Package ‘fairness’

October 13, 2022

**Title**  Algorithmic Fairness Metrics

**Version**  1.2.2

**Maintainer**  Nikita Kozodoi <n.kozodoi@icloud.com>

**Description**  Offers calculation, visualization and comparison of algorithmic fairness metrics. Fair machine learning is an emerging topic with the overarching aim to critically assess whether ML algorithms reinforce existing social biases. Unfair algorithms can propagate such biases and produce predictions with a disparate impact on various sensitive groups of individuals (defined by sex, gender, ethnicity, religion, income, socioeconomic status, physical or mental disabilities). Fair algorithms possess the underlying foundation that these groups should be treated similarly or have similar prediction outcomes. The fairness R package offers the calculation and comparisons of commonly and less commonly used fairness metrics in population subgroups. These methods are described by Calders and Verwer (2010) <doi:10.1007/s10618-010-0190-x>, Chouldechova (2017) <doi:10.1089/big.2016.0047>, Feldman et al. (2015) <doi:10.1145/2783258.2783311>, Friedler et al. (2018) <doi:10.1145/3287560.3287589> and Zafar et al. (2017) <doi:10.1145/3038912.3052660>. The package also offers convenient visualizations to help understand fairness metrics.

**License**  MIT + file LICENSE

**Language**  en-US

**Encoding**  UTF-8

**LazyData**  true

**RoxygenNote**  7.1.1

**URL**  https://kozodoi.me/r/fairness/packages/2020/05/01/fairness-tutorial.html

**BugReports**  https://github.com/kozodoi/fairness/issues

**Depends**  R (>= 3.5.0)

**Imports**  caret, devtools, e1071, ggplot2, pROC

**Suggests**  testthat, knitr, rmarkdown

**VignetteBuilder**  knitr

**NeedsCompilation**  no

**Author**  Nikita Kozodoi [aut, cre],
Tibor V. Varga [aut] (<https://orcid.org/0000-0002-2383-699X>)

**Repository**  CRAN

**Date/Publication**  2021-04-14 15:00:02 UTC
R topics documented:

- acc_parity ................................. 2
- compas .................................. 4
- dem_parity ................................ 5
- equal_odds ................................ 6
- fairness .................................. 8
- fnr_parity ................................ 9
- fpr_parity ................................ 10
- germancredit ............................. 12
- mcc_parity ................................ 13
- npv_parity ................................ 14
- pred_rate_parity ......................... 16
- prop_parity .............................. 17
- roc_parity ................................ 19
- spec_parity ................................ 20

Index

<table>
<thead>
<tr>
<th>acc_parity</th>
<th>Accuracy parity</th>
</tr>
</thead>
</table>

Description

This function computes the Accuracy parity metric

Formula: \((TP + TN) / (TP + FP + TN + FN)\)

Usage

```r
acc_parity(
  data,
  outcome,
  group,
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
  cutoff = 0.5,
  base = NULL,
  group_breaks = NULL
)
```

Arguments

- data  
  Data.frame that contains the necessary columns.
- outcome  
  Column name indicating the binary outcome variable (character).
- group  
  Column name indicating the sensitive group (character).
The function `acc_parity` computes the Accuracy parity metric as described by Friedler et al., 2018. Accuracy metrics are calculated by the division of correctly predicted observations (the sum of all true positives and true negatives) with the number of all predictions. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their accuracies are lower or higher compared to the reference group. Lower accuracies will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.

**Value**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric_plot</td>
<td>Bar plot of Accuracy parity metric</td>
</tr>
<tr>
<td>Probability_plot</td>
<td>Density plot of predicted probabilities per subgroup. Only plotted if probabil-</td>
</tr>
<tr>
<td></td>
<td>ties are defined</td>
</tr>
</tbody>
</table>

**Examples**

```r
data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
acc_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', cutoff = 0.4, base = 'Caucasian')
acc_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')
```
**Modified COMPAS dataset**

**Description**

compas is a landmark dataset to study algorithmic (un)fairness. This data was used to predict recidivism (whether a criminal will reoffend or not) in the USA. The tool was meant to overcome human biases and offer an algorithmic, fair solution to predict recidivism in a diverse population. However, the algorithm ended up propagating existing social biases and thus, offered an unfair algorithmic solution to the problem. In this dataset, a model to predict recidivism has already been fit and predicted probabilities and predicted status (yes/no) for recidivism have been concatenated to the original data.

**Usage**

compas

**Format**

A data frame with 6172 rows and 9 variables:

- **Two_yr_Recidivism** factor, yes/no for recidivism or no recidivism. This is the outcome or target in this dataset
- **Number_of_Priors** numeric, number of priors, normalized to mean = 0 and standard deviation = 1
- **Age_Above_FourtyFive** factor, yes/no for age above 45 years or not
- **Age_Below_TwentyFive** factor, yes/no for age below 25 years or not
- **Female** factor, female/male for gender
- **Misdemeanor** factor, yes/no for having recorded misdemeanor(s) or not
- **ethnicity** factor, Caucasian, African American, Asian, Hispanic, Native American or Other
- **probability** numeric, predicted probabilities for recidivism, ranges from 0 to 1
- **predicted** numeric, predicted values for recidivism, 0/1 for no/yes

**Source**

The dataset is downloaded from Kaggle [https://www.kaggle.com/danofer/compass](https://www.kaggle.com/danofer/compass) and has undergone modifications (e.g. ethnicity was originally encoded using one-hot encoding, number or priors have been normalized, variables have been renamed, prediction model was fit and predicted probabilities and predicted status were concatenated to the original dataset).
**dem_parity**

---

**Description**

This function computes the Demographic parity metric

Formula: \((\text{TP} + \text{FP})\)

**Usage**

```r
dem_parity(
  data,
  outcome,
  group,
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
  cutoff = 0.5,
  base = NULL,
  group_breaks = NULL
)
```

**Arguments**

- **data**  
  Data.frame that contains the necessary columns.

- **outcome**  
  Column name indicating the binary outcome variable (character).

- **group**  
  Column name indicating the sensitive group (character).

- **probs**  
  Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.

- **preds**  
  Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.

- **outcome_base**  
  Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.

- **cutoff**  
  Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.

- **base**  
  Base level of the sensitive group (character).

- **group_breaks**  
  If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number \(\geq 2\) giving the number of intervals into which group feature is to be cut.
Details

This function computes the Demographic parity metric (also known as Statistical Parity, Equal Parity, Equal Acceptance Rate or Independence) as described by Calders and Verwer 2010. Demographic parity is calculated based on the comparison of the absolute number of all positively classified individuals in all subgroups of the data. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their proportion of positively predicted observations are lower or higher compared to the reference group. Lower proportions will be reflected in numbers lower than 1 in the returned named vector.

Value

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric</td>
<td>Absolute number of positive classifications for all groups and metrics standardized for the base group (demographic parity metric). Lower values compared to the reference group mean lower number of positively predicted observations in the selected subgroups</td>
</tr>
<tr>
<td>Metric_plot</td>
<td>Bar plot of Demographic parity metric</td>
</tr>
<tr>
<td>Probability_plot</td>
<td>Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined</td>
</tr>
</tbody>
</table>

Examples

```r
data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
dem_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
            probs = 'probability', cutoff = 0.4, base = 'Caucasian')
dem_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
            preds = 'predicted', cutoff = 0.5, base = 'Hispanic')
```

Description

This function computes the Equalized Odds metric

Formula: TP / (TP + FN)

Usage

```r
equal_odds(
  data,       
  outcome,    
  group,      
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
)```
```r

equal_odds

cutoff = 0.5,
base = NULL,
group_breaks = NULL
)

Arguments

data Data.frame that contains the necessary columns.
outcome Column name indicating the binary outcome variable (character).
group Column name indicating the sensitive group (character).
probs Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base Base level of the sensitive group (character).
group_breaks If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

Details

This function computes the Equalized Odds metric (also known as Equal Opportunity, Positive Rate Parity or Separation). Equalized Odds are calculated by the division of true positives with all positives (irrespective of predicted values). This metrics equals to what is traditionally known as sensitivity. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their sensitivities are lower or higher compared to the reference group. Lower sensitivities will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.

Value

Metric Raw sensitivities for all groups and metrics standardized for the base group (equalized odds parity metric). Lower values compared to the reference group mean lower sensitivities in the selected subgroups
Metric_plot Bar plot of Equalized Odds metric
Probability_plot Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined
```
Examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
equal_odds(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', cutoff = 0.4, base = 'Caucasian')
equal_odds(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

Description

The fairness package offers calculation, visualization and comparison of algorithmic fairness metrics. Fair machine learning is an emerging topic with the overarching aim to critically assess whether ML algorithms reinforce existing social biases. Unfair algorithms can propagate such biases and produce predictions with a disparate impact on various sensitive groups of individuals (defined by sex, gender, ethnicity, religion, income, socioeconomic status, physical or mental disabilities). Fair algorithms possess the underlying foundation that these groups should be treated similarly or have similar prediction outcomes. The fairness R package offers the calculation and comparisons of commonly and less commonly used fairness metrics in population subgroups. The package also offers convenient visualizations to help understand fairness metrics.

Details

Package: fairness
Depends: R (>= 3.5.0)
Type: Package
Version: 1.2.2
Date: 2021-04-14
License: MIT
LazyLoad: Yes

Author(s)

- Nikita Kozodoi <n.kozodoi@icloud.com>
- Tibor V. Varga <tirgit@hotmail.com>

See Also

https://github.com/kozodoi/fairness https://kozodoi.me/r/fairness/packages/2020/05/01/fairness-tutorial.html
fnr_parity  

False Negative Rate parity

Description

This function computes the False Negative Rate (FNR) parity metric

Formula: FN / (TP + FN)

Usage

fnr_parity(
  data,
  outcome,
  group,
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
  cutoff = 0.5,
  base = NULL,
  group_breaks = NULL
)

Arguments

data Data.frame that contains the necessary columns.
outcome Column name indicating the binary outcome variable (character).
group Column name indicating the sensitive group (character).
probs Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base Base level of the sensitive group (character).
group_breaks If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.
Details

This function computes the False Negative Rate (FNR) parity metric as described by Chouldechova 2017. False negative rates are calculated by the division of false negatives with all positives (irrespective of predicted values). In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their false negative rates are lower or higher compared to the reference group. Lower false negative error rates will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean BETTER prediction for the subgroup.

Value

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric_plot</td>
<td>Bar plot of False Negative Rate parity metric</td>
</tr>
<tr>
<td>Probability_plot</td>
<td>Density plot of predicted probabilities per subgroup. Only plotted if probabili-</td>
</tr>
<tr>
<td></td>
<td>ties are defined</td>
</tr>
</tbody>
</table>

Examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
fnr_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', cutoff = 0.4, base = 'Caucasian')
fnr_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

fpr_parity

False Positive Rate parity

Description

This function computes the False Positive Rate (FPR) parity metric

Formula: FP / (TN + FP)

Usage

fpr_parity(
data,
outcome,
group,
probs = NULL,
preds = NULL,
outcome_base = NULL,
cutoff = 0.5,
Arguments

data: Data.frame that contains the necessary columns.
outcome: Column name indicating the binary outcome variable (character).
group: Column name indicating the sensitive group (character).
probs: Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds: Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base: Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff: Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base: Base level of the sensitive group (character).
group_breaks: If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

Details

This function computes the False Positive Rate (FPR) parity metric as described by Chouldechova 2017. False positive rates are calculated by the division of false positives with all negatives (irrespective of predicted values). In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their false positive rates are lower or higher compared to the reference group. Lower false positives error rates will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean BETTER prediction for the subgroup.

Value

Metric: Raw false positive rates for all groups and metrics standardized for the base group (false positive rate parity metric). Lower values compared to the reference group mean lower false positive error rates in the selected subgroups
Metric_plot: Bar plot of False Positives Rate metric
Probability_plot: Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined

Examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
fpr_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
            base = NULL,
            group_breaks = NULL)
germancredit

probs = 'probability', cutoff = 0.4, base = 'Caucasian')
fpr_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

---

**germancredit**

*Modified german credit dataset*

**Description**

`germancredit` is a credit scoring data set that can be used to study algorithmic (un)fairness. This data was used to predict defaults on consumer loans in the German market. In this dataset, a model to predict default has already been fit and predicted probabilities and predicted status (yes/no) for default have been concatenated to the original data.

**Usage**

`germancredit`

**Format**

A data frame with 1000 rows and 23 variables:

- **Account_status** factor, status of existing checking account
- **Duration** numeric, loan duration in month
- **Credit_history** factor, previous credit history
- **Purpose** factor, loan purpose
- **Amount** numeric, credit amount
- **Savings** factor, savings account/bonds
- **Employment** factor, present employment since
- **Installment_rate** numeric, installment rate in percentage of disposable income
- **Guarantors** factor, other debtors / guarantors
- **Resident_since** factor, present residence since
- **Property** factor, property
- **Age** numeric, age in years
- **Other_plans** factor, other installment plans
- **Housing** factor, housing
- **Num_credits** numeric, Number of existing credits at this bank
- **Job** factor, job
- **People_maintenance** numeric, number of people being liable to provide maintenance for
- **Phone** factor, telephone
- **Foreign** factor, foreign worker
BAD factor, GOOD/BAD for whether a customer has defaulted on a loan. This is the outcome or target in this dataset

Female factor, female/male for gender

Probability numeric, predicted probabilities for default, ranges from 0 to 1

Predicted numeric, predicted values for default, 0/1 for no/yes

Source

The dataset has undergone modifications (e.g. categorical variables were encoded, prediction model was fit and predicted probabilities and predicted status were concatenated to the original dataset).

mcc_parity

Matthews Correlation Coefficient parity

Description

This function computes the Matthews Correlation Coefficient (MCC) parity metric

Formula: \[
\frac{TP \times TN - FP \times FN}{\sqrt{(TP + FP) \times (TP + FN) \times (TN + FP) \times (TN + FN)}}
\]

Usage

mcc_parity(
  data,
  outcome,
  group,
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
  cutoff = 0.5,
  base = NULL,
  group_breaks = NULL
)

Arguments

data          Data.frame that contains the necessary columns.
outcome        Column name indicating the binary outcome variable (character).
group          Column name indicating the sensitive group (character).
probs          Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds          Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base   Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff

Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.

base

Base level of the sensitive group (character).

group_breaks

If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

Details

This function computes the Matthews Correlation Coefficient (MCC) parity metric. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their Matthews Correlation Coefficients are lower or higher compared to the reference group. Lower Matthews Correlation Coefficients rates will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.

Value

<table>
<thead>
<tr>
<th>Metric</th>
<th>Raw Matthews Correlation Coefficient metrics for all groups and metrics standardized for the base group (parity metric). Lower values compared to the reference group mean Matthews Correlation Coefficients in the selected subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric_plot</td>
<td>Bar plot of Matthews Correlation Coefficient metric</td>
</tr>
<tr>
<td>Probability_plot</td>
<td>Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined</td>
</tr>
</tbody>
</table>

Examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
mcc_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity', probs = 'probability', cutoff = 0.4, base = 'Caucasian')
mcc_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity', preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

---

npv_parity

Negative Predictive Value parity

Description

This function computes the Negative Predictive Value (NPV) parity metric

Formula: TN / (TN + FN)
npv_parity

Usage

npv_parity(
  data,
  outcome,
  group,
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
  cutoff = 0.5,
  base = NULL,
  group_breaks = NULL
)

Arguments

data          Data.frame that contains the necessary columns.
outcome       Column name indicating the binary outcome variable (character).
group         Column name indicating the sensitive group (character).
probs         Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds         Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base  Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff        Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base          Base level of the sensitive group (character).
group_breaks  If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

Details

This function computes the Negative Predictive Value (NPV) parity metric as described by the Aequitas bias toolkit. Negative Predictive Values are calculated by the division of true negatives with all predicted negatives. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their negative predictive values are lower or higher compared to the reference group. Lower negative predictive values will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.

Value

Metric        Raw negative predictive values for all groups and metrics standardized for the base group (negative predictive value parity metric). Lower values compared to the reference group mean lower negative predictive values in the selected subgroups.
Metric_plot  Bar plot of Negative Predictive Value metric
Probability_plot  Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined

Examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
npv_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', cutoff = 0.4, base = 'Caucasian')
npv_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

pred_rate_parity  Predictive Rate Parity

Description

This function computes the Predictive Rate Parity metric.

Formula: TP / (TP + FP)

Usage

pred_rate_parity(
  data,
  outcome,
  group,
  probs = NULL,
  preds = NULL,
  outcome_base = NULL,
  cutoff = 0.5,
  base = NULL,
  group_breaks = NULL
)

Arguments

data  Data.frame that contains the necessary columns.
outcome  Column name indicating the binary outcome variable (character).
group  Column name indicating the sensitive group (character).
probs  Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds  Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
prop_parity

outcome_base: Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff: Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base: Base level of the sensitive group (character).
group_breaks: If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

details

This function computes the Predictive Rate Parity metric (also known as Sufficiency) as described by Zafar et al., 2017. Predictive rate parity is calculated by the division of true positives with all observations predicted positives. This metrics equals to what is traditionally known as precision or positive predictive value. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their precisions are lower or higher compared to the reference group. Lower precisions will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.

value

Metric: Raw precision metrics for all groups and metrics standardized for the base group (predictive rate parity metric). Lower values compared to the reference group mean lower precisions in the selected subgroups.
Metric_plot: Bar plot of Predictive Rate Parity metric
Probability_plot: Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined.

examples

data(compas)
compas$Two_yr_Recedivism_01 <- ifelse(compas$Two_yr_Recedivism == 'yes', 1, 0)
pred_rate_parity(data = compas, outcome = 'Two_yr_Recedivism_01', group = 'ethnicity',
probs = 'probability', cutoff = 0.4, base = 'Caucasian')
pred_rate_parity(data = compas, outcome = 'Two_yr_Recedivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

prop_parity

prop_parity: Proportional parity

description

This function computes the Proportional parity metric.

Formula: (TP + FP) / (TP + FP + TN + FN)
prop_parity

prop_parity(
    data,
    outcome,
    group,
    probs = NULL,
    preds = NULL,
    outcome_base = NULL,
    cutoff = 0.5,
    base = NULL,
    group_breaks = NULL
)

Arguments

data Data.frame that contains the necessary columns.
outcome Column name indicating the binary outcome variable (character).
group Column name indicating the sensitive group (character).
probs Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base Base level of the sensitive group (character).
group_breaks If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

Details

This function computes the Proportional parity metric (also known as Impact Parity or Minimizing Disparate Impact) as described by Calders and Verwer 2010. Proportional parity is calculated based on the comparison of the proportion of all positively classified individuals in all subgroups of the data. In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their proportion of positively predicted observations are lower or higher compared to the reference group. Lower proportions will be reflected in numbers lower than 1 in the returned named vector.

Value

Metric Raw proportions for all groups and metrics standardized for the base group (proportional parity metric). Lower values compared to the reference group mean lower proportion of positively predicted observations in the selected subgroups.
Metric_plot  Bar plot of Proportional parity metric
Probability_plot  Density plot of predicted probabilities per subgroup. Only plotted if probabili-
ties are defined

Examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
prop_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', cutoff = 0.4, base = 'Caucasian')
prop_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
preds = 'predicted', cutoff = 0.5, base = 'Hispanic')

---

roc_parity  

ROC AUC parity

Description
This function computes the ROC AUC parity metric

Usage
roc_parity(data, outcome, group, probs, base = NULL, group_breaks = NULL)

Arguments

data  Data.frame that contains the necessary columns.
outcome  Column name indicating the binary outcome variable (character).
group  Column name indicating the sensitive group (character).
probs  Column name or vector with the predicted probabilities (numeric between 0 - 1).
base  Base level of the sensitive group (character).
group_breaks  If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

Details
This function computes the ROC AUC values for each subgroup. In the returned table, the reference group will be assigned 1, while all other groups will be assigned values according to whether their ROC AUC values are lower or higher compared to the reference group. Lower ROC AUC will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.
Specification

**Value**

- **Metric**: Raw ROC AUC metrics for all groups and metrics standardized for the base group (parity metric). Lower values compared to the reference group mean lower ROC AUC values in the selected subgroups.
- **Metric_plot**: Bar plot of ROC AUC metric
- **Probability_plot**: Density plot of predicted probabilities per subgroup
- **ROCAUC_plot**: ROC plots for all subgroups

**Examples**

```r
data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
roc_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', base = 'Caucasian')
roc_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity',
probs = 'probability', base = 'African_American')
```

---

**Description**

This function computes the Specificity parity metric

Formula: \( \frac{TN}{TN + FP} \)

**Usage**

```r
spec_parity(
data,  
outcome,  
group,  
probs = NULL,  
preds = NULL,  
outcome_base = NULL,  
cutoff = 0.5,  
base = NULL,  
group_breaks = NULL
)
```

**Arguments**

- **data**: Data.frame that contains the necessary columns.
- **outcome**: Column name indicating the binary outcome variable (character).
- **group**: Column name indicating the sensitive group (character).
spec_parity

probs  Column name or vector with the predicted probabilities (numeric between 0 - 1). Either probs or preds need to be supplied.
preds  Column name or vector with the predicted binary outcome (0 or 1). Either probs or preds need to be supplied.
outcome_base  Base level of the outcome variable (i.e., negative class). Default is the first level of the outcome variable.
cutoff  Cutoff to generate predicted outcomes from predicted probabilities. Default set to 0.5.
base  Base level of the sensitive group (character).
group_breaks  If group is continuous (e.g., age): either a numeric vector of two or more unique cut points or a single number >= 2 giving the number of intervals into which group feature is to be cut.

details

This function computes the Specificity parity metric. Specificities are calculated by the division of true negatives with all negatives (irrespective of predicted values). In the returned named vector, the reference group will be assigned 1, while all other groups will be assigned values according to whether their specificities are lower or higher compared to the reference group. Lower specificities will be reflected in numbers lower than 1 in the returned named vector, thus numbers lower than 1 mean WORSE prediction for the subgroup.

value

Metric  Raw specificity metrics for all groups and metrics standardized for the base group (specificity parity metric). Lower values compared to the reference group mean lower specificities in the selected subgroups
Metric_plot  Bar plot of Specificity parity metric
Probability_plot  Density plot of predicted probabilities per subgroup. Only plotted if probabilities are defined

examples

data(compas)
compas$Two_yr_Recidivism_01 <- ifelse(compas$Two_yr_Recidivism == 'yes', 1, 0)
spec_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity', probs = 'probability', cutoff = 0.4, base = 'Caucasian')
spec_parity(data = compas, outcome = 'Two_yr_Recidivism_01', group = 'ethnicity', preds = 'predicted', cutoff = 0.5, base = 'Hispanic')
Index

* datasets
  - compas, 4
    - germancredit, 12
  - acc_parity, 2
  - compas, 4, 4
  - dem_parity, 5
  - equal_odds, 6
  - fairness, 8
  - fnr_parity, 9
  - fpr_parity, 10
  - germancredit, 12, 12
  - mcc_parity, 13
  - npv_parity, 14
  - pred_rate_parity, 16
  - prop_parity, 17
  - roc_parity, 19
  - spec_parity, 20