

Package ‘BBC’

July 29, 2026

Type Package

Title Bootstrap Bias Correction of Predictive Performance

Version 1.0.0

Date 2026-07-20

Author Michail Tsagris [aut, cre]

Maintainer Michail Tsagris <mtsagris@uoc.gr>

Depends R (>= 4.0)

Imports Hmisc, rangen, Rfast, stats

Suggests Rfast2

Description Bootstrap bias correction for the performance of the cross-validation procedure. The relevant paper is Tsamardinos I., Greasidou E. and Borboudakis G. (2018), <[doi:10.1007/s10994-018-5714-4](https://doi.org/10.1007/s10994-018-5714-4)>.

License GPL (>= 2)

NeedsCompilation no

Repository CRAN

Date/Publication 2026-07-29 17:00:24 UTC

Contents

BBC-package	2
Bootstrap bias correction for the performance of the cross-validation procedure	2
Index	5

BBC-package

Bootstrap Bias Correction of Predictive Performance

Description

Bootstrap bias correction for the predictive performance of the cross-validation procedure.

Details

Package: BBC
Type: Package
Version: 1.0
Date: 2026-07-20

Maintainers

Michail Tsagris <mtsagris@uoc.gr>.

Author(s)

Michail Tsagris <mtsagris@uoc.gr>

References

Ioannis Tsamardinos, Elissavet Greasidou and Giorgos Borboudakis (2018). Bootstrapping the out-of-sample predictions for efficient and accurate cross-validation. *Machine Learning*, 107: 1895–1922.

Bootstrap bias correction for the performance of the
cross-validation procedure

*Bootstrap bias correction for the performance of the cross-validation
procedure*

Description

Bootstrap bias correction for the performance of the cross-validation procedure.

Usage

```
bbc(predictions, target, metric = "auc", conf = 0.95, B = 1000)
```

Arguments

predictions	A matrix with the predicted values.
target	A vector with the target variable, survival object, factor (ordered or unordered) or a numerical vector.
metric	The possible values are: a) Binary target: "auc" (area under the curve), "fscore" (F-score), "prec" (precision), "euclid_sens.spec" (Euclidean distance of sensitivity and specificity), "spec" (specificity), "sens" (sensitivity), "acc" (accuracy, proportion of correct classification). b) Multinomial target: "acc" (accuracy, proportion of correct classification). c) Ordinal target: "ord_mae" (mean absolute error). d) Continuous target: "mae" (MAE with continuous target), "mse" (mean squared error), "pve" (percentage of variance explained). e) Survival target "ci" (concordance index for Cox regression), "ciwr" (concordance index for Weibull regression). g) Count target "poisdev". h) Binomial target "binomdev" (deviance of binomial regression). The "nbdev" (negative binomial deviance) is missing.
conf	A number between 0 and 1, the confidence level.
B	The number of bootstrap replicates. The default number is 1000.

Details

Upon completion of the cross-validation, the predicted values produced by all predictive models across all folds is collected in a matrix P of dimensions $n \times M$, where n is the number of samples and M the number of trained models or configurations. Sampled with replacement a fraction of rows (predictions) from P are denoted as the in-sample values. On average, the newly created set will be comprised by 63.2% of the original individuals (The probability of sampling, with replacement, a sample of n numbers from a set of n numbers is $1 - \left(1 - \frac{1}{n}\right)^n \simeq 1 - \frac{1}{e} = 0.632$), whereas the rest 36.8% will be random copies of them. The non re-sampled rows are denoted as out-of-sample values. The performance of each model in the in-sample rows is calculated and the model (or configuration) with the optimal performance is selected, followed by the calculation of performance in the out-of-sample values. This process is repeated B times and the average performance is returned.

Note, that the only computational overhead is with the repetitive re-sampling and calculation of the predictive performance, i.e. no model is fitted nor trained. The final estimated performance usually underestimates the true performance, but this negative bias is smaller than the optimistic uncorrected performance.

Note, that all metrics are for maximization. For this reason "mse", "mae", "ord_mae", "poisdev", "binomdev" are multiplied by -1.

Value

A list including:

out.perf	The B out sampled performances. Their mean is the "bbc.perf" given above.
----------	---

<code>bbc.perf</code>	The bootstrap bias corrected performance of the chosen algorithm, model or configuration.
<code>ci</code>	The (1- <code>conf</code>)% confidence interval of the BBC performance. It is based on the empirical or percentile method for bootstrap samples. The lower and upper 2.5% of the "out.perf".

Author(s)

R implementation and documentation: Michail Tsagris <mtsagris@uoc.gr>.

References

Ioannis Tsamardinos, Elissavet Greasidou and Giorgos Borboudakis (2018). Bootstrapping the out-of-sample predictions for efficient and accurate cross-validation. *Machine Learning*, 107: 1895–1922.

<https://link.springer.com/article/10.1007/s10994-018-5714-4>

Examples

```
predictions <- matrix(rbinom(200 * 100, 1, 0.7), ncol = 100)
target <- rbinom(200, 1, 0.5)
bbc(predictions, target, metric = "auc")
```

Index

bbc (Bootstrap bias correction for the
performance of the
cross-validation procedure), [2](#)
BBC-package, [2](#)
Bootstrap bias correction for the
performance of the
cross-validation procedure, [2](#)