Package ‘accuracylevel’

June 18, 2026

Title Robust Accuracy-Level Metrics for Predictive Model Evaluation

Version 0.1.0

Author Achmad Syahrul Choir [cre, aut],
Mety Agustini [aut],
Kartika Fithriasari [aut],
Dedy Dwi Prastyo [aut]

Maintainer Achmad Syahrul Choir <madsyair@stis.ac.id>

Description Implements novel accuracy-level metrics for evaluating continuous data prediction models. Four metrics are provided: Counted Squared Error (CSE), Counted Absolute Error (CAE), Counted Absolute Percentage Error (CAPE), and Symmetric Counted Absolute Percentage Error (SCAPE). These metrics offer robust, consistent, and interpretable evaluation on a 0-100% scale, addressing limitations of conventional metrics like RMSE, MAE, and MAPE. The package integrates with 'caret', 'tidymodels', and common forecasting frameworks. Based on Agustini, Fithriasari, and Prastyo (2026) <doi:10.1016/j.dajour.2025.100661>.

License GPL-3

Encoding UTF-8

URL https://github.com/madsyair/accuracylevel

BugReports https://github.com/madsyair/accuracylevel/issues

Depends R (>= 3.5.0)

Imports stats, graphics, utils

Suggests rlang (>= 0.4.0), caret, yardstick, forecast, testthat (>= 3.0.0), knitr, rmarkdown, ggplot2, tibble, dplyr

Config/testthat/edition 3

VignetteBuilder knitr

NeedsCompilation no

Config/roxygen2/version 8.0.0

Repository CRAN

Date/Publication 2026-06-18 13:20:02 UTC

Contents

absolute_error . . . 2
absolute_percentage_error . . . 3
accuracy_level . . . 4
accuracy_level_metrics . . . 6
al_compare_forecasts . . . 7
al_extended_accuracy . . . 8
al_forecast_accuracy . . . 8
al_metric_set . . . 9
al_tsCV . . . 10
auto_threshold . . . 11
cae . . . 12
cae_l1 . . . 13
calculate_threshold . . . 13
cape . . . 15
cape_l1 . . . 16
caret_single_metric . . . 16
caret_summary . . . 17
caret_summary_extended . . . 18
compare_all_metrics . . . 18
compare_models . . . 19
conventional_metrics . . . 20
cse . . . 21
cse_l1 . . . 22
get_all_levels . . . 23
print.al_threshold . . . 24
robust_metrics . . . 24
scape . . . 25
scape_l1 . . . 26
squared_error . . . 27
symmetric_absolute_percentage_error . . . 27

Index **29**

`absolute_error` *Calculate Absolute Error*

Description

Compute absolute error between actual and predicted values, as defined in Equation (2) of Agustini et al. (2026).

Usage

```
absolute_error(actual, predicted, na.rm = FALSE)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`na.rm`	Logical. If `TRUE`, remove `NA` pairs before computing. Default is `FALSE`.

Value

Numeric vector of absolute errors.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
absolute_error(actual, predicted)
```

---

absolute_percentage_error

Calculate Absolute Percentage Error

Description

Compute absolute percentage error between actual and predicted values, as defined in Equation (3) of Agustini et al. (2026). Note that the result is on the proportion scale (not multiplied by 100).

Usage

```
absolute_percentage_error(actual, predicted, na.rm = FALSE)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`na.rm`	Logical. If `TRUE`, remove `NA` pairs before computing. Default is `FALSE`.

Value

Numeric vector of absolute percentage errors. Returns `Inf` for observations where `actual` is zero.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
absolute_percentage_error(actual, predicted)
```

accuracy_level *Compute Accuracy-Level Metrics*

Description

Calculate accuracy-level metrics (CSE, CAE, CAPE, SCAPE) for evaluating prediction model performance. These metrics assess the proportion of observations falling within predefined error threshold levels, providing a robust and interpretable evaluation on a 0–100\ scale.

Usage

```
accuracy_level(
  actual,
  predicted,
  threshold = NULL,
  baseline_actual = NULL,
  baseline_predicted = NULL,
  na.rm = FALSE
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`threshold`	An `al_threshold` object created by `calculate_threshold` or `auto_threshold`. When supplied, the baseline quartiles stored inside this object are used to derive per-error-type thresholds (see Details). If `NULL` (default), thresholds are automatically determined via `auto_threshold`.
`baseline_actual`	Numeric vector of actual values from the baseline model. Used only when `threshold` is `NULL`.
`baseline_predicted`	Numeric vector of predicted values from the baseline model. Used only when `threshold` is `NULL`.
`na.rm`	Logical. If `TRUE`, remove `NA` pairs before computing. Default is `FALSE`.

Details

The accuracy-level method introduces four metrics:

CSE (Counted Squared Error) Proportion of observations within squared error threshold levels.

CAE (Counted Absolute Error) Proportion of observations within absolute error threshold levels.

CAPE (Counted Absolute Percentage Error) Proportion of observations within absolute percentage error threshold levels.

SCAPE (Symmetric Counted Absolute Percentage Error) Proportion of observations within symmetric absolute percentage error threshold levels.

For each metric, four accuracy levels are defined:

- Level 1: $\varepsilon < T$ (highest accuracy)
- Level 2: $T \leq \varepsilon < 2T$
- Level 3: $2T \leq \varepsilon < 5T$
- Level 4: $\varepsilon \geq 5T$ (lowest accuracy)

where T is the base threshold determined from the **baseline** model's error distribution. Crucially, thresholds for CSE, CAE, CAPE, and SCAPE are each derived from the same quartile of the baseline model's SE, AE, APE, and sAPE respectively (Figure 2 of the paper).

Edge cases are handled as follows: observations with a non-finite error (for example APE when `actual` is zero, or sAPE when both `actual` and `predicted` are zero) are assigned to Level 4. When the baseline threshold T equals zero (a perfectly fitting baseline), a machine-epsilon boundary is used so that exact-zero errors fall into Level 1.

Value

An object of class `"accuracy_level"` with elements: `metrics` (data frame with accuracy percentages for each level and metric type), `mean_errors` (data frame with mean errors per level), `threshold` (the primary threshold object used), `thresholds_all` (per-error-type threshold objects), `n_obs` (number of observations), and `counts` (count of observations at each level).

References

Agustini, M., Fithriasari, K., & Prastyo, D.D. (2026). An accuracy-level method for robust evaluation in predictive analytics. *Decision Analytics Journal*, 18, 100661. doi:10.1016/j.dajour.2025.100661

See Also

`calculate_threshold`, `auto_threshold`, `cse`, `cae`, `cape`, `scape`

Examples

```
# ---- Paper Table 4: Simple case ----
actual <- c(7, 6.03, 2.02, 5.1, 9, 1, 3, 4.38, 1, 8.07)
m1 <- c(6.05, 5.02, 1.32, 5.15, 8, 2.2, 2.7, 3.48, 1, 7.56)
m3 <- c(7.01, 6.04, 2.09, 5.11, 9.01, 5.1, 3.01, 4.39, 1, 8.1)

# Model 1 as baseline, Q2
thresh <- calculate_threshold(actual, m1, quartile = 2)

# Evaluate Model 3 (paper expects 90% at L1)
result <- accuracy_level(actual, m3, threshold = thresh)
print(result)
```

accuracy_level_metrics *Full Accuracy-Level Metrics for yardstick*

Description

Full Accuracy-Level Metrics for yardstick

Usage

```
accuracy_level_metrics(data, truth, estimate, na_rm = TRUE, ...)

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

Arguments

data	A data frame containing truth and estimate columns.
truth	Column name for actual values (unquoted).
estimate	Column name for predicted values (unquoted).
na_rm	Logical. Remove NAs? Default TRUE.
...	Additional arguments (ignored).

Value

A tibble with 16 rows (4 metrics x 4 levels).

Examples

```
if (requireNamespace("rlang", quietly = TRUE)) {
  df <- data.frame(truth = c(10, 20, 30, 40, 50),
                   estimate = c(11, 19, 32, 38, 51))
  accuracy_level_metrics(df, truth, estimate)
}
```

al_compare_forecasts *Compare Multiple Forecast Models*

Description

Compare Multiple Forecast Models

Usage

```
al_compare_forecasts(
  ...,
  test = NULL,
  metric = c("cae", "cape", "cse", "scape"),
  threshold = NULL
)
```

Arguments

`...`	Named forecast objects or named lists with `forecast` and `test` elements.
`test`	Test data (used when forecast objects are supplied directly).
`metric`	Metric for determining the optimal model.
`threshold`	Shared `al_threshold` object or `NULL`.

Value

A list with `optimal_model`, `comparison` table, and `full_results`.

Examples

```
actual <- c(10, 20, 30, 40, 50)
res <- al_compare_forecasts(
  A = list(forecast = c(11, 19, 32, 38, 51), test = actual),
  B = list(forecast = c(15, 25, 35, 45, 55), test = actual)
)
res$comparison
```

al_extended_accuracy *Extended Forecast Accuracy Summary*

Description

Extended Forecast Accuracy Summary

Usage

```
al_extended_accuracy(forecast_obj, test, threshold = NULL)
```

Arguments

forecast_obj	A forecast object or numeric predictions.
test	Actual test values.
threshold	Optional threshold object.

Value

A data frame combining traditional and accuracy-level metrics.

Examples

```
pred <- c(11, 19, 32, 38, 51)
actual <- c(10, 20, 30, 40, 50)
al_extended_accuracy(pred, actual)
```

al_forecast_accuracy *Accuracy-Level Metrics for Forecast Objects*

Description

Calculate accuracy-level metrics for forecast objects from the **forecast** package, or for plain numeric predictions.

Usage

```
al_forecast_accuracy(object, test, threshold = NULL)

## Default S3 method:
al_forecast_accuracy(object, test, threshold = NULL)

## S3 method for class 'forecast'
al_forecast_accuracy(object, test, threshold = NULL)
```

Arguments

`object`	A forecast object or numeric vector of predictions.
`test`	Numeric vector or time series of test (actual) values.
`threshold`	An `al_threshold` object or `NULL`.

Value

An `accuracy_level` object.

Examples

```
# With plain numeric vectors
pred <- c(11, 19, 32, 38, 51)
actual <- c(10, 20, 30, 40, 50)
al_forecast_accuracy(pred, actual)
```

`al_metric_set` *Create Metric Set for tidymodels*

Description

Create Metric Set for tidymodels

Usage

```
al_metric_set(include_traditional = TRUE)
```

Arguments

`include_traditional`
: Logical. If `TRUE` (default), also include rmse, mae, and rsq from **yardstick**.

Value

A metric set function.

Note

The level-1 metrics in the set derive their error thresholds from the data being evaluated (a self-referential baseline). In resampling or cross-validation, each fold therefore uses its own threshold, which limits strict cross-fold comparability. For a fixed baseline across folds, evaluate with `accuracy_level` using a pre-computed `al_threshold` object (see `calculate_threshold`). Case weights are not supported; any `case_weights` passed by **tune** are ignored.

Examples

```
if (requireNamespace("yardstick", quietly = TRUE)) {
  al_metrics <- al_metric_set()
}
```

`al_tsCV` *Time Series Cross-Validation with Accuracy-Level Metrics*

Description

Time Series Cross-Validation with Accuracy-Level Metrics

Usage

```
al_tsCV(
  y,
  forecastfunction,
  h = 1,
  initial = 10,
  window = NULL,
  metric = c("cae", "cape", "cse", "scape"),
  ...
)
```

Arguments

`y`	Numeric time series data.
`forecastfunction`	Function that accepts `(x, h, ...)` and returns predictions (either a forecast object or numeric vector).
`h`	Forecast horizon.
`initial`	Initial training window size.
`window`	Rolling window size (`NULL` for expanding window).
`metric`	Metric to report.
`...`	Additional arguments passed to `forecastfunction`.

Value

A data frame of class `"al_tsCV"` with per-fold results.

Examples

```
ma_fc <- function(x, h) rep(mean(x), h)
y <- sin(seq(0, 4 * pi, length.out = 50)) * 10 + 50
res <- al_tsCV(y, ma_fc, h = 5, initial = 20)
print(res)
```

---

auto_threshold *Automatic Threshold Selection*

Description

Automatically select the best quartile for threshold calculation based on the absolute percentage error approaching a target value (default 0.1), following the recommendation in Section 3.4.5 of Agustini et al. (2026).

Usage

```
auto_threshold(
  actual,
  predicted,
  target_ape = 0.1,
  error_type = "ape",
  multipliers = c(2, 5)
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`target_ape`	Target APE value for threshold selection. Default is 0.1 (10 percent).
`error_type`	Error type to calculate threshold for. Default is `"ape"`.
`multipliers`	Numeric vector of multipliers. Default is `c(2, 5)`.

Value

An `al_threshold` object with automatically selected quartile.

Examples

```
actual <- c(10, 20, 30, 40, 50, 60, 70, 80, 90, 100)
predicted <- c(11, 19, 32, 38, 51, 58, 72, 78, 92, 98)
thresh <- auto_threshold(actual, predicted)
print(thresh)
```

cae *Counted Absolute Error (CAE)*

Description

Counted Absolute Error (CAE)

Usage

```
cae(
  actual,
  predicted,
  level = 1,
  threshold = NULL,
  baseline_actual = NULL,
  baseline_predicted = NULL,
  as_decimal = FALSE
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`level`	Integer (1–4). Level to return. Default is 1.
`threshold`	An `al_threshold` object or `NULL` for automatic calculation.
`baseline_actual`	Actual values for baseline model threshold calculation (used only if `threshold` is `NULL`).
`baseline_predicted`	Predicted values for baseline model threshold calculation (used only if `threshold` is `NULL`).
`as_decimal`	Logical. If `TRUE`, return as proportion (0–1); if `FALSE` (default), return as percentage (0–100).

Value

Numeric scalar.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
cae(actual, predicted, level = 1)
```

cae_l1 — *CAE Level 1 Metric for yardstick*

Description

CAE Level 1 Metric for yardstick

Usage

```
cae_l1(data, truth, estimate, na_rm = TRUE, ...)

## S3 method for class 'data.frame'
cae_l1(data, truth, estimate, na_rm = TRUE, ...)
```

Arguments

`data`	A data frame containing truth and estimate columns.
`truth`	Column name for actual values (unquoted).
`estimate`	Column name for predicted values (unquoted).
`na_rm`	Logical. Remove `NA`s? Default `TRUE`.
`...`	Additional arguments (ignored).

Value

A tibble.

calculate_threshold — *Calculate Error Thresholds from a Baseline Model*

Description

Calculate error threshold levels based on a baseline model's error distribution. The threshold is determined using quartiles of the specified error type, following the procedure in Figure 2 of Agustini et al. (2026).

Quartiles are computed using the inverse empirical CDF (R's `type = 1`), consistent with the paper.

Usage

```
calculate_threshold(
  actual,
  predicted,
  error_type = c("ape", "sape", "se", "ae"),
  quartile = 2,
  multipliers = c(2, 5)
)
```

Arguments

`actual`	Numeric vector of actual (observed) values from the baseline model.
`predicted`	Numeric vector of predicted values from the baseline model.
`error_type`	Character string specifying the error type used to select the quartile. One of `"ape"` (default, absolute percentage error), `"sape"` (symmetric APE), `"se"` (squared error), or `"ae"` (absolute error).
`quartile`	Integer (1, 2, or 3) specifying which quartile to use. Default is 2 (median). The recommended approach from the paper is to select the quartile where the APE value is close to 0.1 (10 percent error).
`multipliers`	Numeric vector of length 2 specifying the multipliers for level boundaries. Default is `c(2, 5)`, creating levels L1: error < T, L2: T <= error < 2T, L3: 2T <= error < 5T, L4: error >= 5T.

Value

A list of class `"al_threshold"` with elements: `threshold` (the base threshold value T), `levels` (a list with L1–L4 boundary pairs), `error_type` (the error type used), `quartile` (the quartile used), `multipliers` (the multiplier values), and `baseline_quartiles` (a named list with the selected quartile value for every error type: se, ae, ape, sape – this is the key element that lets `accuracy_level` derive thresholds for all four metrics from a single baseline model).

References

Agustini, M., Fithriasari, K., & Prastyo, D.D. (2026). An accuracy-level method for robust evaluation in predictive analytics. *Decision Analytics Journal*, 18, 100661. doi:10.1016/j.dajour.2025.100661

See Also

`accuracy_level`, `auto_threshold`

Examples

```
# --- Paper Table 4: simple case, Model 1 as baseline ---
actual  <- c(7, 6.03, 2.02, 5.1, 9, 1, 3, 4.38, 1, 8.07)
model1  <- c(6.05, 5.02, 1.32, 5.15, 8, 2.2, 2.7, 3.48, 1, 7.56)

# Q2 of APE ~ 0.1111, close to the target 0.10
thresh <- calculate_threshold(actual, model1, quartile = 2)
print(thresh)

# Stricter thresholds via Q1
thresh_q1 <- calculate_threshold(actual, model1, quartile = 1)
```

cape *Counted Absolute Percentage Error (CAPE)*

Description

Counted Absolute Percentage Error (CAPE)

Usage

```
cape(
  actual,
  predicted,
  level = 1,
  threshold = NULL,
  baseline_actual = NULL,
  baseline_predicted = NULL,
  as_decimal = FALSE
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`level`	Integer (1–4). Level to return. Default is 1.
`threshold`	An `al_threshold` object or `NULL` for automatic calculation.
`baseline_actual`	Actual values for baseline model threshold calculation (used only if `threshold` is `NULL`).
`baseline_predicted`	Predicted values for baseline model threshold calculation (used only if `threshold` is `NULL`).
`as_decimal`	Logical. If `TRUE`, return as proportion (0–1); if `FALSE` (default), return as percentage (0–100).

Value

Numeric scalar.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
cape(actual, predicted, level = 1)
```

cape_l1 — *CAPE Level 1 Metric for yardstick*

Description

CAPE Level 1 Metric for yardstick

Usage

```
cape_l1(data, truth, estimate, na_rm = TRUE, ...)

## S3 method for class 'data.frame'
cape_l1(data, truth, estimate, na_rm = TRUE, ...)
```

Arguments

data	A data frame containing truth and estimate columns.
truth	Column name for actual values (unquoted).
estimate	Column name for predicted values (unquoted).
na_rm	Logical. Remove NAs? Default TRUE.
...	Additional arguments (ignored).

Value

A tibble.

caret_single_metric — *Create Single Metric caret Summary*

Description

Create Single Metric caret Summary

Usage

```
caret_single_metric(
  metric_type = c("cse", "cae", "cape", "scape"),
  level = 1,
  threshold = NULL
)
```

Arguments

metric_type	One of "cse", "cae", "cape", "scape".
level	Level to optimise (1–4). Default is 1.
threshold	An al_threshold object or NULL.

Value

A function suitable for `summaryFunction` in `caret::trainControl`.

Examples

```
if (requireNamespace("caret", quietly = TRUE)) {
  fn <- caret_single_metric("cae", level = 1)
}
```

---

caret_summary *Create Custom caret Metrics*

Description

Create a summary function for use with caret's `trainControl`. Returns L1 accuracy for all four metrics plus traditional metrics.

Usage

```
caret_summary(threshold = NULL)
```

Arguments

`threshold`	An optional `al_threshold` object for consistent thresholds across folds. If `NULL`, thresholds are calculated per fold.

Value

A function suitable for `summaryFunction` in `caret::trainControl`.

Examples

```
if (requireNamespace("caret", quietly = TRUE)) {
  al_summary <- caret_summary()
}
```

caret_summary_extended

Create Extended caret Summary with All Levels

Description

Create Extended caret Summary with All Levels

Usage

```
caret_summary_extended(threshold = NULL)
```

Arguments

threshold	An optional al_threshold object for consistent thresholds across folds. If NULL, thresholds are calculated per fold.

Value

A function suitable for summaryFunction in caret::trainControl.

Examples

```
if (requireNamespace("caret", quietly = TRUE)) {
  al_ext <- caret_summary_extended()
}
```

compare_all_metrics

Compare All Metric Types

Description

Comprehensive comparison of conventional, robust, and accuracy-level metrics.

Usage

```
compare_all_metrics(actual, predicted, threshold = NULL)
```

Arguments

actual	Numeric vector of actual values.
predicted	Numeric vector of predicted values.
threshold	Threshold object for accuracy-level metrics.

Value

A list of class "metrics_comparison" with conventional, robust, accuracy_level, and summary elements.

Examples

```
actual <- c(10, 20, 30, 40, 50, 60, 70, 80, 90, 100)
predicted <- c(11, 19, 32, 38, 51, 58, 72, 78, 92, 98)
result <- compare_all_metrics(actual, predicted)
print(result)
```

---

compare_models *Compare Multiple Models*

Description

Compare multiple prediction models using accuracy-level metrics and identify the optimal one following the model-selection procedure in Figure 3 of Agustini et al. (2026).

Usage

```
compare_models(
  ...,
  metric = c("cse", "cae", "cape", "scape"),
  threshold = NULL
)
```

Arguments

...	Named arguments, each a list with actual and predicted elements.
metric	Metric for comparison. Default is "cse".
threshold	Shared al_threshold object. When NULL (default), the *first* model is used as the baseline.

Details

The optimal model is selected by the Figure 3 algorithm:

1. Compare the Level 1 accuracy across models; the model with the highest value is selected.
2. If two or more models tie on Level 1 accuracy, the tie is broken using the mean error (ME) of the corresponding level (lower ME is better).
3. If the ME values are also equal, the comparison proceeds to the next accuracy level, repeating until the optimal model is identified.

Earlier releases used the simpler rule of ranking by Level 1 then Level 2 accuracy; this version implements the full ME-based tie-break.

Value

A list with `optimal_model`, `comparison` table (accuracy and mean error per level), `metric_used`, and `full_results`.

Examples

```
actual <- c(7, 6.03, 2.02, 5.1, 9, 1, 3, 4.38, 1, 8.07)
m1 <- list(actual = actual,
           predicted = c(6.05, 5.02, 1.32, 5.15, 8, 2.2, 2.7, 3.48, 1, 7.56))
m3 <- list(actual = actual,
           predicted = c(7.01, 6.04, 2.09, 5.11, 9.01, 5.1, 3.01, 4.39, 1, 8.1))

res <- compare_models(Model1 = m1, Model3 = m3, metric = "cape")
print(res$comparison)
res$optimal_model
```

`conventional_metrics` *Calculate Conventional Metrics*

Description

Compute commonly used evaluation metrics including R-squared, RMSE, NRMSE, MAE, MAPE, and SMAPE.

Usage

```
conventional_metrics(actual, predicted, na.rm = FALSE)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`na.rm`	Logical. If `TRUE`, remove `NA` pairs before computing. Default is `FALSE`.

Details

`NRMSE` is normalised by the mean of `actual` (returned as `NA` when that mean is zero). `R_squared` is the usual $1 - SS_{res}/SS_{tot}$ and may be negative for models worse than the mean (unlike the 0–1 range quoted in Table 1 of the paper). `MAPE` and `SMAPE` are returned on the percentage scale and ignore non-finite per-observation terms (e.g. division by a zero actual value).

Value

A named numeric vector with six elements.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
conventional_metrics(actual, predicted)
```

---

cse *Counted Squared Error (CSE)*

Description

Compute the Counted Squared Error metric at a specified level.

Usage

```
cse(
  actual,
  predicted,
  level = 1,
  threshold = NULL,
  baseline_actual = NULL,
  baseline_predicted = NULL,
  as_decimal = FALSE
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`level`	Integer (1–4). Level to return. Default is 1.
`threshold`	An `al_threshold` object or `NULL` for automatic calculation.
`baseline_actual`	Actual values for baseline model threshold calculation (used only if `threshold` is `NULL`).
`baseline_predicted`	Predicted values for baseline model threshold calculation (used only if `threshold` is `NULL`).
`as_decimal`	Logical. If `TRUE`, return as proportion (0–1); if `FALSE` (default), return as percentage (0–100).

Value

Numeric scalar: the percentage (or proportion) of observations at the specified accuracy level.

Examples

```
actual <- c(7, 6.03, 2.02, 5.1, 9, 1, 3, 4.38, 1, 8.07)
predicted <- c(6.05, 5.02, 1.32, 5.15, 8, 2.2, 2.7, 3.48, 1, 7.56)

cse(actual, predicted, level = 1)
sapply(1:4, function(l) cse(actual, predicted, level = l))
```

---

cse_l1 *CSE Level 1 Metric for yardstick*

Description

CSE Level 1 Metric for yardstick

Usage

```
cse_l1(data, truth, estimate, na_rm = TRUE, ...)

## S3 method for class 'data.frame'
cse_l1(data, truth, estimate, na_rm = TRUE, ...)
```

Arguments

data	A data frame containing truth and estimate columns.
truth	Column name for actual values (unquoted).
estimate	Column name for predicted values (unquoted).
na_rm	Logical. Remove NAs? Default TRUE.
...	Additional arguments (ignored).

Value

A tibble with .metric, .estimator, .estimate.

Examples

```
if (requireNamespace("rlang", quietly = TRUE)) {
  df <- data.frame(truth = c(10, 20, 30), estimate = c(11, 19, 28))
  cse_l1(df, truth, estimate)
}
```

get_all_levels — *Get All Levels for a Metric*

Description

Convenience function to obtain all four levels at once.

Usage

```
get_all_levels(
  actual,
  predicted,
  metric = c("cse", "cae", "cape", "scape"),
  threshold = NULL,
  baseline_actual = NULL,
  baseline_predicted = NULL
)
```

Arguments

`actual`	Numeric vector of actual values.
`predicted`	Numeric vector of predicted values.
`metric`	One of `"cse"`, `"cae"`, `"cape"`, `"scape"`.
`threshold`	An `al_threshold` object or `NULL`.
`baseline_actual`	Actual values for baseline model.
`baseline_predicted`	Predicted values for baseline model.

Value

Named numeric vector of length 4.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
get_all_levels(actual, predicted, "cae")
```

print.al_threshold *Print Method for al_threshold Objects*

Description

Print Method for al_threshold Objects

Usage

```
## S3 method for class 'al_threshold'
print(x, ...)
```

Arguments

x	An al_threshold object.
...	Additional arguments (ignored).

Value

Invisibly returns the input object.

robust_metrics *Calculate Robust Metrics*

Description

Compute robust evaluation metrics including Median Absolute Error, Trimmed Mean Squared Error, Huber Loss, and Quantile Loss.

Usage

```
robust_metrics(
  actual,
  predicted,
  trim_percent = 0.1,
  huber_delta = 1,
  tau = 0.5,
  na.rm = FALSE
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`trim_percent`	Proportion to trim for TMSE (default 0.1).
`huber_delta`	Delta parameter for Huber loss (default 1).
`tau`	Quantile for quantile loss (default 0.5 for median).
`na.rm`	Logical. Default is `FALSE`.

Value

A named numeric vector with four elements.

Examples

```
actual <- c(10, 20, 30, 40, 50, 1000)
predicted <- c(11, 19, 32, 38, 51, 60)
robust_metrics(actual, predicted)
```

---

scape — *Symmetric Counted Absolute Percentage Error (SCAPE)*

Description

Symmetric Counted Absolute Percentage Error (SCAPE)

Usage

```
scape(
  actual,
  predicted,
  level = 1,
  threshold = NULL,
  baseline_actual = NULL,
  baseline_predicted = NULL,
  as_decimal = FALSE
)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`level`	Integer (1–4). Level to return. Default is 1.
`threshold`	An `al_threshold` object or `NULL` for automatic calculation.

`baseline_actual`
: Actual values for baseline model threshold calculation (used only if `threshold` is `NULL`).

`baseline_predicted`
: Predicted values for baseline model threshold calculation (used only if `threshold` is `NULL`).

`as_decimal`
: Logical. If `TRUE`, return as proportion (0–1); if `FALSE` (default), return as percentage (0–100).

Value

Numeric scalar.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
scape(actual, predicted, level = 1)
```

`scape_l1` *SCAPE Level 1 Metric for yardstick*

Description

SCAPE Level 1 Metric for yardstick

Usage

```
scape_l1(data, truth, estimate, na_rm = TRUE, ...)

## S3 method for class 'data.frame'
scape_l1(data, truth, estimate, na_rm = TRUE, ...)
```

Arguments

`data`
: A data frame containing truth and estimate columns.

`truth`
: Column name for actual values (unquoted).

`estimate`
: Column name for predicted values (unquoted).

`na_rm`
: Logical. Remove `NA`s? Default `TRUE`.

`...`
: Additional arguments (ignored).

Value

A tibble.

squared_error — *Calculate Squared Error*

Description

Compute squared error between actual and predicted values, as defined in Equation (1) of Agustini et al. (2026).

Usage

```
squared_error(actual, predicted, na.rm = FALSE)
```

Arguments

`actual`	Numeric vector of actual (observed) values.
`predicted`	Numeric vector of predicted values.
`na.rm`	Logical. If `TRUE`, remove `NA` pairs before computing. Default is `FALSE`.

Value

Numeric vector of squared errors.

References

Agustini, M., Fithriasari, K., & Prastyo, D.D. (2026). An accuracy-level method for robust evaluation in predictive analytics. *Decision Analytics Journal*, 18, 100661. doi:10.1016/j.dajour.2025.100661

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
squared_error(actual, predicted)
```

symmetric_absolute_percentage_error — *Calculate Symmetric Absolute Percentage Error*

Description

Compute symmetric absolute percentage error between actual and predicted values, as defined in Equation (4) of Agustini et al. (2026). Note that the result is on the proportion scale (not multiplied by 100).

Usage

```
symmetric_absolute_percentage_error(actual, predicted, na.rm = FALSE)
```

Arguments

actual	Numeric vector of actual (observed) values.
predicted	Numeric vector of predicted values.
na.rm	Logical. If TRUE, remove NA pairs before computing. Default is FALSE.

Value

Numeric vector of symmetric absolute percentage errors. Returns NaN when both actual and predicted are zero.

Examples

```
actual <- c(10, 20, 30, 40, 50)
predicted <- c(11, 19, 32, 38, 51)
symmetric_absolute_percentage_error(actual, predicted)
```

Index

absolute_error, 2
absolute_percentage_error, 3
accuracy_level, 4, *9*, *14*
accuracy_level_metrics, 6
al_compare_forecasts, 7
al_extended_accuracy, 8
al_forecast_accuracy, 8
al_metric_set, 9
al_tsCV, 10
auto_threshold, *4, 5*, 11, *14*

cae, *5*, 12
cae_l1, 13
calculate_threshold, *4, 5*, *9*, 13
cape, *5*, 15
cape_l1, 16
caret_single_metric, 16
caret_summary, 17
caret_summary_extended, 18
compare_all_metrics, 18
compare_models, 19
conventional_metrics, 20
cse, *5*, 21
cse_l1, 22

get_all_levels, 23

print.al_threshold, 24

robust_metrics, 24

scape, *5*, 25
scape_l1, 26
squared_error, 27
symmetric_absolute_percentage_error, 27