted.MEDIAN()`, `forecast.MEDIAN()`, `model_sum.MEDIAN()`, `residuals.MEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("MEDIAN" = MEDIAN(value ~ window()))

model_frame
```

---

me_vec *Calculate the mean error*

Description

Calculate the mean error of a numeric vector.

Usage

```
me_vec(truth, estimate, na_rm = TRUE)
```

Arguments

`truth`	Numeric vector containing the actual values.
`estimate`	Numeric vector containing the forecasts.
`na_rm`	Logical value. If `TRUE`, missing values are removed.

Details

`me_vec()` computes the average signed forecast error `truth - estimate`. Positive values indicate that forecasts are, on average, below the observed values. Negative values indicate that forecasts are, on average, above the observed values.

The metric is reported in the same units as the original data.

Value

A numeric value.

See Also

Other accuracy functions: `mae_vec()`, `make_accuracy()`, `make_errors()`, `mape_vec()`, `mpe_vec()`, `mse_vec()`, `rmse_vec()`, `smape_vec()`

Examples

```
truth <- c(10, 20, 30)
estimate <- c(8, 22, 25)

me_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
me_vec(truth_na, estimate_na)
```

---

model_sum.DSHW *Summarize a DSHW model*

Description

Return a short model label for a fitted `DSHW` model.

Usage

```
## S3 method for class 'DSHW'
model_sum(x)
```

Arguments

`x`	A fitted `DSHW` model object.

Value

A character string.

See Also

Other DSHW: `DSHW()`, `fitted.DSHW()`, `forecast.DSHW()`, `residuals.DSHW()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_load |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 28) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("DSHW" = DSHW(value, periods = c(24, 168)))

model_frame
```

`model_sum.MEDIAN` *Summarize a median model*

Description

Return a short model label for a fitted `MEDIAN` model.

Usage

```
## S3 method for class 'MEDIAN'
model_sum(x)
```

Arguments

`x`	A fitted `MEDIAN` model object.

Value

A character string.

See Also

Other MEDIAN: `MEDIAN()`, `fitted.MEDIAN()`, `forecast.MEDIAN()`, `residuals.MEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)
```

```
model_frame <- train_frame |>
  model("MEDIAN" = MEDIAN(value ~ window()))

model_frame
```

`model_sum.NAIVE2` *Summarize a Naive2 model*

Description

Return a short model label for a fitted `NAIVE2` model.

Usage

```
## S3 method for class 'NAIVE2'
model_sum(x)
```

Arguments

`x`	A fitted `NAIVE2` model object.

Value

A character string.

See Also

Other NAIVE2: `NAIVE2()`, `fitted.NAIVE2()`, `forecast.NAIVE2()`, `residuals.NAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("NAIVE2" = NAIVE2(value ~ season(12)))

model_frame
```

`model_sum.SMEAN` *Summarize a seasonal mean model*

Description

Return a short model label for a fitted `SMEAN` model.

Usage

```
## S3 method for class 'SMEAN'
model_sum(x)
```

Arguments

`x`	A fitted `SMEAN` model object.

Value

A character string.

See Also

Other SMEAN: `SMEAN()`, `fitted.SMEAN()`, `forecast.SMEAN()`, `residuals.SMEAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("SMEAN" = SMEAN(value ~ lag("year")))

model_frame
```

`model_sum.SMEDIAN` *Summarize a seasonal median model*

Description

Return a short model label for a fitted `SMEDIAN` model.

Usage

```
## S3 method for class 'SMEDIAN'
model_sum(x)
```

Arguments

`x`	A fitted `SMEDIAN` model object.

Value

A character string.

See Also

Other SMEDIAN: `SMEDIAN()`, `fitted.SMEDIAN()`, `forecast.SMEDIAN()`, `residuals.SMEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SMEDIAN" = SMEDIAN(value ~ lag("week")))

model_frame
```

`model_sum.SNAIVE2` *Summarize a SNAIVE2 model*

Description

Return a short model label for a fitted `SNAIVE2` model.

Usage

```
## S3 method for class 'SNAIVE2'
model_sum(x)
```

Arguments

`x`	A fitted `SNAIVE2` model object.

Value

A character string.

See Also

Other SNAIVE2: `SNAIVE2()`, `fitted.SNAIVE2()`, `forecast.SNAIVE2()`, `residuals.SNAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SNAIVE2" = SNAIVE2(value))

model_frame
```

`model_sum.TBATS` *Summarize a TBATS model*

Description

Return a short model label for a fitted `TBATS` model.

Usage

```
## S3 method for class 'TBATS'
model_sum(x)
```

Arguments

`x`	A fitted `TBATS` model object.

Value

A character string.

See Also

Other TBATS: `TBATS()`, `fitted.TBATS()`, `forecast.TBATS()`, `residuals.TBATS()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("TBATS" = TBATS(value, periods = c(24, 168)))

model_frame
```

mpe_vec *Calculate the mean percentage error*

Description

Calculate the mean percentage error of a numeric vector.

Usage

```
mpe_vec(truth, estimate, na_rm = TRUE)
```

Arguments

truth	Numeric vector containing the actual values.
estimate	Numeric vector containing the forecasts.
na_rm	Logical value. If TRUE, missing values are removed.

Details

mpe_vec() computes the average signed percentage forecast error: ((truth - estimate) / truth) * 100. Positive values indicate that forecasts are, on average, below the observed values in percentage terms. Negative values indicate that forecasts are, on average, above the observed values.

This metric is undefined when truth is zero and may return Inf, -Inf, or NaN in such cases.

Value

A numeric value.

See Also

Other accuracy functions: mae_vec(), make_accuracy(), make_errors(), mape_vec(), me_vec(), mse_vec(), rmse_vec(), smape_vec()

Examples

```
truth <- c(10, 20, 40)
estimate <- c(8, 22, 30)

mpe_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
mpe_vec(truth_na, estimate_na)
```

mse_vec *Calculate the mean squared error*

Description

Calculate the mean squared error of a numeric vector.

Usage

```
mse_vec(truth, estimate, na_rm = TRUE)
```

Arguments

truth	Numeric vector containing the actual values.
estimate	Numeric vector containing the forecasts.
na_rm	Logical value. If TRUE, missing values are removed.

Details

mse_vec() computes the average squared forecast error (truth - estimate)^2. The metric is reported in squared units of the original data.

Value

A numeric value.

See Also

Other accuracy functions: mae_vec(), make_accuracy(), make_errors(), mape_vec(), me_vec(), mpe_vec(), rmse_vec(), smape_vec()

Examples

```
truth <- c(10, 20, 30)
estimate <- c(8, 22, 25)

mse_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
mse_vec(truth_na, estimate_na)
```

NAIVE2 *Naive2 model*

Description

Specify a Naive2 benchmark model for use with `fabletools::model()`.

Usage

```
NAIVE2(formula, ...)
```

Arguments

`formula`	A model formula specifying the response and optional `season()` special, for example `value ~ season(12)`.
`...`	Further arguments.

Details

`NAIVE2()` implements the Naive2 benchmark from the M4 forecasting competition. The method tests the response for seasonality at the specified frequency.

If seasonality is detected, the response is adjusted using classical multiplicative decomposition. Naive forecasts are produced from the seasonally adjusted response and subsequently reseasonalized.

If seasonality is not detected, the method is equivalent to an ordinary naive forecast.

The `season()` special controls the seasonal frequency. When `period = NULL`, the frequency is inferred from the tsibble index. Alternatively, it can be specified explicitly, such as `season(12)` for monthly data.

Value

A model definition that can be used inside `fabletools::model()`.

See Also

Other NAIVE2: `fitted.NAIVE2()`, `forecast.NAIVE2()`, `model_sum.NAIVE2()`, `residuals.NAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)
```

```
model_frame <- train_frame |>
  model("NAIVE2" = NAIVE2(value ~ season(12)))

model_frame
```

---

pacf_vec *Estimate partial autocorrelations of a numeric vector*

Description

Estimate the sample partial autocorrelation function of a numeric vector.

Usage

```
pacf_vec(x, lag_max = 24, ...)
```

Arguments

x	Numeric vector.
lag_max	Integer. Maximum lag for which the partial autocorrelation is estimated.
...	Further arguments passed to stats::pacf().

Details

pacf_vec() is a small wrapper around stats::pacf(). It returns the sample partial autocorrelations as a numeric vector for lags 1 to lag_max.

Value

A numeric vector containing the sample partial autocorrelations for lags 1 to lag_max.

See Also

Other data analysis: acf_vec(), estimate_acf(), estimate_kurtosis(), estimate_mode(), estimate_pacf(), estimate_skewness(), summarise_data(), summarise_split(), summarise_stats()

Examples

```
library(dplyr)

x <- M4_monthly_data |>
  filter(series == first(series)) |>
  pull(value)

pacf_vec(
  x = x,
  lag_max = 12
)
```

plot_bar *Plot data as a bar chart*

Description

Create a bar chart for grouped numeric values.

Usage

```
plot_bar(
  data,
  x,
  y,
  position = "dodge",
  facet_var = NULL,
  facet_scale = "free",
  facet_nrow = NULL,
  facet_ncol = NULL,
  color = NULL,
  flip = FALSE,
  reorder = FALSE,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  caption = NULL,
  bar_size = 0.75,
  bar_color = "grey35",
  bar_alpha = 1,
  theme_set = theme_tscv(),
  theme_config = list(),
  ...
)
```

Arguments

data	A data.frame, tibble, or tsibble in long format.
x	Unquoted column in data used on the x-axis.
y	Unquoted column in data containing numeric values shown on the y-axis.
position	Character value defining the bar position. Common values are "dodge" and "stack".
facet_var	Optional unquoted column in data used for faceting.
facet_scale	Character value defining facet axis scaling. Common values are "free", "fixed", "free_x", and "free_y".
facet_nrow	Optional integer. Number of rows in the facet layout.

facet_ncol	Optional integer. Number of columns in the facet layout.
color	Optional unquoted column in data used to map bar fill color.
flip	Logical value. If TRUE, the plot is flipped using ggplot2::coord_flip().
reorder	Logical value. If TRUE, add tidytext::scale_x_reordered() for reordered facet labels.
title	Character value. Plot title.
subtitle	Character value. Plot subtitle.
xlab	Character value. Label for the x-axis.
ylab	Character value. Label for the y-axis.
caption	Character value. Plot caption.
bar_size	Numeric value defining the bar border line width.
bar_color	Character value defining the bar fill color. Ignored when color is supplied.
bar_alpha	Numeric value between 0 and 1 defining bar transparency.
theme_set	A complete ggplot2 theme.
theme_config	A named list with additional arguments passed to ggplot2::theme().
...	Currently not used.

Details

plot_bar() is a convenience wrapper around ggplot2::geom_bar() with stat = "identity". It is intended for data that already contains summarized values, for example accuracy metrics, counts, or grouped summary statistics.

The arguments x, y, facet_var, and color are passed as unquoted column names.

If color is supplied, bar fill colors are mapped to that variable and bar_color is ignored. If color is not supplied, all bars are drawn using bar_color.

The argument position controls how bars are displayed when color is supplied. Common values are "dodge" and "stack".

If flip = TRUE, the x-axis and y-axis are swapped using ggplot2::coord_flip().

If reorder = TRUE, tidytext::scale_x_reordered() is added. This is useful when the x-axis has been reordered within facets with tidytext::reorder_within().

Additional theme settings can be supplied through theme_config. This should be a named list of arguments passed to ggplot2::theme().

Value

An object of class ggplot.

See Also

Other data visualization: plot_density(), plot_histogram(), plot_line(), plot_point(), plot_qq(), scale_color_tscv(), scale_fill_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

stats <- summarise_stats(
  .data = data,
  context = context
)

plot_bar(
  data = stats,
  x = series,
  y = mean,
  title = "Average Value by Series",
  xlab = "Series",
  ylab = "Mean"
)

acf_data <- estimate_acf(
  .data = data,
  context = context,
  lag_max = 12
)

plot_bar(
  data = acf_data,
  x = lag,
  y = value,
  facet_var = series,
  title = "Autocorrelation by Series",
  subtitle = "Sample autocorrelation up to lag 12",
  xlab = "Lag",
  ylab = "ACF"
)
```

---

plot_density *Plot a kernel density estimate*

Description

Create a density plot for one or more numeric variables using kernel density estimation.

Usage

```
plot_density(
  data,
  x,
  facet_var = NULL,
  facet_scale = "free",
  facet_nrow = NULL,
  facet_ncol = NULL,
  color = NULL,
  fill = NULL,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  caption = NULL,
  line_width = 0.1,
  line_type = "solid",
  line_color = "grey35",
  fill_color = "grey35",
  fill_alpha = 0.5,
  theme_set = theme_tscv(),
  theme_config = list(),
  ...
)
```

Arguments

data	A data.frame, tibble, or tsibble in long format.
x	Unquoted column in data containing numeric values.
facet_var	Optional unquoted column in data used for faceting.
facet_scale	Character value defining facet axis scaling. Common values are "free", "fixed", "free_x", and "free_y".
facet_nrow	Optional integer. Number of rows in the facet layout.
facet_ncol	Optional integer. Number of columns in the facet layout.
color	Optional unquoted column in data used to map density line and fill color.
fill	Optional unquoted column in data used to map density fill color. Currently not used directly; use color for grouped density plots.
title	Character value. Plot title.
subtitle	Character value. Plot subtitle.
xlab	Character value. Label for the x-axis.
ylab	Character value. Label for the y-axis.
caption	Character value. Plot caption.
line_width	Numeric value defining the density line width.
line_type	Character or numeric value defining the density line type.

line_color	Character value defining the density line color. Ignored when color is supplied.
fill_color	Character value defining the fill color under the density curve. Ignored when color is supplied.
fill_alpha	Numeric value between 0 and 1 defining fill transparency.
theme_set	A complete ggplot2 theme.
theme_config	A named list with additional arguments passed to ggplot2::theme().
...	Further arguments passed to ggplot2::geom_density().

Details

plot_density() is a convenience wrapper around ggplot2::geom_density(). It is useful for comparing the distribution of values across one or more time series, models, groups, or residual sets.

The arguments x, facet_var, color, and fill are passed as unquoted column names.

If color is supplied, both line color and fill color are mapped to that variable. In this case, line_color and fill_color are ignored. If color is not supplied, all density curves use line_color and fill_color.

Missing values are removed before plotting.

Additional arguments can be passed to ggplot2::geom_density() through ..., for example adjust, bw, or kernel.

Additional theme settings can be supplied through theme_config. This should be a named list of arguments passed to ggplot2::theme().

Value

An object of class ggplot.

See Also

Other data visualization: plot_bar(), plot_histogram(), plot_line(), plot_point(), plot_qq(), scale_color_tscv(), scale_fill_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

plot_density(
  data = data,
  x = value,
  facet_var = series,
  title = "Distribution of M4 Monthly Values",
  subtitle = "Kernel density estimates by series",
  xlab = "Value",
  ylab = "Density"
```

```
)

plot_density(
  data = data,
  x = value,
  color = series,
  title = "Distribution of M4 Monthly Values",
  subtitle = "Kernel density estimates by series",
  xlab = "Value",
  ylab = "Density",
  adjust = 1.2
)
```

`plot_histogram` *Plot data as a histogram*

Description

Create a histogram for one or more numeric variables.

Usage

```
plot_histogram(
  data,
  x,
  facet_var = NULL,
  facet_scale = "free",
  facet_nrow = NULL,
  facet_ncol = NULL,
  color = NULL,
  fill = NULL,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  caption = NULL,
  line_color = "grey35",
  line_width = 0.5,
  fill_color = "grey35",
  fill_alpha = 1,
  theme_set = theme_tscv(),
  theme_config = list(),
  ...
)
```

Arguments

`data`	A `data.frame`, `tibble`, or `tsibble` in long format.

x	Unquoted column in data containing numeric values.
facet_var	Optional unquoted column in data used for faceting.
facet_scale	Character value defining facet axis scaling. Common values are "free", "fixed", "free_x", and "free_y".
facet_nrow	Optional integer. Number of rows in the facet layout.
facet_ncol	Optional integer. Number of columns in the facet layout.
color	Optional unquoted column in data used to map histogram outline and fill color.
fill	Optional unquoted column in data used to map histogram fill color. Currently not used directly; use color for grouped histograms.
title	Character value. Plot title.
subtitle	Character value. Plot subtitle.
xlab	Character value. Label for the x-axis.
ylab	Character value. Label for the y-axis.
caption	Character value. Plot caption.
line_color	Character value defining the histogram bar outline color. Ignored when color is supplied.
line_width	Numeric value defining the histogram bar outline width.
fill_color	Character value defining the histogram bar fill color. Ignored when color is supplied.
fill_alpha	Numeric value between 0 and 1 defining bar transparency.
theme_set	A complete ggplot2 theme.
theme_config	A named list with additional arguments passed to ggplot2::theme().
...	Further arguments passed to ggplot2::geom_histogram().

Details

plot_histogram() is a convenience wrapper around ggplot2::geom_histogram(). It is useful for visualizing the distribution of values across one or more time series, models, groups, or residual sets.

The arguments x, facet_var, color, and fill are passed as unquoted column names.

If color is supplied, both bar outline color and fill color are mapped to that variable. In this case, line_color and fill_color are ignored. If color is not supplied, all histogram bars use line_color and fill_color.

Missing values are removed before plotting.

Additional arguments can be passed to ggplot2::geom_histogram() through ..., for example bins, binwidth, or boundary.

Additional theme settings can be supplied through theme_config. This should be a named list of arguments passed to ggplot2::theme().

Value

An object of class ggplot.

See Also

Other data visualization: plot_bar(), plot_density(), plot_line(), plot_point(), plot_qq(), scale_color_tscv(), scale_fill_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

plot_histogram(
  data = data,
  x = value,
  facet_var = series,
  title = "Distribution of M4 Monthly Values",
  subtitle = "Histograms by series",
  xlab = "Value",
  ylab = "Count",
  bins = 20
)

plot_histogram(
  data = data,
  x = value,
  color = series,
  title = "Distribution of M4 Monthly Values",
  subtitle = "Grouped histograms by series",
  xlab = "Value",
  ylab = "Count",
  bins = 20,
  position = "identity",
  fill_alpha = 0.4
)
```

---

plot_line *Plot data as a line chart*

Description

Create a line chart for one or more time series or grouped numeric variables.

Usage

```
plot_line(
  data,
  x,
  y,
  facet_var = NULL,
```

```
  facet_scale = "free",
  facet_nrow = NULL,
  facet_ncol = NULL,
  color = NULL,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  caption = NULL,
  line_size = 0.75,
  line_type = "solid",
  line_color = "grey35",
  line_alpha = 1,
  theme_set = theme_tscv(),
  theme_config = list(),
  ...
)
```

Arguments

data	A data.frame, tibble, or tsibble in long format.
x	Unquoted column in data used on the x-axis.
y	Unquoted column in data containing numeric values shown on the y-axis.
facet_var	Optional unquoted column in data used for faceting.
facet_scale	Character value defining facet axis scaling. Common values are "free", "fixed", "free_x", and "free_y".
facet_nrow	Optional integer. Number of rows in the facet layout.
facet_ncol	Optional integer. Number of columns in the facet layout.
color	Optional unquoted column in data used to map line color.
title	Character value. Plot title.
subtitle	Character value. Plot subtitle.
xlab	Character value. Label for the x-axis.
ylab	Character value. Label for the y-axis.
caption	Character value. Plot caption.
line_size	Numeric value defining the line width.
line_type	Character or numeric value defining the line type.
line_color	Character value defining the line color. Ignored when color is supplied.
line_alpha	Numeric value between 0 and 1 defining line transparency.
theme_set	A complete ggplot2 theme.
theme_config	A named list with additional arguments passed to ggplot2::theme().
...	Currently not used.

Details

`plot_line()` is a convenience wrapper around `ggplot2::geom_line()` for plotting data in long format. It supports optional grouping by color, optional faceting, and the default `tscv` theme.

The arguments `x`, `y`, `facet_var`, and `color` are passed as unquoted column names.

If `color` is supplied, line colors are mapped to that variable and `line_color` is ignored. If `color` is not supplied, all lines are drawn using `line_color`.

Additional theme settings can be supplied through `theme_config`. This should be a named list of arguments passed to `ggplot2::theme()`.

Value

An object of class `ggplot`.

See Also

Other data visualization: `plot_bar()`, `plot_density()`, `plot_histogram()`, `plot_point()`, `plot_qq()`, `scale_color_tscv()`, `scale_fill_tscv()`, `theme_tscv()`, `tscv_cols()`, `tscv_pal()`

Examples

```
library(dplyr)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

plot_line(
  data = data,
  x = index,
  y = value,
  facet_var = series,
  title = "M4 Monthly Time Series",
  subtitle = "Selected monthly series from the M4 forecasting competition",
  xlab = "Time",
  ylab = "Value",
  caption = "Data: M4 Forecasting Competition"
)

plot_line(
  data = data,
  x = index,
  y = value,
  color = series,
  title = "M4 Monthly Time Series",
  xlab = "Time",
  ylab = "Value",
  line_size = 1.5
)
```

plot_point *Plot data as a scatterplot*

Description

Create a scatterplot for two variables.

Usage

```
plot_point(
  data,
  x,
  y,
  facet_var = NULL,
  facet_scale = "free",
  facet_nrow = NULL,
  facet_ncol = NULL,
  color = NULL,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  caption = NULL,
  point_size = 1.5,
  point_type = 16,
  point_color = "grey35",
  point_alpha = 1,
  theme_set = theme_tscv(),
  theme_config = list(),
  ...
)
```

Arguments

data	A data.frame, tibble, or tsibble in long format.
x	Unquoted column in data used on the x-axis.
y	Unquoted column in data containing numeric values shown on the y-axis.
facet_var	Optional unquoted column in data used for faceting.
facet_scale	Character value defining facet axis scaling. Common values are "free", "fixed", "free_x", and "free_y".
facet_nrow	Optional integer. Number of rows in the facet layout.
facet_ncol	Optional integer. Number of columns in the facet layout.
color	Optional unquoted column in data used to map point color.
title	Character value. Plot title.

subtitle	Character value. Plot subtitle.
xlab	Character value. Label for the x-axis.
ylab	Character value. Label for the y-axis.
caption	Character value. Plot caption.
point_size	Numeric value defining the point size.
point_type	Numeric or character value defining the point shape.
point_color	Character value defining the point color. Ignored when color is supplied.
point_alpha	Numeric value between 0 and 1 defining point transparency.
theme_set	A complete ggplot2 theme.
theme_config	A named list with additional arguments passed to ggplot2::theme().
...	Currently not used.

Details

plot_point() is a convenience wrapper around ggplot2::geom_point(). It is useful for plotting relationships between two variables, for example observed values over time, forecast errors by horizon, or one numeric diagnostic against another.

The arguments x, y, facet_var, and color are passed as unquoted column names.

If color is supplied, point colors are mapped to that variable and point_color is ignored. If color is not supplied, all points are drawn using point_color.

Additional theme settings can be supplied through theme_config. This should be a named list of arguments passed to ggplot2::theme().

Value

An object of class ggplot.

See Also

Other data visualization: plot_bar(), plot_density(), plot_histogram(), plot_line(), plot_qq(), scale_color_tscv(), scale_fill_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

data <- M4_monthly_data |>
  filter(series == "M23100")

plot_point(
  data = data,
  x = index,
  y = value,
  title = "M4 Monthly Time Series",
  subtitle = "Series M23100",
  xlab = "Time",
```

```
  ylab = "Value"
)

acf_data <- estimate_acf(
  .data = M4_monthly_data |>
    filter(series %in% c("M23100", "M14395")),
  context = list(
    series_id = "series",
    value_id = "value",
    index_id = "index"
  ),
  lag_max = 12
)

plot_point(
  data = acf_data,
  x = lag,
  y = value,
  color = series,
  title = "Autocorrelation by Series",
  subtitle = "Sample autocorrelation up to lag 12",
  xlab = "Lag",
  ylab = "ACF",
  point_size = 4
)
```

---

plot_qq *Create a quantile-quantile plot*

Description

Create a quantile-quantile plot for one or more numeric variables.

Usage

```
plot_qq(
  data,
  x,
  facet_var = NULL,
  facet_scale = "free",
  facet_nrow = NULL,
  facet_ncol = NULL,
  color = NULL,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  caption = NULL,
  point_size = 2,
```

```
  point_shape = 16,
  point_color = "grey35",
  point_fill = "grey35",
  point_alpha = 0.25,
  line_width = 0.25,
  line_type = "solid",
  line_color = "grey35",
  line_alpha = 1,
  band_color = "grey35",
  band_alpha = 0.25,
  theme_set = theme_tscv(),
  theme_config = list(),
  ...
)
```

Arguments

data	A data.frame, tibble, or tsibble in long format.
x	Unquoted column in data containing numeric values.
facet_var	Optional unquoted column in data used for faceting.
facet_scale	Character value defining facet axis scaling. Common values are "free", "fixed", "free_x", and "free_y".
facet_nrow	Optional integer. Number of rows in the facet layout.
facet_ncol	Optional integer. Number of columns in the facet layout.
color	Optional unquoted column in data used to map point, line, and confidence-band colors.
title	Character value. Plot title.
subtitle	Character value. Plot subtitle.
xlab	Character value. Label for the x-axis.
ylab	Character value. Label for the y-axis.
caption	Character value. Plot caption.
point_size	Numeric value defining the point size.
point_shape	Numeric or character value defining the point shape.
point_color	Character value defining the point outline color. Ignored when color is supplied.
point_fill	Character value defining the point fill color. Ignored when color is supplied.
point_alpha	Numeric value between 0 and 1 defining point transparency.
line_width	Numeric value defining the qq-line width.
line_type	Character or numeric value defining the qq-line type.
line_color	Character value defining the qq-line color. Ignored when color is supplied.
line_alpha	Numeric value between 0 and 1 defining line transparency.
band_color	Character value defining the confidence-band fill color. Ignored when color is supplied.

band_alpha	Numeric value between 0 and 1 defining confidence-band transparency.
theme_set	A complete ggplot2 theme.
theme_config	A named list with additional arguments passed to ggplot2::theme().
...	Further arguments passed to qqplotr::stat_qq_point(), qqplotr::stat_qq_line(), and qqplotr::stat_qq_band().

Details

plot_qq() is a convenience wrapper around the qqplotr functions stat_qq_point(), stat_qq_line(), and stat_qq_band(). It is useful for checking whether values, residuals, or forecast errors approximately follow a theoretical distribution.

By default, the function creates a normal quantile-quantile plot with pointwise confidence bands.

The arguments x, facet_var, and color are passed as unquoted column names.

If color is supplied, point colors, line colors, and confidence-band fills are mapped to that variable. In this case, point_color, point_fill, line_color, and band_color are ignored. If color is not supplied, the fixed styling arguments are used.

Additional arguments can be passed to the underlying qqplotr statistics through ..., for example distributional arguments supported by qqplotr.

Additional theme settings can be supplied through theme_config. This should be a named list of arguments passed to ggplot2::theme().

Value

An object of class ggplot.

See Also

Other data visualization: plot_bar(), plot_density(), plot_histogram(), plot_line(), plot_point(), scale_color_tscv(), scale_fill_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

plot_qq(
  data = data,
  x = value,
  facet_var = series,
  title = "QQ Plot of M4 Monthly Values",
  subtitle = "Normal quantile-quantile plots by series",
  xlab = "Theoretical quantiles",
  ylab = "Sample quantiles"
)

stats <- data |>
```

```
  group_by(series) |>
  mutate(value_centered = value - mean(value, na.rm = TRUE)) |>
  ungroup()

plot_qq(
  data = stats,
  x = value_centered,
  color = series,
  title = "QQ Plot of Centered M4 Monthly Values",
  subtitle = "Normal quantile-quantile plots by series",
  xlab = "Theoretical quantiles",
  ylab = "Sample quantiles"
)
```

`residuals.DSHW` *Extract residuals from a DSHW model*

Description

Extract residuals from a fitted `DSHW` model.

Usage

```
## S3 method for class 'DSHW'
residuals(object, ...)
```

Arguments

`object`	A fitted `DSHW` model object.
`...`	Additional arguments. Currently not used.

Value

Residuals.

See Also

Other DSHW: `DSHW()`, `fitted.DSHW()`, `forecast.DSHW()`, `model_sum.DSHW()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_load |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 28) |>
  as_tsibble(index = time)
```

```
model_frame <- train_frame |>
  model("DSHW" = DSHW(value, periods = c(24, 168)))

residuals(model_frame)
```

`residuals.MEDIAN` *Extract residuals from a median model*

Description

Extract residuals from a fitted `MEDIAN` model.

Usage

```
## S3 method for class 'MEDIAN'
residuals(object, ...)
```

Arguments

`object`	A fitted `MEDIAN` model object.
`...`	Additional arguments. Currently not used.

Value

Residuals.

See Also

Other MEDIAN: `MEDIAN()`, `fitted.MEDIAN()`, `forecast.MEDIAN()`, `model_sum.MEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("MEDIAN" = MEDIAN(value ~ window()))

residuals(model_frame)
```

`residuals.NAIVE2` *Extract residuals from a Naive2 model*

Description

Extract residuals from a fitted `NAIVE2` model.

Usage

```
## S3 method for class 'NAIVE2'
residuals(object, ...)
```

Arguments

`object`	A fitted `NAIVE2` model object.
`...`	Additional arguments. Currently not used.

Value

Residuals.

See Also

Other NAIVE2: `NAIVE2()`, `fitted.NAIVE2()`, `forecast.NAIVE2()`, `model_sum.NAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("NAIVE2" = NAIVE2(value ~ season(12)))

residuals(model_frame)
```

`residuals.SMEAN` *Extract residuals from a seasonal mean model*

Description

Extract residuals from a fitted `SMEAN` model.

Usage

```
## S3 method for class 'SMEAN'
residuals(object, ...)
```

Arguments

`object`	A fitted `SMEAN` model object.
`...`	Additional arguments. Currently not used.

Value

Residuals.

See Also

Other SMEAN: `SMEAN()`, `fitted.SMEAN()`, `forecast.SMEAN()`, `model_sum.SMEAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("SMEAN" = SMEAN(value ~ lag("year")))

residuals(model_frame)
```

`residuals.SMEDIAN` *Extract residuals from a seasonal median model*

Description

Extract residuals from a fitted `SMEDIAN` model.

Usage

```
## S3 method for class 'SMEDIAN'
residuals(object, ...)
```

Arguments

`object`	A fitted `SMEDIAN` model object.
`...`	Additional arguments. Currently not used.

Value

Residuals.

See Also

Other SMEDIAN: `SMEDIAN()`, `fitted.SMEDIAN()`, `forecast.SMEDIAN()`, `model_sum.SMEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SMEDIAN" = SMEDIAN(value ~ lag("week")))

residuals(model_frame)
```

`residuals.SNAIVE2` *Extract residuals from a SNAIVE2 model*

Description

Extract residuals from a fitted `SNAIVE2` model.

Usage

```
## S3 method for class 'SNAIVE2'
residuals(object, ...)
```

Arguments

`object`	A fitted `SNAIVE2` model object.
`...`	Additional arguments. Currently not used.

Value

Residuals.

See Also

Other SNAIVE2: `SNAIVE2()`, `fitted.SNAIVE2()`, `forecast.SNAIVE2()`, `model_sum.SNAIVE2()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SNAIVE2" = SNAIVE2(value))

residuals(model_frame)
```

`residuals.TBATS` *Extract residuals from a TBATS model*

Description

Extract residuals from a fitted TBATS model.

Usage

```
## S3 method for class 'TBATS'
residuals(object, ...)
```

Arguments

`object`	A fitted TBATS model object.
`...`	Additional arguments. Currently not used.

Details

This method is used by `residuals()` when extracting residuals from a mable containing a TBATS model.

Value

Residuals.

See Also

Other TBATS: `TBATS()`, `fitted.TBATS()`, `forecast.TBATS()`, `model_sum.TBATS()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("TBATS" = TBATS(value, periods = c(24, 168)))

residuals(model_frame)
```

`rmse_vec` *Calculate the root mean squared error*

Description

Calculate the root mean squared error of a numeric vector.

Usage

```
rmse_vec(truth, estimate, na_rm = TRUE)
```

Arguments

`truth`	Numeric vector containing the actual values.
`estimate`	Numeric vector containing the forecasts.
`na_rm`	Logical value. If `TRUE`, missing values are removed.

Details

`rmse_vec()` computes the square root of the mean squared forecast error. The metric is reported in the same units as the original data.

Value

A numeric value.

See Also

Other accuracy functions: `mae_vec()`, `make_accuracy()`, `make_errors()`, `mape_vec()`, `me_vec()`, `mpe_vec()`, `mse_vec()`, `smape_vec()`

Examples

```
truth <- c(10, 20, 30)
estimate <- c(8, 22, 25)

rmse_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
rmse_vec(truth_na, estimate_na)
```

scale_color_tscv *Create a tscv color scale*

Description

Create a ggplot2 color scale based on a predefined tscv palette.

Usage

```
scale_color_tscv(palette = "main", discrete = TRUE, reverse = FALSE, ...)
```

Arguments

palette	Character value. Name of the palette.
discrete	Logical value. If TRUE, create a discrete color scale. If FALSE, create a continuous color scale.
reverse	Logical value. If TRUE, the palette is reversed.
...	Additional arguments passed to ggplot2::discrete_scale() or ggplot2::scale_color_gradientn(

Details

scale_color_tscv() creates either a discrete or continuous color scale for the color aesthetic.

For discrete variables, the function uses ggplot2::discrete_scale(). For continuous variables, it uses ggplot2::scale_color_gradientn().

Available palettes are "main", "cool", "hot", "mixed", and "grey".

Value

A ggplot2 scale object.

See Also

Other data visualization: plot_bar(), plot_density(), plot_histogram(), plot_line(), plot_point(), plot_qq(), scale_fill_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

plot_line(
  data = data,
  x = index,
  y = value,
  color = series,
```

```
  title = "M4 Monthly Time Series",
  subtitle = "Selected monthly series",
  xlab = "Time",
  ylab = "Value"
) +
  scale_color_tscv(palette = "main")
```

---

scale_fill_tscv *Create a tscv fill scale*

Description

Create a ggplot2 fill scale based on a predefined tscv palette.

Usage

```
scale_fill_tscv(palette = "main", discrete = TRUE, reverse = FALSE, ...)
```

Arguments

palette	Character value. Name of the palette.
discrete	Logical value. If TRUE, create a discrete fill scale. If FALSE, create a continuous fill scale.
reverse	Logical value. If TRUE, the palette is reversed.
...	Additional arguments passed to ggplot2::discrete_scale() or ggplot2::scale_fill_gradientn()

Details

scale_fill_tscv() creates either a discrete or continuous fill scale for the fill aesthetic.

For discrete variables, the function uses ggplot2::discrete_scale(). For continuous variables, it uses ggplot2::scale_fill_gradientn().

Available palettes are "main", "cool", "hot", "mixed", and "grey".

Value

A ggplot2 scale object.

See Also

Other data visualization: plot_bar(), plot_density(), plot_histogram(), plot_line(), plot_point(), plot_qq(), scale_color_tscv(), theme_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

stats <- summarise_stats(
  .data = data,
  context = context
)

plot_bar(
  data = stats,
  x = series,
  y = mean,
  color = series,
  title = "Average Value by Series",
  xlab = "Series",
  ylab = "Mean"
) +
  scale_fill_tscv(palette = "main")
```

---

slice_test *Slice test data from a split frame*

Description

Extract test observations from a complete time series data set according to a split plan created by `make_split()`.

Usage

```
slice_test(main_frame, split_frame, context)
```

Arguments

`main_frame`	A `tibble` containing the complete time series data.
`split_frame`	A `tibble` containing train and test indices, usually created by `make_split()`.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.

Details

`slice_test()` uses the row positions stored in the `test` list-column of `split_frame` to extract the corresponding observations from `main_frame`. The function is designed for rolling-origin time series cross-validation workflows.

The returned data has the same columns as `main_frame`, plus a `split` column identifying the train-test split. If `main_frame` contains multiple time series, slicing is performed separately for each series using the series identifier supplied in `context`.

When `make_split()` was called with `n_lag > 0`, the test data may include lagged observations before the forecast horizon.

Value

A `tibble` containing the sliced test data. It contains the same columns as `main_frame`, plus a `split` column.

See Also

Other time series cross-validation: `make_future()`, `make_split()`, `make_tsibble()`, `slice_train()`, `split_index()`

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series == "M23100")

split_frame <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

test_frame <- slice_test(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
)
```

test_frame

---

slice_train *Slice training data from a split frame*

Description

Extract training observations from a complete time series data set according to a split plan created by `make_split()`.

Usage

```
slice_train(main_frame, split_frame, context)
```

Arguments

`main_frame`	A `tibble` containing the complete time series data.
`split_frame`	A `tibble` containing train and test indices, usually created by `make_split()`.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.

Details

`slice_train()` uses the row positions stored in the `train` list-column of `split_frame` to extract the corresponding observations from `main_frame`. The function is designed for rolling-origin time series cross-validation workflows.

The returned data has the same columns as `main_frame`, plus a `split` column identifying the train-test split. If `main_frame` contains multiple time series, slicing is performed separately for each series using the series identifier supplied in `context`.

Value

A `tibble` containing the sliced training data. It contains the same columns as `main_frame`, plus a `split` column.

See Also

Other time series cross-validation: `make_future()`, `make_split()`, `make_tsibble()`, `slice_test()`, `split_index()`

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

main_frame <- M4_monthly_data |>
  filter(series == "M23100")

split_frame <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

train_frame <- slice_train(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
)

train_frame
```

---

smape_vec *Calculate the symmetric mean absolute percentage error*

Description

Calculate the symmetric mean absolute percentage error of a numeric vector.

Usage

```
smape_vec(truth, estimate, na_rm = TRUE)
```

Arguments

truth	Numeric vector containing the actual values.
estimate	Numeric vector containing the forecasts.
na_rm	Logical value. If TRUE, missing values are removed.

Details

smape_vec() computes the symmetric mean absolute percentage error: abs(estimate - truth) / ((abs(truth) + abs(estimate)) / 2) * 100.

This metric is undefined when both truth and estimate are zero and may return NaN in such cases.

Value

A numeric value.

See Also

Other accuracy functions: mae_vec(), make_accuracy(), make_errors(), mape_vec(), me_vec(), mpe_vec(), mse_vec(), rmse_vec()

Examples

```
truth <- c(10, 20, 40)
estimate <- c(8, 22, 30)

smape_vec(truth, estimate)

truth_na <- c(10, 20, NA)
estimate_na <- c(8, 22, 25)
smape_vec(truth_na, estimate_na)
```

SMEAN *Seasonal mean model*

Description

Specify a seasonal mean benchmark model for use with fabletools::model().

Usage

```
SMEAN(formula, ...)
```

Arguments

formula	A model formula specifying the response and lag() special, for example value ~ lag("year").
...	Further arguments.

Details

SMEAN() forecasts each future observation using the historical mean of the matching seasonal position. Use the lag() special to define the seasonal period, for example lag("year") for monthly data.

Value

A model definition that can be used inside `fabletools::model()`.

See Also

Other SMEAN: `fitted.SMEAN()`, `forecast.SMEAN()`, `model_sum.SMEAN()`, `residuals.SMEAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- M4_monthly_data |>
  filter(series == first(series)) |>
  as_tsibble(index = index)

model_frame <- train_frame |>
  model("SMEAN" = SMEAN(value ~ lag("year")))

model_frame
```

SMEDIAN *Seasonal median model*

Description

Specify a seasonal median benchmark model for use with `fabletools::model()`.

Usage

```
SMEDIAN(formula, ...)
```

Arguments

`formula`	A model formula specifying the response and `lag()` special, for example `value ~ lag("week")`.
`...`	Further arguments.

Details

`SMEDIAN()` forecasts each future observation using the historical median of the matching seasonal position. Use the `lag()` special to define the seasonal period, for example `lag("week")` for hourly data with weekly seasonality.

Value

A model definition that can be used inside `fabletools::model()`.

See Also

Other SMEDIAN: `fitted.SMEDIAN()`, `forecast.SMEDIAN()`, `model_sum.SMEDIAN()`, `residuals.SMEDIAN()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SMEDIAN" = SMEDIAN(value ~ lag("week")))

model_frame
```

`smooth_outlier` *Identify and replace outliers*

Description

Identify outliers in a numeric time series and replace them with smoothed values.

Usage

```
smooth_outlier(x, periods, ...)
```

Arguments

`x`	Numeric vector containing the time series observations.
`periods`	Numeric vector giving the seasonal periods of the time series, for example `12` for monthly data with yearly seasonality or `c(24, 168)` for hourly data with daily and weekly seasonality.
`...`	Further arguments passed to `forecast::msts()` or `forecast::tsoutliers()`.

Details

`smooth_outlier()` is a small wrapper around `forecast::tsoutliers()`. The input vector is first converted to an `msts` object using the seasonal periods supplied in `periods`.

For non-seasonal time series, `forecast::tsoutliers()` uses a `supsmu`-based approach. For seasonal time series, the series is decomposed using STL and outliers are identified on the remainder component. Detected outliers are replaced by the replacement values returned by `forecast::tsoutliers()`.

The function returns a plain numeric vector with the same length as the input.

Value

A numeric vector where detected outliers are replaced by smoothed values.

See Also

Other data preparation: `check_data()`, `interpolate_missing()`

Examples

```
library(dplyr)

x <- M4_monthly_data |>
  filter(series == first(series)) |>
  pull(value)

x_outlier <- x
x_outlier[20] <- x_outlier[20] * 5

x_smoothed <- smooth_outlier(
  x = x_outlier,
  periods = 12
)

x_outlier[20]
x_smoothed[20]

hourly <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 14) |>
  pull(value)

hourly_outlier <- hourly
hourly_outlier[48] <- hourly_outlier[48] * 5

smooth_outlier(
  x = hourly_outlier,
  periods = c(24, 168)
)
```

SNAIVE2 *Seasonal naive model with weekday-specific lags*

Description

Specify a seasonal naive benchmark model for use with `fabletools::model()`.

Usage

```
SNAIVE2(formula, ...)
```

Arguments

formula	A model formula specifying the response variable, for example value.
...	Further arguments.

Details

SNAIVE2() is intended for hourly time series. It uses a daily lag for Tuesday to Friday observations and a weekly lag otherwise. This can be useful for electricity price or load data where weekdays have similar intraday structure and weekends require a weekly comparison.

Value

A model definition that can be used inside fabletools::model().

See Also

Other SNAIVE2: fitted.SNAIVE2(), forecast.SNAIVE2(), model_sum.SNAIVE2(), residuals.SNAIVE2()

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("SNAIVE2" = SNAIVE2(value))

model_frame
```

---

split_index *Create indices for train and test splits*

Description

Create train and test indices for time series cross-validation.

Usage

```
split_index(
  n_total,
  n_init,
  n_ahead,
  n_skip = 0,
```

```
  n_lag = 0,
  mode = "slide",
  exceed = FALSE
)
```

Arguments

n_total	Integer. The total number of observations in the time series.
n_init	Integer. The number of observations in the initial training window.
n_ahead	Integer. The forecast horizon, i.e. the number of observations in each test window.
n_skip	Integer. The number of observations to skip between split origins. The default is 0.
n_lag	Integer. The number of lagged observations to include before the test window. The default is 0.
mode	Character value. Either "slide" for a fixed-window approach or "stretch" for an expanding-window approach.
exceed	Logical value. If TRUE, test indices may exceed the original sample size.

Details

split_index() creates integer index vectors for rolling-origin resampling. The function can create either fixed-window or expanding-window splits:

- mode = "slide" creates a fixed training window that moves forward over time.
- mode = "stretch" creates an expanding training window that always starts at the first observation.

The first training window contains n_init observations. Each test window contains n_ahead observations. The argument n_skip controls how many observations are skipped between consecutive split origins. For example, with n_ahead = 18 and n_skip = 17, consecutive test windows are non-overlapping.

If n_lag > 0, the test indices include lagged observations before the forecast horizon. This is useful when lagged predictors are needed for constructing features during testing.

If exceed = TRUE, additional out-of-sample test indices are allowed to exceed the original sample size.

Value

A list with two elements:

- train: a list of integer vectors with training indices.
- test: a list of integer vectors with test indices.

See Also

Other time series cross-validation: make_future(), make_split(), make_tsibble(), slice_test(), slice_train()

Examples

```
# Fixed-window splits
fixed_index <- split_index(
  n_total = 180,
  n_init = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "slide",
  exceed = FALSE
)

fixed_index

# Expanding-window splits
expanding_index <- split_index(
  n_total = 180,
  n_init = 120,
  n_ahead = 18,
  n_skip = 17,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
)

expanding_index
```

---

summarise_data *Summarise time series data*

Description

Calculate basic data-quality summary statistics for one or more time series.

Usage

```
summarise_data(.data, context)
```

Arguments

`.data`	A `tibble` in long format containing time series data.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.

Details

`summarise_data()` groups the input data by the series identifier supplied in `context` and returns one row per time series.

The function reports:

- start: first time index;
- end: last time index;
- n_obs: number of observations;
- n_missing: number of missing values;
- pct_missing: percentage of missing values;
- n_zeros: number of zero values;
- pct_zeros: percentage of zero values.

Value

A tibble containing one row per time series and the calculated summary statistics.

See Also

Other data analysis: acf_vec(), estimate_acf(), estimate_kurtosis(), estimate_mode(), estimate_pacf(), estimate_skewness(), pacf_vec(), summarise_split(), summarise_stats()

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

summarise_data(
  .data = data,
  context = context
)
```

---

summarise_split *Summarise train-test splits*

Description

Summarise the time and row-index ranges of training and test samples.

Usage

```
summarise_split(data)
```

Arguments

`data`	A valid `tsibble` in long format. It must contain the columns `split`, `sample`, and `id`.

Details

`summarise_split()` is intended for data sets that contain sliced training and test observations from a time series cross-validation workflow. The input must be a `tsibble` with the columns `split`, `sample`, and `id`:

- `split`: train-test split identifier;
- `sample`: sample label, usually `"train"` or `"test"`;
- `id`: integer row index within the original time series.

The function returns one row per split. For each split, it reports the time range and index range of each sample.

Value

A `tibble` containing the summarized split ranges.

See Also

Other data analysis: `acf_vec()`, `estimate_acf()`, `estimate_kurtosis()`, `estimate_mode()`, `estimate_pacf()`, `estimate_skewness()`, `pacf_vec()`, `summarise_data()`, `summarise_stats()`

Examples

```
library(dplyr)
library(tsibble)

context <- list(
  series_id = "bidding_zone",
  value_id = "value",
  index_id = "time"
)

main_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 120)

split_frame <- make_split(
  main_frame = main_frame,
  context = context,
  type = "first",
  value = 48,
  n_ahead = 24,
  n_skip = 23,
  n_lag = 0,
  mode = "stretch",
  exceed = FALSE
```

```
)

train_frame <- slice_train(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
) |>
  mutate(sample = "train")

test_frame <- slice_test(
  main_frame = main_frame,
  split_frame = split_frame,
  context = context
) |>
  mutate(sample = "test")

split_data <- bind_rows(train_frame, test_frame) |>
  group_by(bidding_zone, split, sample) |>
  mutate(id = row_number()) |>
  ungroup() |>
  as_tsibble(
    index = time,
    key = c(bidding_zone, split, sample)
  )

summarise_split(split_data)
```

`summarise_stats` *Summarise distributional statistics by time series*

Description

Calculate descriptive statistics for one or more time series.

Usage

```
summarise_stats(.data, context)
```

Arguments

`.data`	A `tibble` in long format containing time series data.
`context`	A named `list` with the identifiers for `series_id`, `value_id`, and `index_id`.

Details

`summarise_stats()` groups the input data by the series identifier supplied in `context` and returns one row per time series.

The function reports:

- `mean`: arithmetic mean;
- `median`: median;
- `mode`: kernel-density based mode estimate;
- `sd`: standard deviation;
- `p0`: minimum;
- `p25`: 25 percent quantile;
- `p75`: 75 percent quantile;
- `p100`: maximum;
- `skewness`: moment-based skewness;
- `kurtosis`: moment-based kurtosis.

Missing values are removed when calculating the statistics.

Value

A `tibble` containing one row per time series and the calculated descriptive statistics.

See Also

Other data analysis: `acf_vec()`, `estimate_acf()`, `estimate_kurtosis()`, `estimate_mode()`, `estimate_pacf()`, `estimate_skewness()`, `pacf_vec()`, `summarise_data()`, `summarise_split()`

Examples

```
library(dplyr)

context <- list(
  series_id = "series",
  value_id = "value",
  index_id = "index"
)

data <- M4_monthly_data |>
  filter(series %in% c("M23100", "M14395"))

summarise_stats(
  .data = data,
  context = context
)
```

TBATS *TBATS model*

Description

Specify a TBATS model for use with `fabletools::model()`.

Usage

```
TBATS(formula, ...)
```

Arguments

`formula`	A model formula specifying the response variable, for example `value`.
`...`	Further arguments passed to `forecast::tbats()`, including `periods`.

Details

`TBATS()` is a model specification wrapper around `forecast::tbats()` for the `fable`, `tsibble`, and `fabletools` ecosystem.

TBATS stands for trigonometric seasonality, Box-Cox transformation, ARMA errors, trend, and seasonal components. It can be useful for time series with multiple or complex seasonal patterns.

The seasonal periods must be supplied through the `periods` argument.

Value

A model definition that can be used inside `fabletools::model()`.

See Also

Other TBATS: `fitted.TBATS()`, `forecast.TBATS()`, `model_sum.TBATS()`, `residuals.TBATS()`

Examples

```
library(dplyr)
library(tsibble)
library(fabletools)

train_frame <- elec_price |>
  filter(bidding_zone == "DE") |>
  slice_head(n = 24 * 21) |>
  as_tsibble(index = time)

model_frame <- train_frame |>
  model("TBATS" = TBATS(value, periods = c(24, 168)))

model_frame
```

test_seasonality *Test a time series for seasonality*

Description

Tests whether a numeric time series exhibits seasonality at a specified frequency. The test compares the absolute autocorrelation at the seasonal lag with a 90 percent critical limit. At least three complete seasonal cycles are required. Series with a frequency of one are treated as non-seasonal.

Usage

```
test_seasonality(x, freq)
```

Arguments

x	A numeric vector containing the observed time series.
freq	A positive whole number specifying the seasonal frequency, such as ‘12‘ for monthly data or ‘4‘ for quarterly data.

Value

A single logical value. ‘TRUE‘ indicates that seasonality was detected; otherwise, ‘FALSE‘.

Examples

```
x <- as.numeric(AirPassengers)

test_seasonality(x, freq = 12)
```

theme_tscv *Custom ggplot2 theme for tscv*

Description

Create the default ggplot2 theme used by the tscv package.

Usage

```
theme_tscv(
  base_size = 11,
  base_family = "",
  base_line_size = base_size/22,
  base_rect_size = base_size/22
)
```

Arguments

base_size	Numeric value. Base font size.
base_family	Character value. Base font family.
base_line_size	Numeric value. Base line width for line elements.
base_rect_size	Numeric value. Base line width for rectangle elements.

Details

theme_tscv() returns a complete ggplot2 theme with a clean layout, subtle grid lines, bottom legend placement, and formatting for plot titles, subtitles, captions, facets, and axes.

The theme is used as the default theme in the plotting helpers of the tscv package, such as plot_line(), plot_point(), plot_bar(), plot_histogram(), plot_density(), and plot_qq().

Since the returned object is a regular ggplot2 theme, it can also be added directly to any ggplot object with + theme_tscv().

Value

A complete ggplot2 theme.

See Also

Other data visualization: plot_bar(), plot_density(), plot_histogram(), plot_line(), plot_point(), plot_qq(), scale_color_tscv(), scale_fill_tscv(), tscv_cols(), tscv_pal()

Examples

```
library(dplyr)
library(ggplot2)

data <- M4_monthly_data |>
  filter(series == "M23100") |>
  mutate(index = as.Date(index))

# Plot with the default tscv theme
plot_line(
  data = data,
  x = index,
  y = value,
  title = "M4 Monthly Time Series",
  subtitle = "Series M23100",
  xlab = "Time",
  ylab = "Value",
  theme_set = theme_tscv()
)

# The same plot with the default ggplot2 grey theme
plot_line(
  data = data,
  x = index,
```

```
  y = value,
  title = "M4 Monthly Time Series",
  subtitle = "Series M23100",
  xlab = "Time",
  ylab = "Value",
  theme_set = theme_grey()
)

# theme_tscv() can also be added to regular ggplot objects
ggplot(data, aes(x = index, y = value)) +
  geom_line(color = "grey35") +
  labs(
    title = "M4 Monthly Time Series",
    subtitle = "Series M23100",
    x = "Time",
    y = "Value"
  ) +
  theme_tscv()
```

`tscv_cols` *Extract tscv colors*

Description

Extract named colors from the `tscv` color palette as hexadecimal color codes.

Usage

```
tscv_cols(...)
```

Arguments

`...`	Character values giving the names of colors to extract.

Details

`tscv_cols()` returns the hexadecimal color codes used by the `tscv` package. If no color names are supplied, all available colors are returned.

Available colors are: `"red"`, `"green"`, `"blue"`, `"orange"`, `"yellow"`, `"light grey"`, and `"dark grey"`.

Value

A named character vector of hexadecimal color codes.

See Also

Other data visualization: `plot_bar()`, `plot_density()`, `plot_histogram()`, `plot_line()`, `plot_point()`, `plot_qq()`, `scale_color_tscv()`, `scale_fill_tscv()`, `theme_tscv()`, `tscv_pal()`

Examples

```
# Return all available tscv colors
tscv_cols()

# Return selected colors
tscv_cols("steelblue", "orange", "green")

# Use a tscv color in a plot
library(dplyr)

data <- M4_monthly_data |>
  filter(series == "M23100")

plot_line(
  data = data,
  x = index,
  y = value,
  title = "M4 Monthly Time Series",
  subtitle = "Series M23100",
  xlab = "Time",
  ylab = "Value",
  line_color = tscv_cols("steelblue")
)
```

---

tscv_pal *Create a tscv color palette*

Description

Create a color interpolation function based on one of the predefined `tscv` palettes.

Usage

```
tscv_pal(palette = "main", reverse = FALSE, ...)
```

Arguments

`palette`	Character value. Name of the palette.
`reverse`	Logical value. If `TRUE`, the palette is reversed.
`...`	Additional arguments passed to `grDevices::colorRampPalette()`.

Details

`tscv_pal()` returns a palette function created with `grDevices::colorRampPalette()`. The returned function can be used to generate any number of colors from the selected palette.

Available palettes are:

- `"main"`: blue, green, yellow.

- "cool": blue, green.
- "hot": yellow, orange, red.
- "mixed": blue, green, yellow, orange, red.
- "grey": light grey, dark grey.

Value

A palette function that takes an integer and returns hexadecimal color codes.

See Also

Other data visualization: plot_bar(), plot_density(), plot_histogram(), plot_line(), plot_point(), plot_qq(), scale_color_tscv(), scale_fill_tscv(), theme_tscv(), tscv_cols()

Examples

```
# Create a palette function
pal <- tscv_pal("main")

# Generate five colors
pal(5)

# Reverse the palette
tscv_pal("hot", reverse = TRUE)(5)

# Use generated colors in base R
barplot(
  height = c(3, 5, 4),
  col = tscv_pal("main")(3)
)
```

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