Package ‘yardstick’

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Type Package

Title Tidy Characterizations of Model Performance

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**accuracy**

Accuracy is the proportion of the data that are predicted correctly.

**Usage**

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

**Arguments**

- **data**: Either a `data.frame` containing the `truth` and `estimate` columns, or a `table/matrix` where the true class results should be in the columns of the table.
- **...**: Not currently used.
- **truth**: The unquoted column name (that is a `factor`). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.
- **estimate**: The column identifier for the predicted class results (that is also `factor`). As with `truth` this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.
- **na_rm**: A logical value indicating whether NA values should be stripped before the computation proceeds.

**Value**

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `accuracy_vec()`, a single numeric value (or NA).

**Multiclass**

Accuracy extends naturally to multiclass scenarios. Because of this, macro and micro averaging are not implemented.
Author(s)
Max Kuhn

See Also
Other class metrics: `bal_accuracy()`, `detection_prevalence()`, `f_meas()`, `j_index()`, `kap()`, `mcc()`, `npv()`, `ppv()`, `precision()`, `recall()`, `sens()`, `spec()`

Examples

```r
# Two class
data("two_class_example")
accuracy(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  accuracy(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  accuracy(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  accuracy(obs, pred, estimator = "macro_weighted")

# Vector version
accuracy_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
accuracy_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)
```

average_precision

Area under the precision recall curve

Description

`average_precision()` is an alternative to `pr_auc()` that avoids any ambiguity about what the value of precision should be when `recall == 0` and there are not yet any false positive values (some say it should be 0, others say 1, others say undefined).
average_precision

It computes a weighted average of the precision values returned from `pr_curve()`, where the weights are the increase in recall from the previous threshold. See `pr_curve()` for the full curve.

Usage

```r
average_precision(data, ...)
```

```r
## S3 method for class 'data.frame'
average_precision(data, truth, ..., estimator = NULL, na_rm = TRUE)
```

```r
average_precision_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

Arguments

data A data.frame containing the truth and estimate columns.

... A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.

truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

estimator One of "binary", "macro", or "macro_weighted" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other two are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on truth.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

estimate If truth is binary, a numeric vector of class probabilities corresponding to the "relevant" class. Otherwise, a matrix with as many columns as factor levels of truth. It is assumed that these are in the same order as the levels of truth.

Details

The computation for average precision is a weighted average of the precision values. Assuming you have n rows returned from `pr_curve()`, it is a sum from 2 to n, multiplying the precision value $p_i$ by the increase in recall over the previous threshold, $r_i - r_{i-1}$.

$$AP = \sum (r_i - r_{i-1}) * p_i$$

By summing from 2 to n, the precision value $p_1$ is never used. While `pr_curve()` returns a value for $p_1$, it is technically undefined as $tp / (tp + fp)$ with $tp = 0$ and $fp = 0$. A common convention is to use 1 for $p_1$, but this metric has the nice property of avoiding the ambiguity. On the other hand, $r_1$ is well defined as long as there are some events (p), and it is $tp / p$ with $tp = 0$, so $r_1 = 0$.

When $p_1$ is defined as 1, the `average_precision()` and `roc_auc()` values are often very close to one another.
Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For average_precision_vec(), a single numeric value (or NA).

Multiclass

Macro and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

See Also

pr_curve() for computing the full precision recall curve.
pr_auc() for computing the area under the precision recall curve using the trapezoidal rule.
Other class probability metrics: gain_capture(), mn_log_loss(), pr_auc(), roc_auc(), roc_aunu()

Examples

```r
# Two class example

# `truth` is a 2 level factor. The first level is "Class1", which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section above.
data(two_class_example)

# Binary metrics using class probabilities take a factor `truth` column,
# and a single class probability column containing the probabilities of
# the event of interest. Here, since "Class1" is the first level of
# "truth", it is the event of interest and we pass in probabilities for it.
average_precision(two_class_example, truth, Class1)

# Multiclass example

# `obs` is a 4 level factor. The first level is "VF", which is the
# "event of interest" by default in yardstick. See the Relevant Level
```
data(hpc_cv)

# You can use the col1:colN tidyselect syntax
library(dplyr)
hpc_cv %>%
  filter(Resample == "Fold01") %>%
  average_precision(obs, VF:L)

# Change the first level of `obs` from `"VF"` to `"M"` to alter the
# event of interest. The class probability columns should be supplied
# in the same order as the levels.
hpc_cv %>%
  filter(Resample == "Fold01") %>%
  mutate(obs = relevel(obs, "M")) %>%
  average_precision(obs, M, VF:L)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  average_precision(obs, VF:L)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  average_precision(obs, VF:L, estimator = "macro_weighted")

# Vector version
# Supply a matrix of class probabilities
fold1 <- hpc_cv %>%
  filter(Resample == "Fold01")

average_precision_vec(
  truth = fold1$obs,
  matrix(
    c(fold1$VF, fold1$F, fold1$M, fold1$L),
    ncol = 4
  )
)

---

**bal_accuracy**

*Balanced accuracy*

**Description**

Balanced accuracy is computed here as the average of `sens()` and `spec()`. 
bal_accuracy

Usage

bal_accuracy(data, ...)

## S3 method for class 'data.frame'
bal_accuracy(data, truth, estimate, estimator = NULL, na_rm = TRUE, ...)

bal_accuracy_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)

Arguments

data
Either a data.frame containing the truth and estimate columns, or a table/matrix
where the true class results should be in the columns of the table.

... Not currently used.

truth
The column identifier for the true class results (that is a factor). This should be
an unquoted column name although this argument is passed by expression and
supports quasiquotation (you can unquote column names). For _vec() functions,
a factor vector.

estimate
The column identifier for the predicted class results (that is also factor). As
with truth this can be specified different ways but the primary method is to use
an unquoted variable name. For _vec() functions, a factor vector.

estimator
One of: "binary", "macro", "macro_weighted", or "micro" to specify the
type of averaging to be done. "binary" is only relevant for the two class case.
The other three are general methods for calculating multiclass metrics. The
default will automatically choose "binary" or "macro" based on estimate.

na_rm
A logical value indicating whether NA values should be stripped before the
computation proceeds.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For bal_accuracy_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the
"event" or "positive" result. In yardstick, the default is to use the first level. To change this, a
global option called yardstick.event_first is set to TRUE when the package is loaded. This
can be changed to FALSE if the last level of the factor is considered the level of interest by running:
options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all com-
parisons (such as macro averaging), this option is ignored and the "one" level is always the relevant
result.

Multiclass

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select
macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary
calculation is done. See vignette("multiclass","yardstick") for more information.
Author(s)
Max Kuhn

See Also
Other class metrics: `accuracy()`, `detection_prevalence()`, `f_meas()`, `j_index()`, `kap()`, `mcc()`, `npv()`, `ppv()`, `precision()`, `recall()`, `sens()`, `spec()`

Examples

```r
# Two class
data("two_class_example")
bal_accuracy(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
bal_accuracy(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
bal_accuracy(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
bal_accuracy(obs, pred, estimator = "macro_weighted")

# Vector version
bal_accuracy_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
bal_accuracy_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)
```

---

**Description**

Calculate the concordance correlation coefficient.
Usage
ccc(data, ...)

## S3 method for class 'data.frame'
ccc(data, truth, estimate, bias = FALSE, na_rm = TRUE, ...)
ccc_vec(truth, estimate, bias = FALSE, na_rm = TRUE, ...)

Arguments
data A data.frame containing the truth and estimate columns.
... Not currently used.
truth The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.
estimate The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.
bias A logical; should the biased estimate of variance be used (as is Lin (1989))? 
a_na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details
ccc() is a metric of both consistency/correlation and accuracy, while metrics such as rmse() are strictly for accuracy and metrics such as rsq() are strictly for consistency/correlation

Value
A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For ccc_vec(), a single numeric value (or NA).

Author(s)
Max Kuhn

References
See Also

Other numeric metrics: `huber_loss_pseudo()`, `huber_loss()`, `iic()`, `mae()`, `mape()`, `mase()`, `rmse()`, `rpd()`, `rpiq()`, `rsq_trad()`, `rsq()`, `smape()`

Other consistency metrics: `rpd()`, `rpiq()`, `rsq_trad()`, `rsq()`

Other accuracy metrics: `huber_loss_pseudo()`, `huber_loss()`, `iic()`, `mae()`, `mape()`, `mase()`, `rmse()`, `smape()`

Examples

```r
# Supply truth and predictions as bare column names
ccc(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  ccc(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))
```

Description

Calculates a cross-tabulation of observed and predicted classes.
Usage

conf_mat(data, ...)

## S3 method for class 'data.frame'
conf_mat(data, truth, estimate, dnn = c("Prediction", "Truth"), ...)

## S3 method for class 'conf_mat'
tidy(x, ...)

autoplot.conf_mat(object, type = "mosaic", ...)

Arguments

data A data frame or a base::table.
...
Options to pass to base::table() (not including dnn). This argument is not currently used for the tidy method.
truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.
estimate The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.
dnn A character vector of dimnames for the table.
x A conf_mat object.
object The conf_mat data frame returned from conf_mat().
type Type of plot desired, must be "mosaic" or "heatmap", defaults to "mosaic".

Details

For conf_mat() objects, a broom tidy() method has been created that collapses the cell counts by cell into a data frame for easy manipulation.
There is also a summary() method that computes various classification metrics at once. See summary.conf_mat()
There is a ggplot2::autoplot() method for quickly visualizing the matrix. Both a heatmap and mosaic type is implemented.
The function requires that the factors have exactly the same levels.

Value

conf_mat() produces an object with class conf_mat. This contains the table and other objects.
tidy.conf_mat() generates a tibble with columns name (the cell identifier) and value (the cell count).
When used on a grouped data frame, conf_mat() returns a tibble containing columns for the groups along with conf_mat, a list-column where each element is a conf_mat object.
See Also

`summary.conf_mat()` for computing a large number of metrics from one confusion matrix.

Examples

```r
library(dplyr)
data("hpc_cv")

# The confusion matrix from a single assessment set (i.e. fold)
cm <- hpc_cv %>%
  filter(Resample == "Fold01") %>%
  conf_mat(obs, pred)

cm

# Now compute the average confusion matrix across all folds in
# terms of the proportion of the data contained in each cell.
# First get the raw cell counts per fold using the `tidy` method
library(purrr)
library(tidyr)

cells_per_resample <- hpc_cv %>%
  group_by(Resample) %>%
  conf_mat(obs, pred) %>%
  mutate(tidied = map(conf_mat, tidy)) %>%
  unnest(tidied)

# Get the totals per resample
counts_per_resample <- hpc_cv %>%
  group_by(Resample) %>%
  summarize(total = n()) %>%
  left_join(cells_per_resample, by = "Resample") %>%
  # Compute the proportions
  mutate(prop = value/total) %>%
  group_by(name) %>%
  # Average
  summarize(prop = mean(prop))

counts_per_resample

# Now reshape these into a matrix
mean_cmat <- matrix(counts_per_resample$prop, byrow = TRUE, ncol = 4)
rownames(mean_cmat) <- levels(hpc_cv$obs)
colnames(mean_cmat) <- levels(hpc_cv$obs)

round(mean_cmat, 3)

# The confusion matrix can quickly be visualized using autoplot()
library(ggplot2)

autoplot(cm, type = "mosaic")
autoplot(cm, type = "heatmap")
```
**detection_prevalence**  

**Detection prevalence**

**Description**

Detection prevalence is defined as the number of *predicted* positive events (both true positive and false positive) divided by the total number of predictions.

**Usage**

```r
# S3 method for class 'data.frame'
detection_prevalence(
  data,
  truth,
  estimate,
  estimator = NULL,
  na_rm = TRUE,
  ...
)
```

```r
detection_prevalence_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

**Arguments**

- `data`  
  Either a `data.frame` containing the `truth` and `estimate` columns, or a `table/matrix` where the true class results should be in the columns of the table.

- `...`
  Not currently used.

- `truth`  
  The column identifier for the true class results (that is a `factor`). This should be an unquoted column name although this argument is passed by expression and supports **quasiquotation** (you can unquote column names). For _vec() functions, a `factor` vector.

- `estimate`  
  The column identifier for the predicted class results (that is also `factor`). As with `truth` this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a `factor` vector.

- `estimator`  
  One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on `estimate`.

- `na.rm`  
  A logical value indicating whether NA values should be stripped before the computation proceeds.
**detection_prevalence**

**Value**

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `detection_prevalence_vec()`, a single numeric value (or NA).

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In `yardstick`, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

**Multiclass**

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

**Author(s)**

Max Kuhn

**See Also**

Other class metrics: `accuracy()`, `bal_accuracy()`, `f_meas()`, `j_index()`, `kap()`, `mcc()`, `npv()`, `ppv()`, `precision()`, `recall()`, `sens()`, `spec()`

**Examples**

```r
# Two class
data("two_class_example")
detection_prevalence(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
detection_prevalence(obs, pred)

# Groups are respected
hpc_cv %>%
group_by(Resample) %>%
detection_prevalence(obs, pred)

# Weighted macro averaging
```
```
# Vector version
hpc_cv %>%
  group_by(Resample) %>%
  detection_prevalence(obs, pred, estimator = "macro_weighted")

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
detection_prevalence_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)
```

---

### f_meas

**F Measure**

Description

These functions calculate the *f_meas()* of a measurement system for finding relevant documents compared to reference results (the truth regarding relevance). Highly related functions are *recall()* and *precision()*.

Usage

```
f_meas(data, ...)
```

```
## S3 method for class 'data.frame'
f_meas(data, truth, estimate, beta = 1, estimator = NULL, na_rm = TRUE, ...)

f_meas_vec(truth, estimate, beta = 1, estimator = NULL, na_rm = TRUE, ...)
```

Arguments

- **data**: Either a `data.frame` containing the truth and estimate columns, or a table/matrix where the true class results should be in the columns of the table.
- **...**: Not currently used.
- **truth**: The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.
- **estimate**: The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.
- **beta**: A numeric value used to weight precision and recall. A value of 1 is traditionally used and corresponds to the harmonic mean of the two values but other values weight recall beta times more important than precision.
estimator

One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on estimate.

na_rm

A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The measure "F" is a combination of precision and recall (see below).

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For f_meas_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running:

options(yardstick.event_first = FALSE)

For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Multiclass

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

Implementation

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted</td>
<td>Relevant</td>
<td>Irrelevant</td>
</tr>
<tr>
<td>Relevant</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

The formulas used here are:

\[
\text{recall} = \frac{A}{A + C}
\]

\[
\text{precision} = \frac{A}{A + B}
\]
\[
F_{\text{meas}\beta} = (1 + \beta^2) \times \text{precision} \times \text{recall}/((\beta^2 \times \text{precision}) + \text{recall})
\]

See the references for discussions of the statistics.

Author(s)
Max Kuhn

References

See Also
Other class metrics: `accuracy()`, `bal_accuracy()`, `detection_prevalence()`, `j_index()`, `kap()`, `mcc()`, `npv()`, `ppv()`, `precision()`, `recall()`, `sens()`, `spec()`

Other relevance metrics: `precision()`, `recall()`

Examples
```r
# Two class
data("two_class_example")
f_meas(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  f_meas(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  f_meas(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  f_meas(obs, pred, estimator = "macro_weighted")

# Vector version
f_meas_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
f_meas_vec(two_class_example$truth, two_class_example$predicted)
```
options(yardstick.event_first = TRUE)

---

**gain_capture**  
*Gain capture*

**Description**

`gain_capture()` is a measure of performance similar to an AUC calculation, but applied to a gain curve.

**Usage**

```r
gain_capture(data, ...)
```

```r
## S3 method for class 'data.frame'
gain_capture(data, truth, ..., estimator = NULL, na_rm = TRUE)
```

```r
gain_capture_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

**Arguments**

- **data**  
  A data.frame containing the truth and estimate columns.

- **...**  
  A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.

- **truth**  
  The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

- **estimator**  
  One of "binary", "macro", or "macro_weighted" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other two are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on truth.

- **na_rm**  
  A logical value indicating whether NA values should be stripped before the computation proceeds.

- **estimate**  
  If truth is binary, a numeric vector of class probabilities corresponding to the "relevant" class. Otherwise, a matrix with as many columns as factor levels of truth. *It is assumed that these are in the same order as the levels of truth.*
**Details**

gain_capture() calculates the area under the gain curve, but above the baseline, and then divides that by the area under a perfect gain curve, but above the baseline. It is meant to represent the amount of potential gain "captured" by the model.

The gain_capture() metric is identical to the accuracy ratio (AR), which is also sometimes called the gini coefficient. These two are generally calculated on a cumulative accuracy profile curve, but this is the same as a gain curve. See the Engelmann reference for more information.

**Value**

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For gain_capture_vec(), a single numeric value (or NA).

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running:

```r
options(yardstick.event_first = FALSE)
```

For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

**Multiclass**

Macro and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass", "yardstick") for more information.

**Author(s)**

Max Kuhn

**References**


**See Also**

gain_curve() to compute the full gain curve.

Other class probability metrics: average_precision(), mn_log_loss(), pr_auc(), roc_auc(), roc_aunp(), roc_aunu()
Examples

```
# Two class example

data(two_class_example)

gain_capture(two_class_example, truth, Class1)
```

```
# Multiclass example

data(hpc_cv)

library(dplyr)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  gain_capture(obs, VF:L)
```

```
# Change the first level of `obs` from "VF" to "M" to alter the event of interest. The class probability columns should be supplied in the same order as the levels.

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  mutate(obs = relevel(obs, "M")) %>%
  gain_capture(obs, M, VF:L)
```

```
# Groups are respected

hpc_cv %>%
  group_by(Resample) %>%
  gain_capture(obs, VF:L)
```

```
# Weighted macro averaging

hpc_cv %>%
  group_by(Resample) %>%
  gain_capture(obs, VF:L, estimator = "macro_weighted")
```

```
# Vector version
# Supply a matrix of class probabilities

fold1 <- hpc_cv %>%
  filter(Resample == "Fold01")
```
gain_capture_vec(
  truth = fold1$obs,
  matrix(
    c(fold1$VF, fold1$F, fold1$M, fold1$L),
    ncol = 4
  )
)

# Visualize gain_capture()

# Visually, this represents the area under the black curve, but above the
# 45 degree line, divided by the area of the shaded triangle.
library(ggplot2)
autoplot(gain_curve(two_class_example, truth, Class1))

---

**gain_curve**

---

**Description**

`gain_curve()` constructs the full gain curve and returns a tibble. See `gain_capture()` for the relevant area under the gain curve. Also see `lift_curve()` for a closely related concept.

**Usage**

```r
gain_curve(data, ...)
```

## S3 method for class 'data.frame'

```r
gain_curve(data, truth, ..., na_rm = TRUE)
```

```r
autoplot.gain_df(object, ...)
```

**Arguments**

- **data**
  - A `data.frame` containing the truth and estimate columns.
- **...**
  - A set of unquoted column names or one or more `dplyr` selector functions to choose which variables contain the class probabilities. If `truth` is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of `truth`.
- **truth**
  - The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For `_vec()` functions, a factor vector.
- **na_rm**
  - A logical value indicating whether NA values should be stripped before the computation proceeds.
- **object**
  - The `gain_df` data frame returned from `gain_curve()`.
Details

There is a `ggplot2::autoplot()` method for quickly visualizing the curve. This works for binary and multiclass output, and also works with grouped data (i.e. from resamples). See the examples.

The greater the area between the gain curve and the baseline, the better the model.

Gain curves are identical to CAP curves (cumulative accuracy profile). See the Engelmann reference for more information on CAP curves.

Value

A tibble with class `gain_df` or `gain_grouped_df` having columns:

- `.n` - The index of the current sample.
- `.n_events` - The index of the current unique sample. Values with repeated estimate values are given identical indices in this column.
- `.percent_tested` - The cumulative percentage of values tested.
- `.percent_found` - The cumulative percentage of true results relative to the total number of true results.

Gain and Lift Curves

The motivation behind cumulative gain and lift charts is as a visual method to determine the effectiveness of a model when compared to the results one might expect without a model. As an example, without a model, if you were to advertise to a random 10\% to capture 10\% advertised to your entire customer base. Given a model that predicts which customers are more likely to respond, the hope is that you can more accurately target 10\% \(>10\%\)

The calculation to construct gain curves is as follows:

1. truth and estimate are placed in descending order by the estimate values (estimate here is a single column supplied in ...).
2. The cumulative number of samples with true results relative to the entire number of true results are found. This is the y-axis in a gain chart.

Multiclass

If a multiclass truth column is provided, a one-vs-all approach will be taken to calculate multiple curves, one per level. In this case, there will be an additional column, `.level`, identifying the "one" column in the one-vs-all calculation.

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In `yardstick`, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.
Author(s)
Max Kuhn

References

See Also
Compute the relevant area under the gain curve with `gain_capture()`. Other curve metrics: `lift_curve()`, `pr_curve()`, `roc_curve()`

Examples

```r
# Two class example

# `truth` is a 2 level factor. The first level is `"Class1"`, which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section above.
data(two_class_example)

# Binary metrics using class probabilities take a factor `truth` column,
# and a single class probability column containing the probabilities of
# the event of interest. Here, since `"Class1"` is the first level of
# `"truth``, it is the event of interest and we pass in probabilities for it.
gain_curve(two_class_example, truth, Class1)

# ` autoplot()

library(ggplot2)
library(dplyr)

# Use autoplot to visualize
# The top left hand corner of the grey triangle is a "perfect" gain curve
autoplot(gain_curve(two_class_example, truth, Class1))

# Multiclass one-vs-all approach
# One curve per level
hpc_cv %>%
  filter(Resample == "Fold01") %>%
gain_curve(obs, VF:L) %>%
  autoplot()

# Same as above, but will all of the resamples
# The resample with the minimum (farthest to the left) "perfect" value is
# used to draw the shaded region
hpc_cv %>%
```
get_weights

```r
  group_by(Resample) %>%
  gain_curve(obs, VF:L) %>%
  autoplot()
```

---

**get_weights**  
*Developer helpers*

**Description**

Helpers to be used alongside `metric_vec_template()` and `metric_summarizer()` when creating new metrics. See vignette("custom-metrics","yardstick") for more information.

**Usage**

```r
get_weights(data, estimator)
finalise_estimator(x, estimator = NULL, metric_class = "default")
finalise_estimator_internal(metric_dispatcher, x, estimator)
dots_to_estimate(data, ...)
validate_estimator(estimator, estimator_override = NULL)
```

**Arguments**

- **data**: A table with truth values as columns and predicted values as rows.
- **estimator**: Either `NULL` for auto-selection, or a single character for the type of estimator to use.
- **x**: The column used to autoselect the estimator. This is generally the truth column, but can also be a table if your metric has table methods.
- **metric_class**: A single character of the name of the metric to autoselect the estimator for. This should match the method name created for `finalise_estimator_internal()`.
- **metric_dispatcher**: A simple dummy object with the class provided to `metric_class`. This is created and passed along for you.
- **...**: A set of unquoted column names or one or more `dplyr` selector functions to choose which variables contain the class probabilities. If `truth` is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of `truth`.
- **estimator_override**: A character vector overriding the default allowed estimator list of `c("binary","macro","micro","macro_weighted")`. Set this if your classification estimator does not support all of these methods.
Weight Calculation

`get_weights()` accepts a confusion matrix and an estimator of type "macro", "micro", or "macro_weighted" and returns the correct weights. It is useful when creating multiclass metrics.

Estimator Selection

`finalize_estimator()` is the engine for auto-selection of estimator based on the type of `x`. Generally `x` is the truth column. This function is called from the vector method of your metric.

`finalize_estimator_internal()` is an S3 generic that you should extend for your metric if it does not implement only the following estimator types: "binary", "macro", "micro", and "macro_weighted". If your metric does support all of these, the default version of `finalize_estimator_internal()` will autoselect estimator appropriately. If you need to create a method, it should take the form: `finalize_estimator_internal.metric_name`. Your method for `finalize_estimator_internal()` should do two things:

1. If `estimator` is NULL, autoselect the estimator based on the type of `x` and return a single character for the estimator.
2. If `estimator` is not NULL, validate that it is an allowed estimator for your metric and return it.

If you are using the default for `finalize_estimator_internal()`, the estimator is selected using the following heuristics:

1. If `estimator` is not NULL, it is validated and returned immediately as no auto-selection is needed.
2. If `x` is a:
   • factor - Then "binary" is returned if it has 2 levels, otherwise "macro" is returned.
   • numeric - Then "binary" is returned.
   • table - Then "binary" is returned if it has 2 columns, otherwise "macro" is returned. This is useful if you have table methods.
   • matrix - Then "macro" is returned.

Dots -> Estimate

`dots_to_estimate()` is useful with class probability metrics that take `...` rather than `estimate` as an argument. It constructs either a single name if 1 input is provided to `...` or it constructs a quosure where the expression constructs a matrix of as many columns as are provided to `...`. These are eventually evaluated in the `summarise()` call in `metric_summarizer()` and evaluate to either a vector or a matrix for further use in the underlying vector functions.

Estimator Validation

`validate_estimator()` is called from your metric specific method of `finalize_estimator_internal()` and ensures that a user provided estimator is of the right format and is one of the allowed values.

See Also

`metric_summarizer()` `metric_vec_template()`
**hpc_cv**

---

**hpc_cv**  
*Multiclass Probability Predictions*

---

**Description**  
Multiclass Probability Predictions

**Details**  
This data frame contains the predicted classes and class probabilities for a linear discriminant analysis model fit to the HPC data set from Kuhn and Johnson (2013). These data are the assessment sets from a 10-fold cross-validation scheme. The data column contains the true class (\texttt{obs}), the class prediction (\texttt{pred}) and columns for each class probability (columns \texttt{VF}, \texttt{F}, \texttt{M}, and \texttt{L}). Additionally, a column for the resample indicator is included.

**Value**  
hpc_cv  
a data frame

**Source**  

**Examples**
```
data(hpc_cv)
str(hpc_cv)
```

```
# `obs` is a 4 level factor. The first level is `"VF"`, which is the  
# "event of interest" by default in yardstick. See the Relevant Level  
# section in any classification function (such as `?pr_auc`) to see how  
# to change this.
levels(hpc_cv$obs)
```

---

**huber_loss**  
*Huber loss*

---

**Description**  
Calculate the Huber loss, a loss function used in robust regression. This loss function is less sensitive to outliers than \texttt{rmse()}. This function is quadratic for small residual values and linear for large residual values.
huber_loss

Usage

huber_loss(data, ...)

## S3 method for class 'data.frame'
huber_loss(data, truth, estimate, delta = 1, na_rm = TRUE, ...)

huber_loss_vec(truth, estimate, delta = 1, na_rm = TRUE, ...)

Arguments

data        A data.frame containing the truth and estimate columns.
...
truth       The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.
estimate    The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.
delta       A single numeric value. Defines the boundary where the loss function transitions from quadratic to linear. Defaults to 1.
na_rm        A logical value indicating whether NA values should be stripped before the computation proceeds.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For huber_loss_vec(), a single numeric value (or NA).

Author(s)

James Blair

References


See Also

Other numeric metrics: ccc(), huber_loss_pseudo(), iic(), mae(), mape(), mase(), rmse(), rpd(), rpiq(), rsq_trad(), rsq(), smape()
Other accuracy metrics: ccc(), huber_loss_pseudo(), iic(), mae(), mape(), mase(), rmse(), smape()
Examples

# Supply truth and predictions as bare column names
huber_loss(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  huber_loss(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))

huber_loss_pseudo       Psuedo-Huber Loss

Description

Calculate the Pseudo-Huber Loss, a smooth approximation of huber_loss(). Like huber_loss(), this is less sensitive to outliers than rmse().

Usage

huber_loss_pseudo(data, ...)

## S3 method for class 'data.frame'
huber_loss_pseudo(data, truth, estimate, delta = 1, na.rm = TRUE, ...)

huber_loss_pseudo_vec(truth, estimate, delta = 1, na.rm = TRUE, ...)
huber_loss_pseudo

Arguments

- **data**: A `data.frame` containing the truth and estimate columns.
- **...**: Not currently used.
- **truth**: The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For `_vec()` functions, a numeric vector.
- **estimate**: The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For `_vec()` functions, a numeric vector.
- **delta**: A single numeric value. Defines the boundary where the loss function transitions from quadratic to linear. Defaults to 1.
- **na_rm**: A logical value indicating whether NA values should be stripped before the computation proceeds.

Value

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `huber_loss_pseudo_vec()`, a single numeric value (or NA).

Author(s)

James Blair

References


See Also

Other numeric metrics: `ccc()`, `huber_loss()`, `iic()`, `mae()`, `mape()`, `mase()`, `rmse()`, `rpdiq()`, `rsq_trad()`, `rsq()`, `smape()`

Other accuracy metrics: `ccc()`, `huber_loss()`, `iic()`, `mae()`, `mape()`, `mase()`, `rmse()`, `smape()`

Examples

# Supply truth and predictions as bare column names
huber_loss_pseudo(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10
# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  huber_loss_pseudo(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))

---

## iic

### Index of ideality of correlation

**Description**

Calculate the index of ideality of correlation. This metric has been studied in QSPR/QSAR models as a good criterion for the predictive potential of these models. It is highly dependent on the correlation coefficient as well as the mean absolute error.

Note the application of IIC is useless under two conditions:

- When the negative mean absolute error and positive mean absolute error are both zero.
- When the outliers are symmetric. Since outliers are context dependent, please use your own checks to validate whether this restriction holds and whether the resulting IIC has interpretable value.

The IIC is seen as an alternative to the traditional correlation coefficient and is in the same units as the original data.

**Usage**

```r
iic(data, ...)
```

## S3 method for class 'data.frame'
```r
iic(data, truth, estimate, na.rm = TRUE, ...)
```

```r
iic_vec(truth, estimate, na.rm = TRUE, ...)
```
Arguments

- **data**
  A data.frame containing the truth and estimate columns.

- **truth**
  The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.

- **estimate**
  The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.

- **na_rm**
  A logical value indicating whether NA values should be stripped before the computation proceeds.

Value

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For iic_vec(), a single numeric value (or NA).

Author(s)

Joyce Cahoon

References


See Also

Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), mae(), mape(), mase(), rmse(), rpd(), rpiq(), rsq_trad(), rsq(), smape()

Other accuracy metrics: ccc(), huber_loss_pseudo(), huber_loss(), mae(), mape(), mase(), rmse(), smape()

Examples

# Supply truth and predictions as bare column names
iic(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)

size <- 100

times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
    replicate(
        n = times,
        expr = sample_n(solubility_test, size, replace = TRUE),
        simplify = FALSE
    ),
    .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
    group_by(resample) %>%
    iic(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
    summarise(avg_estimate = mean(.estimate))

---

**j_index**  

*J-index*

---

**Description**

Youden's J statistic is defined as:

\[ \text{sens()} + \text{spec()} - 1 \]

A related metric is Informedness, see the Details section for the relationship.

**Usage**

```r
j_index(data, ...)
```

### S3 method for class 'data.frame'

```r
j_index(data, truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

```r
j_index_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

**Arguments**

- **data**  
  Either a `data.frame` containing the truth and estimate columns, or a `table/matrix` where the true class results should be in the columns of the table.

- **...**  
  Not currently used.

- **truth**  
  The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For `_vec()` functions, a factor vector.
estimate: The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For vec() functions, a factor vector.

estimator: One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on estimate.

na_rm: A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The value of the J-index ranges from [0, 1] and is 1 when there are no false positives and no false negatives.

The binary version of J-index is equivalent to the binary concept of Informedness. Macro-weighted J-index is equivalent to multiclass informedness as defined in Powers, David M W (2011), equation (42).

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values. For grouped data frames, the number of rows returned will be the same as the number of groups. For j_index_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Multiclass

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

Author(s)

Max Kuhn

References

See Also

Other class metrics: accuracy(), bal_accuracy(), detection_prevalence(), f_meas(), kap(), mcc(), npv(), ppv(), precision(), recall(), sens(), spec()

Examples

# Two class
data("two_class_example")
j_index(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  j_index(obs, pred)

# Groups are respected
hpc_cv %>
  group_by(Resample) %>
  j_index(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>
  j_index(obs, pred, estimator = "macro_weighted")

# Vector version
j_index_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
j_index_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)

---

**Kappa**

**Description**

Kappa is a similar measure to accuracy(), but is normalized by the accuracy that would be expected by chance alone and is very useful when one or more classes have large frequency distributions.
Usage

kap(data, ...)

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

kap_vec(truth, estimate, na_rm = TRUE, ...)

Arguments

data  Either a data.frame containing the truth and estimate columns, or a table/matrix where the true class results should be in the columns of the table.

...  Not currently used.

truth  The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

estimate  The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.

na_rm  A logical value indicating whether NA values should be stripped before the computation proceeds.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For kap_vec(), a single numeric value (or NA).

Multiclass

Kappa extends naturally to multiclass scenarios. Because of this, macro and micro averaging are not implemented.

Author(s)

Max Kuhn

References


See Also

Other class metrics: accuracy(), bal_accuracy(), detection_prevalence(), f_meas(), j_index(), mcc(), npv(), ppv(), precision(), recall(), sens(), spec()
**Examples**

```r
# Two class
data("two_class_example")
kap(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
kap(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
kap(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
kap(obs, pred, estimator = "macro_weighted")

# Vector version
kap_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
kap_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)
```

---

**Description**

`lift_curve()` constructs the full lift curve and returns a tibble. See `gain_curve()` for a closely related concept.

**Usage**

```r
lift_curve(data, ...)
```

```r
## S3 method for class 'data.frame'
lift_curve(data, truth, ..., na.rm = TRUE)
```

```r
autoplot.lift_df(object, ...)
```
Arguments

data  A data.frame containing the truth and estimate columns.

...  A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.

truth  The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

na_rm  A logical value indicating whether NA values should be stripped before the computation proceeds.

object  The lift_df data frame returned from lift_curve().

Details

There is a ggplot2::autoplot() method for quickly visualizing the curve. This works for binary and multiclass output, and also works with grouped data (i.e. from resamples). See the examples.

Value

A tibble with class lift_df or lift_grouped_df having columns:

• n - The index of the current sample.
• n_events - The index of the current unique sample. Values with repeated estimate values are given identical indices in this column.
• percent_tested - The cumulative percentage of values tested.
• lift - First calculate the cumulative percentage of true results relative to the total number of true results. Then divide that by percent_tested.

Gain and Lift Curves

The motivation behind cumulative gain and lift charts is as a visual method to determine the effectiveness of a model when compared to the results one might expect without a model. As an example, without a model, if you were to advertise to a random 10\% to capture 10\% advertised to your entire customer base. Given a model that predicts which customers are more likely to respond, the hope is that you can more accurately target 10\% >10\%

The calculation to construct lift curves is as follows:

1. truth and estimate are placed in descending order by the estimate values (estimate here is a single column supplied in ...).
2. The cumulative number of samples with true results relative to the entire number of true results are found.
3. The cumulative \ to construct the lift value. This ratio represents the factor of improvement over an uninformed model. Values >1 represent a valuable model. This is the y-axis of the lift chart.
**Multiclass**

If a multiclass truth column is provided, a one-vs-all approach will be taken to calculate multiple curves, one per level. In this case, there will be an additional column, `.level`, identifying the "one" column in the one-vs-all calculation.

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

**Author(s)**

Max Kuhn

**See Also**

Other curve metrics: `gain_curve()`, `pr_curve()`, `roc_curve()`

**Examples**

```r
# Two class example

# 'truth' is a 2 level factor. The first level is "Class1", which is the # event of interest" by default in yardstick. See the Relevant Level # section above.
data(two_class_example)

# Binary metrics using class probabilities take a factor 'truth' column, # and a single class probability column containing the probabilities of # the event of interest. Here, since "Class1" is the first level of # "truth", it is the event of interest and we pass in probabilities for it.
# `lift_curve(two_class_example, truth, Class1)`

# 'autoplot`

library(ggplot2)
library(dplyr)

# Use autoplot to visualize
autoplot(lift_curve(two_class_example, truth, Class1))

# Multiclass one-vs-all approach
# One curve per level
hpc_cv %>%
```
```r
filter(Resample == "Fold01") %>%
lift_curve(obs, VF:L) %>%
autoplot()

# Same as above, but will all of the resamples
hpc_cv %>%
  group_by(Resample) %>%
lift_curve(obs, VF:L) %>%
  autoplot()
```

---

**mae**  
*Mean absolute error*

**Description**  
Calculate the mean absolute error. This metric is in the same units as the original data.

**Usage**  
```r
mae(data, ...)
```

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

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

**Arguments**

- **data**  
  A data.frame containing the truth and estimate columns.

- **...**  
  Not currently used.

- **truth**  
  The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.

- **estimate**  
  The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.

- **na_rm**  
  A logical value indicating whether NA values should be stripped before the computation proceeds.

**Value**

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.  
For grouped data frames, the number of rows returned will be the same as the number of groups.  
For mae_vec(), a single numeric value (or NA).
mape

Author(s)
Max Kuhn

See Also
Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mape(), mase(), rmse(), rpd(), rpiq(), rsq_trad(), rsq(), smape()
Other accuracy metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mape(), mase(), rmse(), smape()

Examples

# Supply truth and predictions as bare column names
mae(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  mae(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))

---

<table>
<thead>
<tr>
<th>mape</th>
<th>Mean absolute percent error</th>
</tr>
</thead>
</table>

Description

Calculate the mean absolute percentage error. This metric is in *relative units*. 
Usage

mape(data, ...)

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

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

Arguments

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

... Not currently used.

truth The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For `_vec()` functions, a numeric vector.

estimate The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For `_vec()` functions, a numeric vector.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

Note that a value of Inf is returned for `mape()` when the observed value is negative.

Value

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `mape_vec()`, a single numeric value (or NA).

Author(s)

Max Kuhn

See Also

Other numeric metrics: `ccc()`, `huber_loss_pseudo()`, `huber_loss()`, `iic()`, `mae()`, `mase()`, `rmse()`, `rpd()`, `rpiq()`, `rsq_trad()`, `rsq()`, `smape()`

Other accuracy metrics: `ccc()`, `huber_loss_pseudo()`, `huber_loss()`, `iic()`, `mae()`, `mase()`, `rmse()`, `smape()`
Examples

# Supply truth and predictions as bare column names
mape(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  mape(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))

mase

\textit{Mean absolute scaled error}

Description

Calculate the mean absolute scaled error. This metric is \textit{scale independent} and \textit{symmetric}. It is generally used for comparing forecast error in time series settings. Due to the time series nature of this metric, it is necessary to order observations in ascending order by time.

Usage

mase(data, ...)

## S3 method for class 'data.frame'
mase(data, truth, estimate, m = 1L, mae_train = NULL, na_rm = TRUE, ...)
mase_vec(truth, estimate, m = 1L, mae_train = NULL, na_rm = TRUE, ...)
**Arguments**

- **data**
  - A `data.frame` containing the truth and estimate columns.
  - Not currently used.

- **truth**
  - The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports `quasiquotation` (you can unquote column names). For `_vec()` functions, a numeric vector.

- **estimate**
  - The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For `_vec()` functions, a numeric vector.

- **m**
  - An integer value of the number of lags used to calculate the in-sample seasonal naive error. The default is used for non-seasonal time series. If each observation was at the daily level and the data showed weekly seasonality, then \( m = 7 \) would be a reasonable choice for a 7-day seasonal naive calculation.

- **mae_train**
  - A numeric value which allows the user to provide the in-sample seasonal naive mean absolute error. If this value is not provided, then the out-of-sample seasonal naive mean absolute error will be calculated from `truth` and will be used instead.

- **na_rm**
  - A logical value indicating whether NA values should be stripped before the computation proceeds.

**Details**

`mase()` is different from most numeric metrics. The original implementation of `mase()` calls for using the in-sample naive mean absolute error to compute scaled errors with. It uses this instead of the out-of-sample error because there is a chance that the out-of-sample error cannot be computed when forecasting a very short horizon (i.e. the out of sample size is only 1 or 2). However, yardstick only knows about the out-of-sample truth and estimate values. Because of this, the out-of-sample error is used in the computation by default. If the in-sample naive mean absolute error is required and known, it can be passed through in the `mae_train` argument and it will be used instead. If the in-sample data is available, the naive mean absolute error can easily be computed with `mae(data, truth, lagged_truth)`.

**Value**

- A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

  For grouped data frames, the number of rows returned will be the same as the number of groups.

  For `mase_vec()`, a single numeric value (or NA).

**Author(s)**

- Alex Hallam

**References**

mcc

Matthews correlation coefficient

Description

Matthews correlation coefficient

See Also

Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), rmse(), rpd(), rpiq(), rsq_trad(), rsq(), smape()
Other accuracy metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), rmse(), smape()

Examples

# Supply truth and predictions as bare column names
mase(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  mase(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))
Usage

mcc(data, ...)

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

mcc_vec(truth, estimate, na_rm = TRUE, ...)

Arguments

data
  Either a data.frame containing the truth and estimate columns, or a table/matrix
  where the true class results should be in the columns of the table.

...  Not currently used.

truth  The column identifier for the true class results (that is a factor). This should be
        an unquoted column name although this argument is passed by expression and
        supports quasiquotation (you can unquote column names). For _vec() functions,
        a factor vector.

estimate  The column identifier for the predicted class results (that is also factor). As
           with truth this can be specified different ways but the primary method is to use
           an unquoted variable name. For _vec() functions, a factor vector.

na_rm  A logical value indicating whether NA values should be stripped before the
        computation proceeds.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For mcc_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the
"event" or "positive" result. In yardstick, the default is to use the first level. To change this, a
global option called yardstick.event_first is set to TRUE when the package is loaded. This
 can be changed to FALSE if the last level of the factor is considered the level of interest by running:
options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all com-
parisons (such as macro averaging), this option is ignored and the "one" level is always the relevant
result.

Multiclass

mcc() has a known multiclass generalization and that is computed automatically if a factor with
more than 2 levels is provided. Because of this, no averaging methods are provided.

Author(s)

Max Kuhn
References


See Also

Other class metrics: `accuracy()`, `bal_accuracy()`, `detection_prevalence()`, `f_meas()`, `j_index()`, `kap()`, `npv()`, `ppv()`, `precision()`, `recall()`, `sens()`, `spec()`

Examples

```r
# Two class
data("two_class_example")
mcc(two_class_example, truth, predicted)

# Multiclass
# mcc() has a natural multiclass extension
library(dplyr)
data(hpc_cv)
hpc_cv %>%
  group_by(Resample) %>%
mcc(obs, pred)
```

---

**metrics**

*General Function to Estimate Performance*

**Description**

This function estimates one or more common performance estimates depending on the class of `truth` (see **Value** below) and returns them in a three column tibble.

**Usage**

```r
metrics(data, ...)
```

```r
## S3 method for class 'data.frame'
metrics(data, truth, estimate, ..., options = list(), na_rm = TRUE)
```

**Arguments**

- `data` A data.frame containing the truth and estimate columns and any columns specified by `...`.
- `...` A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If `truth` is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of `truth`. 
metrics

- **truth**: The column identifier for the true results (that is numeric or factor). This should be an unquoted column name although this argument is passed by expression and support quasiquotation (you can unquote column names).

- **estimate**: The column identifier for the predicted results (that is also numeric or factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name.

- **options**: A list of named options to pass to pROC::roc() such as direction or smooth. These options should not include response, predictor, levels, or quiet.

- **na_rm**: A logical value indicating whether NA values should be stripped before the computation proceeds.

**Value**

A three column tibble.

- When truth is a factor, there are rows for accuracy() and the Kappa statistic (kap()).
- When truth has two levels and 1 column of class probabilities is passed to ..., there are rows for the two class versions of mn_log_loss() and roc_auc().
- When truth has more than two levels and a full set of class probabilities are passed to ..., there are rows for the multiclass version of mn_log_loss() and the Hand Till generalization of roc_auc().
- When truth is numeric, there are rows for rmse(), rsq(), and mae().

**See Also**

- metric_set()

**Examples**

```r
# Accuracy and kappa
metrics(two_class_example, truth, predicted)

# Add on multinomal log loss and ROC AUC by specifying class prob columns
metrics(two_class_example, truth, predicted, Class1)

# Regression metrics
metrics(solubility_test, truth = solubility, estimate = prediction)

# Multiclass metrics work, but you cannot specify any averaging
# for roc_auc() besides the default, hand_till. Use the specific function
# if you need more customization
library(dplyr)

hpc_cv %>%
  group_by(Resample) %>%
  metrics(obs, pred, VF:L) %>%
  print(n = 40)
```
Description

`metric_set()` allows you to combine multiple metric functions together into a new function that calculates all of them at once.

Usage

```
metric_set(...)
```

Arguments

```
...  The bare names of the functions to be included in the metric set.
```

Details

All functions must be either:

- Only numeric metrics
- A mix of class metrics or class prob metrics

For instance, `rmse()` can be used with `mae()` because they are numeric metrics, but not with `accuracy()` because it is a classification metric. But `accuracy()` can be used with `roc_auc()`.

The returned metric function will have a different argument list depending on whether numeric metrics or a mix of class/prob metrics were passed in.

Numeric metrics will have a signature like: `fn(data, truth, estimate, na_rm = TRUE, ...)`.

Class/prob metrics have a signature of `fn(data, truth, ..., estimate, na.rm = TRUE)`. When mixing class and class prob metrics, pass in the hard predictions (the factor column) as the named argument `estimate`, and the soft predictions (the class probability columns) as bare column names or `tidyselect` selectors to `...`.

See Also

`metrics()`

Examples

```
library(dplyr)

# Multiple regression metrics
multi_metric <- metric_set(rmse, rsq, ccc)

# The returned function has arguments:
# fn(data, truth, estimate, na_rm = TRUE, ...)
multi_metric(solubility_test, truth = solubility, estimate = prediction)
```
# Groups are respected on the new metric function
class_metrics <- metric_set(accuracy, kap)

hpc_cv %>%
  group_by(Resample) %>%
  class_metrics(obs, estimate = pred)

# If you need to set options for certain metrics,
# do so by wrapping the metric and setting the options inside the wrapper,
# passing along truth and estimate as quoted arguments.
# Then add on the function class of the underlying wrapped function,
# and the direction of optimization.
ccc_with_bias <- function(data, truth, estimate, na_rm = TRUE, ...) {
  ccc(
    data = data,
    truth = !! rlang::enquo(truth),
    estimate = !! rlang::enquo(estimate),
    # set bias = TRUE
    bias = TRUE,
    na_rm = na_rm,
    ...
  )
}

# Add on the underlying function class (here, "numeric_metric"), and the
# direction to optimize the metric
class(ccc_with_bias) <- class(ccc)
attr(ccc_with_bias, "direction") <- attr(ccc, "direction")

multi_metric2 <- metric_set(rmse, rsq, ccc_with_bias)

multi_metric2(solubility_test, truth = solubility, estimate = prediction)

# A class probability example:

# Note that, when given class or class prob functions,
# metric_set() returns a function with signature:
# fn(data, truth, ..., estimate)
# to be able to mix class and class prob metrics.

# You must provide the `estimate` column by explicitly naming
# the argument
class_and_probs_metrics <- metric_set(roc_auc, pr_auc, accuracy)

hpc_cv %>%
  group_by(Resample) %>%
  class_and_probs_metrics(obs, VF:L, estimate = pred)
metric_summarizer

Developer function for summarizing new metrics

Description

metric_summarizer() is useful alongside metric_vec_template() for implementing new custom metrics. metric_summarizer() calls the metric function inside dplyr::summarise(). metric_vec_template() is a generalized function that calls the core implementation of a metric function, and includes a number of checks on the types, lengths, and argument inputs. See vignette("custom-metrics","yardstick") for more information.

Usage

metric_summarizer(
  metric_nm,    
  metric_fn,    
  data,         
  truth,        
  estimate,     
  estimator = NULL,    
  na_rm = TRUE,    
  ...,            
  metric_fn_options = list()    
)

Arguments

metric_nm A single character representing the name of the metric to use in the tibble output. This will be modified to include the type of averaging if appropriate.

metric_fn The vector version of your custom metric function. It generally takes truth, estimate, na_rm, and any other extra arguments needed to calculate the metric.

data The data frame with truth and estimate columns passed in from the data frame version of your metric function that called metric_summarizer().

truth The unquoted column name corresponding to the truth column.

estimate Generally, the unquoted column name corresponding to the estimate column. For metrics that take multiple columns through ..., like class probability metrics, this is a result of dots_to_estimate().

estimator For numeric metrics, this is left as NA so averaging is not passed on to the metric function implementation. For classification metrics, this can either be NULL for the default auto-selection of averaging ("binary" or "macro"), or a single character to pass along to the metric implementation describing the kind of averaging to use.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds. The removal is executed in metric_vec_template().

... Currently not used. Metric specific options are passed in through metric_fn_options.
metric_vec_template

metric_fn_options
A named list of metric specific options. These are spliced into the metric function call using !!! from rlang. The default results in nothing being spliced into the call.

Details

metric_summarizer() is generally called from the data frame version of your metric function. It knows how to call your metric over grouped data frames and returns a tibble consistent with other metrics.

See Also

metric_vec_template() finalize_estimator() dots_to_estimate()

Description

metric_vec_template() is useful alongside metric_summarizer() for implementing new custom metrics. metric_summarizer() calls the metric function inside dplyr::summarise(). metric_vec_template() is a generalized function that calls the core implementation of a metric function, and includes a number of checks on the types, lengths, and argument inputs.

Usage

metric_vec_template(
  metric_impl,
  truth,
  estimate,
  na_rm = TRUE,
  cls = "numeric",
  estimator = NULL,
  ...
)

Arguments

metric_impl The core implementation function of your custom metric. This core implementation function is generally defined inside the vector method of your metric function.

truth The realized vector of truth. This is either a factor or a numeric.

estimate The realized estimate result. This is either a numeric vector, a factor vector, or a numeric matrix (in the case of multiple class probability columns) depending on your metric function.
**mn_log_loss**

- **na_rm**
  A logical value indicating whether NA values should be stripped before the computation proceeds. NA values are removed before getting to your core implementation function so you do not have to worry about handling them yourself. If `na_rm=FALSE` and any NA values exist, then NA is automatically returned.

- **cls**
  A character vector of length 1 or 2 corresponding to the class that truth and estimate should be, respectively. If truth and estimate are of the same class, just supply a vector of length 1. If they are different, supply a vector of length 2. For matrices, it is best to supply "numeric" as the class to check here.

- **estimator**
  The type of averaging to use. By this point, the averaging type should be finalized, so this should be a character vector of length 1. By default, this character value is required to be one of: "binary", "macro", "micro", or "macro_weighted". If your metric allows more or less averaging methods, override this with `averaging_override`.

- **...**
  Extra arguments to your core metric function, `metric_impl`, can technically be passed here, but generally the extra args are added through R’s scoping rules because the core metric function is created on the fly when the vector method is called.

**Details**

- `metric_vec_template()` is called from the vector implementation of your metric. Also defined inside your vector implementation is a separate function performing the core implementation of the metric function. This core function is passed along to `metric_vec_template()` as `metric_impl`.

**See Also**

- `metric_summarizer()`
- `finalize_estimator()`
- `dots_to_estimate()`

---

**mn_log_loss**

*Mean log loss*

**Description**

Compute the logarithmic loss of a classification model.

**Usage**

```r
mn_log_loss(data, ...) # S3 method for class 'data.frame'
mn_log_loss(data, truth, ..., na.rm = TRUE, sum = FALSE)
mn_log_loss_vec(truth, estimate, na.rm = TRUE, sum = FALSE, ...)
```
Arguments

- **data**: A `data.frame` containing the truth and estimate columns.
- **...**: A set of unquoted column names or one or more `dplyr` selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.
- **truth**: The column identifier for the true class results (that is a `factor`). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For `_vec()` functions, a factor vector.
- **na_rm**: A logical value indicating whether NA values should be stripped before the computation proceeds.
- **sum**: A logical. Should the sum of the likelihood contributions be returned (instead of the mean value)?
- **estimate**: If truth is binary, a numeric vector of class probabilities corresponding to the "relevant" class. Otherwise, a matrix with as many columns as factor levels of truth. It is assumed that these are in the same order as the levels of truth.

Details

Log loss is a measure of the performance of a classification model. A perfect model has a log loss of 0.

Compared with `accuracy()`, log loss takes into account the uncertainty in the prediction and gives a more detailed view into the actual performance. For example, given two input probabilities of .6 and .9 where both are classified as predicting a positive value, say, "Yes", the accuracy metric would interpret them as having the same value. If the true output is "Yes", log loss penalizes .6 because it is "less sure" of its result compared to the probability of .9.

Value

A `tibble` with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `mn_log_loss_vec()`, a single numeric value (or NA).

Multiclass

Log loss has a known multiclass extension, and is simply the sum of the log loss values for each class prediction. Because of this, no averaging types are supported.

Author(s)

Max Kuhn

See Also

Other class probability metrics: `average_precision()`, `gain_capture()`, `pr_auc()`, `roc_auc()`, `roc_aunp()`, `roc_aunu()`
npv

Examples

# Two class
data("two_class_example")
mn_log_loss(two_class_example, truth, Class1)

# Multiclass
library(dplyr)
data(hpc_cv)

# You can use the col1:colN tidyselect syntax
hpc_cv %>%
  filter(Resample == "Fold01") %>%
mn_log_loss(obs, VF:L)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
mn_log_loss( obs, VF:L)

# Vector version
# Supply a matrix of class probabilities
fold1 <- hpc_cv %>%
  filter(Resample == "Fold01")

mn_log_loss_vec(
  truth = fold1$obs,
  matrix( c(fold1$VF, fold1$F, fold1$M, fold1$L),
            ncol = 4
  )
)

# Supply `...` with quasiquotation
prob_cols <- levels(two_class_example$truth)
mn_log_loss(two_class_example, truth, Class1)
mn_log_loss(two_class_example, truth, !! prob_cols[1])

------------------

npv  Negative predictive value

Description

These functions calculate the npv() (negative predictive value) of a measurement system compared to a reference result (the "truth" or gold standard). Highly related functions are spec(), sens(), and ppv().
Usage

npv(data, ...)

## S3 method for class 'data.frame'
npv(
  data,
  truth,
  estimate,
  prevalence = NULL,
  estimator = NULL,
  na_rm = TRUE,
  ...
)

npv_vec(
  truth,
  estimate,
  prevalence = NULL,
  estimator = NULL,
  na_rm = TRUE,
  ...
)

Arguments

data Either a data.frame containing the truth and estimate columns, or a table/matrix where the true class results should be in the columns of the table.

... Not currently used.

truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For_vec() functions, a factor vector.

estimate The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For_vec() functions, a factor vector.

prevalence A numeric value for the rate of the "positive" class of the data.

estimator One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on estimate.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The positive predictive value (ppv()) is defined as the percent of predicted positives that are actually positive while the negative predictive value (npv()) is defined as the percent of negative positives
that are actually negative.

**Value**

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For npv_vec(), a single numeric value (or NA).

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running:

```
options(yardstick.event_first = FALSE)
```

For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

**Multiclass**

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

**Implementation**

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>Positive</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Negative</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

The formulas used here are:

\[
Sensitivity = A/(A + C) \\
Specificity = D/(B + D) \\
Prevalence = (A + C)/(A + B + C + D) \\
PPV = (Sensitivity*Prevalence)/((Sensitivity*Prevalence)+((1-Specificity)*(1-Prevalence))) \\
NPV = (Specificity*(1-Prevalence))/(((1-Sensitivity)*Prevalence)+((Specificity)*(1-Prevalence)))
\]

See the references for discussions of the statistics.

**Author(s)**

Max Kuhn
References

See Also
Other class metrics: `accuracy()`, `bal_accuracy()`, `detection_prevalence()`, `f_meas()`, `j_index()`, `kap()`, `mcc()`, `ppv()`, `precision()`, `recall()`, `sens()`, `spec()`

Other sensitivity metrics: `ppv()`, `sens()`, `spec()`

Examples
```r
# Two class
data("two_class_example")
npv(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  npv(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  npv(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  npv(obs, pred, estimator = "macro_weighted")

# Vector version
npv_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
npv_vec(two_class_example$truth, two_class_example$predicted)

options(yardstick.event_first = TRUE)
```

---

pathology | Liver Pathology Data

Description
Liver Pathology Data
Details

These data have the results of an $x$-ray examination to determine whether liver is abnormal or not (in the scan column) versus the more extensive pathology results that approximate the truth (in pathology).

Value

pathology    a data frame

Source


Examples

```r
data(pathology)
str(pathology)
```

Description

These functions calculate the `ppv()` (positive predictive value) of a measurement system compared to a reference result (the "truth" or gold standard). Highly related functions are `spec()`, `sens()`, and `npv()`.

Usage

```r
ppv(data, ...)
```

## S3 method for class 'data.frame'

```r
ppv(
data,  
truth,  
estimate,  
prevalence = NULL,  
estimator = NULL,  
na.rm = TRUE,  
... 
)
```

```r
ppv_vec(
  truth,  
estimate,  
prevalence = NULL,
```
estimator = NULL,
na_rm = TRUE,
...
)

Arguments

data Either a data.frame containing the truth and estimate columns, or a table/matrix where the true class results should be in the columns of the table.

... Not currently used.

truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

estimate The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.

prevalence A numeric value for the rate of the "positive" class of the data.

estimator One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on estimate.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The positive predictive value (ppv()) is defined as the percent of predicted positives that are actually positive while the negative predictive value (npv()) is defined as the percent of negative positives that are actually negative.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For ppv_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.
Multiclass

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

Implementation

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>Predicted</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Positive</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

The formulas used here are:

\[
Sensitivity = \frac{A}{A + C}
\]

\[
Specificity = \frac{D}{B + D}
\]

\[
Prevalence = \frac{A + C}{A + B + C + D}
\]

\[
PPV = \frac{Sensitivity \times Prevalence}{(Sensitivity \times Prevalence) + ((1 - Specificity) \times (1 - Prevalence))}
\]

\[
NPV = \frac{Specificity \times (1 - Prevalence)}{((1 - Sensitivity) \times Prevalence) + ((Specificity) \times (1 - Prevalence))}
\]

See the references for discussions of the statistics.

Author(s)

Max Kuhn

References


See Also

Other class metrics: accuracy(), bal_accuracy(), detection_prevalence(), f_meas(), j_index(), kap(), mcc(), npv(), precision(), recall(), sens(), spec()

Other sensitivity metrics: npv(), sens(), spec()
Examples

# Two class
data("two_class_example")
ppv(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  ppv(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  ppv(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  ppv(obs, pred, estimator = "macro_weighted")

# Vector version
ppv_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
ppv_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)

# But what if we think that Class 1 only occurs 40% of the time?
ppv(two_class_example, truth, predicted, prevalence = 0.40)

---

precision  

**Precision**

These functions calculate the **precision()** of a measurement system for finding relevant documents compared to reference results (the truth regarding relevance). Highly related functions are **recall()** and **f_meas()**.

**Usage**

```r
precision(data, ...)
```

## S3 method for class 'data.frame'
precision(data, truth, estimate, estimator = NULL, na_rm = TRUE, ...)

precision_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)

Arguments

data Either a data.frame containing the truth and estimate columns, or a table/matrix where the true class results should be in the columns of the table.
... Not currently used.
truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.
estimate The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.
estimator One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on estimate.
na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The precision is the percentage of predicted truly relevant results of the total number of predicted relevant results and characterizes the "purity in retrieval performance" (Buckland and Gey, 1994). When the denominator of the calculation is 0, precision is undefined. This happens when both # true_positive = 0 and # false_positive = 0 are true, which mean that there were no predicted events. When computing binary precision, a NA value will be returned with a warning. When computing multiclass precision, the individual NA values will be removed, and the computation will proceed, with a warning.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For precision_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.
**Multiclass**

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

**Implementation**

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th>Predicted</th>
<th>Reference Relevant</th>
<th>Reference Irrelevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

The formulas used here are:

\[
recall = \frac{A}{(A + C)}
\]

\[
precision = \frac{A}{(A + B)}
\]

\[
F_{meas_\beta} = \frac{(1 + \beta^2) \cdot precision \cdot recall / ((\beta^2 * precision) + recall)}{(1 + \beta^2)}
\]

See the references for discussions of the statistics.

**Author(s)**

Max Kuhn

**References**


**See Also**

Other class metrics: `accuracy()`, `bal_accuracy()`, `detection_prevalence()`, `f_meas()`, `j_index()`, `kap()`, `mcc()`, `npv()`, `ppv()`, `recall()`, `sens()`, `spec()`

Other relevance metrics: `f_meas()`, `recall()`

**Examples**

# Two class
data("two_class_example")
precision(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  precision(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  precision(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  precision(obs, pred, estimator = "macro_weighted")

# Vector version
precision_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
precision_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)

---

**pr_auc**

*Area under the precision recall curve*

**Description**

`pr_auc()` is a metric that computes the area under the precision recall curve. See `pr_curve()` for the full curve.

**Usage**

```r
pr_auc(data, ...)
```

```r
## S3 method for class 'data.frame'
pr_auc(data, truth, ..., estimator = NULL, na_rm = TRUE)
```

```r
pr_auc_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

**Arguments**

- `data` A `data.frame` containing the truth and estimate columns.
- `...` A set of unquoted column names or one or more `dplyr` selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.
The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

One of "binary", "macro", or "macro_weighted" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other two are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on truth.

A logical value indicating whether NA values should be stripped before the computation proceeds.

If truth is binary, a numeric vector of class probabilities corresponding to the "relevant" class. Otherwise, a matrix with as many columns as factor levels of truth. It is assumed that these are in the same order as the levels of truth.

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For pr_auc_vec(), a single numeric value (or NA).

Macro and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Max Kuhn

pr_curve() for computing the full precision recall curve.

Other class probability metrics: average_precision(), gain_capture(), mn_log_loss(), roc_auc(), roc_aunp(), roc_aunu()
Examples

# Two class example

# `truth` is a 2 level factor. The first level is "Class1", which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section above.

# Binary metrics using class probabilities take a factor `truth` column,
# and a single class probability column containing the probabilities of
# the event of interest. Here, since "Class1" is the first level of
# "truth", it is the event of interest and we pass in probabilities for it.

```r
data(two_class_example)
pr_auc(two_class_example, truth, Class1)
```

# Multiclass example

# `obs` is a 4 level factor. The first level is "VF", which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section above.

```r
library(dplyr)
data(hpc_cv)
# You can use the col1:colN tidyselect syntax
hpc_cv %>%
  filter(Resample == "Fold01") %>%
  pr_auc(obs, VF:L)
# Change the first level of `obs` from "VF" to "M" to alter the
# event of interest. The class probability columns should be supplied
# in the same order as the levels.

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  mutate(obs = relevel(obs, "M")) %>%
  pr_auc(obs, M, VF:L)
# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  pr_auc(obs, VF:L)
# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
  pr_auc(obs, VF:L, estimator = "macro_weighted")
# Vector version
# Supply a matrix of class probabilities
fold1 <- hpc_cv %>%
  filter(Resample == "Fold01")
pr_auc_vec(
    truth = fold1$obs,
    matrix(
        c(fold1$VF, fold1$F, fold1$M, fold1$L),
        ncol = 4
    )
)

Description
pr_curve() constructs the full precision recall curve and returns a tibble. See pr_auc() for the area under the precision recall curve.

Usage
pr_curve(data, ...)

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

autoplot.pr_df(object, ...)

Arguments
data      A data.frame containing the truth and estimate columns.
...        A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.
truth     The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.
na_rm     A logical value indicating whether NA values should be stripped before the computation proceeds.
object    The pr_df data frame returned from pr_curve().

Details
pr_curve() computes the precision at every unique value of the probability column (in addition to infinity).

There is a ggplot2::autoplot() method for quickly visualizing the curve. This works for binary and multiclass output, and also works with grouped data (i.e. from resamples). See the examples.
Value

A tibble with class pr_df or pr_grouped_df having columns .threshold, recall, and precision.

Multiclass

If a multiclass truth column is provided, a one-vs-all approach will be taken to calculate multiple curves, one per level. In this case, there will be an additional column, .level, identifying the "one" column in the one-vs-all calculation.

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Author(s)

Max Kuhn

See Also

Compute the area under the precision recall curve with pr_auc(). Other curve metrics: gain_curve(), lift_curve(), roc_curve()

Examples

```r
# Two class example

data(two_class_example)

# Binary metrics using class probabilities take a factor `truth` column, and a single class probability column containing the probabilities of the event of interest. Here, since "Class1" is the first level of "truth", it is the event of interest and we pass in probabilities for it.
pr_curve(two_class_example, truth, Class1)

# `autoplot()`

# Visualize the curve using ggplot2 manually
library(ggplot2)
library(dplyr)
```
These functions calculate the **recall()** of a measurement system for finding relevant documents compared to reference results (the truth regarding relevance). Highly related functions are **precision()** and **f_meas()**.

### Usage

```r
recall(data, ...)  

## S3 method for class 'data.frame'
recall(data, truth, estimate, estimator = NULL, na.rm = TRUE, ...)  

recall_vec(truth, estimate, estimator = NULL, na.rm = TRUE, ...)
```

### Arguments

- **data**: Either a `data.frame` containing the `truth` and `estimate` columns, or a `table/matrix` where the true class results should be in the columns of the table.
- **...**: Not currently used.
- **truth**: The column identifier for the true class results (that is a `factor`). This should be an unquoted column name although this argument is passed by expression and supports `quasiquotation` (you can unquote column names). For `_vec()` functions, a `factor` vector.
**recall**

**estimate**

The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.

**estimator**

One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The default will automatically choose "binary" or "macro" based on estimate.

**na_rm**

A logical value indicating whether NA values should be stripped before the computation proceeds.

**Details**

The recall (aka sensitivity) is defined as the proportion of relevant results out of the number of samples which were actually relevant. When there are no relevant results, recall is not defined and a value of NA is returned.

When the denominator of the calculation is 0, recall is undefined. This happens when both # true_positive = 0 and # false_negative = 0 are true, which mean that there were no true events. When computing binary recall, a NA value will be returned with a warning. When computing multiclass recall, the individual NA values will be removed, and the computation will proceed, with a warning.

**Value**

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For recall_vec(), a single numeric value (or NA).

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

**Multiclass**

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

**Implementation**

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Predicted</th>
<th>Relevant</th>
<th>Irrelevant</th>
</tr>
</thead>
</table>

relevant  a  b
irrelevant  c  d

The formulas used here are:

\[ recall = \frac{A}{A + C} \]

\[ precision = \frac{A}{A + B} \]

\[ F_{\text{meas}_\beta} = \frac{(1 + \beta^2) \times precision \times recall}{(\beta^2 \times precision) + recall} \]

See the references for discussions of the statistics.

**Author(s)**
Max Kuhn

**References**

**See Also**
Other class metrics: `accuracy()`, `bal_accuracy()`, `detection_prevalence()`, `f meas()`, `j index()`, `kap()`, `mcc()`, `npv()`, `ppv()`, `precision()`, `sens()`, `spec()`
Other relevance metrics: `f meas()`, `precision()`

**Examples**

# Two class
data("two_class_example")
recall(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  recall(obs, pred)

# Groups are respected
hpc_cv %>%
group_by(Resample) %>%
  recall(obs, pred)

# Weighted macro averaging
```r
hpc_cv %>%
  group_by(Resample) %>
  recall(obs, pred, estimator = "macro_weighted")

# Vector version
recall_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
recall_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)
```

---

## rmse

*Root mean squared error*

### Description

Calculate the root mean squared error. `rmse()` is a metric that is in the same units as the original data.

### Usage

```r
rmse(data, ...)
```

### S3 method for class 'data.frame'

```r
rmse(data, truth, estimate, na_rm = TRUE, ...)
```

### `rmse_vec()`

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

### Arguments

- **data**
  - `A data.frame containing the truth and estimate columns.`

- **...**
  - `Not currently used.`

- **truth**
  - The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.

- **estimate**
  - The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.

- **na_rm**
  - A logical value indicating whether NA values should be stripped before the computation proceeds.
Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For rmse_vec(), a single numeric value (or NA).

Author(s)

Max Kuhn

See Also

Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), mase(), rpd(), rpiq(), rsq_trad(), rsq(), smape()

Other accuracy metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), mase(), smape()

Examples

# Supply truth and predictions as bare column names
rmse(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  rmse(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))
roc_auc

Area under the receiver operator curve

Description

roc_auc() is a metric that computes the area under the ROC curve. See roc_curve() for the full curve.

Usage

roc_auc(data, ...)

## S3 method for class 'data.frame'
roc_auc(data, truth, ..., options = list(), estimator = NULL, na_rm = TRUE)

roc_auc_vec(
  truth,
  estimate,
  options = list(),
  estimator = NULL,
  na_rm = TRUE,
  ...
)

Arguments

data A data.frame containing the truth and estimate columns.

... A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.

truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

options A list of named options to pass to pROC::roc() such as direction or smooth. These options should not include response, predictor, levels, or quiet.

estimator One of "binary", "hand_till", "macro", or "macro_weighted" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The others are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "hand_till" based on truth.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

estimate If truth is binary, a numeric vector of class probabilities corresponding to the "relevant" class. Otherwise, a matrix with as many columns as factor levels of truth. It is assumed that these are in the same order as the levels of truth.
Details

For most methods, `roc_auc()` defaults to allowing `pROC::roc()` control the direction of the computation, but allows you to control this by passing `options = list(direction = "<")` or any other allowed direction value. However, the Hand, Till (2001) method assumes that the individual AUCs are all above 0.5, so if an AUC value below 0.5 is computed, then 1 is subtracted from it to get the correct result. When not using the Hand, Till method, pROC advises setting the direction when doing resampling so that the AUC values are not biased upwards.

Generally, an ROC AUC value is between 0.5 and 1, with 1 being a perfect prediction model. If your value is between 0 and 0.5, then this implies that you have meaningful information in your model, but it is being applied incorrectly because doing the opposite of what the model predicts would result in an AUC >0.5.

Value

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `roc_auc_vec()`, a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Multiclass

The default multiclass method for computing `roc_auc()` is to use the method from Hand, Till, (2001). Unlike macro-averaging, this method is insensitive to class distributions like the binary ROC AUC case.

Macro and macro-weighted averaging are still provided, even though they are not the default. In fact, macro-weighted averaging corresponds to the same definition of multiclass AUC given by Provost and Domingos (2001).

Author(s)

Max Kuhn

References


roc_auc


See Also

roc_curve() for computing the full ROC curve.

Other class probability metrics: average_precision(), gain_capture(), mn_log_loss(), pr_auc(), roc_aunp(), roc_aunu()

Examples

```r
# Two class example

# 'truth' is a 2 level factor. The first level is "Class1", which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section above.
data(two_class_example)

# Binary metrics using class probabilities take a factor 'truth' column,
# and a single class probability column containing the probabilities of
# the event of interest. Here, since "Class1" is the first level of
# "truth", it is the event of interest and we pass in probabilities for it.
roc_auc(two_class_example, truth, Class1)
```

```r
# Multiclass example

# 'obs' is a 4 level factor. The first level is "VF", which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section above.
data(hpc_cv)

# You can use the col1:colN tidyselect syntax
library(dplyr)
hpc_cv %>%
  filter(Resample == "Fold01") %>%
  roc_auc(obs, VF:L)

# Change the first level of 'obs' from "VF" to "M" to alter the
# event of interest. The class probability columns should be supplied
# in the same order as the levels.
hpc_cv %>%
  filter(Resample == "Fold01") %>%
  mutate(obs = relevel(obs, "M")) %>%
  roc_auc(obs, M, VF:L)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
  roc_auc(obs, VF:L)
```
# Weighted macro averaging
hpc_cv %>%
group_by(Resample) %>%
roc_auc(obs, VF:L, estimator = "macro_weighted")

# Vector version
# Supply a matrix of class probabilities
fold1 <- hpc_cv %>%
filter(Resample == "Fold01")

roc_auc_vec(
  truth = fold1$obs,
  matrix(
    c(fold1$VF, fold1$F, fold1$M, fold1$L),
    ncol = 4
  )
)

# Options for pROC::roc()
# Pass options via a named list and not through ...
roc_auc(
  two_class_example,
  truth = truth,
  Class1,
  options = list(smooth = TRUE)
)

---

roc_aunp  
Area under the ROC curve of each class against the rest, using the a priori class distribution

### Description

roc_aunp() is a multiclass metric that computes the area under the ROC curve of each class against the rest, using the a priori class distribution. This is equivalent to roc_auc(estimator = "macro_weighted").

### Usage

roc_aunp(data, ...)

## S3 method for class 'data.frame'
roc_aunp(data, truth, ..., options = list(), na_rm = TRUE)

roc_aunp_vec(truth, estimate, options = list(), na_rm = TRUE, ...)
Arguments

- `data` A `data.frame` containing the truth and estimate columns.
- `...` A set of unquoted column names or one or more `dplyr` selector functions to choose which variables contain the class probabilities. There should be as many columns as factor levels of truth.
- `truth` The column identifier for the true class results (that is a `factor`). This should be an unquoted column name although this argument is passed by expression and supports quasiquote (you can unquote column names). For `_vec()` functions, a `factor` vector.
- `options` A list of named options to pass to `pROC::roc()` such as `direction` or `smooth`. These options should not include `response`, `predictor`, `levels`, or `quiet`.
- `na.rm` A logical value indicating whether NA values should be stripped before the computation proceeds.
- `estimate` A matrix with as many columns as factor levels of `truth`. *It is assumed that these are in the same order as the levels of `truth`.*

Details

Like the other ROC AUC metrics, `roc_aunp()` defaults to allowing `pROC::roc()` control the direction of the computation, but allows you to control this by passing `options = list(direction = "<")` or any other allowed direction value. `pROC` advises setting the direction when doing resampling so that the AUC values are not biased upwards.

Generally, an ROC AUC value is between 0.5 and 1, with 1 being a perfect prediction model. If your value is between 0 and 0.5, then this implies that you have meaningful information in your model, but it is being applied incorrectly because doing the opposite of what the model predicts would result in an AUC > 0.5.

Value

A `tibble` with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `roc_aunp_vec()`, a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to `TRUE` when the package is loaded. This can be changed to `FALSE` if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Multiclass

This multiclass method for computing the area under the ROC curve uses the a priori class distribution and is equivalent to `roc_auc(estimator = "macro_weighted")`. 
roc_aunp

Author(s)
Julia Silge

References

See Also
roc_aunu() for computing the area under the ROC curve of each class against the rest, using the uniform class distribution.

Other class probability metrics: average_precision(), gain_capture(), mn_log_loss(), pr_auc(), roc_auc(), roc_aunu()

Examples
# Multiclass example
# `obs` is a 4 level factor. The first level is `"VF"`, which is the # "event of interest" by default in yardstick. See the Relevant Level # section above.
# You can use the col1:colN tidyselect syntax
library(dplyr)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  roc_aunp(obs, VF:L)

# Change the first level of `obs` from `"VF"` to `"M"` to alter the # event of interest. The class probability columns should be supplied # in the same order as the levels.

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  mutate(obs = relevel(obs, "M")) %>%
  roc_aunp(obs, M, VF:L)

# Groups are respected

hpc_cv %>%
  group_by(Resample) %>%
  roc_aunp(obs, VF:L)

# Vector version
# Supply a matrix of class probabilities

fold1 <- hpc_cv %>%
  filter(Resample == "Fold01")

roc_aunp_vec(
  truth = fold1$obs,
  matrix(
# Options for `pROC::roc()`

# Pass options via a named list and not through `...`!
roc_aunu(
  hpc_cv,                         
  obs, VF:L,                      
  options = list(smooth = TRUE)  
)

---

**roc_aunu**  

*Area under the ROC curve of each class against the rest, using the uniform class distribution*

---

**Description**

roc_aunu() is a multiclass metric that computes the area under the ROC curve of each class against the rest, using the uniform class distribution. This is equivalent to roc_auc(estimator = "macro").

**Usage**

roc_aunu(data, ...)

### S3 method for class 'data.frame'
roc_aunu(data, truth, ..., options = list(), na_rm = TRUE)

roc_aunu_vec(truth, estimate, options = list(), na_rm = TRUE, ...)

**Arguments**

- **data**  
  A data.frame containing the truth and estimate columns.

- **...**  
  A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. There should be as many columns as factor levels of truth.

- **truth**  
  The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

- **options**  
  A list of named options to pass to pROC::roc() such as direction or smooth. These options should not include response, predictor, levels, or quiet.
roc_aunu

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

estimate A matrix with as many columns as factor levels of truth. It is assumed that these are in the same order as the levels of truth.

Details

Like the other ROC AUC metrics, roc_aunu() defaults to allowing pROC::roc() control the direction of the computation, but allows you to control this by passing options = list(direction = "<") or any other allowed direction value. pROC advises setting the direction when doing resampling so that the AUC values are not biased upwards.

Generally, an ROC AUC value is between 0.5 and 1, with 1 being a perfect prediction model. If your value is between 0 and 0.5, then this implies that you have meaningful information in your model, but it is being applied incorrectly because doing the opposite of what the model predicts would result in an AUC >0.5.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For roc_aunu_vec(), a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Multiclass

This multiclass method for computing the area under the ROC curve uses the uniform class distribution and is equivalent to roc_auc(estimator = "macro").

Author(s)

Julia Silge

References

See Also

roc_aunp() for computing the area under the ROC curve of each class against the rest, using the a priori class distribution.

Other class probability metrics: average_precision(), gain_capture(), mn_log_loss(), pr_auc(), roc_auc(), roc_aunp()

Examples

# Multiclass example

# `obs` is a 4 level factor. The first level is `"VF"`, which is the # "event of interest" by default in yardstick. See the Relevant Level # section above.
data(hpc_cv)

# You can use the col1:colN tidyselect syntax
library(dplyr)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  roc_aunu(obs, VF:L)

# Change the first level of `obs` from `"VF"` to `"M"` to alter the # event of interest. The class probability columns should be supplied # in the same order as the levels.

hpc_cv %>%
  filter(Resample == "Fold01") %>%
  mutate(obs = relevel(obs, "M")) %>%
  roc_aunu(obs, M, VF:L)

# Groups are respected

hpc_cv %>%
  group_by(Resample) %>%
  roc_aunu(obs, VF:L)

# Vector version
# Supply a matrix of class probabilities
fold1 <- hpc_cv %>%
  filter(Resample == "Fold01")

roc_aunu_vec(
  truth = fold1$obs,
  matrix(
    c(fold1$VF, fold1$F, fold1$M, fold1$L),
    ncol = 4
  )
)

# Options for `pROC::roc()`

# Pass options via a named list and not through `...`!
roc_curve(  
  hpc_cv,  
  obs,  
  VF:L,  
  options = list(smooth = TRUE)  
)

---

**roc_curve**

**Receiver operator curve**

**Description**

roc_curve() constructs the full ROC curve and returns a tibble. See roc_auc() for the area under the ROC curve.

**Usage**

roc_curve(data, ...)

```r
## S3 method for class 'data.frame'
roc_curve(data, truth, ..., options = list(), na_rm = TRUE)

autoplot.roc_df(object, ...)
```

**Arguments**

- **data**
  A data.frame containing the truth and estimate columns.

- **...**
  A set of unquoted column names or one or more dplyr selector functions to choose which variables contain the class probabilities. If truth is binary, only 1 column should be selected. Otherwise, there should be as many columns as factor levels of truth.

- **truth**
  The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

- **options**
  A list of named options to pass to pROC::roc() such as direction or smooth. These options should not include response, predictor, levels, or quiet.

- **na_rm**
  A logical value indicating whether NA values should be stripped before the computation proceeds.

- **object**
  The roc_df data frame returned from roc_curve().
Details

roc_curve() computes the sensitivity at every unique value of the probability column (in addition to infinity and minus infinity). If a smooth ROC curve was produced, the unique observed values of the specificity are used to create the curve points. In either case, this may not be efficient for large data sets.

There is a ggplot2::autoplot() method for quickly visualizing the curve. This works for binary and multiclass output, and also works with grouped data (i.e. from resamples). See the examples.

Value

A tibble with class roc_df or roc_grouped_df having columns specificity and sensitivity. If an ordinary (i.e. non-smoothed) curve is used, there is also a column for .threshold.

Multiclass

If a multiclass truth column is provided, a one-vs-all approach will be taken to calculate multiple curves, one per level. In this case, there will be an additional column, .level, identifying the "one" column in the one-vs-all calculation.

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called yardstick.event_first is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: options(yardstick.event_first = FALSE). For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Author(s)

Max Kuhn

See Also

Compute the area under the ROC curve with roc_auc().

Other curve metrics: gain_curve(), lift_curve(), pr_curve()

Examples

# Two class example

data(two_class_example)

data(two_class_example)

# Binary metrics using class probabilities take a factor 'truth' column,
and a single class probability column containing the probabilities of
the event of interest. Here, since "Class1" is the first level of
``truth``, it is the event of interest and we pass in probabilities for it.
roc_curve(two_class_example, truth, Class1)

# Visualize the curve using ggplot2 manually
library(ggplot2)
library(dplyr)
roc_curve(two_class_example, truth, Class1) %>%
ggplot(aes(x = 1 - specificity, y = sensitivity)) +
  geom_path() +
  geom_abline(lty = 3) +
  coord_equal() +
  theme_bw()

# Or use autoplot
autoplot(roc_curve(two_class_example, truth, Class1))

## Not run:
# Multiclass one-vs-all approach
# One curve per level
hpc_cv %>%
  filter(Resample == "Fold01") %>%
  roc_curve(obs, VF:L) %>%
  autoplot()

# Same as above, but will all of the resamples
hpc_cv %>%
group_by(Resample) %>%
roc_curve(obs, VF:L) %>%
autoplot()

## End(Not run)

---

rpd | Ratio of performance to deviation

**Description**

These functions are appropriate for cases where the model outcome is a numeric. The ratio of performance to deviation (`rpd()`) and the ratio of performance to inter-quartile (`rpiq()`) are both measures of consistency/correlation between observed and predicted values (and not of accuracy).
rpd

Usage

rpd(data, ...)

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

rpd_vec(truth, estimate, na_rm = TRUE, ...)

Arguments

data A data.frame containing the truth and estimate columns.

... Not currently used.

truth The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.

estimate The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

In the field of spectroscopy in particular, the ratio of performance to deviation (RPD) has been used as the standard way to report the quality of a model. It is the ratio between the standard deviation of a variable and the standard error of prediction of that variable by a given model. However, its systematic use has been criticized by several authors, since using the standard deviation to represent the spread of a variable can be misleading on skewed dataset. The ratio of performance to interquartile has been introduced by Bellon-Maurel et al. (2010) to address some of these issues, and generalise the RPD to non-normally distributed variables.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For rpd_vec(), a single numeric value (or NA).

Author(s)

Pierre Roudier

References


See Also

The closely related inter-quartile metric: rpiq()

Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), mase(), rmse(), rpiq(), rsq_trad(), rsq(), smape()

Other consistency metrics: ccc(), rpiq(), rsq_trad(), rsq()

Examples

# Supply truth and predictions as bare column names
rpd(solubility_test, solubility, prediction)

library(dplyr)
set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  rpd(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))

rpiq  
Ratio of performance to inter-quartile
Description

These functions are appropriate for cases where the model outcome is a numeric. The ratio of performance to deviation (rpd()) and the ratio of performance to inter-quartile (rpiq()) are both measures of consistency/correlation between observed and predicted values (and not of accuracy).

Usage

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

Arguments

- `data`: A data.frame containing the truth and estimate columns.
- `...`: Not currently used.
- `truth`: The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.
- `estimate`: The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.
- `na_rm`: A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

In the field of spectroscopy in particular, the ratio of performance to deviation (RPD) has been used as the standard way to report the quality of a model. It is the ratio between the standard deviation of a variable and the standard error of prediction of that variable by a given model. However, its systematic use has been criticized by several authors, since using the standard deviation to represent the spread of a variable can be misleading on skewed dataset. The ratio of performance to inter-quartile has been introduced by Bellon-Maurel et al. (2010) to address some of these issues, and generalise the RPD to non-normally distributed variables.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For rpd_vec(), a single numeric value (or NA).

Author(s)

Pierre Roudier
References


See Also

The closely related deviation metric: \textit{rpd()}


Other consistency metrics: \textit{ccc()}, \textit{rpd()}, \textit{rsq\_trad()}, \textit{rsq()}

Examples

# Supply truth and predictions as bare column names
rpd(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  rpd(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))
rsq

Description

Calculate the coefficient of determination using correlation. For the traditional measure of R squared, see rsq_trad().

Usage

rsq(data, ...)

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

rsq_vec(truth, estimate, na_rm = TRUE, ...)

Arguments

data A data.frame containing the truth and estimate columns.
...

not currently used.

truth The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.

estimate The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.

na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The two estimates for the coefficient of determination, rsq() and rsq_trad(), differ by their formula. The former guarantees a value on (0, 1) while the latter can generate inaccurate values when the model is non-informative (see the examples). Both are measures of consistency/correlation and not of accuracy.

rsq() is simply the squared correlation between truth and estimate.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values. For grouped data frames, the number of rows returned will be the same as the number of groups. For rsq_vec(), a single numeric value (or NA).
Author(s)
Max Kuhn

References

See Also
Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), mase(), rmse(). rpd(), rpiq(), rsq_trad(). smape()
Other consistency metrics: ccc(), rpd(), rpiq(), rsq_trad()

Examples
# Supply truth and predictions as bare column names
rsq(solubility_test, solubility, prediction)

library(dplyr)

set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  rsq(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))
# With uninformative data, the traditional version of R^2 can return
# negative values.
set.seed(2291)
solubility_test$randomized <- sample(solubility_test$prediction)
rsq(solubility_test, solubility, randomized)
rsq_trad(solubility_test, solubility, randomized)
Description

Calculate the coefficient of determination using the traditional definition of $R$ squared using sum of squares. For a measure of $R$ squared that is strictly between $(0, 1)$, see `rsq()`.

Usage

```r
rsq_trad(data, ...)
```

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

```r
rsq_trad_vec(truth, estimate, na_rm = TRUE, ...)
```

Arguments

- `data`: A `data.frame` containing the truth and estimate columns.
- `...`: Not currently used.
- `truth`: The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For `_vec()` functions, a numeric vector.
- `estimate`: The column identifier for the predicted results (that is also numeric). As with `truth` this can be specified different ways but the primary method is to use an unquoted variable name. For `_vec()` functions, a numeric vector.
- `na_rm`: A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The two estimates for the coefficient of determination, `rsq()` and `rsq_trad()`, differ by their formula. The former guarantees a value on $(0, 1)$ while the latter can generate inaccurate values when the model is non-informative (see the examples). Both are measures of consistency/correlation and not of accuracy.

Value

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `rsq_trad_vec()`, a single numeric value (or NA).
Author(s)
Max Kuhn

References

See Also
Other numeric metrics: ccc(), huber_loss_pseudo(), huber_loss(), iic(), mae(), mape(), mase(), rmse(). rpd(), rpiq(). rsq(). smape()
Other consistency metrics: ccc(), rpd(), rpiq(). rsq()

Examples
# Supply truth and predictions as bare column names
rsq_trad(solubility_test, solubility, prediction)

library(dplyr)
set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  rsq_trad(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))
# With uninformative data, the traditional version of R^2 can return
# negative values.
set.seed(2291)
solubility_test$randomized <- sample(solubility_test$prediction)
rsq(solubility_test, solubility, randomized)
rsq_trad(solubility_test, solubility, randomized)
## Description

These functions calculate the `sens()` (sensitivity) of a measurement system compared to a reference result (the "truth" or gold standard). Highly related functions are `spec()`, `ppv()`, and `npv()`.

## Usage

```r
sens(data, ...)

# S3 method for class 'data.frame'
sens(data, truth, estimate, estimator = NULL, na_rm = TRUE, ...)

sensitivity(data, ...)

sens_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)

sensitivity_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
```

## Arguments

- `data`: Either a `data.frame` containing the `truth` and `estimate` columns, or a `table/matrix` where the true class results should be in the columns of the table.
- `...`: Not currently used.
- `truth`: The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.
- `estimate`: The column identifier for the predicted class results (that is also factor). As with `truth` this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.
- `estimator`: One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on `estimate`.
- `na_rm`: A logical value indicating whether NA values should be stripped before the computation proceeds.

## Details

The sensitivity (`sens()`) is defined as the proportion of positive results out of the number of samples which were actually positive.

When the denominator of the calculation is 0, sensitivity is undefined. This happens when both `# true_positive = 0` and `# false_negative = 0` are true, which mean that there were no true events.
When computing binary sensitivity, a NA value will be returned with a warning. When computing multiclass sensitivity, the individual NA values will be removed, and the computation will proceed, with a warning.

**Value**

A tibble with columns `.metric`, `.estimator`, and `.estimate` and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `sens_vec()`, a single numeric value (or NA).

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

**Multiclass**

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass","yardstick") for more information.

**Implementation**

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th>Predicted</th>
<th>Reference</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Negative</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

The formulas used here are:

\[
\text{Sensitivity} = \frac{A}{A+C}
\]

\[
\text{Specificity} = \frac{D}{B+D}
\]

\[
\text{Prevalence} = \frac{A+C}{A+B+C+D}
\]

\[
PPV = \frac{(\text{Sensitivity}\times\text{Prevalence})}{((\text{Sensitivity}\times\text{Prevalence})+(1-\text{Specificity})\times(1-\text{Prevalence}))}
\]

\[
NPV = \frac{(\text{Specificity}\times(1-\text{Prevalence}))}{((1-\text{Sensitivity})\times\text{Prevalence})+(\text{Specificity}\times(1-\text{Prevalence}))}
\]

See the references for discussions of the statistics.
sens

Author(s)
Max Kuhn

References

See Also
Other class metrics: accuracy(), bal_accuracy(), detection_prevalence(), f_meas(), j_index(), kap(), mcc(), npv(), ppv(), precision(), recall(), spec()

Other sensitivity metrics: npv(), ppv(), spec()

Examples
# Two class
data("two_class_example")
sens(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
sens(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
sens(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
sens(obs, pred, estimator = "macro_weighted")

# Vector version
sens_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
sens_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)
Description

Calculate the symmetric mean absolute percentage error. This metric is in relative units.

Usage

smape(data, ...)

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

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

Arguments

data A data.frame containing the truth and estimate columns.
...
truth The column identifier for the true results (that is numeric). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a numeric vector.
estimate The column identifier for the predicted results (that is also numeric). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a numeric vector.
na_rm A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

This implementation of smape() is the "usual definition" where the denominator is divided by two.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.
For grouped data frames, the number of rows returned will be the same as the number of groups.
For smape_vec(), a single numeric value (or NA).

Author(s)

Max Kuhn, Riaz Hedayati
See Also

Other numeric metrics: `ccc()`, `huber_loss_pseudo()`, `huber_loss()`, `iic()`, `mae()`, `mape()`, `mase()`, `rmse()`, `rpd()`, `rpiq()`, `rsq_trad()`, `rsq()`
Other accuracy metrics: `ccc()`, `huber_loss_pseudo()`, `huber_loss()`, `iic()`, `mae()`, `mape()`, `mase()`, `rmse()`

Examples

# Supply truth and predictions as bare column names
smape(solubility_test, solubility, prediction)

library(dplyr)
set.seed(1234)
size <- 100
times <- 10

# create 10 resamples
solubility_resampled <- bind_rows(
  replicate(
    n = times,
    expr = sample_n(solubility_test, size, replace = TRUE),
    simplify = FALSE
  ),
  .id = "resample"
)

# Compute the metric by group
metric_results <- solubility_resampled %>%
  group_by(resample) %>%
  smape(solubility, prediction)

metric_results

# Resampled mean estimate
metric_results %>%
  summarise(avg_estimate = mean(.estimate))

solubility_test

Solubility Predictions from MARS Model

Description

Solubility Predictions from MARS Model

Details

For the solubility data in Kuhn and Johnson (2013), these data are the test set results for the MARS model. The observed solubility (in column `solubility`) and the model results (prediction) are contained in the data.
Value

solubility_test

a data frame

Source


Examples

data(solubility_test)
str(solubility_test)

specc Specificity

Description

These functions calculate the spec() (specificity) of a measurement system compared to a reference result (the "truth" or gold standard). Highly related functions are sens(), ppv(), and npv().

Usage

spec(data, ...)

## S3 method for class 'data.frame'
spec(data, truth, estimate, estimator = NULL, na_rm = TRUE, ...)
specificity(data, ...)
spec_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)
specificity_vec(truth, estimate, estimator = NULL, na_rm = TRUE, ...)

Arguments

data Either a data.frame containing the truth and estimate columns, or a table/matrix where the true class results should be in the columns of the table.

... Not currently used.

truth The column identifier for the true class results (that is a factor). This should be an unquoted column name although this argument is passed by expression and supports quasiquotation (you can unquote column names). For _vec() functions, a factor vector.

estimate The column identifier for the predicted class results (that is also factor). As with truth this can be specified different ways but the primary method is to use an unquoted variable name. For _vec() functions, a factor vector.
estimator

One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on `estimate`.

na_rm

A logical value indicating whether NA values should be stripped before the computation proceeds.

Details

The specificity measures the proportion of negatives that are correctly identified as negatives.

When the denominator of the calculation is 0, specificity is undefined. This happens when both # true_negative = 0 and # false_positive = 0 are true, which mean that there were no true negatives. When computing binary specificity, a NA value will be returned with a warning. When computing multiclass specificity, the individual NA values will be removed, and the computation will proceed, with a warning.

Value

A tibble with columns .metric, .estimator, and .estimate and 1 row of values.

For grouped data frames, the number of rows returned will be the same as the number of groups.

For `spec_vec()`, a single numeric value (or NA).

Relevant Level

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In `yardstick`, the default is to use the first level. To change this, a global option called `yardstick.event_first` is set to TRUE when the package is loaded. This can be changed to FALSE if the last level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.

Multiclass

Macro, micro, and macro-weighted averaging is available for this metric. The default is to select macro averaging if a truth factor with more than 2 levels is provided. Otherwise, a standard binary calculation is done. See vignette("multiclass", "yardstick") for more information.

Implementation

Suppose a 2x2 table with notation:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>Positive</td>
<td>A</td>
</tr>
<tr>
<td>Negative</td>
<td>C</td>
</tr>
</tbody>
</table>
The formulas used here are:

\[ Sensitivity = \frac{A}{A + C} \]

\[ Specificity = \frac{D}{B + D} \]

\[ Prevalence = \frac{(A + C)}{(A + B + C + D)} \]

\[ PPV = \frac{(Sensitivity \times Prevalence)}{((Sensitivity \times Prevalence) + ((1 - Specificity) \times (1 - Prevalence)))} \]

\[ NPV = \frac{(Specificity \times (1 - Prevalence))}{(((1 - Sensitivity) \times Prevalence) + ((Specificity) \times (1 - Prevalence)))} \]

See the references for discussions of the statistics.

Author(s)

Max Kuhn

References


See Also

Other class metrics: accuracy(), bal_accuracy(), detection_prevalence(), f_meas(), j_index(), kap(), mcc(), npv(), ppv(), precision(), recall(), sens()

Other sensitivity metrics: npv(), ppv(), sens()

Examples

# Two class
data("two_class_example")
spec(two_class_example, truth, predicted)

# Multiclass
library(dplyr)
data(hpc_cv)

hpc_cv %>%
  filter(Resample == "Fold01") %>%
spec(obs, pred)

# Groups are respected
hpc_cv %>%
  group_by(Resample) %>%
spec(obs, pred)

# Weighted macro averaging
hpc_cv %>%
  group_by(Resample) %>%
spec(obs, pred, estimator = "macro_weighted")
# Vector version
spec_vec(two_class_example$truth, two_class_example$predicted)

# Making Class2 the "relevant" level
options(yardstick.event_first = FALSE)
spec_vec(two_class_example$truth, two_class_example$predicted)
options(yardstick.event_first = TRUE)

---

**summary.conf_mat**

**Summary Statistics for Confusion Matrices**

**Description**

Various statistical summaries of confusion matrices are produced and returned in a tibble. These include those shown in the help pages for `sens()`, `recall()`, and `accuracy()`, among others.

**Usage**

```r
## S3 method for class 'conf_mat'
summary(object, prevalence = NULL, beta = 1, estimator = NULL, ...)
```

**Arguments**

- `object`: An object of class `conf_mat()`.
- `prevalence`: A number in (0, 1) for the prevalence (i.e. prior) of the event. If left to the default, the data are used to derive this value.
- `beta`: A numeric value used to weight precision and recall for `f_meas()`.
- `estimator`: One of: "binary", "macro", "macro_weighted", or "micro" to specify the type of averaging to be done. "binary" is only relevant for the two class case. The other three are general methods for calculating multiclass metrics. The default will automatically choose "binary" or "macro" based on estimate.
- `...`: Not currently used.

**Value**

A tibble containing various classification metrics.

**Relevant Level**

There is no common convention on which factor level should automatically be considered the "event" or "positive" result. In yardstick, the default is to use the `first` level. To change this, a global option called `yardstick.event_first` is set to `TRUE` when the package is loaded. This can be changed to `FALSE` if the `last` level of the factor is considered the level of interest by running: `options(yardstick.event_first = FALSE)`. For multiclass extensions involving one-vs-all comparisons (such as macro averaging), this option is ignored and the "one" level is always the relevant result.
two_class_example

**See Also**

`conf_mat()`

**Examples**

data("two_class_example")

cmat <- conf_mat(two_class_example, truth = "truth", estimate = "predicted")
summary(cmat)
summary(cmat, prevalence = 0.70)

library(dplyr)
library(purrr)
library(tidyr)
data("hpc_cv")

# Compute statistics per resample then summarize
all_metrics <- hpc_cv %>%
group_by(Resample) %>%
conf_mat(obs, pred) %>%
mutate(summary_tbl = map(conf_mat, summary)) %>%
unnest(summary_tbl)

all_metrics %>%
group_by(.metric) %>%
summarise(
  mean = mean(.estimate, na.rm = TRUE),
  sd = sd(.estimate, na.rm = TRUE)
)

---

two_class_example  Two Class Predictions

**Description**

Two Class Predictions

**Details**

These data are a test set from a model built for two classes ("Class1" and "Class2"). There are columns for the true and predicted classes and column for the probabilities for each class.

**Value**

`two_class_example`

  a data frame
Examples

```r
data(two_class_example)
str(two_class_example)
#
# `truth` is a 2 level factor. The first level is `"Class1"`, which is the
# "event of interest" by default in yardstick. See the Relevant Level
# section in any classification function (such as `?pr_auc`) to see how
# to change this.
levels(hpc_cv$obs)
```
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