

# Package ‘predfairness’

May 9, 2026

**Type** Package

**Title** Discrimination Mitigation for Machine Learning Models

**Version** 0.1.0

**Date** 2021-07-14

**Maintainer** Thaís de Bessa Gontijo de Oliveira <thais.bgo@gmail.com>

**Description** Based on different statistical definitions of discrimination, several methods have been proposed to detect and mitigate social inequality in machine learning models. This package aims to provide an alternative to fairness treatment in predictive models. The ROC method implemented in this package is described by Kamiran, Karim and Zhang (2012) <<https://ieeexplore.ieee.org/document/6413831/>>.

**License** GPL (>= 2)

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.1.1

**Suggests** caret, stats

**NeedsCompilation** no

**Author** Thaís de Bessa Gontijo de Oliveira [aut, cre],  
Leonardo Paes Vieira [aut],  
Gustavo Rodrigues Lacerda Silva [ctb],  
Barbara Bianca Alves Cardoso [ctb],  
Douglas Alexandre Gomes Vieira [ctb]

**Depends** R (>= 3.5.0)

**Repository** CRAN

**Date/Publication** 2021-07-28 11:50:02 UTC

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`adult.data`*Adult Dataset*

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**Description**

Sample extracted from the 1994 USA census. Each observation is related to an individual.

**Format**

Data frame with 32,561 rows and 15 columns.

- `income`: factor, >50K / <=50K. Income of each person.
- `age`: integer, age of each person.
- `workclass` factor, category of work. Private, Self-emp-not-inc, Self-emp-inc, Federal-gov, Local-gov, State-gov, Without-pay, Never-worked.
- `fnlwtg`: numeric
- `education`: factor. Bachelors, Some-college, 11th, HS-grad, Prof-school, Assoc-acdm, Assoc-voc, 9th, 7th-8th, 12th, Masters, 1st-4th, 10th, Doctorate, 5th-6th, Preschool.
- `education_num`: numeric. Variable education converted to numeric.
- `marital-status`: factor of marital status. Married-civ-spouse, Divorced, Never-married, Separated, Widowed, Married-spouse-absent, Married-AF-spouse.
- `occupation`: factor. Tech-support, Craft-repair, Other-service, Sales, Exec-managerial, Prof-specialty, Handlers-cleaners, Machine-op-inspct, Adm-clerical, Farming-fishing, Transport-moving, Priv-house-serv, Protective-serv, Armed-Forces.
- `relationship`:: factor. Wife, Own-child, Husband, Not-in-family, Other-relative, Unmarried.
- `race`: factor. White, Asian-Pac-Islander, Amer-Indian-Eskimo, Other, Black.
- `capital_gain`: numeric.
- `capital_loss`. numeric.
- `hours-per-week`: numeric. Worked hours per week.
- `native-country`:: factor. Country of origin.

**Value**

Returns a data frame with 32,561 rows and 15 columns.

**Source**

Dataset extracted from: [UCL Machine Learning Repository](#)

**References**

Dua, D. and Graff, C. (2019). UCI Machine Learning Repository [<http://archive.ics.uci.edu/ml>]. Irvine, CA: University of California, School of Information and Computer Science.

**Examples**

```
data('adult.data')
```

---

```
roc_method
```

---

```
Reject Option based Classification method
```

---

**Description**

Reject Option based Classification (ROC) method for discrimination reduction in predictive models. Given a probabilistic model for binary classifications, ROC is a post processing method which changes instances' classification labels in a defined probability interval. In a probabilistic model, the decision criteria is defined by simply choosing the category with the higher estimated probability. Considering a binary classification, a model returns two complementary probabilities.

Assuming that discriminatory classifications occurs near rejection boundary (when probabilities are near 0.5), the ROC method defines an interval in which probabilities can be considered next to the boundary. Then, once the interval size ([0.5, theta]) is defined, the method looks for the higher probability between the two classes. If a privileged person receives a positive classification with probability between 0.5 and theta, the method turn this classification to negative. Conversely, if the method finds a deprived person with negative classification probability between 0.5 and theta, then it changes her to positive.

**Usage**

```
roc_method(
  pred_mod,
  positive_col,
  positive_class,
  negative_col,
  sensible_col,
  privileged_group,
  classification_col,
  theta
)
```

**Arguments**

```
pred_mod      data frame - predictions and its probabilities with respect to each category.
positive_col  string - positive classification probabilities column name
positive_class string - positive classification label
negative_col  string - negative classification probabilities column name
sensible_col  string - sensible attribute column name
privileged_group
              string - privileged group label
classification_col
              string - classifications column name
theta         numeric - classification probabilities threshold
```

## Details

In a binary classification, the highest probability is always greater than 0.5. Considering already classified instances, and selecting people from the privileged-positive classified group and deprived-negative classified group, the method searches for those with the maximum probability less than  $\theta$ . In this case, the function will change the instance's classification label and replace the two probabilities with their complementary. The user must run the data frame with predictions, the column name with the sensible attribute, as well as the privileged group name through the ROC method. Also, the user must add the classification column name, the categories probabilities columns names and the name of the category considered the positive one. This function returns a data frame with updated probabilities and classifications.

## Value

Returns a new data frame with updated classifications and probabilities, maintaining the structure (columns and its names) of the original data frame, ran in the method.

## Author(s)

Leonardo Paes Vieira

## References

F. Kamiran, A. Karim and X. Zhang, "Decision Theory for Discrimination-Aware Classification," 2012 IEEE 12th International Conference on Data Mining, 2012, pp. 924-929, doi: 10.1109/ICDM.2012.45.

## Examples

```
data('adult.data')

adult.data$income = ifelse(test = adult.data$income == '>50K',
                           yes = 1, no = 0)

adult.data = adult.data[, colnames(adult.data) %in%
                          c('age', 'education', 'sex',
                              'income', 'capital_gain')]

adult.data = adult.data[sample(1:nrow(adult.data), size = 100, replace = FALSE), ]

##### Logistic Regression

if (!requireNamespace("stats", quietly = TRUE)) {
  stop("Package \"stats\" needed for this example to work.",
       call. = FALSE)}

mod = glm(formula = income ~., data = adult.data, family = binomial(link = 'logit'))

### The 'predict' function returns the classes probabilities
### automatically for caret (package) models

pred = data.frame(greater = mod$fitted.values, less = 1 - mod$fitted.values, sex = adult.data$sex,
                  classification = ifelse(mod$fitted.values >= 0.5, 'greater', 'less'))
```

```
theta = 0.6
```

```
pred_changed = roc_method(pred_mod = pred, positive_col = 'greater',  
                           positive_class = 'greater', negative_col = 'less',  
                           sensible_col = 'sex', privileged_group = 'Male',  
                           classification_col = 'classification',  
                           theta = theta)
```

```
pred_changed
```

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