

# Package ‘measures’

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**Title** Performance Measures for Statistical Learning

**Version** 0.3

**Description** Provides the biggest amount of statistical measures in the whole R world. Includes measures of regression, (multiclass) classification and multilabel classification. The measures come mainly from the 'mlr' package and were programmed by several 'mlr' developers.

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---

ACC	<i>Accuracy</i>
-----	-----------------

---

**Description**

Defined as: `mean(response == truth)`

**Usage**

```
ACC(truth, response)
```

**Arguments**

truth	vector of true values
response	vector of predicted values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
response = as.factor(sample(c(1,2,3), n, replace = TRUE))
ACC(truth, response)
```

---

ARSQ	<i>Adjusted coefficient of determination</i>
------	--

---

**Description**

Defined as:  $1 - (1 - \text{rsq}) * (p / (n - p - 1L))$ . Adjusted R-squared is only defined for normal linear regression.

**Usage**

```
ARSQ(truth, response, n, p)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values
n	[numeric] number of observations
p	[numeric] number of predictors

**Examples**

```
n = 20
p = 5
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
ARSQ(truth, response, n, p)
```

---

AUC

*Area under the curve*

---

**Description**

Integral over the graph that results from computing fpr and tpr for many different thresholds.

**Usage**

```
AUC(probabilities, truth, negative, positive)
```

**Arguments**

probabilities	[numeric] vector of predicted probabilities
truth	vector of true values
negative	negative class
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
AUC(probabilities, truth, negative, positive)
```

---

BAC	<i>Balanced accuracy</i>
-----	--------------------------

---

**Description**

Mean of true positive rate and true negative rate.

**Usage**

```
BAC(truth, response, negative, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
BAC(truth, response, negative, positive)
```

---

BER	<i>Balanced error rate</i>
-----	----------------------------

---

**Description**

Mean of misclassification error rates on all individual classes.

**Usage**

```
BER(truth, response)
```

**Arguments**

truth	vector of true values
response	vector of predicted values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
response = as.factor(sample(c(1,2,3), n, replace = TRUE))
BER(truth, response)
```

---

 Brier

*Brier score*


---

**Description**

The Brier score is defined as the quadratic difference between the probability and the value (1,0) for the class. That means we use the numeric representation 1 and 0 for our target classes. It is similar to the mean squared error in regression. `multiclass.brier` is the sum over all one vs. all comparisons and for a binary classification  $2 * \text{brier}$ .

**Usage**

```
Brier(probabilities, truth, negative, positive)
```

**Arguments**

<code>probabilities</code>	[numeric] vector of predicted probabilities
<code>truth</code>	vector of true values
<code>negative</code>	negative class
<code>positive</code>	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
Brier(probabilities, truth, negative, positive)
```

---

BrierScaled	<i>Brier scaled</i>
-------------	---------------------

---

**Description**

Brier score scaled to [0,1], see <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3575184/>.

**Usage**

```
BrierScaled(probabilities, truth, negative, positive)
```

**Arguments**

probabilities	[numeric] vector of predicted probabilities
truth	vector of true values
negative	negative class
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
BrierScaled(probabilities, truth, negative, positive)
```

---

EXPVAR	<i>Explained variance</i>
--------	---------------------------

---

**Description**

Similar to RSQ (R-squared). Defined as explained\_sum\_of\_squares / total\_sum\_of\_squares.

**Usage**

```
EXPVAR(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
EXPVAR(truth, response)
```

---

F1

*F1 measure*

---

**Description**

Defined as:  $2 * tp / (\text{sum}(\text{truth} == \text{positive}) + \text{sum}(\text{response} == \text{positive}))$

**Usage**

```
F1(truth, response, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
F1(truth, response, positive)
```

---

FDR

*False discovery rate*

---

**Description**

Defined as:  $fp / (tp + fp)$

**Usage**

```
FDR(truth, response, positive)
```



**Arguments**

truth	vector of true values
response	vector of predicted values
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
FDR(truth, response, positive)
```

---

FN	<i>False negatives</i>
----	------------------------

---

**Description**

Sum of misclassified observations in the negative class. Also called misses.

**Usage**

```
FN(truth, response, negative)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
negative = 0
FN(truth, response, negative)
```

---

FNR *False negative rate*

---

**Description**

Percentage of misclassified observations in the negative class.

**Usage**

```
FNR(truth, response, negative, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
FNR(truth, response, negative, positive)
```

---

FP *False positives*

---

**Description**

Sum of misclassified observations in the positive class. Also called false alarms.

**Usage**

```
FP(truth, response, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
FPR(truth, response, positive)
```

---

FPR

*False positive rate*

---

**Description**

Percentage of misclassified observations in the positive class. Also called false alarm rate or fall-out.

**Usage**

```
FPR(truth, response, negative, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
FPR(truth, response, negative, positive)
```

GMEAN

*G-mean*

---

**Description**

Geometric mean of recall and specificity.

**Usage**

```
GMEAN(truth, response, negative, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class
positive	positive class

**References**

He, H. & Garcia, E. A. (2009) \*Learning from Imbalanced Data.\* IEEE Transactions on Knowledge and Data Engineering, vol. 21, no. 9. pp. 1263-1284.

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
GMEAN(truth, response, negative, positive)
```

---

GPR*Geometric mean of precision and recall.*

---

**Description**

Defined as:  $\sqrt{\text{ppv} * \text{tpr}}$

**Usage**

```
GPR(truth, response, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
GPR(truth, response, positive)
```

KAPPA

*Cohen's kappa***Description**

Defined as:  $1 - (1 - p_0) / (1 - p_e)$ . With:  $p_0$  = 'observed frequency of agreement' and  $p_e$  = 'expected agreement frequency under independence'

**Usage**

```
KAPPA(truth, response)
```

**Arguments**

truth	vector of true values
response	vector of predicted values <code>n = 20 set.seed(122) truth = as.factor(sample(c(1,2,3), n, replace = TRUE)) response = as.factor(sample(c(1,2,3), n, repla</code> KAPPA(truth, response)

KendallTau

*Kendall's tau***Description**

Defined as: Kendall's tau correlation between truth and response. Only looks at the order. See Rosset et al.: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.95.1398&rep=rep1&type=pdf>.

**Usage**

```
KendallTau(truth, response)
```

**Arguments**

truth            [numeric] vector of true values  
response        [numeric] vector of predicted values

**Examples**

```
n = 20  
set.seed(123)  
truth = rnorm(n)  
response = rnorm(n)  
KendallTau(truth, response)
```

---

listAllMeasures	<i>List all measures</i>
-----------------	--------------------------

---

**Description**

Lists all measures that are available in the package with their corresponding task.

**Usage**

```
listAllMeasures()
```

**Value**

Dataframe with all available measures and the corresponding task

**Examples**

```
listAllMeasures()
```

---

Logloss	<i>Logarithmic loss</i>
---------	-------------------------

---

**Description**

Defined as:  $-\text{mean}(\log(p_i))$ , where  $p_i$  is the predicted probability of the true class of observation  $i$ . Inspired by <https://www.kaggle.com/wiki/MultiClassLogLoss>.

**Usage**

```
Logloss(probabilities, truth)
```

**Arguments**

probabilities	[numeric] vector (or matrix with column names of the classes) of predicted probabilities
truth	vector of true values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
probabilities = matrix(runif(60), 20, 3)
probabilities = probabilities/rowSums(probabilities)
colnames(probabilities) = c(1,2,3)
Logloss(probabilities, truth)
```

---

LSR

*Logarithmic Scoring Rule*


---

**Description**

Defined as:  $\text{mean}(\log(p_i))$ , where  $p_i$  is the predicted probability of the true class of observation  $i$ . This scoring rule is the same as the negative logloss, self-information or surprisal. See: Bickel, J. E. (2007). Some comparisons among quadratic, spherical, and logarithmic scoring rules. *Decision Analysis*, 4(2), 49-65.

**Usage**

```
LSR(probabilities, truth)
```

**Arguments**

probabilities	[numeric] vector (or matrix with column names of the classes) of predicted probabilities
truth	vector of true values <code>n = 20 set.seed(122) truth = as.factor(sample(c(1,2,3), n, replace = TRUE)) probabilities = matrix(runif(60), 20, 3) probabilities = probabilities/rowSums(probabilities) colnames(probabilities) = c(1,2,3) LSR(probabilities, truth)</code>

---

MAE	<i>Mean of absolute errors</i>
-----	--------------------------------

---

**Description**

Defined as: `mean(abs(response - truth))`

**Usage**

```
MAE(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
MAE(truth, response)
```

---

MAPE	<i>Mean absolute percentage error</i>
------	---------------------------------------

---

**Description**

Defined as the `abs(truth_i - response_i) / truth_i`. Won't work if any truth value is equal to zero. In this case the output will be NA.

**Usage**

```
MAPE(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
MAPE(truth, response)
```



---

MCC *Matthews correlation coefficient*

---

**Description**

Defined as  $(tp * tn - fp * fn) / \sqrt{(tp + fp) * (tp + fn) * (tn + fp) * (tn + fn)}$ , denominator set to 1 if 0.

**Usage**

```
MCC(truth, response, negative, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
negative = 0
MCC(truth, response, negative, positive)
```

---

MEDAE *Median of absolute errors*

---

**Description**

Defined as: `median(abs(response - truth))`.

**Usage**

```
MEDAE(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
MEDAE(truth, response)
```

---

MEDSE

*Median of squared errors*

---

**Description**

Defined as:  $\text{median}((\text{response} - \text{truth})^2)$ .

**Usage**

```
MEDSE(truth, response)
```

**Arguments**

truth            [numeric] vector of true values  
response        [numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
MEDSE(truth, response)
```

---

MMCE

*Mean misclassification error*

---

**Description**

Defined as:  $\text{mean}(\text{response} \neq \text{truth})$

**Usage**

```
MMCE(truth, response)
```

**Arguments**

truth            vector of true values  
response        vector of predicted values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
response = as.factor(sample(c(1,2,3), n, replace = TRUE))
MMCE(truth, response)
```

---

MSE

*Mean of squared errors*

---

**Description**

Defined as:  $\text{mean}((\text{response} - \text{truth})^2)$

**Usage**

```
MSE(truth, response)
```

**Arguments**

truth            [numeric] vector of true values  
response        [numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
MSE(truth, response)
```

---

MSLE

*Mean squared logarithmic error*

---

**Description**

Defined as:  $\text{mean}((\log(\text{response} + 1, \text{exp}(1)) - \log(\text{truth} + 1, \text{exp}(1)))^2)$ . This is mostly used for count data, note that all predicted and actual target values must be greater or equal '-1' to compute the mean squared logarithmic error.

**Usage**

```
MSLE(truth, response)
```

**Arguments**

truth            [numeric] vector of true values  
response        [numeric] vector of predicted values

**Examples**

```
n = 20  
set.seed(123)  
truth = abs(rnorm(n))  
response = abs(rnorm(n))  
MSLE(truth, response)
```

---

multiclass.AU1P            *Weighted average 1 vs. 1 multiclass AUC*

---

**Description**

Computes AUC of  $c(c - 1)$  binary classifiers while considering the a priori distribution of the classes. See Ferri et al.: <https://www.math.ucdavis.edu/~saito/data/roc/ferri-class-perf-metrics.pdf>.

**Usage**

```
multiclass.AU1P(probabilities, truth)
```

**Arguments**

probabilities   [numeric] matrix of predicted probabilities with columnnames of the classes  
truth            vector of true values

**Examples**

```
n = 20  
set.seed(122)  
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))  
probabilities = matrix(runif(60), 20, 3)  
probabilities = probabilities/rowSums(probabilities)  
colnames(probabilities) = c(1,2,3)  
multiclass.AU1P(probabilities, truth)
```

---

multiclass.AU1U	<i>Average 1 vs. 1 multiclass AUC</i>
-----------------	---------------------------------------

---

**Description**

Computes AUC of  $c(c - 1)$  binary classifiers (all possible pairwise combinations) while considering uniform distribution of the classes. See Ferri et al.: <https://www.math.ucdavis.edu/~saito/data/roc/ferri-class-perf-metrics.pdf>.

**Usage**

```
multiclass.AU1U(probabilities, truth)
```

**Arguments**

probabilities [numeric] matrix of predicted probabilities with columnnames of the classes  
truth vector of true values

**Examples**

```
n = 20  
set.seed(122)  
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))  
probabilities = matrix(runif(60), 20, 3)  
probabilities = probabilities/rowSums(probabilities)  
colnames(probabilities) = c(1,2,3)  
multiclass.AU1U(probabilities, truth)
```

---

multiclass.AUNP	<i>Weighted average 1 vs. rest multiclass AUC</i>
-----------------	---

---

**Description**

Computes the AUC treating a  $c$ -dimensional classifier as  $c$  two-dimensional classifiers, taking into account the prior probability of each class. See Ferri et al.: <https://www.math.ucdavis.edu/~saito/data/roc/ferri-class-perf-metrics.pdf>.

**Usage**

```
multiclass.AUNP(probabilities, truth)
```

**Arguments**

probabilities [numeric] matrix of predicted probabilities with columnnames of the classes  
truth vector of true values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
probabilities = matrix(runif(60), 20, 3)
probabilities = probabilities/rowSums(probabilities)
colnames(probabilities) = c(1,2,3)
multiclass.AUNP(probabilities, truth)
```

---

multiclass.AUNU	<i>Average 1 vs. rest multiclass AUC</i>
-----------------	--

---

**Description**

Computes the AUC treating a c-dimensional classifier as c two-dimensional classifiers, where classes are assumed to have uniform distribution, in order to have a measure which is independent of class distribution change. See Ferri et al.: <https://www.math.ucdavis.edu/~saito/data/roc/ferri-class-perf-metrics.pdf>.

**Usage**

```
multiclass.AUNU(probabilities, truth)
```

**Arguments**

probabilities [numeric] matrix of predicted probabilities with columnnames of the classes  
truth vector of true values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
probabilities = matrix(runif(60), 20, 3)
probabilities = probabilities/rowSums(probabilities)
colnames(probabilities) = c(1,2,3)
multiclass.AUNU(probabilities, truth)
```

---

multiclass.Brier	<i>Multiclass Brier score</i>
------------------	-------------------------------

---

**Description**

Defined as:  $(1/n) \sum_i \sum_j (y_{ij} - p_{ij})^2$ , where  $y_{ij} = 1$  if observation  $i$  has class  $j$  (else 0), and  $p_{ij}$  is the predicted probability of observation  $i$  for class  $j$ . From <http://docs.lib.noaa.gov/rescue/mwr/078/mwr-078-01-0001.pdf>.

**Usage**

```
multiclass.Brier(probabilities, truth)
```

**Arguments**

probabilities	[numeric] matrix of predicted probabilities with columnnames of the classes
truth	vector of true values

**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
probabilities = matrix(runif(60), 20, 3)
probabilities = probabilities/rowSums(probabilities)
colnames(probabilities) = c(1,2,3)
multiclass.Brier(probabilities, truth)
```

---

MultilabelACC	<i>Accuracy (multilabel)</i>
---------------	------------------------------

---

**Description**

Averaged proportion of correctly predicted labels with respect to the total number of labels for each instance, following the definition by Charte and Charte: <https://journal.r-project.org/archive/2015-2/charte-chart.pdf>. Fractions where the denominator becomes 0 are replaced with 1 before computing the average across all instances.

**Usage**

```
MultilabelACC(truth, response)
```

**Arguments**

truth	matrix of true values
response	matrix of predicted values <code>n = 20</code> <code>set.seed(122)</code> <code>truth = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3)</code> <code>response = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3)</code> <code>MultilabelACC(truth, response)</code>

---

MultilabelF1                      *F1 measure (multilabel)*

---

### Description

Harmonic mean of precision and recall on a per instance basis (Micro-F1), following the definition by Montanes et al.: <http://www.sciencedirect.com/science/article/pii/S0031320313004019>. Fractions where the denominator becomes 0 are replaced with 1 before computing the average across all instances.

### Usage

```
MultilabelF1(truth, response)
```

### Arguments

truth	matrix of true values
response	matrix of predicted values n = 20 set.seed(122) truth = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3) response = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3) MultilabelF1(truth, response)

---

MultilabelHamloss                      *Hamming loss*

---

### Description

Proportion of labels that are predicted incorrectly, following the definition by Charte and Charte: <https://journal.r-project.org/archive/2015-2/charte-charte.pdf>.

### Usage

```
MultilabelHamloss(truth, response)
```

### Arguments

truth	matrix of true values
response	matrix of predicted values

### Examples

```
n = 20
set.seed(122)
truth = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3)
response = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3)
MultilabelHamloss(truth, response)
```



---

MultilabelPPV	<i>Positive predictive value (multilabel)</i>
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---

**Description**

Also called precision. Averaged ratio of correctly predicted labels for each instance, following the definition by Charte and Charte: <https://journal.r-project.org/archive/2015-2/charte-chart.pdf>. Fractions where the denominator becomes 0 are ignored in the average calculation.

**Usage**

```
MultilabelPPV(truth, response)
```

**Arguments**

truth	matrix of true values
response	matrix of predicted values n = 20 set.seed(122) truth = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3) response = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3) MultilabelPPV(truth, response)

---

MultilabelSubset01	<i>Subset-0-1 loss</i>
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---

**Description**

Proportion of observations where the complete multilabel set (all 0-1-labels) is predicted incorrectly, following the definition by Charte and Charte: <https://journal.r-project.org/archive/2015-2/charte-chart.pdf>.

**Usage**

```
MultilabelSubset01(truth, response)
```

**Arguments**

truth	matrix of true values
response	matrix of predicted values

**Examples**

```
n = 20
set.seed(122)
truth = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3)
response = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3)
MultilabelSubset01(truth, response)
```

---

MultilabelTPR	<i>TPR (multilabel)</i>
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---

**Description**

Also called recall. Averaged proportion of predicted labels which are relevant for each instance, following the definition by Charte and Charte: <https://journal.r-project.org/archive/2015-2/charte-chart.pdf>. Fractions where the denominator becomes 0 are ignored in the average calculation.

**Usage**

```
MultilabelTPR(truth, response)
```

**Arguments**

truth	matrix of true values
response	matrix of predicted values

```
n = 20 set.seed(122) truth = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3) response = matrix(sample(c(0,1), 60, replace = TRUE), 20, 3) MultilabelTPR(truth, response)
```

---

NPV	<i>Negative predictive value</i>
-----	----------------------------------

---

**Description**

Defined as:  $tn / (tn + fn)$ .

**Usage**

```
NPV(truth, response, negative)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
negative = 0
NPV(truth, response, negative)
```

---

PPV *Positive predictive value*

---

### Description

Defined as:  $tp / (tp + fp)$ . Also called precision. If the denominator is 0, PPV is set to be either 1 or 0 depending on whether the highest probability prediction is positive (1) or negative (0).

### Usage

```
PPV(truth, response, positive, probabilities = NULL)
```

### Arguments

truth	vector of true values
response	vector of predicted values
positive	positive class
probabilities	[numeric] vector of predicted probabilities

### Examples

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
PPV(truth, response, positive, probabilities = NULL)
```

---

QSR *Quadratic Scoring Rule*

---

### Description

Defined as:  $1 - (1/n) \sum_i \sum_j (y_{ij} - p_{ij})^2$ , where  $y_{ij} = 1$  if observation  $i$  has class  $j$  (else 0), and  $p_{ij}$  is the predicted probability of observation  $i$  for class  $j$ . This scoring rule is the same as  $1 - \text{multiclass.brier}$ . See: Bickel, J. E. (2007). Some comparisons among quadratic, spherical, and logarithmic scoring rules. *Decision Analysis*, 4(2), 49-65.

### Usage

```
QSR(probabilities, truth)
```

**Arguments**

probabilities [numeric] vector (or matrix with column names of the classes) of predicted probabilities

truth vector of true values `n = 20` `set.seed(122)` `truth = as.factor(sample(c(1,2,3), n, replace = TRUE))` `probabilities = matrix(runif(60), 20, 3)` `probabilities = probabilities/rowSums(probabilities)` `colnames(probabilities) = c(1,2,3)` `QSR(probabilities, truth)`

RAE

*Relative absolute error***Description**

Defined as `sum_of_absolute_errors / mean_absolute_deviation`. Undefined for single instances and when every truth value is identical. In this case the output will be NA.

**Usage**

```
RAE(truth, response)
```

**Arguments**

truth [numeric] vector of true values

response [numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
RAE(truth, response)
```

RMSE

*Root mean squared error***Description**

The RMSE is aggregated as `sqrt(mean(rmse.vals.on.test.sets^2))`

**Usage**

```
RMSE(truth, response)
```

**Arguments**

truth            [numeric] vector of true values  
response        [numeric] vector of predicted values

**Examples**

```
n = 20  
set.seed(123)  
truth = rnorm(n)  
response = rnorm(n)  
RMSE(truth, response)
```

---

RMSLE

*Root mean squared logarithmic error*

---

**Description**

Definition taken from: <https://www.kaggle.com/wiki/RootMeanSquaredLogarithmicError>. This is mostly used for count data, note that all predicted and actual target values must be greater or equal '-1' to compute the root mean squared logarithmic error.

**Usage**

```
RMSLE(truth, response)
```

**Arguments**

truth            [numeric] vector of true values  
response        [numeric] vector of predicted values

**Examples**

```
n = 20  
set.seed(123)  
truth = abs(rnorm(n))  
response = abs(rnorm(n))  
RMSLE(truth, response)
```

---

RRSE	<i>Root relative squared error</i>
------	------------------------------------

---

**Description**

Defined as  $\sqrt{\text{sum\_of\_squared\_errors} / \text{total\_sum\_of\_squares}}$ . Undefined for single instances and when every truth value is identical. In this case the output will be NA.

**Usage**

```
RRSE(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
RRSE(truth, response)
```

---

RSQ	<i>Coefficient of determination</i>
-----	-------------------------------------

---

**Description**

Also called R-squared, which is  $1 - \text{residual\_sum\_of\_squares} / \text{total\_sum\_of\_squares}$ .

**Usage**

```
RSQ(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
RSQ(truth, response)
```

---

SAE	<i>Sum of absolute errors</i>
-----	-------------------------------

---

**Description**

Defined as: `sum(abs(response - truth))`"

**Usage**

```
SAE(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
SAE(truth, response)
```

---

SpearmanRho	<i>Spearman's rho</i>
-------------	-----------------------

---

**Description**

Defined as: Spearman's rho correlation between truth and response. Only looks at the order. See Rosset et al.: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.95.1398&rep=rep1&type=pdf>.

**Usage**

```
SpearmanRho(truth, response)
```

**Arguments**

truth	[numeric] vector of true values
response	[numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
SpearmanRho(truth, response)
```

---

SSE *Sum of squared errors*

---

**Description**

Defined as:  $\text{sum}((\text{response} - \text{truth})^2)$

**Usage**

SSE(truth, response)

**Arguments**

truth            [numeric] vector of true values  
 response        [numeric] vector of predicted values

**Examples**

```
n = 20
set.seed(123)
truth = rnorm(n)
response = rnorm(n)
SSE(truth, response)
```

---

SSR *Spherical Scoring Rule*

---

**Description**

Defined as:  $\text{mean}(p_i(\sum_j(p_{ij})))$ , where  $p_i$  is the predicted probability of the true class of observation  $i$  and  $p_{ij}$  is the predicted probability of observation  $i$  for class  $j$ . See: Bickel, J. E. (2007). Some comparisons among quadratic, spherical, and logarithmic scoring rules. *Decision Analysis*, 4(2), 49-65.

**Usage**

SSR(probabilities, truth)

**Arguments**

probabilities    [numeric] vector (or matrix with column names of the classes) of predicted probabilities  
 truth            vector of true values



**Examples**

```
n = 20
set.seed(122)
truth = as.factor(sample(c(1,2,3), n, replace = TRUE))
probabilities = matrix(runif(60), 20, 3)
probabilities = probabilities/rowSums(probabilities)
colnames(probabilities) = c(1,2,3)
SSR(probabilities, truth)
```

---

TN	<i>True negatives</i>
----	-----------------------

---

**Description**

Sum of correctly classified observations in the negative class. Also called correct rejections.

**Usage**

```
TN(truth, response, negative)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
negative = 0
TN(truth, response, negative)
```

---

TNR	<i>True negative rate</i>
-----	---------------------------

---

**Description**

Percentage of correctly classified observations in the negative class. Also called specificity.

**Usage**

```
TNR(truth, response, negative)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
negative	negative class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
negative = 0
TNR(truth, response, negative)
```

---

TP	<i>True positives</i>
----	-----------------------

---

**Description**

Sum of all correctly classified observations in the positive class.

**Usage**

```
TP(truth, response, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
TP(truth, response, positive)
```

---

TPR	<i>True positive rate</i>
-----	---------------------------

---

**Description**

Percentage of correctly classified observations in the positive class. Also called hit rate or recall or sensitivity.

**Usage**

```
TPR(truth, response, positive)
```

**Arguments**

truth	vector of true values
response	vector of predicted values
positive	positive class

**Examples**

```
n = 20
set.seed(125)
truth = as.factor(sample(c(1,0), n, replace = TRUE))
probabilities = runif(n)
response = as.factor(as.numeric(probabilities > 0.5))
positive = 1
TPR(truth, response, positive)
```

---

WKAPPA	<i>Mean quadratic weighted kappa</i>
--------	--------------------------------------

---

**Description**

Defined as:  $1 - \frac{\sum(\text{weights} * \text{conf.mat})}{\sum(\text{weights} * \text{expected.mat})}$ , the weight matrix measures seriousness of disagreement with the squared euclidean metric.

**Usage**

```
WKAPPA(truth, response)
```

**Arguments**

truth	vector of true values
response	vector of predicted values <code>n = 20 set.seed(122) truth = as.factor(sample(c(1,2,3), n, replace = TRUE)) response = as.factor(sample(c(1,2,3), n, repla WKAPPA(truth, response)</code>

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