# Post-processing measures

## Imports

```
library(fairmodels)
library(tidymodels)
```

```
## -- Attaching packages -------------------------------------- tidymodels 0.2.0 --

## v broom        0.8.0     v recipes      0.2.0
## v dials        0.1.1     v rsample      0.1.1
## v dplyr        1.0.9     v tibble       3.1.7
## v ggplot2      3.3.6     v tidyr        1.2.0
## v infer        1.0.0     v tune         0.2.0
## v modeldata    0.1.1     v workflows    0.2.6
## v parsnip      0.2.1     v workflowsets 0.2.1
## v purrr        0.3.4     v yardstick    0.0.9

## -- Conflicts ----------------------------------------- tidymodels_conflicts() --
## x purrr::discard() masks scales::discard()
## x dplyr::filter()  masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## x recipes::step()  masks stats::step()
## * Use suppressPackageStartupMessages() to eliminate package startup messages
```

```
library(rpart)
```

```
##
## Attaching package: 'rpart'

## The following object is masked from 'package:dials':
##
##     prune
```

```
library(discrim)
```

```
##
## Attaching package: 'discrim'

## The following object is masked from 'package:dials':
##
##     smoothness
```

```
source("../scripts/metrics_on_dataset.R")
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v readr   2.1.2     v forcats 0.5.1
## v stringr 1.4.0

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x readr::col_factor() masks scales::col_factor()
## x purrr::discard()    masks scales::discard()
## x dplyr::filter()     masks stats::filter()
## x stringr::fixed()    masks recipes::fixed()
## x dplyr::lag()        masks stats::lag()
## x readr::spec()       masks yardstick::spec()
```

### Data

```
df <- read_rds("../data/selection.rds") %>%
  select(-gender, -rating) %>%
  mutate(accepted = as.factor(accepted))
```

## Naive Bayes ensamble

### Functions

```
adjust_fit <- function(cutoffs, direction){
  if (direction == "up"){
    cutoffs["Non_Dutch"] <- cutoffs["Non_Dutch"] - 0.01
  } else if (direction == "down"){
    cutoffs["Dutch"] <- cutoffs["Dutch"] + 0.01
  }
  cutoffs
}

df_disc <- function(df){
  summary_true <- group_fairness(df, nationality, predicted)[[1]] %>%
    filter(predicted == "TRUE")
  max_val <- max(select(summary_true, perc))
  min_val <- min(select(summary_true, perc))

  list(disc = max_val - min_val, n = sum(select(summary_true, total)))
}

predictions <- function(df, fitted_models, cutoffs) {
  df_dutch <- filter(df, nationality == "Dutch")
  df_non_dutch <- filter(df, nationality != "Dutch")
```

```r
  predictions_dutch <- predict(fitted_models[["Dutch"]], df_dutch, type="prob")[".pred_TRUE"]
  predictions_non_dutch <- predict(fitted_models[["Non_Dutch"]], df_non_dutch, type="prob")[".pred_TRUE

  df_dutch["predicted"] <- as.factor(predictions_dutch >= cutoffs["Dutch"])
  df_non_dutch["predicted"] <- as.factor(predictions_non_dutch >= cutoffs["Non_Dutch"])

  joined_df = bind_rows(df_dutch, df_non_dutch)
}

causal_discrimination_joined_model <- function(df, fitted_models, cutoffs) {
  pop_size <- nrow(df)

  df_dutch <- filter(df, nationality == "Dutch")
  df_non_dutch <- filter(df, nationality != "Dutch")

  predictions_dutch <- predict(fitted_models[["Dutch"]], df_dutch, type="prob")[".pred_TRUE"]
  inv_predictions_dutch <- predict(fitted_models[["Non_Dutch"]], df_dutch, type="prob")[".pred_TRUE"]

  predictions_non_dutch <- predict(fitted_models[["Non_Dutch"]], df_non_dutch, type="prob")[".pred_TRUE
  inv_predictions_non_dutch <- predict(fitted_models[["Dutch"]], df_non_dutch, type="prob")[".pred_TRUE

  df_dutch["predicted"] <- as.factor(predictions_dutch >= cutoffs["Dutch"])
  df_dutch["inv_predicted"] <- as.factor(inv_predictions_dutch >= cutoffs["Non_Dutch"])
  df_non_dutch["predicted"] <- as.factor(predictions_non_dutch >= cutoffs["Non_Dutch"])
  df_non_dutch["inv_predicted"] <- as.factor(inv_predictions_non_dutch >= cutoffs["Dutch"])

  joined_df <- bind_rows(df_dutch, df_non_dutch) %>%
    mutate(different = predicted != inv_predicted)

  list(sum(joined_df$different)/pop_size, joined_df)
}
```

## Setup

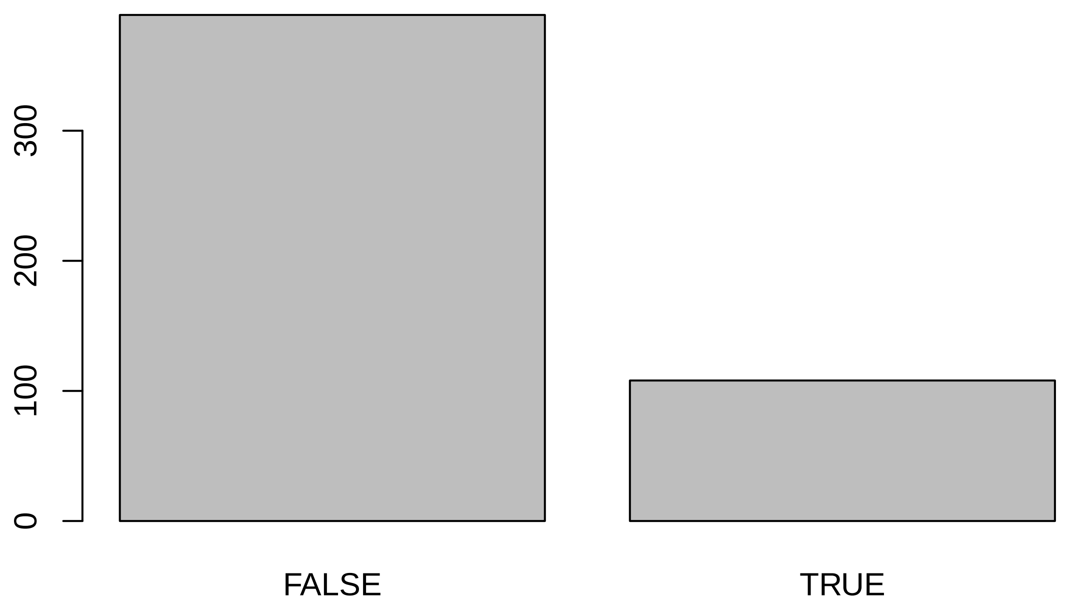
```r
original_n <- sum(df$accepted == "TRUE")

df_dutch <- filter(df, nationality == "Dutch")
df_non_dutch <- filter(df, nationality != "Dutch")

model <- naive_Bayes()
```

```r
cutoffs <- c(Dutch = 0.5, Non_Dutch = 0.5)

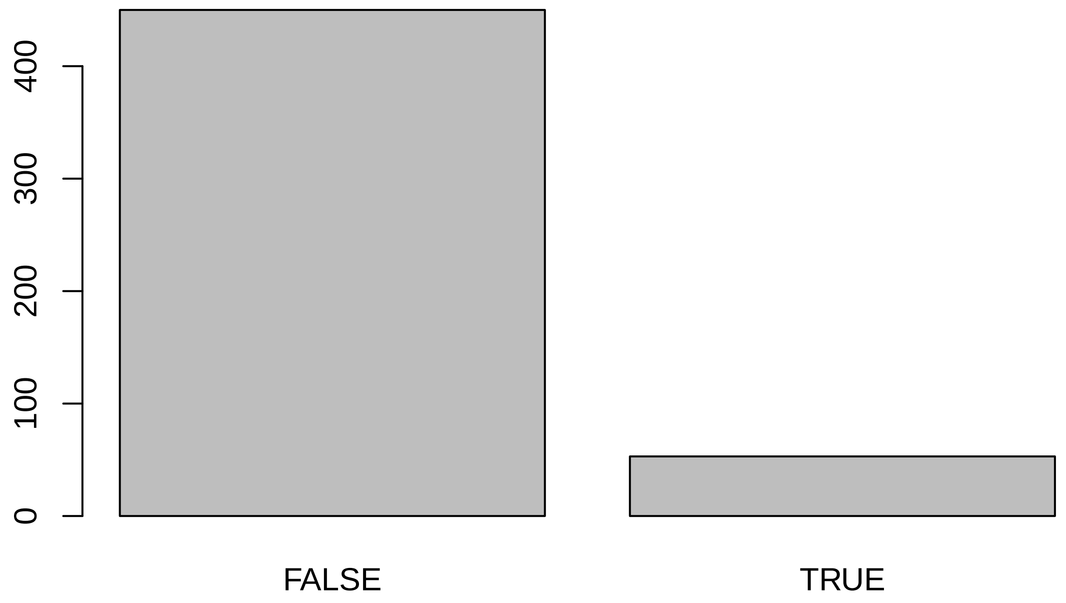
models <- list(Dutch = model %>%
              fit(accepted ~ test_score + english_cert + extracurricular, df_dutch),
            Non_Dutch = model %>%
              fit(accepted ~ test_score + english_cert + extracurricular, df_non_dutch))

predictions_df = predictions(df, models, cutoffs)

plot(filter(predictions_df, nationality == "Dutch") %>% select(predicted))
```



```
plot(filter(predictions_df, nationality == "Non_Dutch") %>% select(predicted))
```



```
result <- df_disc(predictions_df)
```

```
## ‘summarise()‘ has grouped output by ’nationality’. You can override using the
## ‘.groups‘ argument.
```

```
i <- 0
while (result$disc > 2) {

  if (result$n < original_n) {
    cutoffs <- adjust_fit(cutoffs, "up")
  } else {
    cutoffs <- adjust_fit(cutoffs, "down")
  }

  predictions_df = predictions(df, models, cutoffs)

  result <- df_disc(predictions_df)
  # print(result)
}
```

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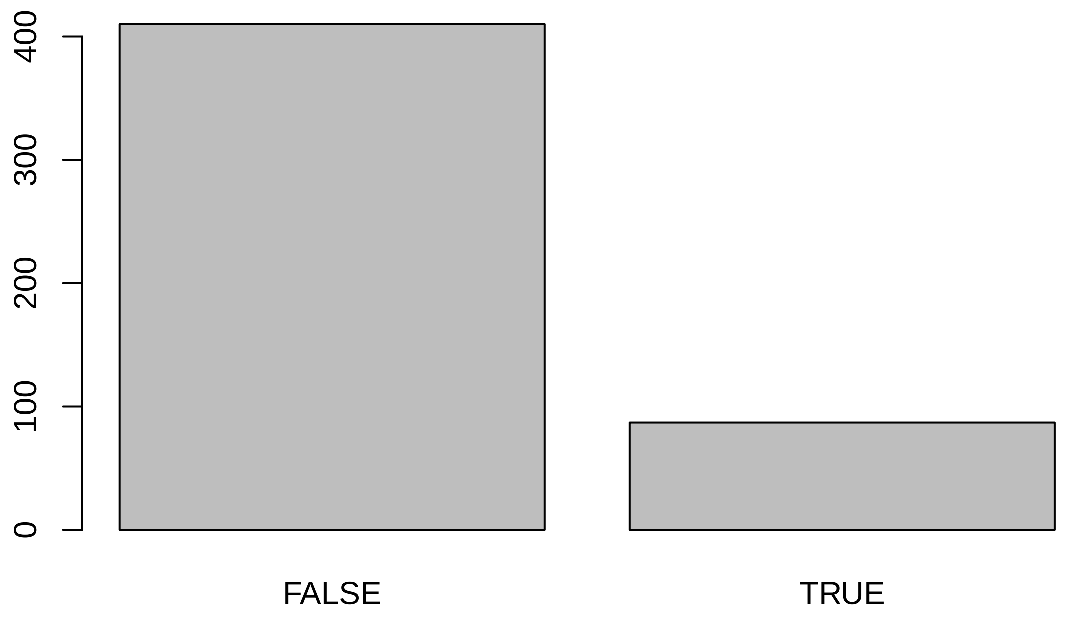
```

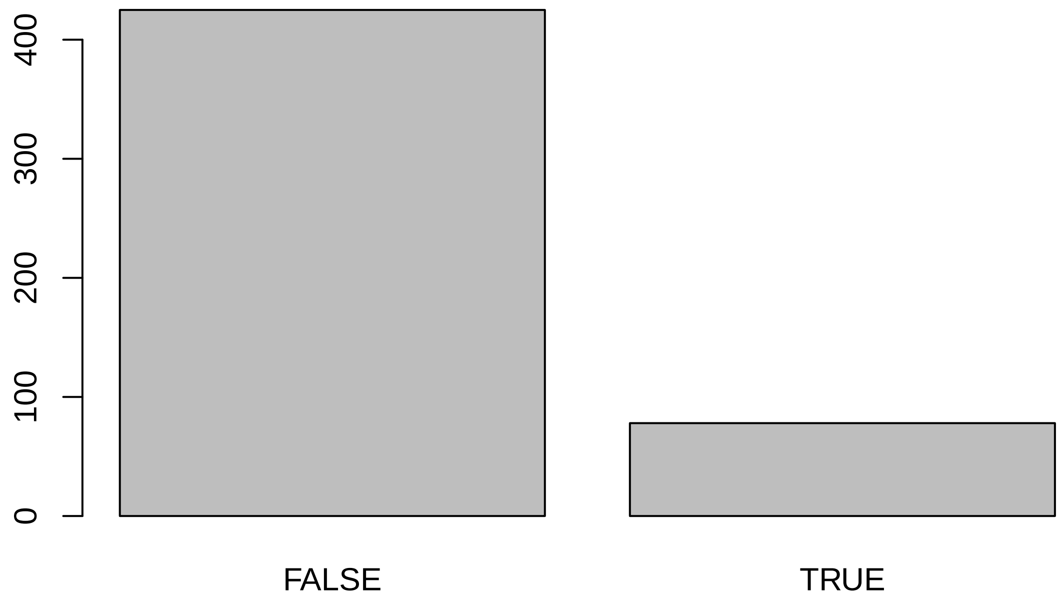
```
print(cutoffs)
```

```
##     Dutch Non_Dutch
##      0.70      0.02
```

```
plot(filter(predictions_df, nationality == "Dutch") %>% select(predicted))
```



```
plot(filter(predictions_df, nationality == "Non_Dutch") %>% select(predicted))
```



## Metrics

```
print(group_fairness(predictions_df, nationality, predicted)[[1]])
```

```
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```

```
## # A tibble: 4 x 4
##   nationality predicted total  perc
##   <fct>       <fct>     <int> <dbl>
## 1 Dutch       FALSE       410  82.5
## 2 Dutch       TRUE         87  17.5
## 3 Non_Dutch   FALSE       425  84.5
## 4 Non_Dutch   TRUE         78  15.5
```

```
print(causal_discrimination_joined_model(df, models, cutoffs)[[1]])
```

```
## [1] 0.064
```