

Code File Thesis: Predicting a Child's Genuine Smile

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```
# load styler for styling the R code. Create citations for the thesis report.  
# Remaining packages are loaded while coding.  
library(styler)  
library(report)  
citation("report")  
citation("styler")
```

Thesis code file

This document can serve as a guideline for performing a social science or marketing study involving video analysis. The features retrieved from the video's can be used to train and predict classification models.

This document holds the following structure:

Part 1: Preparing the data - Load the processed video CSV file into R - Combining different CSV files into a master data frame - Pre-process the data frame obtained by the loaded and combined data - Data cleaning steps - Feature creation - Creating descriptive statistics

Part 2: EDA - Descriptive statistics tables - Distribution analysis

Part 3: Train and predict - Train and test set - Training models (decision trees and SVM) - Prediction - Evaluation

Part 4: Remain code used in this project

A complete reference list of can be found in the thesis file. References of the packages used to create the code, can be found in the code blocks. They are not printed in the HTML or pdf output. Some ideas have been obtained using help forums like stackoverflow (<https://stackoverflow.com/>). Usually in the posts you can also find help debugging your code.

Disclaimer

The thesis and this RMarkdown code file do not contain any studies with human participants or animals performed by the author. Data used in this study were previously collected. The original owner of the data retains ownership of the data during and after the completion of this thesis.

Part 1: processing video's into one dataset in R.

Before loading the data a new Project directory is created. All data used for this project is stored in this directory.

Load the data

The database is processed through OpenFace2.0 and consists of 475 csv files. These are loaded into R using the dplyr package. The original filename is added to the database using the flnm function. The function appends the filename to each record during the initial reading of the csv files. Next, this function reading multiple csv files add once is used, instead of the `read_csv()` function.

Attributions and Appreciations: With special thanks to: <https://stackoverflow.com/users/5088194/leerssej> for providing the code for both functions to append the filenames and load multiple csv files add once in one dataframe.

```
# load packages
library(tidyverse)
library(data.table)

# *dplyr()*
# 'read_csv()'

# functions to load the data
read_plus <- function(flnm) {
  read_csv(flnm) %>%
    mutate(filename = flnm)
}

map_df_read_csv <- function(path, pattern = "*.csv") {
  list.files(path, pattern, full.names = TRUE) %>%
    map_df(~ read_plus(.))
}

# create a data frame and relocate the ID column as the first column
df <- map_df_read_csv("Data_Openface/CSV", "*.csv")
df %>% relocate(filename, .before = face_id)

# save the data frame
write.csv(x = df, file = "masterfile", row.names = FALSE)

# citation("tidyverse")
# citation("data.table")
```

Last step, the dataframe is saved as “masterfile” in the project directory.

Combining information about the dataset in one dataframe

Check the filename column using tables of a copy of the original dataframe. First, the dataframe is loaded the dataframe the project drive, and a copy of the file is created. Next, file names are changed into readable files to connect to the gender and age information from separate text files. Open the file of details. Adjust the filename column to be the same as the dataframe. Use `inner_join()` from the dplyr package to connect the two dataframes. Check the number of observations and variables. Last save the new dataframe as a csv raw database to work with in the next steps of the process, EDA and datacleaning.

From now on the masterfile_connected will be the raw database saved as it contains the full set of elements. The database contains of 95,830 observations and 719 variables.

```

# reload the data and create a copy as working file
library(tidyverse)
df <- read.csv("masterfile")
df_copy <- df
df_copy %>% relocate(filename, .before = face_id)
# check the data frame ID
table(df_copy$filename)

# clean filename information to a readable format
df_copy$filename <- gsub(".csv", "", df_copy$filename)
df_copy$filename <- gsub("Data_Openface/CSV/", "", df_copy$filename)
df_copy$filename
table(df_copy$filename)

# open file information from the text file
UvA_subjects <- read.csv("UvA-NEMO_Smile_Database_File_Details.txt",
  header = FALSE, skip = 4, sep = "\t"
)

# create column names
colnames(UvA_subjects) <-
  c("filename", "subject", "gender", "age", "smile_type")

# clean filename format
UvA_subjects$filename <- gsub(".mp4", "", UvA_subjects$filename)

# join the two datasets by filename
UvA_df <- inner_join(UvA_subjects, df_copy, "filename")

# save the data frame
write.csv(x = UvA_df, file = "masterfile_connected", row.names = FALSE)

```

Data cleaning

For datacleaning, the masterfile_connected is used and will serve as base for further pre-processing. Next step is checking the data for NA's. The colSums table shows there are no NA values in the database. A visualized NA report is showing no values meaning no NA's and a full combination field for the dataframe.

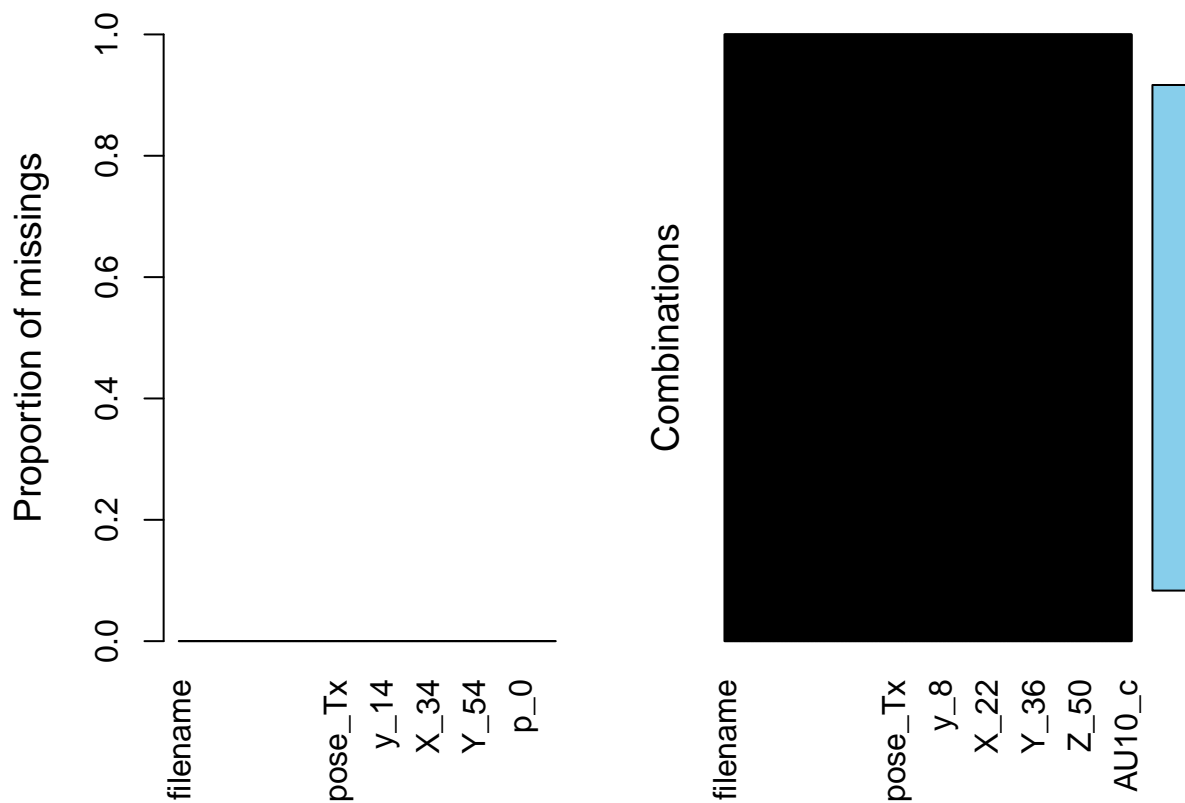
```

# load packages
library(tidyverse)
library(dplyr)
library("VIM")

# load masterfile and create a copy
UvA_original <- read.csv("masterfile_connected")

# check for NA's on different levels using tables and summary data
table(UvA_original$subject, useNA = "always")
table(UvA_original$subject, UvA_original$age)
colSums(is.na(UvA_original))
aggr(UvA_original)

```



```
table(UvA_original$age, UvA_original$smile_type)
table(UvA_original$gender, UvA_original$smile_type)
table(UvA_original$smile_type, UvA_original$subject)
summary(UvA_original[, 1:10])
summary(UvA_original[, 11:20])

# AU selection check
summary(UvA_original[, 700:719])

citation("dplyr")
citation("VIM")
```

Next the confidence and success rate from the original file are checked. All 95.830 video frames are processed successfully by OpenFace and the `mean()` confidence rate is 98.

```
# Check the confidence and success rate of the loaded video's.
table(UvA_original$confidence)
```

```
##
##  0.88  0.93  0.98
##      6 2150 93674
```

```
table(UvA_original$success)
```

```
##
```

```
##      1
## 95830
```

```
mean(UvA_original$confidence)
```

```
## [1] 0.978872
```

Feature selection and creation.

After loading and checking the data the next step is to create and select the features for the models. There are three different types of features to work with in this research question: parts or symmetry of the face, facial expression and temporal features. In the code below, the dataset is converted to a final dataset including all the features either selected or created. This final dataset is used in the next part of the report to build the models and perform the analysis. In the thesis report an elaboration will be given on the description, selection and calculation of the features.

```
# load packages
library(readr)
library(scales)

# create a copy from the original dataset to create the final dataset
UvA_final <- UvA_original

# select and create the features for the database using a pipeline
UvA_final <- UvA_final %>%
  select(
    filename, subject, gender, age, smile_type, frame, timestamp,
    starts_with("gaze_angle"), starts_with("pose_"), starts_with("AU"),
    x_36, x_37, x_38, x_39, x_42, x_43, x_44, x_45, x_48, x_54, y_36, y_37,
    y_38, y_39, y_42, y_43, y_44, y_45, y_48, y_54
  ) %>%
  mutate(AU06_12_c = ifelse(AU06_c == 1 & AU12_c == 1, 1, 0)) %>%
  mutate(lip = sqrt((x_48 - x_54)^2 + (y_48 - y_54)^2)) %>%
  mutate(eye_x_m_l = (x_36 + x_39) / 2) %>%
  mutate(eye_y_m_l = (y_36 + y_39) / 2) %>%
  mutate(eye_x_m_r = (x_42 + x_45) / 2) %>%
  mutate(eye_y_m_r = (y_42 + y_45) / 2) %>%
  mutate(eye_x_u_l = (x_37 + x_38) / 2) %>%
  mutate(eye_y_u_l = (y_37 + y_38) / 2) %>%
  mutate(eye_x_u_r = (x_43 + x_44) / 2) %>%
  mutate(eye_y_u_r = (y_43 + y_44) / 2) %>%
  mutate(
    eye_l = sqrt((eye_x_m_l - eye_x_u_l)^2 + (eye_y_m_l - eye_y_u_l)^2)
  ) %>%
  mutate(
    eye_r = sqrt((eye_x_m_r - eye_x_u_r)^2 + (eye_y_m_r - eye_y_u_r)^2)
  ) %>%
  mutate(eye = (eye_l + eye_r) / 2) %>%
  mutate(lip_m_x = (x_48 + x_54) / 2) %>%
  mutate(lip_m_y = (y_48 + y_54) / 2) %>%
  mutate(amplitude = rescale(sqrt((x_54 - lip_m_x)^2 + (y_54 - lip_m_y)^2))) %>%
  mutate(duration = 0.02) %>%
```

```

mutate(stage = duration / amplitude) %>%
group_by(filename) %>%
mutate(apex = ifelse(amplitude > mean(amplitude), amplitude, NA)) %>%
mutate(onset_offset = ifelse(amplitude <= mean(amplitude), amplitude, NA)) %>%
mutate(onset = ifelse(onset_offset & frame < mean(frame), amplitude, NA)) %>%
mutate(offset = ifelse(onset_offset & frame >= mean(frame),
  amplitude, NA
)) %>%
select(
  filename, subject, gender, age, smile_type, frame, timestamp,
  starts_with("gaze"), starts_with("pose_R"),
  starts_with("AU") & ends_with("_r"),
  lip, eye, amplitude, stage, apex, offset, onset
) %>%
ungroup()

# save the final file.
write_csv(UvA_final, "UvA_final")

# Mathematical Notes:

# distance between landmark points 36 and 39 left and 42 and 45 right eyes
# eye middle point of x and y = x_eye_middle (x36 + x39)/2 etc y
# eye upper middle point of x and y = x_eye_upper_middle (x37 + x38)/2
# same for the right eye

# euclidean distance for eye: sqrt(x2-x1)2+(y2-y1)2
# see calculation lip but than for eye_middle point vs eye_upper_point

# eye gaze only take the angle

# duration ratio = timestamp/duration
# amplitude = lip middle towards left lip corner

# check if sum stats are the same as with OpenFacer - done same result
# all(UvA_face_check$pose_Tz_sd, UvA_sum$pose_Tz_sd)

# citation("readr")
# citation("scales")

```

Temporal features apex, onset & offset

For apex, onset and offset, four options for defining the stages have been reviewed. All options show about the same signal as the lip amplitude feature created to measure onset, apex and offset. The options are, the longest subsequence and, start, middle and end point of AU06 and starting point of AU12, based on the categorical variables, and the mean `abline()` of amplitude. AU12 proves to be always there and starts at different levels for every subject, so this feature could not be used as the categorical variable always displays one. The same goes for the amplitude itself, but because the data show a relative long apex face, the mean is close to the apex value. Therefore a split of stages based on the mean `abline()` would be a solid solution. The longest subsequence variable could be used as it concerns a single smile but does not show a stable enough sequence to be used (see picture). The AU06 categorical variable starts from zero with every subject, but about 80 participants do not show a offset based on this metric. Therefore the choice is to proceed with the mean `abline()` split point of the three stages, onset, apex and offset. The plot shows all

4 as an illustration.

Attributions and Appreciations: With special thanks to: Jinjing Xie <https://www.r-bloggers.com/2014/09/compute-longest-increasingdecreasing-subsequence-using-rcpp/> for providing the code for the function.

```
# load packages
library(compiler)

# function for creating longest sub sequence
longest_subseq.R <- cmpfun(function(x) {
  P <- integer(length(x))
  M <- integer(length(x) + 1)
  L <- newL <- 0
  for (i in seq_along(x) - 1) {
    lo <- 1
    hi <- L
    while (lo <= hi) {
      mid <- (lo + hi) %/% 2
      if (x[M[mid + 1] + 1] < x[i + 1]) {
        lo <- mid + 1
      } else {
        hi <- mid - 1
      }
    }
    newL <- lo
    P[i + 1] <- M[newL]
    if (newL > L) {
      M[newL + 1] <- i
      L <- newL
    } else if (x[i + 1] < x[M[newL + 1] + 1]) {
      M[newL + 1] <- i
    }
  }
  k <- M[L + 1]
  re <- integer(L)
  for (i in L:1) {
    re[i] <- k + 1
    k <- P[k + 1]
  }
  re
})

# check the result of one participant number 20.
longest_subseq.R(UvA_final$amplitude[1:193])
```

```
## [1]  2  3  5  6  8  9 11 12 13 14 15 16 17 18 19 20 21 22 23
## [20] 24 48 49 50 51 52 53 54 59 60 61 67 68 70 72 78 79 80 83
## [39] 85 90 94 95 100 101 106 108 110 111 113 115 116 119 121
```

```
# create graphs to check the four options.
par(mfrow = c(2, 2))
par(mai = c(.8, .8, .2, .2))

# option 1: mean calculation
```

```

plot(UvA_final$frame[1:193], UvA_final$amplitude[1:193],
     main = "Sequences amplitude",
     ylab = "amplitude", xlab = "frame", pch = 16, col = "#0000004D",
     cex.main = 0.7
)
abline(mean(UvA_final$amplitude[1:193]), 0, col = "blue", pch = 16)
abline(v = 15, lty = 2)
abline(v = 175, lty = 2)
text(5, 0.7, "onset")
text(100, 0.7, "apex")
text(187, 0.7, "offset")

# option 2: AU12
plot(UvA_final$frame[1:193], UvA_final$AU12_r[1:193],
     main = "Sequences AU12_r",
     ylab = "amplitude", xlab = "frame", pch = 16, col = "#0000004D",
     cex.main = 0.7
)

# option 3: AU06
plot(UvA_final$frame[1:193], UvA_final$AU06_r[1:193],
     main = "Sequences AU06_r",
     ylab = "amplitude", xlab = "frame", pch = 16, col = "#0000004D",
     cex.main = 0.7
)

# option 4: LIS (increasing and decreasing)
plot(UvA_final$amplitude[1:193],
     main = "Longest Increasing (blue) and Decreasing (red) Subsequences",
     ylab = "amplitude", xlab = "frame", pch = 16, col = "#0000004D",
     cex.main = 0.7
)
ind <- longest_subseq.R(UvA_final$amplitude[1:193])
ind

```

```

## [1] 2 3 5 6 8 9 11 12 13 14 15 16 17 18 19 20 21 22 23
## [20] 24 48 49 50 51 52 53 54 59 60 61 67 68 70 72 78 79 80 83
## [39] 85 90 94 95 100 101 106 108 110 111 113 115 116 119 121

```

```

points(ind, UvA_final$amplitude[1:193][ind], pch = 16, col = "blue")
rind <- longest_subseq.R(-UvA_final$amplitude[1:193])
rind

```

```

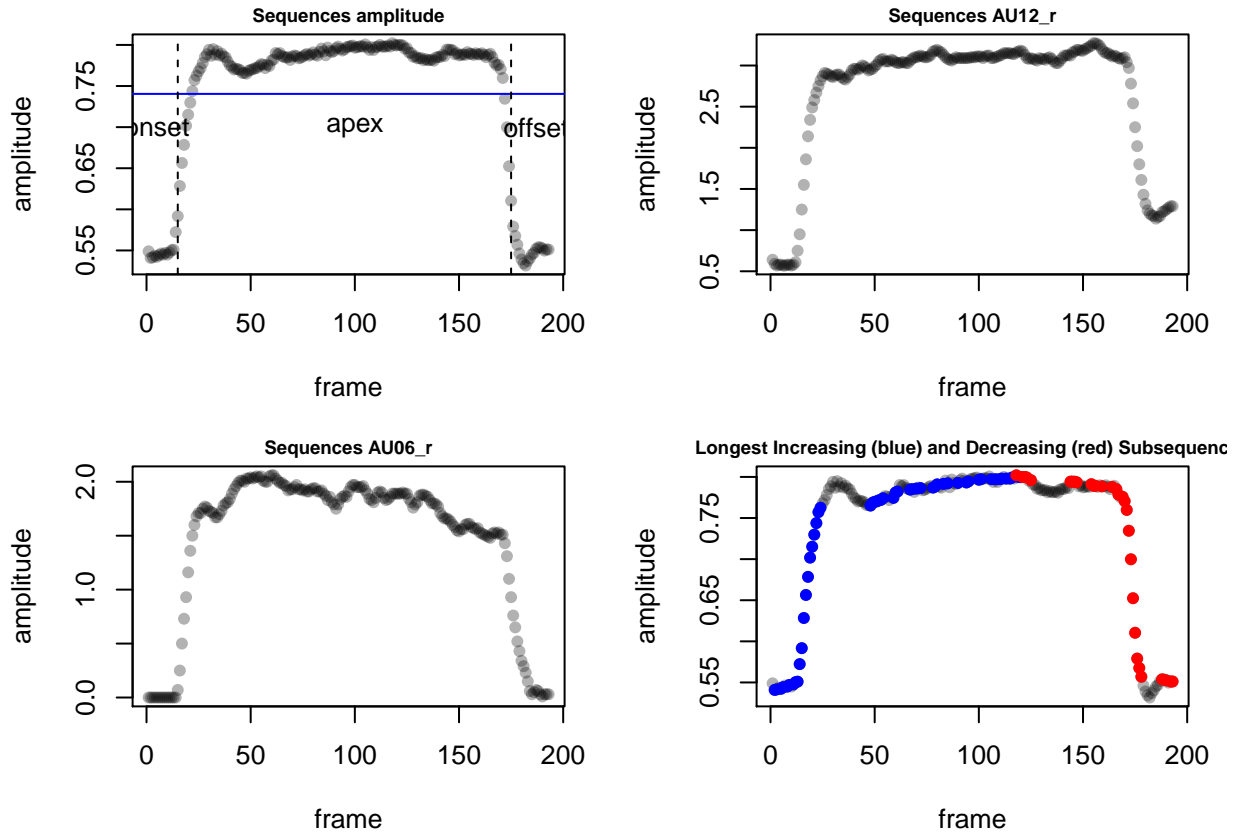
## [1] 118 121 122 123 125 144 145 146 147 154 155 156 159 164 166 167 169 170 171
## [20] 172 173 174 175 176 177 178 188 190 192 193

```

```

points(rind, UvA_final$amplitude[1:193][rind], pch = 16, col = "red")

```

```
# citation("compiler")
```

Creating descriptive statistics

With the final dataset, summary statistics are created using 2 files. The first file will contain the summary statistics, minimum value `min()`, maximum value `max()`, the average value `mean()` and standard deviation `sd()`. The `min()` and `max()` values will be analyzed from the tables and for the `mean()` and `sd()` histograms are made to show the distribution as well as the difference in distribution between the two smile types. This section will be used a set to report these values in the thesis if applicable, e.g., the average time of the video recording or the number of frames. The second file of summary statistics will be used as the input file for models and will contain the mean values only, as described in part 2.

```
# load packages
library(scales)
library(tidyverse)
library(dplyr)

# create a file to create the summary static files from the the final dataset.
# Using a copy of the final dataset.
UvA_basis <- read.csv("UvA_final")
dim(UvA_basis)
```

```
## [1] 95830    36
```

```

# file 1 containing all summary statistics for all features.
UvA_sum <- UvA_basis %>%
  group_by(filename, subject, gender, age, smile_type) %>%
  summarise_all(list(min = min, max = max, mean = mean, sd = sd), na.rm = TRUE)
# save the file
write_csv(UvA_sum, "UvA_sum")

# file 2 create set of features with value mean.
UvA_modelset <- UvA_basis %>%
  select(
    filename, subject, gender, age, smile_type, gaze_angle_x, gaze_angle_y,
    pose_Rx, pose_Ry, pose_Rz, starts_with("AU") & ends_with("_r"),
    lip, eye, amplitude, stage, apex, offset, onset
  ) %>%
  group_by(filename, subject, gender, age, smile_type) %>%
  summarise_all(list(mean = mean), na.rm = TRUE) %>%
  ungroup()
# save the file
write_csv(UvA_modelset, "UvA_modelset")

```

EDA

Decriptive statistics tables

An overall table of the descriptive statistics is created by the `summery()` function. For a split based on the classification the `psych` package is used with the `describeBy()` function which groups the classifier `smile_type` and `smile_type + gender`. Both these files will be analyzed used the output table.

```

# load packages
library(psych)

# the overall summary of the descriptive statistics
desc_stats <- summary(UvA_sum)
desc_stats

```

```

##      filename      subject      gender      age
## Length:475      Min.   : 20.0  Length:475      Min.   : 8.00
## Class :character 1st Qu.:161.5  Class :character 1st Qu.: 9.00
## Mode  :character Median :272.0  Mode  :character Median :10.00
##                      Mean   :286.7                      Mean   :10.86
##                      3rd Qu.:449.0                      3rd Qu.:12.00
##                      Max.    :543.0                      Max.    :17.00
##
##      smile_type      frame_min timestamp_min gaze_angle_x_min
## Length:475      Min.    :1      Min.    :0      Min.    : -0.1720
## Class :character 1st Qu.:1      1st Qu.:0      1st Qu.: 0.1040
## Mode  :character Median :1      Median :0      Median : 0.1580
##                      Mean    :1      Mean    :0      Mean    : 0.1478
##                      3rd Qu.:1      3rd Qu.:0      3rd Qu.: 0.2000
##                      Max.    :1      Max.    :0      Max.    : 0.3920
##

```

```

## gaze_angle_y_min    pose_Rx_min    pose_Ry_min    pose_Rz_min
## Min.    :-0.1260    Min.    :-0.3730    Min.    :-0.4630    Min.    :-0.37500
## 1st Qu.: 0.1485    1st Qu.: 0.0370    1st Qu.: -0.2490    1st Qu.: -0.08500
## Median : 0.2080    Median : 0.1150    Median : -0.2020    Median : -0.03700
## Mean   : 0.2041    Mean   : 0.1031    Mean   : -0.1978    Mean   : -0.04409
## 3rd Qu.: 0.2590    3rd Qu.: 0.1760    3rd Qu.: -0.1435    3rd Qu.: 0.00700
## Max.   : 0.4840    Max.   : 0.3110    Max.   : 0.0360    Max.   : 0.12900
##
## AU01_r_min    AU02_r_min    AU04_r_min    AU05_r_min    AU06_r_min
## Min.    :0      Min.    :0      Min.    :0.0000    Min.    :0      Min.    :0.00000
## 1st Qu.:0      1st Qu.:0      1st Qu.:0.0000    1st Qu.:0      1st Qu.:0.00000
## Median :0      Median :0      Median :0.0000    Median :0      Median :0.00000
## Mean   :0      Mean   :0      Mean   :0.1395    Mean   :0      Mean   :0.06373
## 3rd Qu.:0      3rd Qu.:0      3rd Qu.:0.0000    3rd Qu.:0      3rd Qu.:0.00000
## Max.   :0      Max.   :0      Max.   :3.3600    Max.   :0      Max.   :1.82000
##
## AU07_r_min    AU09_r_min    AU10_r_min    AU12_r_min
## Min.    :0.0000    Min.    :0      Min.    :0.00000    Min.    :0.0000
## 1st Qu.:0.0000    1st Qu.:0      1st Qu.:0.00000    1st Qu.:0.0000
## Median :0.0000    Median :0      Median :0.00000    Median :0.0000
## Mean   :0.2175    Mean   :0      Mean   :0.02585    Mean   :0.2299
## 3rd Qu.:0.1500    3rd Qu.:0      3rd Qu.:0.00000    3rd Qu.:0.3500
## Max.   :3.5900    Max.   :0      Max.   :1.64000    Max.   :2.5600
##
## AU14_r_min    AU15_r_min    AU17_r_min    AU20_r_min    AU23_r_min
## Min.    :0.000    Min.    :0      Min.    :0      Min.    :0      Min.    :0
## 1st Qu.:0.110    1st Qu.:0      1st Qu.:0      1st Qu.:0      1st Qu.:0
## Median :0.510    Median :0      Median :0      Median :0      Median :0
## Mean   :0.534    Mean   :0      Mean   :0      Mean   :0      Mean   :0
## 3rd Qu.:0.840    3rd Qu.:0      3rd Qu.:0      3rd Qu.:0      3rd Qu.:0
## Max.   :1.850    Max.   :0      Max.   :0      Max.   :0      Max.   :0
##
## AU25_r_min    AU26_r_min    AU45_r_min    lip_min    eye_min
## Min.    :0      Min.    :0      Min.    :0      Min.    : 95.03    Min.    : 0.3457
## 1st Qu.:0      1st Qu.:0      1st Qu.:0      1st Qu.:136.17    1st Qu.: 2.7174
## Median :0      Median :0      Median :0      Median :148.75    Median : 4.8403
## Mean   :0      Mean   :0      Mean   :0      Mean   :148.52    Mean   : 5.7299
## 3rd Qu.:0      3rd Qu.:0      3rd Qu.:0      3rd Qu.:159.62    3rd Qu.: 8.7795
## Max.   :0      Max.   :0      Max.   :0      Max.   :204.53    Max.   :15.4864
##
## amplitude_min    stage_min    apex_min    offset_min
## Min.    :0.0000    Min.    :0.02000    Min.    :0.1344    Min.    :0.0006176
## 1st Qu.:0.2745    1st Qu.:0.02731    1st Qu.:0.4488    1st Qu.:0.2973016
## Median :0.3585    Median :0.03148    Median :0.5412    Median :0.3917766
## Mean   :0.3569    Mean   :0.03383    Mean   :0.5388    Mean   :0.3886023
## 3rd Qu.:0.4310    3rd Qu.:0.03715    3rd Qu.:0.6427    3rd Qu.:0.4754893
## Max.   :0.7306    Max.   :0.09461    Max.   :0.9014    Max.   :0.7306418
##
## onset_min    frame_max    timestamp_max    gaze_angle_x_max
## Min.    :0.02589    Min.    : 55.0    Min.    : 1.080    Min.    :0.0170
## 1st Qu.:0.29948    1st Qu.:136.5    1st Qu.: 2.710    1st Qu.:0.1990
## Median :0.38134    Median :176.0    Median : 3.500    Median :0.2480
## Mean   :0.37796    Mean   :201.7    Mean   : 4.015    Mean   :0.2441
## 3rd Qu.:0.45648    3rd Qu.:234.0    3rd Qu.: 4.660    3rd Qu.:0.2935

```

```

## Max. :0.75256 Max. :705.0 Max. :14.080 Max. :0.4680
##
## gaze_angle_y_max pose_Rx_max pose_Ry_max pose_Rz_max
## Min. :0.0710 Min. : -0.0980 Min. : -0.4020 Min. : -0.15900
## 1st Qu.:0.3325 1st Qu.: 0.1615 1st Qu.: -0.1875 1st Qu.: -0.00750
## Median :0.4040 Median : 0.2180 Median : -0.1320 Median : 0.03700
## Mean :0.4077 Mean : 0.2116 Mean : -0.1313 Mean : 0.04434
## 3rd Qu.:0.4855 3rd Qu.: 0.2805 3rd Qu.: -0.0775 3rd Qu.: 0.08600
## Max. :0.6920 Max. : 0.4460 Max. : 0.1810 Max. : 0.33100
##
## AU01_r_max AU02_r_max AU04_r_max AU05_r_max
## Min. :0.1300 Min. :0.1300 Min. :0.0000 Min. :0.1000
## 1st Qu.:0.4150 1st Qu.:0.3500 1st Qu.:0.0000 1st Qu.:0.3000
## Median :0.6500 Median :0.4700 Median :0.2000 Median :0.4600
## Mean :0.7772 Mean :0.5596 Mean :0.5686 Mean :0.5215
## 3rd Qu.:0.9150 3rd Qu.:0.6300 3rd Qu.:0.8300 3rd Qu.:0.6500
## Max. :5.0000 Max. :3.0900 Max. :4.4900 Max. :2.3400
##
## AU06_r_max AU07_r_max AU09_r_max AU10_r_max
## Min. :0.000 Min. :0.000 Min. :0.0800 Min. :0.000
## 1st Qu.:1.265 1st Qu.:1.165 1st Qu.:0.2100 1st Qu.:0.615
## Median :1.740 Median :1.770 Median :0.2900 Median :1.270
## Mean :1.800 Mean :1.804 Mean :0.3511 Mean :1.210
## 3rd Qu.:2.320 3rd Qu.:2.400 3rd Qu.:0.4400 3rd Qu.:1.740
## Max. :3.740 Max. :5.000 Max. :1.8800 Max. :3.340
##
## AU12_r_max AU14_r_max AU15_r_max AU17_r_max
## Min. :0.790 Min. :0.030 Min. :0.1300 Min. :0.290
## 1st Qu.:2.390 1st Qu.:1.540 1st Qu.:0.2750 1st Qu.:0.835
## Median :2.800 Median :1.850 Median :0.3900 Median :1.200
## Mean :2.782 Mean :1.851 Mean :0.4486 Mean :1.274
## 3rd Qu.:3.200 3rd Qu.:2.170 3rd Qu.:0.5450 3rd Qu.:1.560
## Max. :4.700 Max. :3.430 Max. :2.7600 Max. :3.970
##
## AU20_r_max AU23_r_max AU25_r_max AU26_r_max
## Min. :0.1000 Min. :0.0900 Min. :0.310 Min. :0.290
## 1st Qu.:0.3000 1st Qu.:0.3100 1st Qu.:0.745 1st Qu.:0.780
## Median :0.4200 Median :0.5200 Median :1.140 Median :1.030
## Mean :0.4768 Mean :0.5904 Mean :1.340 Mean :1.143
## 3rd Qu.:0.5900 3rd Qu.:0.7500 3rd Qu.:1.835 3rd Qu.:1.350
## Max. :1.6100 Max. :1.9100 Max. :3.460 Max. :4.730
##
## AU45_r_max lip_max eye_max amplitude_max
## Min. :0.220 Min. :126.7 Min. : 7.248 Min. :0.2114
## 1st Qu.:0.610 1st Qu.:175.7 1st Qu.:11.375 1st Qu.:0.5384
## Median :1.730 Median :190.3 Median :12.624 Median :0.6354
## Mean :1.803 Mean :189.2 Mean :12.747 Mean :0.6282
## 3rd Qu.:2.855 3rd Qu.:204.8 3rd Qu.:14.077 3rd Qu.:0.7323
## Max. :5.000 Max. :244.9 Max. :22.049 Max. :1.0000
##
## stage_max apex_max offset_max onset_max
## Min. :0.02737 Min. :0.2114 Min. :0.1277 Min. :0.1330
## 1st Qu.:0.04640 1st Qu.:0.5384 1st Qu.:0.4402 1st Qu.:0.4401
## Median :0.05579 Median :0.6354 Median :0.5288 Median :0.5301

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## Mean      :   Inf      Mean      :0.6282      Mean      :0.5284      Mean      :0.5295
## 3rd Qu.:0.07286      3rd Qu.:0.7323      3rd Qu.:0.6303      3rd Qu.:0.6311
## Max.      :   Inf      Max.      :1.0000      Max.      :0.8980      Max.      :0.8867
##
##      frame_mean      timestamp_mean      gaze_angle_x_mean      gaze_angle_y_mean
## Min.      : 28.00      Min.      :0.540      Min.      : -0.03577      Min.      : -0.004175
## 1st Qu.: 68.75      1st Qu.:1.355      1st Qu.: 0.15391      1st Qu.: 0.235610
## Median : 88.50      Median :1.750      Median : 0.20332      Median : 0.287323
## Mean      :101.37      Mean      :2.007      Mean      : 0.19704      Mean      : 0.282436
## 3rd Qu.:117.50      3rd Qu.:2.330      3rd Qu.: 0.24110      3rd Qu.: 0.329117
## Max.      :353.00      Max.      :7.040      Max.      : 0.42931      Max.      : 0.520731
##
##      pose_Rx_mean      pose_Ry_mean      pose_Rz_mean      AU01_r_mean
## Min.      : -0.1145      Min.      : -0.4267      Min.      : -0.1801186      Min.      :0.03137
## 1st Qu.: 0.1090      1st Qu.: -0.2119      1st Qu.: -0.0458966      1st Qu.:0.06947
## Median : 0.1732      Median : -0.1687      Median : -0.0003729      Median :0.10456
## Mean      : 0.1647      Mean      : -0.1646      Mean      : 0.0001707      Mean      :0.13077
## 3rd Qu.: 0.2315      3rd Qu.: -0.1111      3rd Qu.: 0.0429667      3rd Qu.:0.15482
## Max.      : 0.3679      Max.      : 0.0518      Max.      : 0.2370769      Max.      :1.06200
##
##      AU02_r_mean      AU04_r_mean      AU05_r_mean      AU06_r_mean
## Min.      :0.01783      Min.      :0.00000      Min.      :0.01407      Min.      :0.0000
## 1st Qu.:0.03469      1st Qu.:0.00000      1st Qu.:0.02607      1st Qu.:0.6064
## Median :0.04575      Median :0.01016      Median :0.03526      Median :0.9590
## Mean      :0.05639      Mean      :0.29150      Mean      :0.04307      Mean      :1.0220
## 3rd Qu.:0.06178      3rd Qu.:0.26155      3rd Qu.:0.05253      3rd Qu.:1.4284
## Max.      :0.37496      Max.      :3.75359      Max.      :0.24129      Max.      :2.9500
##
##      AU07_r_mean      AU09_r_mean      AU10_r_mean      AU12_r_mean
## Min.      :0.0000      Min.      :0.01123      Min.      :0.0000      Min.      :0.3104
## 1st Qu.:0.3844      1st Qu.:0.02544      1st Qu.:0.1689      1st Qu.:1.5263
## Median :0.8927      Median :0.03456      Median :0.5586      Median :1.8963
## Mean      :1.0017      Mean      :0.04377      Mean      :0.6229      Mean      :1.8779
## 3rd Qu.:1.4146      3rd Qu.:0.05073      3rd Qu.:0.9638      3rd Qu.:2.2728
## Max.      :4.8921      Max.      :0.29978      Max.      :2.1251      Max.      :3.3969
##
##      AU14_r_mean      AU15_r_mean      AU17_r_mean      AU20_r_mean
## Min.      :0.001011      Min.      :0.02597      Min.      :0.07526      Min.      :0.01914
## 1st Qu.:1.058506      1st Qu.:0.05114      1st Qu.:0.22504      1st Qu.:0.04126
## Median :1.318199      Median :0.06472      Median :0.32262      Median :0.05595
## Mean      :1.312488      Mean      :0.07568      Mean      :0.36455      Mean      :0.06591
## 3rd Qu.:1.613258      3rd Qu.:0.08640      3rd Qu.:0.45501      3rd Qu.:0.07602
## Max.      :2.805286      Max.      :0.36451      Max.      :1.67080      Max.      :0.31641
##
##      AU23_r_mean      AU25_r_mean      AU26_r_mean      AU45_r_mean
## Min.      :0.01494      Min.      :0.06867      Min.      :0.08846      Min.      :0.03696
## 1st Qu.:0.04066      1st Qu.:0.21927      1st Qu.:0.19091      1st Qu.:0.08465
## Median :0.06374      Median :0.40466      Median :0.26665      Median :0.14633
## Mean      :0.07844      Mean      :0.53228      Mean      :0.29881      Mean      :0.18336
## 3rd Qu.:0.09597      3rd Qu.:0.74531      3rd Qu.:0.36326      3rd Qu.:0.24501
## Max.      :0.31894      Max.      :1.89141      Max.      :1.41270      Max.      :0.95777
##
##      lip_mean      eye_mean      amplitude_mean      stage_mean
## Min.      :115.1      Min.      : 4.653      Min.      :0.1342      Min.      :0.02283

```

```

## 1st Qu.:162.0 1st Qu.: 9.114 1st Qu.:0.4468 1st Qu.:0.03222
## Median :175.8 Median :10.381 Median :0.5390 Median :0.03844
## Mean :175.3 Mean :10.466 Mean :0.5358 Mean : Inf
## 3rd Qu.:190.5 3rd Qu.:11.680 3rd Qu.:0.6373 3rd Qu.:0.04669
## Max. :229.6 Max. :17.306 Max. :0.8981 Max. : Inf
##
## apex_mean offset_mean onset_mean frame_sd
## Min. :0.1839 Min. :0.02657 Min. :0.03989 Min. : 16.02
## 1st Qu.:0.5044 1st Qu.:0.35351 1st Qu.:0.34981 1st Qu.: 39.55
## Median :0.6008 Median :0.44376 Median :0.43873 Median : 50.95
## Mean :0.5959 Mean :0.44482 Mean :0.43614 Mean : 58.38
## 3rd Qu.:0.6972 3rd Qu.:0.54219 3rd Qu.:0.52342 3rd Qu.: 67.69
## Max. :0.9582 Max. :0.77740 Max. :0.78238 Max. :203.66
##
## timestamp_sd gaze_angle_x_sd gaze_angle_y_sd pose_Rx_sd
## Min. :0.3204 Min. :0.004268 Min. :0.006175 Min. :0.005344
## 1st Qu.:0.7910 1st Qu.:0.012138 1st Qu.:0.026885 1st Qu.:0.015464
## Median :1.0190 Median :0.016913 Median :0.037900 Median :0.023031
## Mean :1.1677 Mean :0.020123 Mean :0.040922 Mean :0.027226
## 3rd Qu.:1.3539 3rd Qu.:0.023455 3rd Qu.:0.051110 3rd Qu.:0.032555
## Max. :4.0732 Max. :0.101646 Max. :0.122763 Max. :0.156937
##
## pose_Ry_sd pose_Rz_sd AU01_r_sd AU02_r_sd
## Min. :0.003045 Min. :0.002531 Min. :0.03744 Min. :0.03076
## 1st Qu.:0.008281 1st Qu.:0.009640 1st Qu.:0.10330 1st Qu.:0.06795
## Median :0.012707 Median :0.016293 Median :0.16113 Median :0.09569
## Mean :0.016447 Mean :0.023986 Mean :0.20228 Mean :0.11850
## 3rd Qu.:0.020009 3rd Qu.:0.028439 3rd Qu.:0.24067 3rd Qu.:0.12989
## Max. :0.094527 Max. :0.165375 Max. :1.77870 Max. :0.79933
##
## AU04_r_sd AU05_r_sd AU06_r_sd AU07_r_sd
## Min. :0.00000 Min. :0.02550 Min. :0.00000 Min. :0.00000
## 1st Qu.:0.00000 1st Qu.:0.05897 1st Qu.:0.4205 1st Qu.:0.2867
## Median :0.03379 Median :0.08229 Median :0.5532 Median :0.4026
## Mean :0.10454 Mean :0.10411 Mean :0.5699 Mean :0.4193
## 3rd Qu.:0.17489 3rd Qu.:0.12720 3rd Qu.:0.7176 3rd Qu.:0.5393
## Max. :0.67294 Max. :0.60876 Max. :1.3138 Max. :1.2569
##
## AU09_r_sd AU10_r_sd AU12_r_sd AU14_r_sd
## Min. :0.01757 Min. :0.00000 Min. :0.2404 Min. :0.00543
## 1st Qu.:0.04715 1st Qu.:0.1979 1st Qu.:0.6376 1st Qu.:0.22035
## Median :0.06596 Median :0.3946 Median :0.7956 Median :0.29707
## Mean :0.08367 Mean :0.3789 Mean :0.8276 Mean :0.31989
## 3rd Qu.:0.10112 3rd Qu.:0.5431 3rd Qu.:0.9779 3rd Qu.:0.40174
## Max. :0.56374 Max. :1.1471 Max. :2.0527 Max. :0.82670
##
## AU15_r_sd AU17_r_sd AU20_r_sd AU23_r_sd
## Min. :0.03162 Min. :0.06655 Min. :0.02474 Min. :0.02427
## 1st Qu.:0.07073 1st Qu.:0.21955 1st Qu.:0.06895 1st Qu.:0.07299
## Median :0.09319 Median :0.33761 Median :0.09610 Median :0.12103
## Mean :0.11180 Mean :0.37142 Mean :0.11509 Mean :0.14534
## 3rd Qu.:0.13323 3rd Qu.:0.45936 3rd Qu.:0.14000 3rd Qu.:0.19001
## Max. :0.64167 Max. :1.49028 Max. :0.52165 Max. :0.54104
##

```

```
##      AU25_r_sd      AU26_r_sd      AU45_r_sd      lip_sd
## Min.      :0.06876   Min.      :0.06916   Min.      :0.04699   Min.      : 2.839
## 1st Qu.:0.20905   1st Qu.:0.21161   1st Qu.:0.14292   1st Qu.: 9.507
## Median :0.37274   Median :0.29238   Median :0.31528   Median :11.928
## Mean      :0.46673   Mean      :0.32550   Mean      :0.37306   Mean      :12.429
## 3rd Qu.:0.67814   3rd Qu.:0.39434   3rd Qu.:0.55286   3rd Qu.:15.330
## Max.      :1.43521   Max.      :1.46384   Max.      :1.50215   Max.      :31.297
##
##      eye_sd      amplitude_sd      stage_sd      apex_sd
## Min.      :0.1934   Min.      :0.01894   Min.      :0.001363   Min.      :0.005714
## 1st Qu.:0.8221   1st Qu.:0.06344   1st Qu.:0.004642   1st Qu.:0.015893
## Median :1.3406   Median :0.07959   Median :0.006758   Median :0.021934
## Mean      :1.4573   Mean      :0.08293   Mean      :0.009031   Mean      :0.022950
## 3rd Qu.:1.9303   3rd Qu.:0.10229   3rd Qu.:0.010379   3rd Qu.:0.028079
## Max.      :5.1009   Max.      :0.20884   Max.      :0.164760   Max.      :0.074245
##
##                                     NA's      :1
##      offset_sd      onset_sd
## Min.      :0.001877   Min.      :0.002385
## 1st Qu.:0.026013   1st Qu.:0.031080
## Median :0.038472   Median :0.045371
## Mean      :0.041893   Mean      :0.048238
## 3rd Qu.:0.055286   3rd Qu.:0.062726
## Max.      :0.139375   Max.      :0.153071
##
```

```
# descriptive statistics per classifier
```

```
desc_stats_class <- describeBy(UvA_sum, UvA_sum$smile_type)
desc_stats_class
```

```
##
## Descriptive statistics by group
## group: deliberate
##      vars      n      mean      sd median trimmed      mad      min      max
## filename*      1 240 120.50  69.43 120.50 120.50  88.96    1.00 240.00
## subject        2 240 290.22 154.82 277.00 289.55 214.98   20.00 543.00
## gender*        3 240   1.52   0.50   2.00   1.52   0.00    1.00   2.00
## age            4 240  10.96   2.36  10.50  10.70   2.22    8.00  17.00
## smile_type*    5 240   1.00   0.00   1.00   1.00   0.00    1.00   1.00
## frame_min      6 240   1.00   0.00   1.00   1.00   0.00    1.00   1.00
## timestamp_min  7 240   0.00   0.00   0.00   0.00   0.00    0.00   0.00
## gaze_angle_x_min 8 240   0.14   0.08   0.15   0.15   0.07   -0.17   0.37
## gaze_angle_y_min 9 240   0.21   0.09   0.22   0.21   0.08   -0.10   0.48
## pose_Rx_min    10 240   0.11   0.10   0.13   0.12   0.11   -0.33   0.29
## pose_Ry_min    11 240  -0.19   0.08  -0.20  -0.19   0.08   -0.44   0.03
## pose_Rz_min    12 240  -0.04   0.07  -0.03  -0.04   0.06   -0.26   0.09
## AU01_r_min     13 240   0.00   0.00   0.00   0.00   0.00    0.00   0.00
## AU02_r_min     14 240   0.00   0.00   0.00   0.00   0.00    0.00   0.00
## AU04_r_min     15 240   0.14   0.47   0.00   0.01   0.00    0.00   2.99
## AU05_r_min     16 240   0.00   0.00   0.00   0.00   0.00    0.00   0.00
## AU06_r_min     17 240   0.05   0.19   0.00   0.00   0.00    0.00   1.35
## AU07_r_min     18 240   0.19   0.49   0.00   0.06   0.00    0.00   3.46
## AU09_r_min     19 240   0.00   0.00   0.00   0.00   0.00    0.00   0.00
## AU10_r_min     20 240   0.02   0.13   0.00   0.00   0.00    0.00   1.64
## AU12_r_min     21 240   0.16   0.32   0.00   0.09   0.00    0.00   2.56
```

## AU14_r_min	22	240	0.51	0.44	0.47	0.47	0.53	0.00	1.82
## AU15_r_min	23	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU17_r_min	24	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU20_r_min	25	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU23_r_min	26	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU25_r_min	27	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU26_r_min	28	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU45_r_min	29	240	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## lip_min	30	240	147.95	18.35	147.61	147.84	17.94	95.03	204.53
## eye_min	31	240	5.79	3.64	5.06	5.53	4.20	0.54	15.49
## amplitude_min	32	240	0.35	0.12	0.35	0.35	0.12	0.00	0.73
## stage_min	33	240	0.03	0.01	0.03	0.03	0.01	0.02	0.09
## apex_min	34	240	0.55	0.13	0.54	0.55	0.14	0.13	0.84
## offset_min	35	240	0.38	0.13	0.38	0.38	0.13	0.00	0.73
## onset_min	36	240	0.38	0.12	0.38	0.38	0.11	0.03	0.75
## frame_max	37	240	159.69	51.34	151.00	152.72	37.81	84.00	438.00
## timestamp_max	38	240	3.17	1.03	3.00	3.03	0.76	1.66	8.74
## gaze_angle_x_max	39	240	0.24	0.07	0.24	0.24	0.07	0.02	0.46
## gaze_angle_y_max	40	240	0.41	0.11	0.40	0.41	0.11	0.10	0.69
## pose_Rx_max	41	240	0.21	0.10	0.21	0.21	0.09	-0.10	0.42
## pose_Ry_max	42	240	-0.13	0.08	-0.13	-0.13	0.08	-0.38	0.18
## pose_Rz_max	43	240	0.04	0.08	0.03	0.03	0.06	-0.16	0.33
## AU01_r_max	44	240	0.82	0.60	0.72	0.73	0.42	0.13	5.00
## AU02_r_max	45	240	0.53	0.33	0.47	0.47	0.21	0.13	3.09
## AU04_r_max	46	240	0.50	0.76	0.12	0.34	0.18	0.00	4.10
## AU05_r_max	47	240	0.53	0.35	0.44	0.47	0.25	0.10	2.34
## AU06_r_max	48	240	1.71	0.76	1.68	1.71	0.74	0.00	3.53
## AU07_r_max	49	240	1.67	0.93	1.62	1.64	0.88	0.00	5.00
## AU09_r_max	50	240	0.32	0.17	0.27	0.29	0.13	0.08	0.98
## AU10_r_max	51	240	1.05	0.74	1.07	1.02	0.87	0.00	2.86
## AU12_r_max	52	240	2.77	0.67	2.74	2.78	0.66	0.79	4.70
## AU14_r_max	53	240	1.86	0.43	1.85	1.86	0.47	0.83	2.89
## AU15_r_max	54	240	0.42	0.23	0.36	0.39	0.16	0.13	1.27
## AU17_r_max	55	240	1.25	0.64	1.19	1.17	0.55	0.29	3.97
## AU20_r_max	56	240	0.45	0.24	0.39	0.42	0.19	0.10	1.46
## AU23_r_max	57	240	0.56	0.35	0.48	0.51	0.29	0.09	1.88
## AU25_r_max	58	240	1.40	0.80	1.22	1.34	0.85	0.31	3.38
## AU26_r_max	59	240	1.10	0.48	1.02	1.05	0.42	0.31	2.93
## AU45_r_max	60	240	1.91	1.31	1.91	1.84	1.85	0.22	5.00
## lip_max	61	240	190.26	21.01	191.42	190.83	22.46	126.71	239.26
## eye_max	62	240	12.92	2.15	12.78	12.88	1.78	7.67	19.03
## amplitude_max	63	240	0.64	0.14	0.64	0.64	0.15	0.21	0.96
## stage_max	64	240	Inf	NaN	0.06	0.06	0.02	0.03	Inf
## apex_max	65	240	0.64	0.14	0.64	0.64	0.15	0.21	0.96
## offset_max	66	240	0.53	0.13	0.53	0.53	0.14	0.13	0.84
## onset_max	67	240	0.53	0.13	0.53	0.54	0.14	0.13	0.84
## frame_mean	68	240	80.34	25.67	76.00	76.86	18.90	42.50	219.50
## timestamp_mean	69	240	1.59	0.51	1.50	1.52	0.38	0.83	4.37
## gaze_angle_x_mean	70	240	0.19	0.07	0.20	0.19	0.06	-0.04	0.41
## gaze_angle_y_mean	71	240	0.29	0.08	0.29	0.29	0.07	0.05	0.52
## pose_Rx_mean	72	240	0.17	0.10	0.17	0.17	0.10	-0.11	0.37
## pose_Ry_mean	73	240	-0.16	0.08	-0.17	-0.16	0.07	-0.41	0.05
## pose_Rz_mean	74	240	0.00	0.06	0.00	0.00	0.06	-0.18	0.24
## AU01_r_mean	75	240	0.14	0.13	0.12	0.12	0.07	0.03	1.06

## AU02_r_mean	76	240	0.06	0.04	0.05	0.05	0.02	0.02	0.37
## AU04_r_mean	77	240	0.27	0.59	0.01	0.12	0.01	0.00	3.50
## AU05_r_mean	78	240	0.05	0.03	0.04	0.04	0.02	0.01	0.24
## AU06_r_mean	79	240	0.97	0.58	0.91	0.94	0.53	0.00	2.82
## AU07_r_mean	80	240	0.93	0.78	0.80	0.83	0.67	0.00	4.89
## AU09_r_mean	81	240	0.04	0.02	0.03	0.04	0.02	0.01	0.15
## AU10_r_mean	82	240	0.53	0.48	0.48	0.47	0.53	0.00	2.06
## AU12_r_mean	83	240	1.84	0.57	1.86	1.85	0.56	0.31	3.34
## AU14_r_mean	84	240	1.33	0.41	1.32	1.34	0.42	0.31	2.20
## AU15_r_mean	85	240	0.07	0.04	0.06	0.07	0.03	0.03	0.36
## AU17_r_mean	86	240	0.37	0.20	0.34	0.35	0.17	0.08	1.67
## AU20_r_mean	87	240	0.06	0.04	0.05	0.06	0.03	0.02	0.27
## AU23_r_mean	88	240	0.08	0.06	0.06	0.07	0.04	0.02	0.29
## AU25_r_mean	89	240	0.61	0.44	0.49	0.56	0.43	0.07	1.89
## AU26_r_mean	90	240	0.29	0.14	0.26	0.27	0.11	0.09	1.13
## AU45_r_mean	91	240	0.20	0.14	0.17	0.18	0.13	0.04	0.96
## lip_mean	92	240	176.25	19.78	175.91	176.85	20.89	115.14	220.98
## eye_mean	93	240	10.64	2.04	10.53	10.60	1.56	4.65	16.57
## amplitude_mean	94	240	0.54	0.13	0.54	0.55	0.14	0.13	0.84
## stage_mean	95	240	Inf	NaN	0.04	0.04	0.01	0.02	Inf
## apex_mean	96	240	0.61	0.14	0.61	0.61	0.15	0.19	0.89
## offset_mean	97	240	0.43	0.13	0.43	0.43	0.14	0.03	0.78
## onset_mean	98	240	0.43	0.12	0.43	0.43	0.13	0.04	0.78
## frame_sd	99	240	46.24	14.82	43.73	44.23	10.91	24.39	126.58
## timestamp_sd	100	240	0.92	0.30	0.87	0.88	0.22	0.49	2.53
## gaze_angle_x_sd	101	240	0.02	0.01	0.02	0.02	0.01	0.00	0.10
## gaze_angle_y_sd	102	240	0.04	0.02	0.04	0.04	0.02	0.01	0.12
## pose_Rx_sd	103	240	0.02	0.01	0.02	0.02	0.01	0.01	0.08
## pose_Ry_sd	104	240	0.02	0.01	0.01	0.01	0.01	0.00	0.07
## pose_Rz_sd	105	240	0.02	0.02	0.01	0.02	0.01	0.00	0.14
## AU01_r_sd	106	240	0.22	0.20	0.18	0.19	0.11	0.04	1.78
## AU02_r_sd	107	240	0.12	0.09	0.10	0.10	0.04	0.03	0.80
## AU04_r_sd	108	240	0.09	0.12	0.02	0.07	0.03	0.00	0.59
## AU05_r_sd	109	240	0.11	0.08	0.08	0.10	0.05	0.03	0.61
## AU06_r_sd	110	240	0.59	0.27	0.57	0.59	0.24	0.00	1.31
## AU07_r_sd	111	240	0.42	0.23	0.40	0.41	0.20	0.00	1.15
## AU09_r_sd	112	240	0.08	0.04	0.06	0.07	0.04	0.02	0.25
## AU10_r_sd	113	240	0.36	0.27	0.34	0.35	0.33	0.00	1.12
## AU12_r_sd	114	240	0.92	0.28	0.89	0.90	0.29	0.24	2.05
## AU14_r_sd	115	240	0.34	0.13	0.32	0.33	0.13	0.12	0.82
## AU15_r_sd	116	240	0.11	0.06	0.09	0.10	0.04	0.03	0.46
## AU17_r_sd	117	240	0.39	0.23	0.35	0.36	0.20	0.07	1.49
## AU20_r_sd	118	240	0.11	0.07	0.09	0.10	0.05	0.02	0.42
## AU23_r_sd	119	240	0.14	0.10	0.12	0.13	0.08	0.02	0.51
## AU25_r_sd	120	240	0.51	0.35	0.41	0.47	0.35	0.07	1.44
## AU26_r_sd	121	240	0.32	0.16	0.29	0.30	0.14	0.09	1.08
## AU45_r_sd	122	240	0.41	0.30	0.36	0.39	0.33	0.05	1.50
## lip_sd	123	240	13.83	4.38	13.57	13.70	4.12	2.84	31.30
## eye_sd	124	240	1.53	0.86	1.40	1.46	0.91	0.19	5.10
## amplitude_sd	125	240	0.09	0.03	0.09	0.09	0.03	0.02	0.21
## stage_sd	126	239	0.01	0.01	0.01	0.01	0.00	0.00	0.16
## apex_sd	127	240	0.02	0.01	0.02	0.02	0.01	0.01	0.07
## offset_sd	128	240	0.04	0.02	0.04	0.04	0.02	0.00	0.13
## onset_sd	129	240	0.05	0.02	0.05	0.05	0.02	0.00	0.15

##	range	skew	kurtosis	se
## filename*	239.00	0.00	-1.22	4.48
## subject	523.00	0.09	-1.40	9.99
## gender*	1.00	-0.07	-2.00	0.03
## age	9.00	0.85	0.00	0.15
## smile_type*	0.00	NaN	NaN	0.00
## frame_min	0.00	NaN	NaN	0.00
## timestamp_min	0.00	NaN	NaN	0.00
## gaze_angle_x_min	0.54	-0.84	1.66	0.01
## gaze_angle_y_min	0.58	-0.27	0.51	0.01
## pose_Rx_min	0.62	-0.70	0.64	0.01
## pose_Ry_min	0.47	0.04	0.28	0.01
## pose_Rz_min	0.36	-0.59	0.07	0.00
## AU01_r_min	0.00	NaN	NaN	0.00
## AU02_r_min	0.00	NaN	NaN	0.00
## AU04_r_min	2.99	4.16	17.86	0.03
## AU05_r_min	0.00	NaN	NaN	0.00
## AU06_r_min	1.35	4.68	23.81	0.01
## AU07_r_min	3.46	3.34	13.33	0.03
## AU09_r_min	0.00	NaN	NaN	0.00
## AU10_r_min	1.64	9.84	105.19	0.01
## AU12_r_min	2.56	3.06	13.73	0.02
## AU14_r_min	1.82	0.53	-0.54	0.03
## AU15_r_min	0.00	NaN	NaN	0.00
## AU17_r_min	0.00	NaN	NaN	0.00
## AU20_r_min	0.00	NaN	NaN	0.00
## AU23_r_min	0.00	NaN	NaN	0.00
## AU25_r_min	0.00	NaN	NaN	0.00
## AU26_r_min	0.00	NaN	NaN	0.00
## AU45_r_min	0.00	NaN	NaN	0.00
## lip_min	109.50	0.07	-0.02	1.18
## eye_min	14.95	0.53	-0.75	0.24
## amplitude_min	0.73	0.07	-0.02	0.01
## stage_min	0.07	2.30	9.11	0.00
## apex_min	0.71	-0.28	-0.29	0.01
## offset_min	0.73	0.02	-0.20	0.01
## onset_min	0.73	0.00	0.12	0.01
## frame_max	354.00	1.90	5.55	3.31
## timestamp_max	7.08	1.90	5.55	0.07
## gaze_angle_x_max	0.44	-0.17	0.35	0.00
## gaze_angle_y_max	0.59	0.20	-0.17	0.01
## pose_Rx_max	0.52	-0.42	-0.09	0.01
## pose_Ry_max	0.56	0.27	0.88	0.01
## pose_Rz_max	0.49	0.89	1.87	0.01
## AU01_r_max	4.87	2.96	13.58	0.04
## AU02_r_max	2.96	3.28	17.31	0.02
## AU04_r_max	4.10	2.17	5.31	0.05
## AU05_r_max	2.24	2.08	6.26	0.02
## AU06_r_max	3.53	0.06	-0.34	0.05
## AU07_r_max	5.00	0.47	0.61	0.06
## AU09_r_max	0.90	1.26	1.38	0.01
## AU10_r_max	2.86	0.13	-0.97	0.05
## AU12_r_max	3.91	-0.09	0.10	0.04
## AU14_r_max	2.06	-0.09	-0.56	0.03

## AU15_r_max	1.14	1.58	2.41	0.01
## AU17_r_max	3.68	1.36	2.79	0.04
## AU20_r_max	1.36	1.32	1.90	0.02
## AU23_r_max	1.79	1.22	1.20	0.02
## AU25_r_max	3.07	0.59	-0.69	0.05
## AU26_r_max	2.62	1.04	1.10	0.03
## AU45_r_max	4.78	0.27	-1.22	0.08
## lip_max	112.55	-0.23	-0.18	1.36
## eye_max	11.36	0.21	0.15	0.14
## amplitude_max	0.75	-0.23	-0.18	0.01
## stage_max	Inf	NaN	NaN	NaN
## apex_max	0.75	-0.23	-0.18	0.01
## offset_max	0.71	-0.21	-0.30	0.01
## onset_max	0.70	-0.27	-0.29	0.01
## frame_mean	177.00	1.90	5.55	1.66
## timestamp_mean	3.54	1.90	5.55	0.03
## gaze_angle_x_mean	0.45	-0.30	0.73	0.00
## gaze_angle_y_mean	0.47	-0.11	0.36	0.01
## pose_Rx_mean	0.48	-0.47	-0.18	0.01
## pose_Ry_mean	0.45	0.09	0.33	0.00
## pose_Rz_mean	0.42	0.04	0.55	0.00
## AU01_r_mean	1.03	4.32	24.41	0.01
## AU02_r_mean	0.36	4.22	23.97	0.00
## AU04_r_mean	3.50	3.22	11.30	0.04
## AU05_r_mean	0.23	2.64	10.95	0.00
## AU06_r_mean	2.82	0.55	-0.08	0.04
## AU07_r_mean	4.89	1.43	3.47	0.05
## AU09_r_mean	0.14	1.49	2.66	0.00
## AU10_r_mean	2.06	0.82	0.16	0.03
## AU12_r_mean	3.03	-0.04	-0.19	0.04
## AU14_r_mean	1.89	-0.19	-0.62	0.03
## AU15_r_mean	0.34	2.78	13.00	0.00
## AU17_r_mean	1.60	1.90	7.24	0.01
## AU20_r_mean	0.26	1.98	4.95	0.00
## AU23_r_mean	0.27	1.51	2.08	0.00
## AU25_r_mean	1.82	0.84	-0.17	0.03
## AU26_r_mean	1.04	1.86	6.04	0.01
## AU45_r_mean	0.92	1.58	4.24	0.01
## lip_mean	105.84	-0.26	-0.30	1.28
## eye_mean	11.92	0.25	0.52	0.13
## amplitude_mean	0.71	-0.26	-0.30	0.01
## stage_mean	Inf	NaN	NaN	NaN
## apex_mean	0.70	-0.24	-0.33	0.01
## offset_mean	0.75	-0.07	-0.21	0.01
## onset_mean	0.74	-0.18	0.08	0.01
## frame_sd	102.19	1.90	5.55	0.96
## timestamp_sd	2.04	1.90	5.55	0.02
## gaze_angle_x_sd	0.10	2.65	9.71	0.00
## gaze_angle_y_sd	0.11	1.07	1.99	0.00
## pose_Rx_sd	0.08	1.52	2.72	0.00
## pose_Ry_sd	0.07	2.36	6.50	0.00
## pose_Rz_sd	0.14	2.30	5.81	0.00
## AU01_r_sd	1.74	4.10	23.08	0.01
## AU02_r_sd	0.77	3.81	20.22	0.01

```

## AU04_r_sd      0.59  1.49      1.80 0.01
## AU05_r_sd      0.58  2.40      8.93 0.01
## AU06_r_sd      1.31  0.04     -0.30 0.02
## AU07_r_sd      1.15  0.28     -0.07 0.02
## AU09_r_sd      0.23  1.28      1.28 0.00
## AU10_r_sd      1.12  0.30     -0.82 0.02
## AU12_r_sd      1.81  0.61      0.97 0.02
## AU14_r_sd      0.70  0.62      0.14 0.01
## AU15_r_sd      0.43  2.07      5.60 0.00
## AU17_r_sd      1.42  1.56      3.86 0.01
## AU20_r_sd      0.39  1.72      3.08 0.00
## AU23_r_sd      0.49  1.32      1.34 0.01
## AU25_r_sd      1.37  0.74     -0.45 0.02
## AU26_r_sd      1.00  1.32      2.53 0.01
## AU45_r_sd      1.46  0.79      0.27 0.02
## lip_sd         28.46 0.53      1.09 0.28
## eye_sd         4.91  0.87      1.10 0.06
## amplitude_sd   0.19  0.53      1.09 0.00
## stage_sd       0.16  9.06     109.53 0.00
## apex_sd        0.07  1.45      5.25 0.00
## offset_sd      0.13  0.80      0.97 0.00
## onset_sd       0.15  0.71      0.90 0.00
## -----
## group: spontaneous
##      vars  n  mean      sd median trimmed  mad   min   max
## filename*    1 235 118.00  67.98 118.00  118.00  87.47   1.00 235.00
## subject      2 235 283.17 148.56 258.00  280.91 195.70  20.00 534.00
## gender*      3 235   1.52   0.50   2.00   1.52   0.00   1.00   2.00
## age          4 235  10.76   2.30  10.00  10.49   1.48   8.00  17.00
## smile_type*  5 235   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## frame_min    6 235   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## timestamp_min 7 235   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## gaze_angle_x_min 8 235  0.15  0.08  0.17  0.16  0.07  -0.13  0.39
## gaze_angle_y_min 9 235  0.20  0.09  0.20  0.20  0.08  -0.13  0.48
## pose_Rx_min  10 235  0.09  0.11  0.11  0.10  0.10  -0.37  0.31
## pose_Ry_min  11 235 -0.20  0.09 -0.20 -0.20  0.08  -0.46  0.04
## pose_Rz_min  12 235 -0.05  0.08 -0.04 -0.04  0.08  -0.38  0.13
## AU01_r_min   13 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU02_r_min   14 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU04_r_min   15 235  0.14  0.45  0.00  0.02  0.00  0.00  3.36
## AU05_r_min   16 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU06_r_min   17 235  0.08  0.23  0.00  0.02  0.00  0.00  1.82
## AU07_r_min   18 235  0.24  0.52  0.00  0.11  0.00  0.00  3.59
## AU09_r_min   19 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU10_r_min   20 235  0.03  0.13  0.00  0.00  0.00  0.00  0.86
## AU12_r_min   21 235  0.30  0.43  0.05  0.21  0.07  0.00  1.95
## AU14_r_min   22 235  0.56  0.44  0.53  0.52  0.53  0.00  1.85
## AU15_r_min   23 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU17_r_min   24 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU20_r_min   25 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU23_r_min   26 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU25_r_min   27 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU26_r_min   28 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU45_r_min   29 235  0.00  0.00  0.00  0.00  0.00  0.00  0.00

```

## lip_min	30	235	149.10	17.74	149.13	148.93	17.14	101.23	189.97
## eye_min	31	235	5.67	3.47	4.70	5.43	3.65	0.35	15.45
## amplitude_min	32	235	0.36	0.12	0.36	0.36	0.11	0.04	0.63
## stage_min	33	235	0.03	0.01	0.03	0.03	0.01	0.02	0.09
## apex_min	34	235	0.53	0.13	0.54	0.53	0.14	0.16	0.90
## offset_min	35	235	0.40	0.12	0.40	0.40	0.13	0.09	0.65
## onset_min	36	235	0.38	0.12	0.38	0.38	0.12	0.04	0.74
## frame_max	37	235	244.70	105.60	224.00	234.26	93.40	55.00	705.00
## timestamp_max	38	235	4.87	2.11	4.46	4.67	1.87	1.08	14.08
## gaze_angle_x_max	39	235	0.25	0.07	0.25	0.25	0.07	0.02	0.47
## gaze_angle_y_max	40	235	0.40	0.11	0.41	0.41	0.12	0.07	0.62
## pose_Rx_max	41	235	0.22	0.09	0.22	0.22	0.08	-0.06	0.45
## pose_Ry_max	42	235	-0.13	0.09	-0.13	-0.13	0.09	-0.40	0.11
## pose_Rz_max	43	235	0.05	0.08	0.05	0.04	0.07	-0.11	0.30
## AU01_r_max	44	235	0.73	0.53	0.59	0.64	0.34	0.15	4.52
## AU02_r_max	45	235	0.59	0.40	0.46	0.51	0.22	0.16	2.24
## AU04_r_max	46	235	0.64	0.87	0.29	0.46	0.43	0.00	4.49
## AU05_r_max	47	235	0.51	0.27	0.46	0.48	0.24	0.12	2.01
## AU06_r_max	48	235	1.89	0.77	1.85	1.88	0.74	0.00	3.74
## AU07_r_max	49	235	1.94	0.99	1.89	1.90	0.92	0.00	5.00
## AU09_r_max	50	235	0.39	0.25	0.32	0.35	0.16	0.08	1.88
## AU10_r_max	51	235	1.37	0.74	1.40	1.37	0.76	0.00	3.34
## AU12_r_max	52	235	2.79	0.59	2.84	2.82	0.58	1.19	4.20
## AU14_r_max	53	235	1.85	0.45	1.86	1.85	0.46	0.03	3.43
## AU15_r_max	54	235	0.47	0.27	0.41	0.44	0.18	0.14	2.76
## AU17_r_max	55	235	1.30	0.60	1.21	1.24	0.52	0.30	3.96
## AU20_r_max	56	235	0.50	0.24	0.44	0.47	0.22	0.12	1.61
## AU23_r_max	57	235	0.63	0.38	0.57	0.58	0.34	0.10	1.91
## AU25_r_max	58	235	1.28	0.70	1.09	1.20	0.67	0.32	3.46
## AU26_r_max	59	235	1.18	0.60	1.07	1.10	0.42	0.29	4.73
## AU45_r_max	60	235	1.69	1.09	1.54	1.63	1.45	0.22	4.27
## lip_max	61	235	188.09	20.82	189.16	188.57	22.50	127.31	244.90
## eye_max	62	235	12.57	2.32	12.55	12.53	2.15	7.25	22.05
## amplitude_max	63	235	0.62	0.14	0.63	0.62	0.15	0.22	1.00
## stage_max	64	235	0.06	0.04	0.06	0.06	0.02	0.03	0.48
## apex_max	65	235	0.62	0.14	0.63	0.62	0.15	0.22	1.00
## offset_max	66	235	0.53	0.13	0.53	0.53	0.15	0.15	0.90
## onset_max	67	235	0.53	0.13	0.53	0.53	0.14	0.16	0.89
## frame_mean	68	235	122.85	52.80	112.50	117.63	46.70	28.00	353.00
## timestamp_mean	69	235	2.44	1.06	2.23	2.33	0.93	0.54	7.04
## gaze_angle_x_mean	70	235	0.20	0.07	0.21	0.20	0.06	-0.01	0.43
## gaze_angle_y_mean	71	235	0.28	0.08	0.28	0.28	0.07	0.00	0.50
## pose_Rx_mean	72	235	0.16	0.09	0.17	0.17	0.08	-0.11	0.37
## pose_Ry_mean	73	235	-0.17	0.08	-0.17	-0.17	0.07	-0.43	0.05
## pose_Rz_mean	74	235	0.00	0.07	0.00	0.00	0.07	-0.18	0.19
## AU01_r_mean	75	235	0.12	0.09	0.10	0.10	0.05	0.03	0.95
## AU02_r_mean	76	235	0.06	0.04	0.04	0.05	0.02	0.02	0.29
## AU04_r_mean	77	235	0.31	0.63	0.02	0.16	0.02	0.00	3.75
## AU05_r_mean	78	235	0.04	0.02	0.03	0.04	0.01	0.01	0.12
## AU06_r_mean	79	235	1.08	0.62	0.99	1.04	0.65	0.00	2.95
## AU07_r_mean	80	235	1.08	0.83	0.96	1.00	0.85	0.00	4.76
## AU09_r_mean	81	235	0.05	0.04	0.04	0.04	0.02	0.01	0.30
## AU10_r_mean	82	235	0.72	0.52	0.67	0.70	0.61	0.00	2.13
## AU12_r_mean	83	235	1.91	0.58	1.92	1.92	0.54	0.40	3.40

## AU14_r_mean	84	235	1.30	0.42	1.31	1.31	0.42	0.00	2.81
## AU15_r_mean	85	235	0.08	0.04	0.07	0.07	0.03	0.03	0.30
## AU17_r_mean	86	235	0.36	0.19	0.31	0.33	0.15	0.11	1.06
## AU20_r_mean	87	235	0.07	0.04	0.06	0.06	0.02	0.02	0.32
## AU23_r_mean	88	235	0.08	0.05	0.06	0.07	0.04	0.01	0.32
## AU25_r_mean	89	235	0.46	0.31	0.37	0.42	0.27	0.08	1.70
## AU26_r_mean	90	235	0.31	0.17	0.27	0.29	0.13	0.09	1.41
## AU45_r_mean	91	235	0.16	0.11	0.13	0.15	0.08	0.04	0.63
## lip_mean	92	235	174.40	19.69	175.04	174.72	22.09	118.36	229.63
## eye_mean	93	235	10.29	2.18	10.24	10.23	2.15	5.32	17.31
## amplitude_mean	94	235	0.53	0.13	0.53	0.53	0.15	0.16	0.90
## stage_mean	95	235	0.04	0.02	0.04	0.04	0.01	0.02	0.13
## apex_mean	96	235	0.58	0.14	0.59	0.59	0.15	0.18	0.96
## offset_mean	97	235	0.46	0.13	0.46	0.46	0.14	0.14	0.73
## onset_mean	98	235	0.44	0.12	0.45	0.44	0.14	0.08	0.76
## frame_sd	99	235	70.78	30.48	64.81	67.77	26.96	16.02	203.66
## timestamp_sd	100	235	1.42	0.61	1.30	1.36	0.54	0.32	4.07
## gaze_angle_x_sd	101	235	0.02	0.01	0.02	0.02	0.01	0.00	0.10
## gaze_angle_y_sd	102	235	0.04	0.02	0.04	0.04	0.02	0.01	0.10
## pose_Rx_sd	103	235	0.03	0.02	0.02	0.03	0.01	0.01	0.16
## pose_Ry_sd	104	235	0.02	0.01	0.01	0.02	0.01	0.00	0.09
## pose_Rz_sd	105	235	0.03	0.02	0.02	0.02	0.01	0.00	0.17
## AU01_r_sd	106	235	0.18	0.16	0.14	0.15	0.08	0.04	1.60
## AU02_r_sd	107	235	0.12	0.09	0.09	0.10	0.05	0.03	0.62
## AU04_r_sd	108	235	0.12	0.16	0.05	0.09	0.07	0.00	0.67
## AU05_r_sd	109	235	0.10	0.05	0.08	0.09	0.04	0.03	0.35
## AU06_r_sd	110	235	0.55	0.21	0.54	0.54	0.18	0.00	1.15
## AU07_r_sd	111	235	0.42	0.22	0.41	0.41	0.18	0.00	1.26
## AU09_r_sd	112	235	0.09	0.07	0.07	0.08	0.04	0.02	0.56
## AU10_r_sd	113	235	0.40	0.22	0.41	0.40	0.20	0.00	1.15
## AU12_r_sd	114	235	0.74	0.19	0.72	0.73	0.21	0.32	1.34
## AU14_r_sd	115	235	0.30	0.12	0.27	0.29	0.11	0.01	0.83
## AU15_r_sd	116	235	0.11	0.07	0.10	0.11	0.04	0.04	0.64
## AU17_r_sd	117	235	0.35	0.18	0.32	0.33	0.16	0.08	1.23
## AU20_r_sd	118	235	0.12	0.06	0.10	0.11	0.05	0.03	0.52
## AU23_r_sd	119	235	0.15	0.09	0.13	0.13	0.08	0.03	0.54
## AU25_r_sd	120	235	0.42	0.28	0.33	0.39	0.23	0.07	1.43
## AU26_r_sd	121	235	0.33	0.18	0.29	0.31	0.14	0.07	1.46
## AU45_r_sd	122	235	0.33	0.23	0.28	0.30	0.22	0.05	1.21
## lip_sd	123	235	11.00	3.42	10.82	10.88	3.44	3.98	19.10
## eye_sd	124	235	1.38	0.69	1.27	1.33	0.70	0.23	3.77
## amplitude_sd	125	235	0.07	0.02	0.07	0.07	0.02	0.03	0.13
## stage_sd	126	235	0.01	0.01	0.01	0.01	0.00	0.00	0.10
## apex_sd	127	235	0.02	0.01	0.02	0.02	0.01	0.01	0.05
## offset_sd	128	235	0.04	0.02	0.03	0.04	0.02	0.00	0.14
## onset_sd	129	235	0.04	0.02	0.04	0.04	0.02	0.01	0.12
##			range	skew	kurtosis	se			
## filename*	234.00	0.00	-1.22	4.43					
## subject	514.00	0.19	-1.28	9.69					
## gender*	1.00	-0.08	-2.00	0.03					
## age	9.00	1.00	0.33	0.15					
## smile_type*	0.00	NaN	NaN	0.00					
## frame_min	0.00	NaN	NaN	0.00					
## timestamp_min	0.00	NaN	NaN	0.00					

## gaze_angle_x_min	0.52	-0.61	1.46	0.01
## gaze_angle_y_min	0.61	-0.14	1.38	0.01
## pose_Rx_min	0.68	-0.71	0.86	0.01
## pose_Ry_min	0.50	-0.07	0.14	0.01
## pose_Rz_min	0.50	-0.68	1.20	0.01
## AU01_r_min	0.00	NaN	NaN	0.00
## AU02_r_min	0.00	NaN	NaN	0.00
## AU04_r_min	3.36	4.28	20.21	0.03
## AU05_r_min	0.00	NaN	NaN	0.00
## AU06_r_min	1.82	4.11	20.83	0.01
## AU07_r_min	3.59	3.15	11.80	0.03
## AU09_r_min	0.00	NaN	NaN	0.00
## AU10_r_min	0.86	4.29	18.95	0.01
## AU12_r_min	1.95	1.58	1.74	0.03
## AU14_r_min	1.85	0.47	-0.65	0.03
## AU15_r_min	0.00	NaN	NaN	0.00
## AU17_r_min	0.00	NaN	NaN	0.00
## AU20_r_min	0.00	NaN	NaN	0.00
## AU23_r_min	0.00	NaN	NaN	0.00
## AU25_r_min	0.00	NaN	NaN	0.00
## AU26_r_min	0.00	NaN	NaN	0.00
## AU45_r_min	0.00	NaN	NaN	0.00
## lip_min	88.74	0.04	-0.40	1.16
## eye_min	15.10	0.57	-0.68	0.23
## amplitude_min	0.59	0.04	-0.40	0.01
## stage_min	0.07	2.43	9.81	0.00
## apex_min	0.75	-0.16	-0.32	0.01
## offset_min	0.55	-0.03	-0.68	0.01
## onset_min	0.70	0.07	-0.15	0.01
## frame_max	650.00	1.17	1.98	6.89
## timestamp_max	13.00	1.17	1.98	0.14
## gaze_angle_x_max	0.44	-0.05	0.57	0.00
## gaze_angle_y_max	0.55	-0.22	-0.39	0.01
## pose_Rx_max	0.51	-0.48	0.25	0.01
## pose_Ry_max	0.51	-0.02	-0.13	0.01
## pose_Rz_max	0.42	0.49	0.38	0.01
## AU01_r_max	4.37	2.92	13.47	0.03
## AU02_r_max	2.08	2.02	4.19	0.03
## AU04_r_max	4.49	1.81	3.22	0.06
## AU05_r_max	1.89	1.86	5.70	0.02
## AU06_r_max	3.74	0.10	-0.16	0.05
## AU07_r_max	5.00	0.50	0.45	0.06
## AU09_r_max	1.80	2.43	8.56	0.02
## AU10_r_max	3.34	0.04	-0.35	0.05
## AU12_r_max	3.01	-0.33	-0.07	0.04
## AU14_r_max	3.40	-0.27	1.13	0.03
## AU15_r_max	2.62	3.53	23.08	0.02
## AU17_r_max	3.66	1.17	2.29	0.04
## AU20_r_max	1.49	1.27	2.14	0.02
## AU23_r_max	1.81	1.19	1.27	0.02
## AU25_r_max	3.14	0.91	0.16	0.05
## AU26_r_max	4.44	1.97	6.50	0.04
## AU45_r_max	4.05	0.31	-1.24	0.07
## lip_max	117.59	-0.25	-0.24	1.36

## eye_max	14.80	0.38	1.12	0.15
## amplitude_max	0.78	-0.25	-0.24	0.01
## stage_max	0.45	6.04	56.02	0.00
## apex_max	0.78	-0.25	-0.24	0.01
## offset_max	0.74	-0.16	-0.35	0.01
## onset_max	0.73	-0.17	-0.35	0.01
## frame_mean	325.00	1.17	1.98	3.44
## timestamp_mean	6.50	1.17	1.98	0.07
## gaze_angle_x_mean	0.44	-0.04	0.53	0.00
## gaze_angle_y_mean	0.51	-0.20	1.00	0.00
## pose_Rx_mean	0.48	-0.47	0.11	0.01
## pose_Ry_mean	0.48	-0.08	0.07	0.01
## pose_Rz_mean	0.36	0.10	-0.41	0.00
## AU01_r_mean	0.92	4.32	29.72	0.01
## AU02_r_mean	0.27	3.07	10.93	0.00
## AU04_r_mean	3.75	2.80	8.51	0.04
## AU05_r_mean	0.11	1.66	3.35	0.00
## AU06_r_mean	2.95	0.56	0.02	0.04
## AU07_r_mean	4.76	1.11	1.82	0.05
## AU09_r_mean	0.29	3.55	17.18	0.00
## AU10_r_mean	2.13	0.40	-0.74	0.03
## AU12_r_mean	2.99	-0.09	-0.15	0.04
## AU14_r_mean	2.80	-0.19	0.44	0.03
## AU15_r_mean	0.26	2.04	5.97	0.00
## AU17_r_mean	0.94	1.29	1.67	0.01
## AU20_r_mean	0.30	2.62	11.87	0.00
## AU23_r_mean	0.30	1.57	3.25	0.00
## AU25_r_mean	1.61	1.28	1.67	0.02
## AU26_r_mean	1.32	2.37	9.87	0.01
## AU45_r_mean	0.59	1.59	2.74	0.01
## lip_mean	111.27	-0.17	-0.33	1.28
## eye_mean	11.98	0.38	0.35	0.14
## amplitude_mean	0.74	-0.17	-0.33	0.01
## stage_mean	0.11	2.76	11.95	0.00
## apex_mean	0.77	-0.21	-0.28	0.01
## offset_mean	0.60	-0.10	-0.57	0.01
## onset_mean	0.68	-0.12	-0.32	0.01
## frame_sd	187.64	1.17	1.98	1.99
## timestamp_sd	3.75	1.17	1.98	0.04
## gaze_angle_x_sd	0.09	2.71	11.41	0.00
## gaze_angle_y_sd	0.09	0.91	0.93	0.00
## pose_Rx_sd	0.15	2.20	6.91	0.00
## pose_Ry_sd	0.09	2.12	6.17	0.00
## pose_Rz_sd	0.16	2.74	10.42	0.00
## AU01_r_sd	1.56	4.42	31.16	0.01
## AU02_r_sd	0.59	2.66	8.05	0.01
## AU04_r_sd	0.67	1.57	2.06	0.01
## AU05_r_sd	0.32	1.86	4.41	0.00
## AU06_r_sd	1.15	0.10	0.33	0.01
## AU07_r_sd	1.26	0.66	1.12	0.01
## AU09_r_sd	0.54	3.27	15.18	0.00
## AU10_r_sd	1.15	0.19	0.26	0.01
## AU12_r_sd	1.02	0.29	-0.34	0.01
## AU14_r_sd	0.82	0.85	1.04	0.01


```
## AU15_r_sd      0.60  3.06   17.11 0.00
## AU17_r_sd      1.14  1.49    3.38 0.01
## AU20_r_sd      0.49  2.10    7.71 0.00
## AU23_r_sd      0.52  1.27    1.73 0.01
## AU25_r_sd      1.36  1.02    0.35 0.02
## AU26_r_sd      1.39  2.05    7.43 0.01
## AU45_r_sd      1.16  1.02    0.72 0.01
## lip_sd         15.12 0.31   -0.51 0.22
## eye_sd          3.54 0.75    0.46 0.05
## amplitude_sd    0.10 0.31   -0.51 0.00
## stage_sd        0.09 7.06   73.80 0.00
## apex_sd         0.05 0.74    0.37 0.00
## offset_sd       0.14 1.41    2.75 0.00
## onset_sd        0.11 0.85    0.59 0.00
```

```
# descriptive statistics per classifier and boys/girls
```

```
desc_stats_class_gender <- describeBy(UvA_sum ~ smile_type + gender)
desc_stats_class_gender
```

```
##
## Descriptive statistics by group
## smile_type: deliberate
## gender: female
##
```

	vars	n	mean	sd	median	trimmed	mad	min	max
## filename*	1	116	58.50	33.63	58.50	58.50	43.00	1.00	116.00
## subject	2	116	282.35	158.93	252.00	279.59	189.77	20.00	543.00
## gender*	3	116	1.00	0.00	1.00	1.00	0.00	1.00	1.00
## age	4	116	11.46	2.51	11.00	11.28	2.97	8.00	17.00
## smile_type*	5	116	1.00	0.00	1.00	1.00	0.00	1.00	1.00
## frame_min	6	116	1.00	0.00	1.00	1.00	0.00	1.00	1.00
## timestamp_min	7	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## gaze_angle_x_min	8	116	0.14	0.08	0.15	0.14	0.07	-0.17	0.26
## gaze_angle_y_min	9	116	0.21	0.08	0.22	0.21	0.08	-0.01	0.48
## pose_Rx_min	10	116	0.13	0.09	0.14	0.13	0.10	-0.10	0.29
## pose_Ry_min	11	116	-0.18	0.07	-0.20	-0.18	0.08	-0.39	0.03
## pose_Rz_min	12	116	-0.04	0.06	-0.03	-0.03	0.06	-0.22	0.09
## AU01_r_min	13	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU02_r_min	14	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU04_r_min	15	116	0.16	0.54	0.00	0.02	0.00	0.00	2.99
## AU05_r_min	16	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU06_r_min	17	116	0.06	0.18	0.00	0.01	0.00	0.00	1.35
## AU07_r_min	18	116	0.27	0.56	0.00	0.14	0.00	0.00	3.46
## AU09_r_min	19	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU10_r_min	20	116	0.03	0.19	0.00	0.00	0.00	0.00	1.64
## AU12_r_min	21	116	0.24	0.38	0.00	0.16	0.00	0.00	2.56
## AU14_r_min	22	116	0.57	0.39	0.57	0.55	0.42	0.00	1.44
## AU15_r_min	23	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU17_r_min	24	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU20_r_min	25	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU23_r_min	26	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU25_r_min	27	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU26_r_min	28	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## AU45_r_min	29	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00
## lip_min	30	116	150.76	19.36	148.81	150.74	20.95	95.03	204.53

## eye_min	31	116	5.80	3.29	5.31	5.68	4.16	0.54	14.01
## amplitude_min	32	116	0.37	0.13	0.36	0.37	0.14	0.00	0.73
## stage_min	33	116	0.03	0.01	0.03	0.03	0.01	0.02	0.09
## apex_min	34	116	0.56	0.14	0.54	0.56	0.14	0.13	0.84
## offset_min	35	116	0.40	0.14	0.39	0.39	0.15	0.00	0.73
## onset_min	36	116	0.40	0.13	0.39	0.40	0.12	0.03	0.75
## frame_max	37	116	155.22	49.30	151.00	148.67	35.58	84.00	438.00
## timestamp_max	38	116	3.08	0.99	3.00	2.95	0.71	1.66	8.74
## gaze_angle_x_max	39	116	0.24	0.06	0.24	0.24	0.07	0.11	0.39
## gaze_angle_y_max	40	116	0.42	0.10	0.41	0.41	0.10	0.19	0.68
## pose_Rx_max	41	116	0.22	0.09	0.21	0.22	0.09	0.00	0.42
## pose_Ry_max	42	116	-0.12	0.07	-0.13	-0.12	0.08	-0.27	0.18
## pose_Rz_max	43	116	0.05	0.08	0.04	0.05	0.07	-0.14	0.33
## AU01_r_max	44	116	0.81	0.44	0.73	0.76	0.40	0.20	2.85
## AU02_r_max	45	116	0.50	0.25	0.47	0.47	0.21	0.13	1.60
## AU04_r_max	46	116	0.55	0.82	0.27	0.38	0.40	0.00	4.10
## AU05_r_max	47	116	0.52	0.35	0.42	0.47	0.27	0.10	2.34
## AU06_r_max	48	116	1.94	0.68	1.95	1.92	0.77	0.49	3.49
## AU07_r_max	49	116	1.85	0.93	1.83	1.83	0.81	0.01	5.00
## AU09_r_max	50	116	0.31	0.15	0.28	0.29	0.13	0.08	0.77
## AU10_r_max	51	116	1.31	0.73	1.33	1.31	0.76	0.00	2.86
## AU12_r_max	52	116	2.89	0.59	2.90	2.89	0.60	1.40	4.12
## AU14_r_max	53	116	1.86	0.39	1.84	1.87	0.43	1.02	2.70
## AU15_r_max	54	116	0.42	0.23	0.35	0.39	0.15	0.15	1.27
## AU17_r_max	55	116	1.33	0.64	1.27	1.25	0.49	0.29	3.72
## AU20_r_max	56	116	0.48	0.24	0.42	0.45	0.19	0.16	1.24
## AU23_r_max	57	116	0.59	0.36	0.54	0.55	0.36	0.09	1.88
## AU25_r_max	58	116	1.49	0.83	1.33	1.43	0.90	0.31	3.38
## AU26_r_max	59	116	1.12	0.48	1.02	1.07	0.44	0.31	2.86
## AU45_r_max	60	116	1.89	1.28	1.84	1.83	1.77	0.25	4.73
## lip_max	61	116	191.46	21.38	191.42	192.86	22.34	126.71	232.87
## eye_max	62	116	12.86	2.03	12.64	12.81	1.65	7.67	18.57
## amplitude_max	63	116	0.64	0.14	0.64	0.65	0.15	0.21	0.92
## stage_max	64	116	Inf	NaN	0.06	0.06	0.02	0.03	Inf
## apex_max	65	116	0.64	0.14	0.64	0.65	0.15	0.21	0.92
## offset_max	66	116	0.54	0.14	0.53	0.55	0.15	0.13	0.84
## onset_max	67	116	0.54	0.14	0.53	0.55	0.14	0.13	0.84
## frame_mean	68	116	78.11	24.65	76.00	74.84	17.79	42.50	219.50
## timestamp_mean	69	116	1.54	0.49	1.50	1.48	0.36	0.83	4.37
## gaze_angle_x_mean	70	116	0.19	0.06	0.20	0.19	0.06	0.06	0.30
## gaze_angle_y_mean	71	116	0.29	0.08	0.29	0.29	0.06	0.12	0.52
## pose_Rx_mean	72	116	0.18	0.09	0.18	0.18	0.10	-0.03	0.37
## pose_Ry_mean	73	116	-0.15	0.07	-0.17	-0.15	0.07	-0.32	0.05
## pose_Rz_mean	74	116	0.01	0.06	0.01	0.01	0.06	-0.16	0.24
## AU01_r_mean	75	116	0.14	0.08	0.13	0.13	0.08	0.03	0.45
## AU02_r_mean	76	116	0.05	0.03	0.05	0.05	0.02	0.02	0.20
## AU04_r_mean	77	116	0.30	0.66	0.02	0.15	0.03	0.00	3.50
## AU05_r_mean	78	116	0.05	0.03	0.04	0.04	0.02	0.01	0.24
## AU06_r_mean	79	116	1.14	0.58	1.08	1.11	0.65	0.09	2.82
## AU07_r_mean	80	116	1.08	0.84	0.98	1.00	0.78	0.00	4.89
## AU09_r_mean	81	116	0.04	0.02	0.03	0.04	0.02	0.01	0.13
## AU10_r_mean	82	116	0.70	0.51	0.72	0.67	0.56	0.00	2.06
## AU12_r_mean	83	116	1.97	0.56	1.93	1.96	0.61	0.78	3.34
## AU14_r_mean	84	116	1.34	0.37	1.31	1.35	0.40	0.46	2.13

## AU15_r_mean	85	116	0.07	0.04	0.06	0.07	0.03	0.03	0.24
## AU17_r_mean	86	116	0.40	0.22	0.35	0.36	0.14	0.11	1.67
## AU20_r_mean	87	116	0.07	0.04	0.06	0.07	0.03	0.02	0.27
## AU23_r_mean	88	116	0.09	0.06	0.07	0.08	0.04	0.02	0.28
## AU25_r_mean	89	116	0.67	0.46	0.59	0.63	0.52	0.08	1.89
## AU26_r_mean	90	116	0.29	0.15	0.26	0.27	0.11	0.10	1.13
## AU45_r_mean	91	116	0.20	0.14	0.18	0.19	0.14	0.04	0.96
## lip_mean	92	116	177.74	20.65	175.98	178.86	21.06	115.14	220.98
## eye_mean	93	116	10.56	1.85	10.54	10.61	1.40	4.65	16.01
## amplitude_mean	94	116	0.55	0.14	0.54	0.56	0.14	0.13	0.84
## stage_mean	95	116	Inf	NaN	0.04	0.04	0.01	0.02	Inf
## apex_mean	96	116	0.62	0.14	0.61	0.63	0.15	0.19	0.89
## offset_mean	97	116	0.45	0.14	0.43	0.45	0.15	0.03	0.78
## onset_mean	98	116	0.44	0.13	0.44	0.45	0.13	0.04	0.78
## frame_sd	99	116	44.95	14.23	43.73	43.06	10.27	24.39	126.58
## timestamp_sd	100	116	0.90	0.28	0.87	0.86	0.21	0.49	2.53
## gaze_angle_x_sd	101	116	0.02	0.02	0.02	0.02	0.01	0.01	0.10
## gaze_angle_y_sd	102	116	0.04	0.02	0.04	0.04	0.02	0.01	0.12
## pose_Rx_sd	103	116	0.02	0.01	0.02	0.02	0.01	0.01	0.07
## pose_Ry_sd	104	116	0.02	0.01	0.01	0.01	0.01	0.00	0.07
## pose_Rz_sd	105	116	0.03	0.03	0.02	0.02	0.01	0.00	0.14
## AU01_r_sd	106	116	0.22	0.12	0.20	0.20	0.13	0.04	0.80
## AU02_r_sd	107	116	0.11	0.07	0.10	0.10	0.05	0.03	0.44
## AU04_r_sd	108	116	0.10	0.12	0.04	0.07	0.07	0.00	0.59
## AU05_r_sd	109	116	0.11	0.08	0.08	0.10	0.05	0.03	0.61
## AU06_r_sd	110	116	0.66	0.23	0.66	0.65	0.27	0.14	1.31
## AU07_r_sd	111	116	0.44	0.22	0.43	0.44	0.19	0.00	1.02
## AU09_r_sd	112	116	0.08	0.04	0.07	0.07	0.04	0.02	0.22
## AU10_r_sd	113	116	0.45	0.27	0.44	0.45	0.30	0.00	1.12
## AU12_r_sd	114	116	0.91	0.26	0.88	0.90	0.28	0.41	1.61
## AU14_r_sd	115	116	0.33	0.12	0.31	0.32	0.13	0.13	0.72
## AU15_r_sd	116	116	0.11	0.06	0.09	0.10	0.04	0.04	0.38
## AU17_r_sd	117	116	0.42	0.24	0.38	0.39	0.15	0.08	1.49
## AU20_r_sd	118	116	0.13	0.08	0.10	0.11	0.06	0.04	0.42
## AU23_r_sd	119	116	0.16	0.10	0.13	0.14	0.09	0.02	0.45
## AU25_r_sd	120	116	0.55	0.37	0.46	0.52	0.36	0.08	1.44
## AU26_r_sd	121	116	0.33	0.17	0.29	0.31	0.13	0.09	1.08
## AU45_r_sd	122	116	0.41	0.29	0.35	0.39	0.33	0.06	1.50
## lip_sd	123	116	13.43	3.81	13.54	13.45	4.07	5.64	21.98
## eye_sd	124	116	1.52	0.81	1.37	1.45	0.83	0.20	4.24
## amplitude_sd	125	116	0.09	0.03	0.09	0.09	0.03	0.04	0.15
## stage_sd	126	115	0.01	0.02	0.01	0.01	0.00	0.00	0.16
## apex_sd	127	116	0.02	0.01	0.02	0.02	0.01	0.01	0.04
## offset_sd	128	116	0.04	0.02	0.04	0.04	0.02	0.01	0.10
## onset_sd	129	116	0.05	0.02	0.05	0.05	0.02	0.00	0.10
##			range	skew	kurtosis	se			
## filename*	115.00	0.00	-1.23	3.12					
## subject	523.00	0.22	-1.29	14.76					
## gender*	0.00	NaN	NaN	0.00					
## age	9.00	0.58	-0.58	0.23					
## smile_type*	0.00	NaN	NaN	0.00					
## frame_min	0.00	NaN	NaN	0.00					
## timestamp_min	0.00	NaN	NaN	0.00					
## gaze_angle_x_min	0.44	-1.20	2.05	0.01					

## gaze_angle_y_min	0.49	0.15	0.78	0.01
## pose_Rx_min	0.39	-0.25	-0.67	0.01
## pose_Ry_min	0.42	0.21	-0.03	0.01
## pose_Rz_min	0.32	-0.45	-0.09	0.01
## AU01_r_min	0.00	NaN	NaN	0.00
## AU02_r_min	0.00	NaN	NaN	0.00
## AU04_r_min	2.99	4.21	17.22	0.05
## AU05_r_min	0.00	NaN	NaN	0.00
## AU06_r_min	1.35	4.47	24.86	0.02
## AU07_r_min	3.46	2.83	10.14	0.05
## AU09_r_min	0.00	NaN	NaN	0.00
## AU10_r_min	1.64	6.85	49.77	0.02
## AU12_r_min	2.56	2.70	11.12	0.04
## AU14_r_min	1.44	0.14	-0.86	0.04
## AU15_r_min	0.00	NaN	NaN	0.00
## AU17_r_min	0.00	NaN	NaN	0.00
## AU20_r_min	0.00	NaN	NaN	0.00
## AU23_r_min	0.00	NaN	NaN	0.00
## AU25_r_min	0.00	NaN	NaN	0.00
## AU26_r_min	0.00	NaN	NaN	0.00
## AU45_r_min	0.00	NaN	NaN	0.00
## lip_min	109.50	0.04	0.11	1.80
## eye_min	13.47	0.30	-1.12	0.31
## amplitude_min	0.73	0.04	0.11	0.01
## stage_min	0.07	2.81	11.05	0.00
## apex_min	0.71	-0.48	-0.03	0.01
## offset_min	0.73	0.00	-0.13	0.01
## onset_min	0.73	-0.16	0.34	0.01
## frame_max	354.00	2.47	9.87	4.58
## timestamp_max	7.08	2.47	9.87	0.09
## gaze_angle_x_max	0.28	-0.02	-0.60	0.01
## gaze_angle_y_max	0.49	0.28	-0.45	0.01
## pose_Rx_max	0.42	0.03	-0.54	0.01
## pose_Ry_max	0.45	0.77	1.36	0.01
## pose_Rz_max	0.48	1.03	2.06	0.01
## AU01_r_max	2.65	1.32	2.96	0.04
## AU02_r_max	1.47	1.77	4.61	0.02
## AU04_r_max	4.10	2.48	6.79	0.08
## AU05_r_max	2.24	1.91	5.75	0.03
## AU06_r_max	3.00	0.21	-0.60	0.06
## AU07_r_max	4.99	0.46	1.02	0.09
## AU09_r_max	0.69	0.89	0.18	0.01
## AU10_r_max	2.86	-0.10	-0.76	0.07
## AU12_r_max	2.72	-0.07	-0.40	0.05
## AU14_r_max	1.68	-0.06	-0.73	0.04
## AU15_r_max	1.12	1.54	2.38	0.02
## AU17_r_max	3.43	1.38	2.67	0.06
## AU20_r_max	1.08	1.10	0.74	0.02
## AU23_r_max	1.79	1.10	0.91	0.03
## AU25_r_max	3.07	0.51	-0.79	0.08
## AU26_r_max	2.55	0.96	0.93	0.04
## AU45_r_max	4.48	0.22	-1.33	0.12
## lip_max	106.16	-0.54	0.11	1.98
## eye_max	10.90	0.24	0.28	0.19

## amplitude_max	0.71	-0.54	0.11	0.01
## stage_max	Inf	NaN	NaN	NaN
## apex_max	0.71	-0.54	0.11	0.01
## offset_max	0.71	-0.43	-0.02	0.01
## onset_max	0.70	-0.47	0.00	0.01
## frame_mean	177.00	2.47	9.87	2.29
## timestamp_mean	3.54	2.47	9.87	0.05
## gaze_angle_x_mean	0.24	-0.26	-0.76	0.01
## gaze_angle_y_mean	0.40	0.52	0.51	0.01
## pose_Rx_mean	0.40	-0.05	-0.60	0.01
## pose_Ry_mean	0.36	0.34	-0.09	0.01
## pose_Rz_mean	0.40	0.28	1.15	0.01
## AU01_r_mean	0.42	1.26	2.26	0.01
## AU02_r_mean	0.18	2.56	8.08	0.00
## AU04_r_mean	3.50	3.35	11.65	0.06
## AU05_r_mean	0.22	2.54	10.89	0.00
## AU06_r_mean	2.73	0.49	-0.41	0.05
## AU07_r_mean	4.89	1.44	3.69	0.08
## AU09_r_mean	0.12	1.38	1.98	0.00
## AU10_r_mean	2.06	0.52	-0.40	0.05
## AU12_r_mean	2.56	0.10	-0.39	0.05
## AU14_r_mean	1.67	-0.06	-0.64	0.03
## AU15_r_mean	0.21	1.91	4.99	0.00
## AU17_r_mean	1.56	2.47	9.80	0.02
## AU20_r_mean	0.25	1.83	3.92	0.00
## AU23_r_mean	0.27	1.30	1.22	0.01
## AU25_r_mean	1.81	0.65	-0.54	0.04
## AU26_r_mean	1.03	2.32	8.85	0.01
## AU45_r_mean	0.91	1.80	5.69	0.01
## lip_mean	105.84	-0.47	-0.04	1.92
## eye_mean	11.36	-0.20	0.83	0.17
## amplitude_mean	0.71	-0.47	-0.04	0.01
## stage_mean	Inf	NaN	NaN	NaN
## apex_mean	0.70	-0.52	-0.08	0.01
## offset_mean	0.75	-0.15	0.09	0.01
## onset_mean	0.74	-0.33	0.40	0.01
## frame_sd	102.19	2.47	9.87	1.32
## timestamp_sd	2.04	2.47	9.87	0.03
## gaze_angle_x_sd	0.10	2.43	7.90	0.00
## gaze_angle_y_sd	0.11	0.83	1.18	0.00
## pose_Rx_sd	0.06	1.16	1.04	0.00
## pose_Ry_sd	0.07	2.04	4.45	0.00
## pose_Rz_sd	0.14	2.25	5.42	0.00
## AU01_r_sd	0.76	1.36	3.47	0.01
## AU02_r_sd	0.41	2.51	7.97	0.01
## AU04_r_sd	0.59	1.68	2.93	0.01
## AU05_r_sd	0.58	2.46	10.38	0.01
## AU06_r_sd	1.18	0.23	-0.50	0.02
## AU07_r_sd	1.02	0.19	-0.03	0.02
## AU09_r_sd	0.21	1.17	1.09	0.00
## AU10_r_sd	1.12	0.02	-0.74	0.02
## AU12_r_sd	1.21	0.60	-0.23	0.02
## AU14_r_sd	0.58	0.75	0.33	0.01
## AU15_r_sd	0.34	1.90	4.48	0.01

```

## AU17_r_sd      1.41  1.89    5.13  0.02
## AU20_r_sd      0.38  1.55    2.10  0.01
## AU23_r_sd      0.43  1.10    0.48  0.01
## AU25_r_sd      1.36  0.63   -0.68  0.03
## AU26_r_sd      0.99  1.55    3.67  0.02
## AU45_r_sd      1.44  0.81    0.47  0.03
## lip_sd         16.35 -0.01   -0.77  0.35
## eye_sd          4.03  0.77    0.24  0.08
## amplitude_sd    0.11 -0.01   -0.77  0.00
## stage_sd        0.16  8.92   86.69  0.00
## apex_sd         0.04  0.37   -0.42  0.00
## offset_sd       0.09  0.42    0.19  0.00
## onset_sd        0.10  0.30   -0.17  0.00
## -----
## smile_type: spontaneous
## gender: female
## vars      n    mean      sd median trimmed   mad    min    max
## filename*  1 113  57.00  32.76  57.00   57.00  41.51   1.00 113.00
## subject    2 113 275.07 154.03 251.00  271.66 185.32 20.00 534.00
## gender*    3 113   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## age        4 113  11.01   2.45  10.00  10.75   2.97   8.00  17.00
## smile_type* 5 113   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## frame_min   6 113   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## timestamp_min 7 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## gaze_angle_x_min 8 113   0.15   0.07   0.16   0.16   0.06  -0.13   0.28
## gaze_angle_y_min 9 113   0.20   0.08   0.20   0.20   0.08  -0.07   0.48
## pose_Rx_min 10 113   0.10   0.11   0.12   0.11   0.08  -0.37   0.31
## pose_Ry_min 11 113  -0.20   0.07  -0.20  -0.20   0.06  -0.38   0.04
## pose_Rz_min 12 113  -0.05   0.09  -0.04  -0.04   0.08  -0.34   0.12
## AU01_r_min  13 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU02_r_min  14 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU04_r_min  15 113   0.14   0.53   0.00   0.01   0.00   0.00   3.36
## AU05_r_min  16 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU06_r_min  17 113   0.07   0.18   0.00   0.02   0.00   0.00   0.93
## AU07_r_min  18 113   0.28   0.56   0.00   0.15   0.00   0.00   3.59
## AU09_r_min  19 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU10_r_min  20 113   0.03   0.12   0.00   0.00   0.00   0.00   0.86
## AU12_r_min  21 113   0.44   0.49   0.28   0.37   0.42   0.00   1.76
## AU14_r_min  22 113   0.64   0.46   0.59   0.62   0.52   0.00   1.59
## AU15_r_min  23 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU17_r_min  24 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU20_r_min  25 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU23_r_min  26 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU25_r_min  27 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU26_r_min  28 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU45_r_min  29 113   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## lip_min     30 113 151.98  18.28 151.90 152.23 17.85 101.23 189.97
## eye_min     31 113   5.72   3.43   4.70   5.51   3.93   0.84  13.82
## amplitude_min 32 113   0.38   0.12   0.38   0.38   0.12   0.04   0.63
## stage_min   33 113   0.03   0.01   0.03   0.03   0.01   0.02   0.09
## apex_min    34 113   0.55   0.14   0.55   0.55   0.15   0.16   0.80
## offset_min   35 113   0.42   0.13   0.43   0.43   0.13   0.12   0.65
## onset_min   36 113   0.40   0.12   0.40   0.40   0.12   0.04   0.68
## frame_max   37 113 237.58 100.18 212.00 226.31 71.16 77.00 606.00

```

## timestamp_max	38	113	4.73	2.00	4.22	4.51	1.42	1.52	12.10
## gaze_angle_x_max	39	113	0.25	0.06	0.25	0.25	0.06	0.11	0.38
## gaze_angle_y_max	40	113	0.42	0.10	0.42	0.42	0.12	0.14	0.62
## pose_Rx_max	41	113	0.23	0.08	0.22	0.23	0.08	0.00	0.42
## pose_Ry_max	42	113	-0.12	0.08	-0.13	-0.12	0.08	-0.30	0.08
## pose_Rz_max	43	113	0.06	0.08	0.05	0.05	0.07	-0.10	0.30
## AU01_r_max	44	113	0.70	0.39	0.61	0.65	0.30	0.15	2.30
## AU02_r_max	45	113	0.58	0.39	0.44	0.50	0.24	0.17	2.24
## AU04_r_max	46	113	0.66	0.86	0.40	0.49	0.59	0.00	4.49
## AU05_r_max	47	113	0.52	0.29	0.46	0.48	0.24	0.12	2.01
## AU06_r_max	48	113	2.10	0.70	2.03	2.08	0.70	0.44	3.64
## AU07_r_max	49	113	2.05	0.94	2.04	2.04	0.86	0.00	5.00
## AU09_r_max	50	113	0.38	0.25	0.30	0.34	0.15	0.08	1.88
## AU10_r_max	51	113	1.55	0.74	1.61	1.53	0.76	0.00	3.34
## AU12_r_max	52	113	2.89	0.56	2.96	2.92	0.59	1.19	4.20
## AU14_r_max	53	113	1.91	0.39	1.91	1.91	0.43	1.03	2.91
## AU15_r_max	54	113	0.46	0.24	0.42	0.43	0.21	0.14	1.77
## AU17_r_max	55	113	1.39	0.64	1.35	1.33	0.44	0.30	3.96
## AU20_r_max	56	113	0.52	0.28	0.44	0.48	0.24	0.15	1.61
## AU23_r_max	57	113	0.64	0.38	0.58	0.59	0.37	0.11	1.91
## AU25_r_max	58	113	1.31	0.71	1.15	1.24	0.65	0.32	3.12
## AU26_r_max	59	113	1.16	0.51	1.09	1.10	0.39	0.31	3.27
## AU45_r_max	60	113	1.64	1.07	1.53	1.58	1.44	0.22	4.27
## lip_max	61	113	190.36	21.24	190.20	191.59	19.92	127.31	228.96
## eye_max	62	113	12.63	2.22	12.75	12.65	2.07	7.46	18.17
## amplitude_max	63	113	0.64	0.14	0.64	0.64	0.13	0.22	0.89
## stage_max	64	113	0.06	0.05	0.05	0.06	0.02	0.03	0.48
## apex_max	65	113	0.64	0.14	0.64	0.64	0.13	0.22	0.89
## offset_max	66	113	0.54	0.14	0.55	0.55	0.15	0.15	0.80
## onset_max	67	113	0.54	0.13	0.55	0.55	0.14	0.16	0.79
## frame_mean	68	113	119.29	50.09	106.50	113.65	35.58	39.00	303.50
## timestamp_mean	69	113	2.37	1.00	2.11	2.25	0.71	0.76	6.05
## gaze_angle_x_mean	70	113	0.20	0.06	0.20	0.20	0.05	0.07	0.32
## gaze_angle_y_mean	71	113	0.29	0.07	0.28	0.28	0.06	0.12	0.50
## pose_Rx_mean	72	113	0.17	0.08	0.17	0.18	0.07	-0.02	0.37
## pose_Ry_mean	73	113	-0.16	0.07	-0.17	-0.16	0.06	-0.35	0.05
## pose_Rz_mean	74	113	0.01	0.07	0.00	0.00	0.07	-0.16	0.16
## AU01_r_mean	75	113	0.11	0.06	0.10	0.10	0.05	0.03	0.36
## AU02_r_mean	76	113	0.05	0.04	0.04	0.05	0.02	0.02	0.29
## AU04_r_mean	77	113	0.31	0.65	0.03	0.16	0.04	0.00	3.75
## AU05_r_mean	78	113	0.04	0.02	0.03	0.04	0.01	0.01	0.12
## AU06_r_mean	79	113	1.24	0.56	1.22	1.22	0.63	0.10	2.89
## AU07_r_mean	80	113	1.18	0.83	1.15	1.12	0.88	0.00	4.76
## AU09_r_mean	81	113	0.05	0.04	0.03	0.04	0.01	0.01	0.29
## AU10_r_mean	82	113	0.84	0.52	0.88	0.83	0.62	0.00	2.13
## AU12_r_mean	83	113	2.05	0.55	2.05	2.07	0.55	0.41	3.40
## AU14_r_mean	84	113	1.36	0.37	1.37	1.37	0.43	0.53	2.21
## AU15_r_mean	85	113	0.08	0.04	0.06	0.07	0.03	0.03	0.23
## AU17_r_mean	86	113	0.39	0.21	0.35	0.37	0.18	0.11	1.06
## AU20_r_mean	87	113	0.07	0.04	0.06	0.06	0.03	0.02	0.32
## AU23_r_mean	88	113	0.08	0.05	0.07	0.07	0.04	0.02	0.32
## AU25_r_mean	89	113	0.48	0.33	0.39	0.44	0.30	0.08	1.63
## AU26_r_mean	90	113	0.30	0.15	0.26	0.28	0.12	0.09	0.80
## AU45_r_mean	91	113	0.17	0.12	0.13	0.15	0.09	0.04	0.63

## lip_mean	92	113	176.97	20.27	177.87	177.92	21.92	118.36	214.74
## eye_mean	93	113	10.20	2.11	10.31	10.24	2.02	5.32	15.40
## amplitude_mean	94	113	0.55	0.14	0.55	0.55	0.15	0.16	0.80
## stage_mean	95	113	0.04	0.02	0.04	0.04	0.01	0.03	0.13
## apex_mean	96	113	0.60	0.14	0.60	0.61	0.14	0.18	0.87
## offset_mean	97	113	0.48	0.13	0.48	0.48	0.14	0.14	0.73
## onset_mean	98	113	0.46	0.13	0.46	0.46	0.14	0.08	0.72
## frame_sd	99	113	68.73	28.92	61.34	65.47	20.54	22.37	175.08
## timestamp_sd	100	113	1.37	0.58	1.23	1.31	0.41	0.45	3.50
## gaze_angle_x_sd	101	113	0.02	0.01	0.02	0.02	0.01	0.01	0.10
## gaze_angle_y_sd	102	113	0.04	0.02	0.04	0.04	0.02	0.01	0.10
## pose_Rx_sd	103	113	0.03	0.02	0.02	0.03	0.01	0.01	0.16
## pose_Ry_sd	104	113	0.02	0.01	0.01	0.02	0.01	0.00	0.09
## pose_Rz_sd	105	113	0.03	0.03	0.02	0.02	0.01	0.00	0.17
## AU01_r_sd	106	113	0.17	0.10	0.15	0.15	0.08	0.04	0.57
## AU02_r_sd	107	113	0.12	0.09	0.09	0.10	0.05	0.03	0.62
## AU04_r_sd	108	113	0.12	0.15	0.07	0.10	0.11	0.00	0.66
## AU05_r_sd	109	113	0.10	0.06	0.08	0.09	0.03	0.03	0.35
## AU06_r_sd	110	113	0.60	0.21	0.56	0.59	0.19	0.13	1.15
## AU07_r_sd	111	113	0.44	0.23	0.42	0.42	0.17	0.00	1.26
## AU09_r_sd	112	113	0.09	0.07	0.07	0.08	0.03	0.02	0.56
## AU10_r_sd	113	113	0.45	0.23	0.44	0.45	0.22	0.00	1.15
## AU12_r_sd	114	113	0.71	0.19	0.69	0.70	0.21	0.33	1.14
## AU14_r_sd	115	113	0.29	0.11	0.27	0.28	0.12	0.07	0.64
## AU15_r_sd	116	113	0.11	0.06	0.09	0.10	0.04	0.04	0.43
## AU17_r_sd	117	113	0.39	0.21	0.35	0.36	0.16	0.08	1.23
## AU20_r_sd	118	113	0.12	0.08	0.10	0.11	0.05	0.03	0.52
## AU23_r_sd	119	113	0.15	0.09	0.13	0.14	0.09	0.03	0.54
## AU25_r_sd	120	113	0.44	0.28	0.39	0.41	0.28	0.07	1.22
## AU26_r_sd	121	113	0.32	0.16	0.30	0.31	0.14	0.07	0.94
## AU45_r_sd	122	113	0.33	0.24	0.27	0.30	0.23	0.05	1.21
## lip_sd	123	113	10.86	3.41	10.53	10.75	3.43	3.98	18.73
## eye_sd	124	113	1.43	0.72	1.27	1.37	0.69	0.23	3.77
## amplitude_sd	125	113	0.07	0.02	0.07	0.07	0.02	0.03	0.12
## stage_sd	126	113	0.01	0.01	0.01	0.01	0.00	0.00	0.10
## apex_sd	127	113	0.02	0.01	0.02	0.02	0.01	0.01	0.05
## offset_sd	128	113	0.04	0.02	0.03	0.03	0.02	0.00	0.14
## onset_sd	129	113	0.05	0.02	0.04	0.04	0.02	0.01	0.12
##			range	skew	kurtosis	se			
## filename*	112.00	0.00	-1.23	3.08					
## subject	514.00	0.26	-1.23	14.49					
## gender*	0.00	NaN	NaN	0.00					
## age	9.00	0.79	-0.11	0.23					
## smile_type*	0.00	NaN	NaN	0.00					
## frame_min	0.00	NaN	NaN	0.00					
## timestamp_min	0.00	NaN	NaN	0.00					
## gaze_angle_x_min	0.41	-0.83	1.27	0.01					
## gaze_angle_y_min	0.56	0.46	1.76	0.01					
## pose_Rx_min	0.68	-0.96	2.32	0.01					
## pose_Ry_min	0.41	0.32	0.30	0.01					
## pose_Rz_min	0.46	-0.78	1.21	0.01					
## AU01_r_min	0.00	NaN	NaN	0.00					
## AU02_r_min	0.00	NaN	NaN	0.00					
## AU04_r_min	3.36	4.45	20.10	0.05					

## AU05_r_min	0.00	NaN	NaN	0.00
## AU06_r_min	0.93	2.72	7.09	0.02
## AU07_r_min	3.59	3.20	12.95	0.05
## AU09_r_min	0.00	NaN	NaN	0.00
## AU10_r_min	0.86	4.26	20.70	0.01
## AU12_r_min	1.76	0.89	-0.38	0.05
## AU14_r_min	1.59	0.29	-1.04	0.04
## AU15_r_min	0.00	NaN	NaN	0.00
## AU17_r_min	0.00	NaN	NaN	0.00
## AU20_r_min	0.00	NaN	NaN	0.00
## AU23_r_min	0.00	NaN	NaN	0.00
## AU25_r_min	0.00	NaN	NaN	0.00
## AU26_r_min	0.00	NaN	NaN	0.00
## AU45_r_min	0.00	NaN	NaN	0.00
## lip_min	88.74	-0.16	-0.14	1.72
## eye_min	12.98	0.46	-1.04	0.32
## amplitude_min	0.59	-0.16	-0.14	0.01
## stage_min	0.07	3.04	11.51	0.00
## apex_min	0.65	-0.49	0.07	0.01
## offset_min	0.52	-0.27	-0.51	0.01
## onset_min	0.64	-0.19	-0.02	0.01
## frame_max	529.00	1.18	1.41	9.42
## timestamp_max	10.58	1.18	1.41	0.19
## gaze_angle_x_max	0.28	-0.40	-0.29	0.01
## gaze_angle_y_max	0.48	-0.09	-0.73	0.01
## pose_Rx_max	0.42	-0.37	0.30	0.01
## pose_Ry_max	0.38	0.14	-0.41	0.01
## pose_Rz_max	0.41	0.61	0.48	0.01
## AU01_r_max	2.15	1.27	1.93	0.04
## AU02_r_max	2.07	2.15	5.20	0.04
## AU04_r_max	4.49	2.07	4.93	0.08
## AU05_r_max	1.89	1.88	5.46	0.03
## AU06_r_max	3.20	0.24	-0.56	0.07
## AU07_r_max	5.00	0.32	0.60	0.09
## AU09_r_max	1.80	2.62	10.75	0.02
## AU10_r_max	3.34	0.12	-0.32	0.07
## AU12_r_max	3.01	-0.43	0.13	0.05
## AU14_r_max	1.88	0.00	-0.76	0.04
## AU15_r_max	1.63	2.10	7.59	0.02
## AU17_r_max	3.66	1.33	2.99	0.06
## AU20_r_max	1.46	1.36	2.10	0.03
## AU23_r_max	1.80	1.13	1.12	0.04
## AU25_r_max	2.80	0.78	-0.18	0.07
## AU26_r_max	2.96	1.32	2.77	0.05
## AU45_r_max	4.05	0.34	-1.16	0.10
## lip_max	101.65	-0.60	0.35	2.00
## eye_max	10.71	-0.08	-0.04	0.21
## amplitude_max	0.68	-0.60	0.35	0.01
## stage_max	0.45	6.08	46.18	0.00
## apex_max	0.68	-0.60	0.35	0.01
## offset_max	0.64	-0.47	0.04	0.01
## onset_max	0.64	-0.49	0.06	0.01
## frame_mean	264.50	1.18	1.41	4.71
## timestamp_mean	5.29	1.18	1.41	0.09

## gaze_angle_x_mean	0.26	-0.27	-0.21	0.01
## gaze_angle_y_mean	0.39	0.61	0.79	0.01
## pose_Rx_mean	0.39	-0.11	-0.18	0.01
## pose_Ry_mean	0.40	0.15	0.17	0.01
## pose_Rz_mean	0.32	0.10	-0.54	0.01
## AU01_r_mean	0.32	1.38	2.10	0.01
## AU02_r_mean	0.27	3.22	14.34	0.00
## AU04_r_mean	3.75	3.27	11.58	0.06
## AU05_r_mean	0.10	1.49	2.43	0.00
## AU06_r_mean	2.80	0.50	0.02	0.05
## AU07_r_mean	4.76	1.03	2.33	0.08
## AU09_r_mean	0.28	3.48	17.03	0.00
## AU10_r_mean	2.13	0.23	-0.75	0.05
## AU12_r_mean	2.98	-0.24	-0.04	0.05
## AU14_r_mean	1.68	-0.10	-0.90	0.04
## AU15_r_mean	0.20	1.62	2.73	0.00
## AU17_r_mean	0.94	1.07	0.90	0.02
## AU20_r_mean	0.29	2.65	9.82	0.00
## AU23_r_mean	0.30	1.79	4.18	0.00
## AU25_r_mean	1.55	1.13	0.91	0.03
## AU26_r_mean	0.71	1.25	1.56	0.01
## AU45_r_mean	0.59	1.60	2.45	0.01
## lip_mean	96.38	-0.49	0.05	1.91
## eye_mean	10.08	-0.12	-0.18	0.20
## amplitude_mean	0.64	-0.49	0.05	0.01
## stage_mean	0.11	3.25	12.67	0.00
## apex_mean	0.68	-0.57	0.24	0.01
## offset_mean	0.59	-0.29	-0.36	0.01
## onset_mean	0.64	-0.33	0.08	0.01
## frame_sd	152.71	1.18	1.41	2.72
## timestamp_sd	3.05	1.18	1.41	0.05
## gaze_angle_x_sd	0.09	2.94	14.68	0.00
## gaze_angle_y_sd	0.09	0.75	0.52	0.00
## pose_Rx_sd	0.15	2.52	7.95	0.00
## pose_Ry_sd	0.09	2.23	6.53	0.00
## pose_Rz_sd	0.16	2.52	7.85	0.00
## AU01_r_sd	0.53	1.27	1.70	0.01
## AU02_r_sd	0.59	2.88	10.91	0.01
## AU04_r_sd	0.66	1.56	2.43	0.01
## AU05_r_sd	0.32	1.80	3.81	0.01
## AU06_r_sd	1.03	0.52	-0.22	0.02
## AU07_r_sd	1.26	0.93	1.53	0.02
## AU09_r_sd	0.54	3.32	16.13	0.01
## AU10_r_sd	1.15	0.37	0.24	0.02
## AU12_r_sd	0.80	0.28	-0.62	0.02
## AU14_r_sd	0.57	0.71	0.07	0.01
## AU15_r_sd	0.39	1.98	5.75	0.01
## AU17_r_sd	1.14	1.42	2.61	0.02
## AU20_r_sd	0.49	2.19	6.86	0.01
## AU23_r_sd	0.51	1.39	2.27	0.01
## AU25_r_sd	1.15	0.85	-0.19	0.03
## AU26_r_sd	0.87	1.30	2.18	0.02
## AU45_r_sd	1.16	1.14	1.20	0.02
## lip_sd	14.75	0.27	-0.63	0.32

```

## eye_sd          3.54  0.89    0.77  0.07
## amplitude_sd    0.10  0.27   -0.63  0.00
## stage_sd        0.09  6.61   53.38  0.00
## apex_sd         0.05  0.89    0.65  0.00
## offset_sd       0.13  1.49    2.81  0.00
## onset_sd        0.11  0.90    0.83  0.00
## -----
## smile_type: deliberate
## gender: male
##               vars   n   mean    sd median trimmed   mad   min   max
## filename*      1 124  62.50  35.94  62.50   62.50  45.96   1.00 124.00
## subject        2 124 297.57 151.14 282.50  300.13 220.17  54.00 520.00
## gender*        3 124   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## age            4 124  10.49   2.11  10.00  10.21   1.48   8.00  17.00
## smile_type*    5 124   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## frame_min      6 124   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## timestamp_min  7 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## gaze_angle_x_min 8 124   0.15   0.09   0.16   0.15   0.07  -0.12   0.37
## gaze_angle_y_min 9 124   0.20   0.09   0.22   0.21   0.08  -0.10   0.38
## pose_Rx_min    10 124   0.10   0.11   0.11   0.11   0.10  -0.33   0.29
## pose_Ry_min    11 124  -0.20   0.09  -0.20  -0.20   0.07  -0.44   0.01
## pose_Rz_min    12 124  -0.04   0.07  -0.03  -0.04   0.07  -0.26   0.09
## AU01_r_min     13 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU02_r_min     14 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU04_r_min     15 124   0.12   0.40   0.00   0.01   0.00   0.00   2.18
## AU05_r_min     16 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU06_r_min     17 124   0.04   0.20   0.00   0.00   0.00   0.00   1.21
## AU07_r_min     18 124   0.12   0.40   0.00   0.01   0.00   0.00   2.36
## AU09_r_min     19 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU10_r_min     20 124   0.00   0.02   0.00   0.00   0.00   0.00   0.24
## AU12_r_min     21 124   0.09   0.24   0.00   0.03   0.00   0.00   1.34
## AU14_r_min     22 124   0.46   0.47   0.34   0.40   0.50   0.00   1.82
## AU15_r_min     23 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU17_r_min     24 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU20_r_min     25 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU23_r_min     26 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU25_r_min     27 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU26_r_min     28 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## AU45_r_min     29 124   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## lip_min        30 124 145.32  17.01 147.00  145.34  16.40 110.17 184.45
## eye_min        31 124   5.77   3.96   4.56   5.43   3.85   0.57  15.49
## amplitude_min  32 124   0.34   0.11   0.35   0.34   0.11   0.10   0.60
## stage_min      33 124   0.03   0.01   0.03   0.03   0.01   0.02   0.06
## apex_min       34 124   0.54   0.13   0.54   0.54   0.14   0.27   0.83
## offset_min     35 124   0.36   0.12   0.38   0.36   0.12   0.12   0.61
## onset_min      36 124   0.36   0.12   0.36   0.36   0.11   0.10   0.73
## frame_max      37 124 163.86  53.03 153.00  157.38  40.03  90.00 385.00
## timestamp_max  38 124   3.26   1.06   3.04   3.13   0.80   1.78   7.68
## gaze_angle_x_max 39 124   0.24   0.08   0.24   0.24   0.07   0.02   0.46
## gaze_angle_y_max 40 124   0.41   0.11   0.40   0.40   0.11   0.10   0.69
## pose_Rx_max    41 124   0.19   0.10   0.21   0.20   0.09  -0.10   0.36
## pose_Ry_max    42 124  -0.14   0.08  -0.14  -0.14   0.08  -0.38   0.04
## pose_Rz_max    43 124   0.03   0.08   0.03   0.02   0.06  -0.16   0.28
## AU01_r_max     44 124   0.84   0.72   0.72   0.71   0.42   0.13   5.00

```

## AU02_r_max	45	124	0.56	0.39	0.47	0.48	0.19	0.15	3.09
## AU04_r_max	46	124	0.46	0.71	0.00	0.31	0.01	0.00	2.83
## AU05_r_max	47	124	0.53	0.36	0.46	0.48	0.26	0.12	2.30
## AU06_r_max	48	124	1.50	0.77	1.50	1.50	0.72	0.00	3.53
## AU07_r_max	49	124	1.50	0.91	1.46	1.45	0.76	0.00	4.40
## AU09_r_max	50	124	0.32	0.19	0.26	0.29	0.13	0.10	0.98
## AU10_r_max	51	124	0.81	0.67	0.69	0.77	1.02	0.00	2.28
## AU12_r_max	52	124	2.66	0.72	2.70	2.65	0.74	0.79	4.70
## AU14_r_max	53	124	1.85	0.46	1.86	1.86	0.51	0.83	2.89
## AU15_r_max	54	124	0.42	0.23	0.36	0.38	0.17	0.13	1.27
## AU17_r_max	55	124	1.17	0.63	1.10	1.10	0.61	0.29	3.97
## AU20_r_max	56	124	0.42	0.23	0.36	0.39	0.20	0.10	1.46
## AU23_r_max	57	124	0.52	0.34	0.46	0.47	0.27	0.11	1.61
## AU25_r_max	58	124	1.32	0.76	1.13	1.26	0.73	0.32	3.30
## AU26_r_max	59	124	1.09	0.48	1.00	1.04	0.39	0.38	2.93
## AU45_r_max	60	124	1.93	1.34	1.98	1.85	1.93	0.22	5.00
## lip_max	61	124	189.14	20.68	191.42	188.83	22.46	144.05	239.26
## eye_max	62	124	12.98	2.26	12.92	12.95	2.01	7.83	19.03
## amplitude_max	63	124	0.63	0.14	0.64	0.63	0.15	0.33	0.96
## stage_max	64	124	0.07	0.03	0.06	0.06	0.02	0.03	0.20
## apex_max	65	124	0.63	0.14	0.64	0.63	0.15	0.33	0.96
## offset_max	66	124	0.52	0.13	0.53	0.52	0.13	0.26	0.82
## onset_max	67	124	0.52	0.12	0.53	0.53	0.13	0.26	0.81
## frame_mean	68	124	82.43	26.52	77.00	79.19	20.02	45.50	193.00
## timestamp_mean	69	124	1.63	0.53	1.52	1.56	0.40	0.89	3.84
## gaze_angle_x_mean	70	124	0.19	0.08	0.21	0.20	0.06	-0.04	0.41
## gaze_angle_y_mean	71	124	0.28	0.08	0.30	0.29	0.07	0.05	0.46
## pose_Rx_mean	72	124	0.15	0.10	0.17	0.16	0.10	-0.11	0.32
## pose_Ry_mean	73	124	-0.17	0.08	-0.17	-0.17	0.07	-0.41	0.04
## pose_Rz_mean	74	124	-0.01	0.07	0.00	-0.01	0.06	-0.18	0.16
## AU01_r_mean	75	124	0.15	0.16	0.11	0.12	0.06	0.03	1.06
## AU02_r_mean	76	124	0.06	0.05	0.05	0.05	0.02	0.02	0.37
## AU04_r_mean	77	124	0.24	0.52	0.00	0.10	0.00	0.00	2.40
## AU05_r_mean	78	124	0.05	0.03	0.04	0.04	0.02	0.01	0.24
## AU06_r_mean	79	124	0.80	0.53	0.71	0.77	0.53	0.00	2.48
## AU07_r_mean	80	124	0.78	0.68	0.66	0.68	0.58	0.00	3.02
## AU09_r_mean	81	124	0.04	0.02	0.03	0.04	0.02	0.01	0.15
## AU10_r_mean	82	124	0.36	0.36	0.25	0.31	0.37	0.00	1.46
## AU12_r_mean	83	124	1.73	0.56	1.84	1.74	0.55	0.31	3.25
## AU14_r_mean	84	124	1.31	0.44	1.36	1.33	0.44	0.31	2.20
## AU15_r_mean	85	124	0.07	0.04	0.06	0.07	0.02	0.03	0.36
## AU17_r_mean	86	124	0.35	0.19	0.31	0.33	0.19	0.08	1.02
## AU20_r_mean	87	124	0.06	0.03	0.05	0.05	0.02	0.02	0.18
## AU23_r_mean	88	124	0.07	0.05	0.06	0.06	0.04	0.02	0.29
## AU25_r_mean	89	124	0.55	0.42	0.42	0.50	0.35	0.07	1.86
## AU26_r_mean	90	124	0.29	0.13	0.28	0.27	0.12	0.09	0.78
## AU45_r_mean	91	124	0.20	0.14	0.16	0.18	0.13	0.04	0.79
## lip_mean	92	124	174.86	18.90	175.85	174.96	20.62	134.86	219.12
## eye_mean	93	124	10.71	2.21	10.52	10.60	1.68	6.06	16.57
## amplitude_mean	94	124	0.53	0.13	0.54	0.53	0.14	0.27	0.83
## stage_mean	95	124	0.04	0.01	0.04	0.04	0.01	0.02	0.09
## apex_mean	96	124	0.60	0.14	0.61	0.60	0.14	0.31	0.89
## offset_mean	97	124	0.42	0.12	0.43	0.42	0.13	0.18	0.72
## onset_mean	98	124	0.42	0.12	0.43	0.42	0.12	0.12	0.75

## frame_sd	99	124	47.45	15.31	44.31	45.58	11.56	26.12	111.28
## timestamp_sd	100	124	0.95	0.31	0.89	0.91	0.23	0.52	2.23
## gaze_angle_x_sd	101	124	0.02	0.01	0.02	0.02	0.01	0.00	0.09
## gaze_angle_y_sd	102	124	0.04	0.02	0.04	0.04	0.02	0.01	0.12
## pose_Rx_sd	103	124	0.02	0.01	0.02	0.02	0.01	0.01	0.08
## pose_Ry_sd	104	124	0.01	0.01	0.01	0.01	0.01	0.00	0.06
## pose_Rz_sd	105	124	0.02	0.02	0.01	0.02	0.01	0.00	0.11
## AU01_r_sd	106	124	0.23	0.25	0.17	0.18	0.10	0.04	1.78
## AU02_r_sd	107	124	0.12	0.11	0.10	0.10	0.04	0.03	0.80
## AU04_r_sd	108	124	0.08	0.12	0.00	0.06	0.00	0.00	0.47
## AU05_r_sd	109	124	0.11	0.08	0.09	0.10	0.05	0.03	0.53
## AU06_r_sd	110	124	0.53	0.29	0.52	0.52	0.25	0.00	1.21
## AU07_r_sd	111	124	0.39	0.25	0.37	0.38	0.24	0.00	1.15
## AU09_r_sd	112	124	0.08	0.05	0.06	0.07	0.03	0.02	0.25
## AU10_r_sd	113	124	0.28	0.25	0.22	0.25	0.33	0.00	0.97
## AU12_r_sd	114	124	0.92	0.30	0.91	0.91	0.29	0.24	2.05
## AU14_r_sd	115	124	0.36	0.14	0.36	0.35	0.15	0.12	0.82
## AU15_r_sd	116	124	0.11	0.07	0.09	0.10	0.04	0.03	0.46
## AU17_r_sd	117	124	0.36	0.22	0.33	0.33	0.22	0.07	1.11
## AU20_r_sd	118	124	0.10	0.06	0.09	0.09	0.04	0.02	0.34
## AU23_r_sd	119	124	0.13	0.09	0.11	0.12	0.08	0.03	0.51
## AU25_r_sd	120	124	0.47	0.33	0.37	0.44	0.29	0.07	1.42
## AU26_r_sd	121	124	0.32	0.15	0.29	0.30	0.13	0.09	0.79
## AU45_r_sd	122	124	0.42	0.31	0.38	0.39	0.35	0.05	1.44
## lip_sd	123	124	14.20	4.84	13.58	13.93	4.17	2.84	31.30
## eye_sd	124	124	1.54	0.91	1.45	1.47	0.98	0.19	5.10
## amplitude_sd	125	124	0.09	0.03	0.09	0.09	0.03	0.02	0.21
## stage_sd	126	124	0.01	0.01	0.01	0.01	0.00	0.00	0.05
## apex_sd	127	124	0.02	0.01	0.02	0.02	0.01	0.01	0.07
## offset_sd	128	124	0.05	0.02	0.04	0.04	0.02	0.00	0.13
## onset_sd	129	124	0.06	0.03	0.05	0.05	0.02	0.00	0.15
##			range	skew	kurtosis	se			
## filename*	123.00	0.00	-1.23	3.23					
## subject	466.00	-0.04	-1.52	13.57					
## gender*	0.00	NaN	NaN	0.00					
## age	9.00	1.11	0.89	0.19					
## smile_type*	0.00	NaN	NaN	0.00					
## frame_min	0.00	NaN	NaN	0.00					
## timestamp_min	0.00	NaN	NaN	0.00					
## gaze_angle_x_min	0.49	-0.59	1.22	0.01					
## gaze_angle_y_min	0.48	-0.50	0.10	0.01					
## pose_Rx_min	0.62	-0.88	0.85	0.01					
## pose_Ry_min	0.45	0.01	0.26	0.01					
## pose_Rz_min	0.35	-0.64	-0.01	0.01					
## AU01_r_min	0.00	NaN	NaN	0.00					
## AU02_r_min	0.00	NaN	NaN	0.00					
## AU04_r_min	2.18	3.45	11.17	0.04					
## AU05_r_min	0.00	NaN	NaN	0.00					
## AU06_r_min	1.21	4.77	22.63	0.02					
## AU07_r_min	2.36	4.01	16.74	0.04					
## AU09_r_min	0.00	NaN	NaN	0.00					
## AU10_r_min	0.24	8.50	74.37	0.00					
## AU12_r_min	1.34	3.12	10.00	0.02					
## AU14_r_min	1.82	0.85	-0.20	0.04					

## AU15_r_min	0.00	NaN	NaN	0.00
## AU17_r_min	0.00	NaN	NaN	0.00
## AU20_r_min	0.00	NaN	NaN	0.00
## AU23_r_min	0.00	NaN	NaN	0.00
## AU25_r_min	0.00	NaN	NaN	0.00
## AU26_r_min	0.00	NaN	NaN	0.00
## AU45_r_min	0.00	NaN	NaN	0.00
## lip_min	74.28	-0.02	-0.47	1.53
## eye_min	14.91	0.64	-0.71	0.36
## amplitude_min	0.50	-0.02	-0.47	0.01
## stage_min	0.04	1.06	0.99	0.00
## apex_min	0.56	-0.06	-0.59	0.01
## offset_min	0.50	-0.12	-0.69	0.01
## onset_min	0.63	0.10	-0.07	0.01
## frame_max	295.00	1.45	2.64	4.76
## timestamp_max	5.90	1.45	2.64	0.10
## gaze_angle_x_max	0.44	-0.23	0.42	0.01
## gaze_angle_y_max	0.59	0.16	-0.09	0.01
## pose_Rx_max	0.46	-0.67	-0.26	0.01
## pose_Ry_max	0.43	-0.02	0.21	0.01
## pose_Rz_max	0.44	0.74	1.44	0.01
## AU01_r_max	4.87	2.99	11.42	0.06
## AU02_r_max	2.94	3.26	14.86	0.04
## AU04_r_max	2.83	1.60	1.69	0.06
## AU05_r_max	2.18	2.20	6.49	0.03
## AU06_r_max	3.53	0.15	-0.34	0.07
## AU07_r_max	4.40	0.49	0.22	0.08
## AU09_r_max	0.88	1.39	1.53	0.02
## AU10_r_max	2.28	0.27	-1.25	0.06
## AU12_r_max	3.91	0.04	0.18	0.06
## AU14_r_max	2.06	-0.09	-0.57	0.04
## AU15_r_max	1.14	1.59	2.34	0.02
## AU17_r_max	3.68	1.38	2.96	0.06
## AU20_r_max	1.36	1.57	3.24	0.02
## AU23_r_max	1.50	1.33	1.49	0.03
## AU25_r_max	2.98	0.64	-0.68	0.07
## AU26_r_max	2.55	1.10	1.22	0.04
## AU45_r_max	4.78	0.30	-1.18	0.12
## lip_max	95.21	0.08	-0.39	1.86
## eye_max	11.19	0.16	-0.03	0.20
## amplitude_max	0.64	0.08	-0.39	0.01
## stage_max	0.16	1.70	2.75	0.00
## apex_max	0.64	0.08	-0.39	0.01
## offset_max	0.56	0.00	-0.57	0.01
## onset_max	0.55	-0.07	-0.63	0.01
## frame_mean	147.50	1.45	2.64	2.38
## timestamp_mean	2.95	1.45	2.64	0.05
## gaze_angle_x_mean	0.45	-0.36	0.85	0.01
## gaze_angle_y_mean	0.41	-0.51	-0.06	0.01
## pose_Rx_mean	0.43	-0.71	-0.37	0.01
## pose_Ry_mean	0.44	0.03	0.32	0.01
## pose_Rz_mean	0.34	-0.05	0.00	0.01
## AU01_r_mean	1.03	3.91	16.81	0.01
## AU02_r_mean	0.36	4.13	20.44	0.00

## AU04_r_mean	2.40	2.64	6.40	0.05
## AU05_r_mean	0.23	2.68	10.76	0.00
## AU06_r_mean	2.48	0.62	0.24	0.05
## AU07_r_mean	3.02	1.22	1.49	0.06
## AU09_r_mean	0.14	1.58	3.19	0.00
## AU10_r_mean	1.46	0.79	-0.28	0.03
## AU12_r_mean	2.94	-0.16	-0.28	0.05
## AU14_r_mean	1.89	-0.23	-0.76	0.04
## AU15_r_mean	0.34	3.14	15.26	0.00
## AU17_r_mean	0.94	0.89	0.54	0.02
## AU20_r_mean	0.16	1.79	3.53	0.00
## AU23_r_mean	0.27	1.72	3.16	0.00
## AU25_r_mean	1.79	1.02	0.30	0.04
## AU26_r_mean	0.69	1.23	1.71	0.01
## AU45_r_mean	0.75	1.33	2.54	0.01
## lip_mean	84.25	-0.05	-0.58	1.70
## eye_mean	10.51	0.46	0.11	0.20
## amplitude_mean	0.56	-0.05	-0.58	0.01
## stage_mean	0.06	1.25	1.19	0.00
## apex_mean	0.59	0.05	-0.53	0.01
## offset_mean	0.54	-0.05	-0.67	0.01
## onset_mean	0.62	-0.06	-0.27	0.01
## frame_sd	85.16	1.45	2.64	1.37
## timestamp_sd	1.70	1.45	2.64	0.03
## gaze_angle_x_sd	0.09	2.87	11.79	0.00
## gaze_angle_y_sd	0.11	1.18	2.12	0.00
## pose_Rx_sd	0.08	1.78	3.79	0.00
## pose_Ry_sd	0.06	2.67	9.23	0.00
## pose_Rz_sd	0.11	2.21	5.01	0.00
## AU01_r_sd	1.74	3.75	16.21	0.02
## AU02_r_sd	0.77	3.78	17.96	0.01
## AU04_r_sd	0.47	1.29	0.57	0.01
## AU05_r_sd	0.51	2.32	7.43	0.01
## AU06_r_sd	1.21	0.19	-0.39	0.03
## AU07_r_sd	1.15	0.40	-0.09	0.02
## AU09_r_sd	0.23	1.33	1.27	0.00
## AU10_r_sd	0.97	0.60	-0.57	0.02
## AU12_r_sd	1.81	0.59	1.42	0.03
## AU14_r_sd	0.70	0.46	-0.12	0.01
## AU15_r_sd	0.43	2.17	6.17	0.01
## AU17_r_sd	1.04	1.11	1.27	0.02
## AU20_r_sd	0.31	1.74	3.45	0.01
## AU23_r_sd	0.49	1.54	2.47	0.01
## AU25_r_sd	1.35	0.81	-0.33	0.03
## AU26_r_sd	0.70	1.00	0.75	0.01
## AU45_r_sd	1.39	0.76	0.05	0.03
## lip_sd	28.46	0.68	1.23	0.43
## eye_sd	4.91	0.92	1.44	0.08
## amplitude_sd	0.19	0.68	1.23	0.00
## stage_sd	0.04	1.89	3.95	0.00
## apex_sd	0.07	2.06	7.82	0.00
## offset_sd	0.13	0.89	0.81	0.00
## onset_sd	0.15	0.79	0.77	0.00
## -----				

```

## smile_type: spontaneous
## gender: male
##
##      vars  n   mean    sd median trimmed   mad   min   max
## filename*    1 122  61.50  35.36  61.50   61.50  45.22   1.00 122.00
## subject      2 122 290.67 143.53 272.00  289.95 197.93  54.00 525.00
## gender*      3 122   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## age          4 122  10.53   2.14  10.00  10.24   1.48   8.00  17.00
## smile_type*  5 122   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## frame_min    6 122   1.00   0.00   1.00   1.00   0.00   1.00   1.00
## timestamp_min 7 122   0.00   0.00   0.00   0.00   0.00   0.00   0.00
## gaze_angle_x_min 8 122  0.16  0.09  0.17  0.16  0.09  -0.13  0.39
## gaze_angle_y_min 9 122  0.20  0.09  0.20  0.20  0.08  -0.13  0.38
## pose_Rx_min  10 122  0.08  0.11  0.09  0.09  0.11  -0.22  0.28
## pose_Ry_min  11 122 -0.21  0.10 -0.21 -0.21  0.09  -0.46  0.02
## pose_Rz_min  12 122 -0.05  0.08 -0.04 -0.04  0.07  -0.38  0.13
## AU01_r_min   13 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU02_r_min   14 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU04_r_min   15 122  0.14  0.38  0.00  0.03  0.00  0.00  1.92
## AU05_r_min   16 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU06_r_min   17 122  0.08  0.26  0.00  0.01  0.00  0.00  1.82
## AU07_r_min   18 122  0.21  0.49  0.00  0.08  0.00  0.00  2.50
## AU09_r_min   19 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU10_r_min   20 122  0.04  0.14  0.00  0.00  0.00  0.00  0.81
## AU12_r_min   21 122  0.17  0.33  0.00  0.10  0.00  0.00  1.95
## AU14_r_min   22 122  0.48  0.42  0.49  0.44  0.53  0.00  1.85
## AU15_r_min   23 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU17_r_min   24 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU20_r_min   25 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU23_r_min   26 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU25_r_min   27 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU26_r_min   28 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## AU45_r_min   29 122  0.00  0.00  0.00  0.00  0.00  0.00  0.00
## lip_min      30 122 146.44 16.86 146.36 145.97 18.16 109.27 185.49
## eye_min      31 122  5.63  3.52  4.68  5.36  3.39  0.35 15.45
## amplitude_min 32 122  0.34  0.11  0.34  0.34  0.12  0.09  0.60
## stage_min    33 122  0.03  0.01  0.03  0.03  0.01  0.02  0.06
## apex_min     34 122  0.52  0.13  0.53  0.51  0.14  0.29  0.90
## offset_min   35 122  0.38  0.12  0.37  0.37  0.12  0.09  0.63
## onset_min    36 122  0.36  0.11  0.37  0.36  0.12  0.15  0.74
## frame_max    37 122 251.30 110.38 226.50 241.56 101.56  55.00 705.00
## timestamp_max 38 122  5.01  2.21  4.51  4.81  2.03  1.08 14.08
## gaze_angle_x_max 39 122  0.25  0.08  0.25  0.25  0.08  0.02  0.47
## gaze_angle_y_max 40 122  0.39  0.12  0.40  0.40  0.13  0.07  0.62
## pose_Rx_max  41 122  0.21  0.10  0.21  0.21  0.11  -0.06  0.45
## pose_Ry_max  42 122 -0.14  0.10 -0.14 -0.14  0.10  -0.40  0.11
## pose_Rz_max  43 122  0.04  0.07  0.04  0.04  0.07  -0.11  0.26
## AU01_r_max   44 122  0.76  0.63  0.56  0.63  0.34  0.23  4.52
## AU02_r_max   45 122  0.60  0.41  0.47  0.52  0.21  0.16  2.04
## AU04_r_max   46 122  0.61  0.88  0.21  0.43  0.31  0.00  3.56
## AU05_r_max   47 122  0.51  0.26  0.46  0.48  0.22  0.15  1.85
## AU06_r_max   48 122  1.69  0.79  1.63  1.68  0.73  0.00  3.74
## AU07_r_max   49 122  1.84  1.03  1.66  1.78  0.90  0.00  5.00
## AU09_r_max   50 122  0.40  0.25  0.34  0.35  0.18  0.12  1.55
## AU10_r_max   51 122  1.22  0.70  1.31  1.23  0.74  0.00  2.87

```


## AU12_r_max	52	122	2.70	0.60	2.71	2.72	0.57	1.23	4.05
## AU14_r_max	53	122	1.79	0.50	1.81	1.80	0.43	0.03	3.43
## AU15_r_max	54	122	0.49	0.29	0.41	0.45	0.16	0.19	2.76
## AU17_r_max	55	122	1.22	0.55	1.09	1.17	0.48	0.38	2.82
## AU20_r_max	56	122	0.49	0.21	0.44	0.47	0.20	0.12	1.14
## AU23_r_max	57	122	0.61	0.38	0.53	0.56	0.32	0.10	1.91
## AU25_r_max	58	122	1.25	0.69	1.04	1.16	0.63	0.38	3.46
## AU26_r_max	59	122	1.20	0.68	1.02	1.11	0.41	0.29	4.73
## AU45_r_max	60	122	1.74	1.11	1.55	1.68	1.48	0.25	3.96
## lip_max	61	122	185.98	20.29	187.39	185.88	25.78	146.48	244.90
## eye_max	62	122	12.51	2.43	12.45	12.43	2.25	7.25	22.05
## amplitude_max	63	122	0.61	0.14	0.62	0.61	0.17	0.34	1.00
## stage_max	64	122	0.07	0.03	0.06	0.06	0.02	0.03	0.21
## apex_max	65	122	0.61	0.14	0.62	0.61	0.17	0.34	1.00
## offset_max	66	122	0.51	0.13	0.52	0.51	0.14	0.29	0.90
## onset_max	67	122	0.51	0.13	0.52	0.51	0.14	0.28	0.89
## frame_mean	68	122	126.15	55.19	113.75	121.28	50.78	28.00	353.00
## timestamp_mean	69	122	2.50	1.10	2.26	2.41	1.02	0.54	7.04
## gaze_angle_x_mean	70	122	0.21	0.08	0.21	0.21	0.08	-0.01	0.43
## gaze_angle_y_mean	71	122	0.27	0.08	0.28	0.27	0.08	0.00	0.45
## pose_Rx_mean	72	122	0.15	0.10	0.17	0.16	0.09	-0.11	0.34
## pose_Ry_mean	73	122	-0.18	0.09	-0.18	-0.18	0.09	-0.43	0.05
## pose_Rz_mean	74	122	0.00	0.07	-0.01	0.00	0.07	-0.18	0.19
## AU01_r_mean	75	122	0.12	0.11	0.09	0.10	0.05	0.04	0.95
## AU02_r_mean	76	122	0.06	0.05	0.05	0.05	0.02	0.02	0.29
## AU04_r_mean	77	122	0.32	0.60	0.01	0.17	0.01	0.00	2.70
## AU05_r_mean	78	122	0.04	0.02	0.04	0.04	0.01	0.01	0.12
## AU06_r_mean	79	122	0.93	0.63	0.77	0.88	0.52	0.00	2.95
## AU07_r_mean	80	122	0.99	0.82	0.81	0.89	0.68	0.00	3.63
## AU09_r_mean	81	122	0.05	0.04	0.04	0.04	0.02	0.01	0.30
## AU10_r_mean	82	122	0.61	0.50	0.54	0.57	0.55	0.00	1.84
## AU12_r_mean	83	122	1.79	0.58	1.78	1.78	0.54	0.40	3.38
## AU14_r_mean	84	122	1.23	0.46	1.23	1.24	0.39	0.00	2.81
## AU15_r_mean	85	122	0.08	0.04	0.07	0.07	0.02	0.03	0.30
## AU17_r_mean	86	122	0.32	0.15	0.27	0.30	0.12	0.12	0.87
## AU20_r_mean	87	122	0.06	0.03	0.06	0.06	0.02	0.02	0.16
## AU23_r_mean	88	122	0.08	0.05	0.06	0.07	0.04	0.01	0.26
## AU25_r_mean	89	122	0.43	0.28	0.35	0.40	0.24	0.12	1.70
## AU26_r_mean	90	122	0.32	0.19	0.28	0.29	0.13	0.10	1.41
## AU45_r_mean	91	122	0.16	0.10	0.13	0.15	0.08	0.05	0.48
## lip_mean	92	122	172.02	18.90	173.39	171.86	21.21	138.57	229.63
## eye_mean	93	122	10.36	2.25	9.99	10.21	2.29	5.80	17.31
## amplitude_mean	94	122	0.51	0.13	0.52	0.51	0.14	0.29	0.90
## stage_mean	95	122	0.04	0.01	0.04	0.04	0.01	0.02	0.08
## apex_mean	96	122	0.57	0.13	0.58	0.57	0.15	0.32	0.96
## offset_mean	97	122	0.44	0.12	0.45	0.44	0.13	0.21	0.73
## onset_mean	98	122	0.43	0.12	0.44	0.43	0.13	0.21	0.76
## frame_sd	99	122	72.69	31.86	65.53	69.88	29.32	16.02	203.66
## timestamp_sd	100	122	1.45	0.64	1.31	1.40	0.59	0.32	4.07
## gaze_angle_x_sd	101	122	0.02	0.01	0.02	0.02	0.01	0.00	0.09
## gaze_angle_y_sd	102	122	0.04	0.02	0.04	0.04	0.02	0.01	0.10
## pose_Rx_sd	103	122	0.03	0.02	0.02	0.03	0.01	0.01	0.11
## pose_Ry_sd	104	122	0.02	0.01	0.01	0.02	0.01	0.00	0.07
## pose_Rz_sd	105	122	0.02	0.02	0.02	0.02	0.01	0.00	0.11

## AU01_r_sd	106	122	0.19	0.19	0.14	0.15	0.09	0.05	1.60
## AU02_r_sd	107	122	0.13	0.10	0.10	0.10	0.05	0.04	0.54
## AU04_r_sd	108	122	0.12	0.17	0.03	0.08	0.04	0.00	0.67
## AU05_r_sd	109	122	0.10	0.05	0.09	0.09	0.04	0.03	0.34
## AU06_r_sd	110	122	0.50	0.21	0.49	0.50	0.20	0.00	0.99
## AU07_r_sd	111	122	0.41	0.21	0.40	0.40	0.17	0.00	1.03
## AU09_r_sd	112	122	0.09	0.07	0.07	0.08	0.04	0.02	0.54
## AU10_r_sd	113	122	0.35	0.19	0.38	0.35	0.17	0.00	0.74
## AU12_r_sd	114	122	0.76	0.19	0.75	0.75	0.20	0.32	1.34
## AU14_r_sd	115	122	0.30	0.13	0.26	0.29	0.10	0.01	0.83
## AU15_r_sd	116	122	0.12	0.07	0.10	0.11	0.04	0.05	0.64
## AU17_r_sd	117	122	0.32	0.15	0.29	0.31	0.14	0.10	0.95
## AU20_r_sd	118	122	0.11	0.05	0.10	0.11	0.05	0.03	0.30
## AU23_r_sd	119	122	0.14	0.09	0.12	0.13	0.08	0.03	0.47
## AU25_r_sd	120	122	0.41	0.27	0.31	0.37	0.21	0.11	1.43
## AU26_r_sd	121	122	0.33	0.20	0.28	0.31	0.13	0.09	1.46
## AU45_r_sd	122	122	0.33	0.21	0.28	0.30	0.21	0.06	0.92
## lip_sd	123	122	11.13	3.44	11.07	10.98	3.58	4.95	19.10
## eye_sd	124	122	1.33	0.67	1.31	1.29	0.75	0.23	3.19
## amplitude_sd	125	122	0.07	0.02	0.07	0.07	0.02	0.03	0.13
## stage_sd	126	122	0.01	0.00	0.01	0.01	0.00	0.00	0.02
## apex_sd	127	122	0.03	0.01	0.03	0.02	0.01	0.01	0.05
## offset_sd	128	122	0.04	0.02	0.04	0.04	0.02	0.00	0.13
## onset_sd	129	122	0.04	0.02	0.04	0.04	0.02	0.01	0.11
##			range	skew	kurtosis	se			
## filename*	121.00	0.00	-1.23	3.20					
## subject	471.00	0.14	-1.37	12.99					
## gender*	0.00	NaN	NaN	0.00					
## age	9.00	1.19	0.82	0.19					
## smile_type*	0.00	NaN	NaN	0.00					
## frame_min	0.00	NaN	NaN	0.00					
## timestamp_min	0.00	NaN	NaN	0.00					
## gaze_angle_x_min	0.52	-0.52	1.19	0.01					
## gaze_angle_y_min	0.51	-0.54	0.85	0.01					
## pose_Rx_min	0.51	-0.50	-0.34	0.01					
## pose_Ry_min	0.48	-0.14	-0.28	0.01					
## pose_Rz_min	0.50	-0.56	1.09	0.01					
## AU01_r_min	0.00	NaN	NaN	0.00					
## AU02_r_min	0.00	NaN	NaN	0.00					
## AU04_r_min	1.92	3.16	9.76	0.03					
## AU05_r_min	0.00	NaN	NaN	0.00					
## AU06_r_min	1.82	4.31	20.80	0.02					
## AU07_r_min	2.50	3.00	9.06	0.04					
## AU09_r_min	0.00	NaN	NaN	0.00					
## AU10_r_min	0.81	4.21	17.09	0.01					
## AU12_r_min	1.95	2.87	9.64	0.03					
## AU14_r_min	1.85	0.61	-0.16	0.04					
## AU15_r_min	0.00	NaN	NaN	0.00					
## AU17_r_min	0.00	NaN	NaN	0.00					
## AU20_r_min	0.00	NaN	NaN	0.00					
## AU23_r_min	0.00	NaN	NaN	0.00					
## AU25_r_min	0.00	NaN	NaN	0.00					
## AU26_r_min	0.00	NaN	NaN	0.00					
## AU45_r_min	0.00	NaN	NaN	0.00					

## lip_min	76.23	0.20	-0.61	1.53
## eye_min	15.10	0.67	-0.41	0.32
## amplitude_min	0.51	0.20	-0.61	0.01
## stage_min	0.04	0.67	-0.47	0.00
## apex_min	0.61	0.15	-0.52	0.01
## offset_min	0.54	0.18	-0.67	0.01
## onset_min	0.59	0.29	-0.14	0.01
## frame_max	650.00	1.13	2.16	9.99
## timestamp_max	13.00	1.13	2.16	0.20
## gaze_angle_x_max	0.44	0.01	0.21	0.01
## gaze_angle_y_max	0.55	-0.23	-0.40	0.01
## pose_Rx_max	0.51	-0.40	-0.14	0.01
## pose_Ry_max	0.51	0.00	-0.23	0.01
## pose_Rz_max	0.37	0.29	-0.16	0.01
## AU01_r_max	4.29	2.94	11.44	0.06
## AU02_r_max	1.88	1.90	3.26	0.04
## AU04_r_max	3.56	1.57	1.59	0.08
## AU05_r_max	1.70	1.76	5.44	0.02
## AU06_r_max	3.74	0.19	0.00	0.07
## AU07_r_max	5.00	0.68	0.46	0.09
## AU09_r_max	1.43	2.23	6.41	0.02
## AU10_r_max	2.87	-0.12	-0.75	0.06
## AU12_r_max	2.82	-0.21	-0.19	0.05
## AU14_r_max	3.40	-0.24	1.32	0.05
## AU15_r_max	2.57	4.07	26.86	0.03
## AU17_r_max	2.44	0.82	0.06	0.05
## AU20_r_max	1.02	0.83	0.18	0.02
## AU23_r_max	1.81	1.23	1.36	0.03
## AU25_r_max	3.08	1.02	0.49	0.06
## AU26_r_max	4.44	2.10	6.50	0.06
## AU45_r_max	3.71	0.27	-1.34	0.10
## lip_max	98.42	0.09	-0.64	1.84
## eye_max	14.80	0.71	1.84	0.22
## amplitude_max	0.66	0.09	-0.64	0.01
## stage_max	0.18	1.82	5.60	0.00
## apex_max	0.66	0.09	-0.64	0.01
## offset_max	0.61	0.12	-0.57	0.01
## onset_max	0.61	0.13	-0.58	0.01
## frame_mean	325.00	1.13	2.16	5.00
## timestamp_mean	6.50	1.13	2.16	0.10
## gaze_angle_x_mean	0.44	-0.01	0.33	0.01
## gaze_angle_y_mean	0.46	-0.53	0.56	0.01
## pose_Rx_mean	0.45	-0.55	-0.19	0.01
## pose_Ry_mean	0.48	-0.09	-0.26	0.01
## pose_Rz_mean	0.36	0.10	-0.35	0.01
## AU01_r_mean	0.92	4.11	22.90	0.01
## AU02_r_mean	0.27	2.84	8.41	0.00
## AU04_r_mean	2.70	2.20	4.33	0.05
## AU05_r_mean	0.11	1.79	4.08	0.00
## AU06_r_mean	2.95	0.84	0.42	0.06
## AU07_r_mean	3.63	1.21	1.39	0.07
## AU09_r_mean	0.29	3.57	16.95	0.00
## AU10_r_mean	1.84	0.58	-0.68	0.04
## AU12_r_mean	2.98	0.08	-0.06	0.05

```
## AU14_r_mean      2.80 -0.10      0.77  0.04
## AU15_r_mean      0.26  2.41      8.85  0.00
## AU17_r_mean      0.74  1.33      1.70  0.01
## AU20_r_mean      0.14  0.98      0.80  0.00
## AU23_r_mean      0.25  1.26      1.73  0.00
## AU25_r_mean      1.58  1.38      2.45  0.03
## AU26_r_mean      1.32  2.69     10.97  0.02
## AU45_r_mean      0.44  1.36      1.75  0.01
## lip_mean         91.06  0.14     -0.53  1.71
## eye_mean         11.51  0.75      0.54  0.20
## amplitude_mean    0.61  0.14     -0.53  0.01
## stage_mean        0.05  0.80     -0.27  0.00
## apex_mean         0.64  0.13     -0.59  0.01
## offset_mean       0.53  0.04     -0.81  0.01
## onset_mean        0.55  0.06     -0.73  0.01
## frame_sd          187.64  1.13      2.16  2.88
## timestamp_sd       3.75  1.13      2.16  0.06
## gaze_angle_x_sd    0.08  2.50      8.79  0.00
## gaze_angle_y_sd    0.09  1.06      1.35  0.00
## pose_Rx_sd         0.11  1.44      2.43  0.00
## pose_Ry_sd         0.06  1.71      3.43  0.00
## pose_Rz_sd         0.10  2.03      5.09  0.00
## AU01_r_sd         1.55  4.15     23.39  0.02
## AU02_r_sd         0.50  2.46      6.03  0.01
## AU04_r_sd         0.67  1.57      1.72  0.02
## AU05_r_sd         0.31  1.90      4.90  0.00
## AU06_r_sd         0.99 -0.29      0.09  0.02
## AU07_r_sd         1.03  0.29      0.21  0.02
## AU09_r_sd         0.52  3.18     14.01  0.01
## AU10_r_sd         0.74 -0.31     -0.78  0.02
## AU12_r_sd         1.02  0.29     -0.19  0.02
## AU14_r_sd         0.82  0.91      1.49  0.01
## AU15_r_sd         0.60  3.67     22.46  0.01
## AU17_r_sd         0.84  1.04      1.42  0.01
## AU20_r_sd         0.27  0.96      0.67  0.00
## AU23_r_sd         0.45  1.11      0.92  0.01
## AU25_r_sd         1.33  1.18      0.94  0.02
## AU26_r_sd         1.38  2.34      8.78  0.02
## AU45_r_sd         0.85  0.86     -0.11  0.02
## lip_sd            14.15  0.35     -0.45  0.31
## eye_sd            2.96  0.54     -0.21  0.06
## amplitude_sd       0.09  0.35     -0.45  0.00
## stage_sd          0.02  1.22      0.76  0.00
## apex_sd           0.05  0.60      0.11  0.00
## offset_sd          0.13  1.33      2.69  0.00
## onset_sd          0.11  0.79      0.28  0.00
```

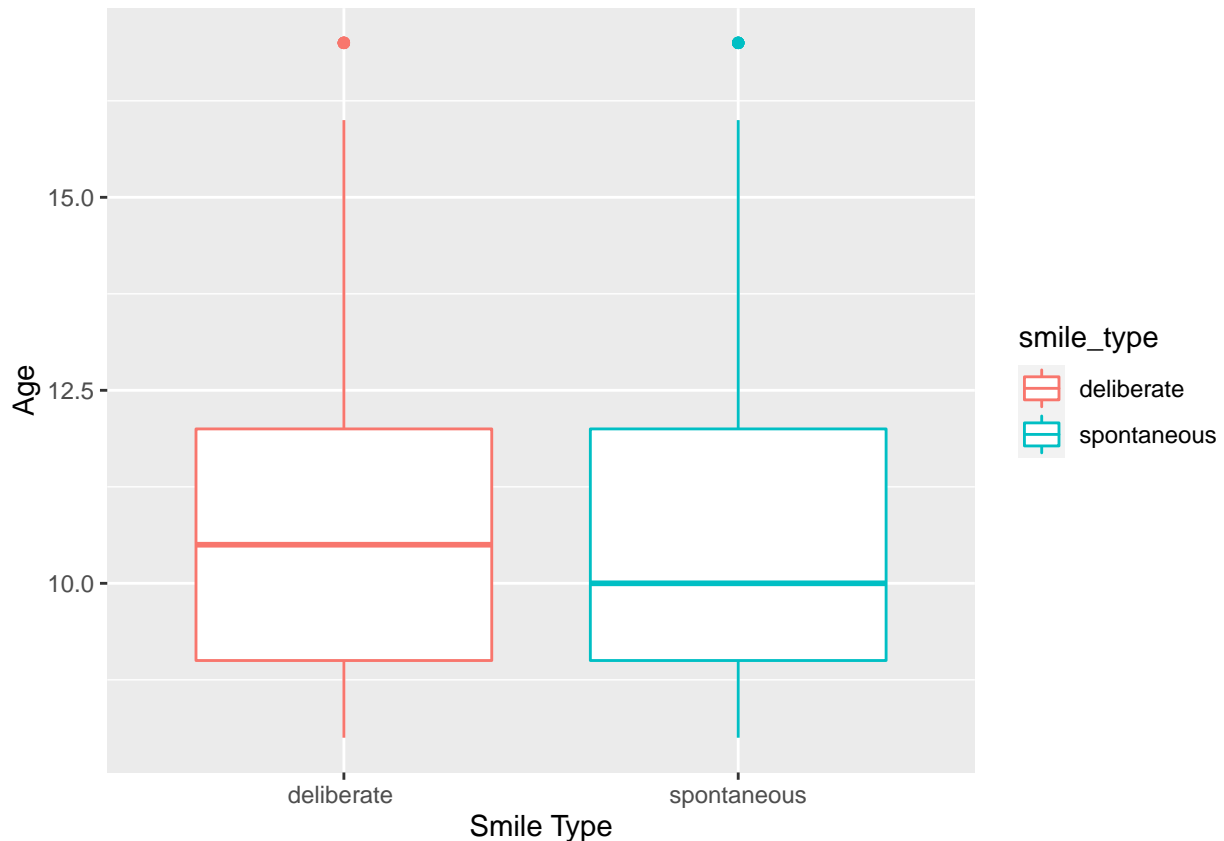
```
# citation("psych")
```

Distribution analysis

The main conclusions of the descriptive statistics will be given in the thesis report. The ggplot package is used to create distribution visualization of the distribution of the features.

```
# loading packages
library(ggplot2)
library(ggpubr)

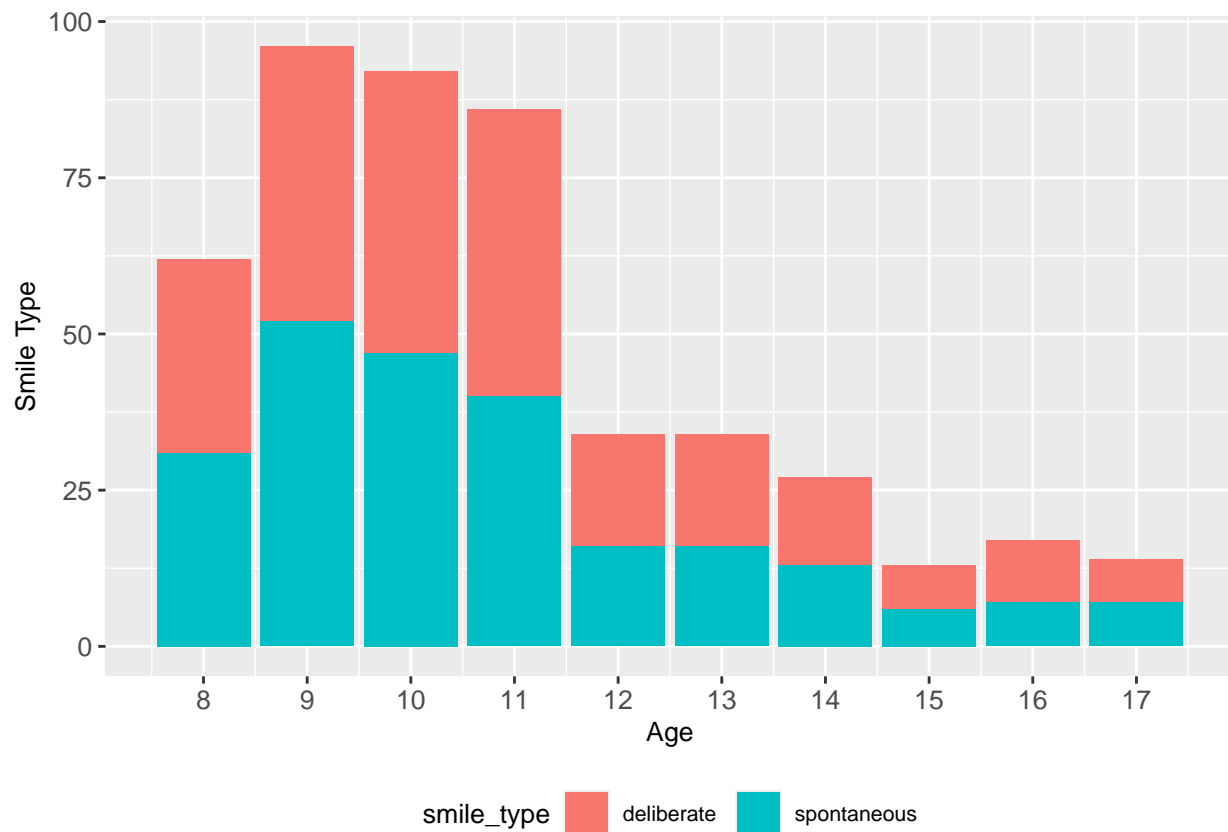
# age & gender distribution of the video's
ggplot(UvA_sum, aes(y = age, x = smile_type, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "Age") +
  scale_x_discrete(name = "Smile Type")
```



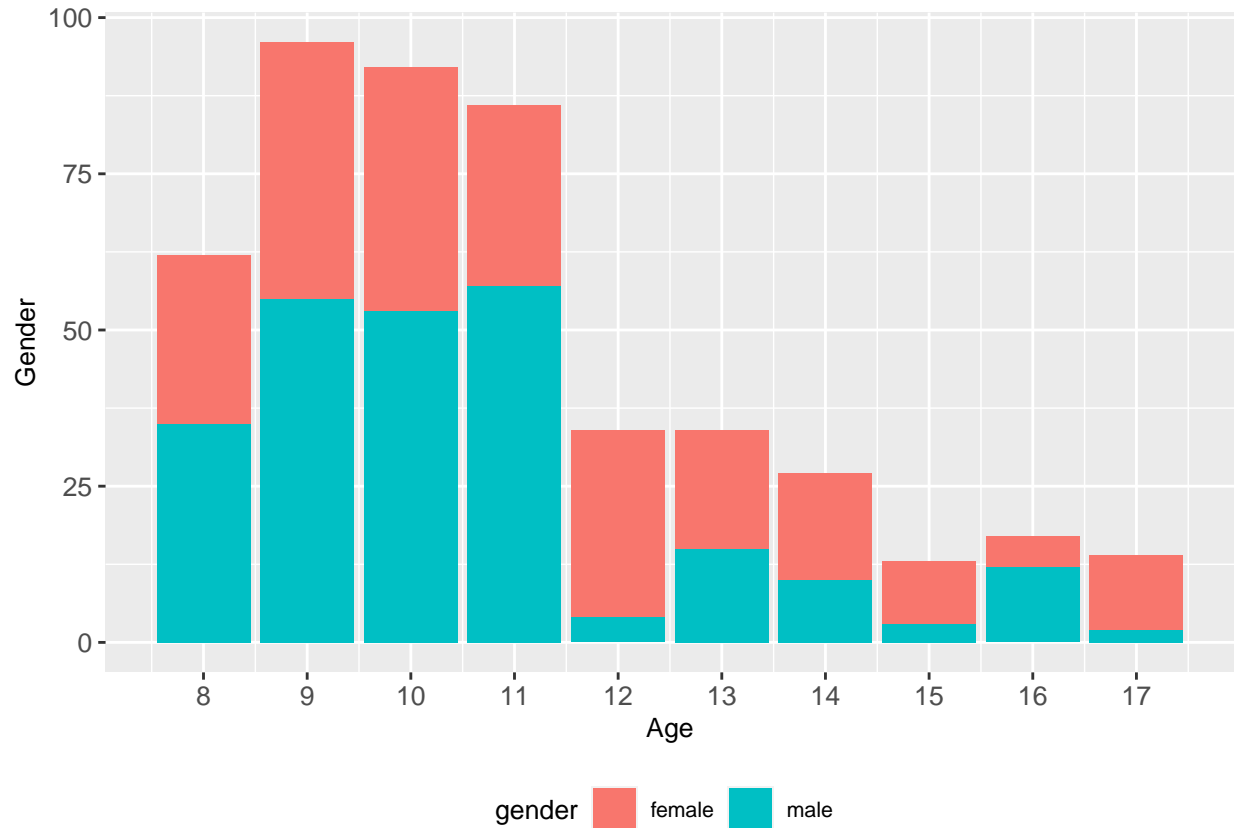
```
fig1 <- ggplot(UvA_sum, aes(y = age, x = smile_type, color = gender)) +
  geom_boxplot() +
  scale_y_continuous(name = "Age") +
  scale_x_discrete(name = "Smile Type")

ggplot(data = UvA_sum, aes(x = age, fill = smile_type)) +
  geom_bar(stat = "count") +
  scale_x_continuous(
    name = "Age",
    breaks = c(8, 9, 10, 11, 12, 13, 14, 15, 16, 17)
  ) +
  scale_y_continuous(name = "Smile Type") +
  labs() +
  theme(
    legend.position = "bottom", text = element_text(size = 10),
```

```
axis.text = element_text(size = 10)
)
```

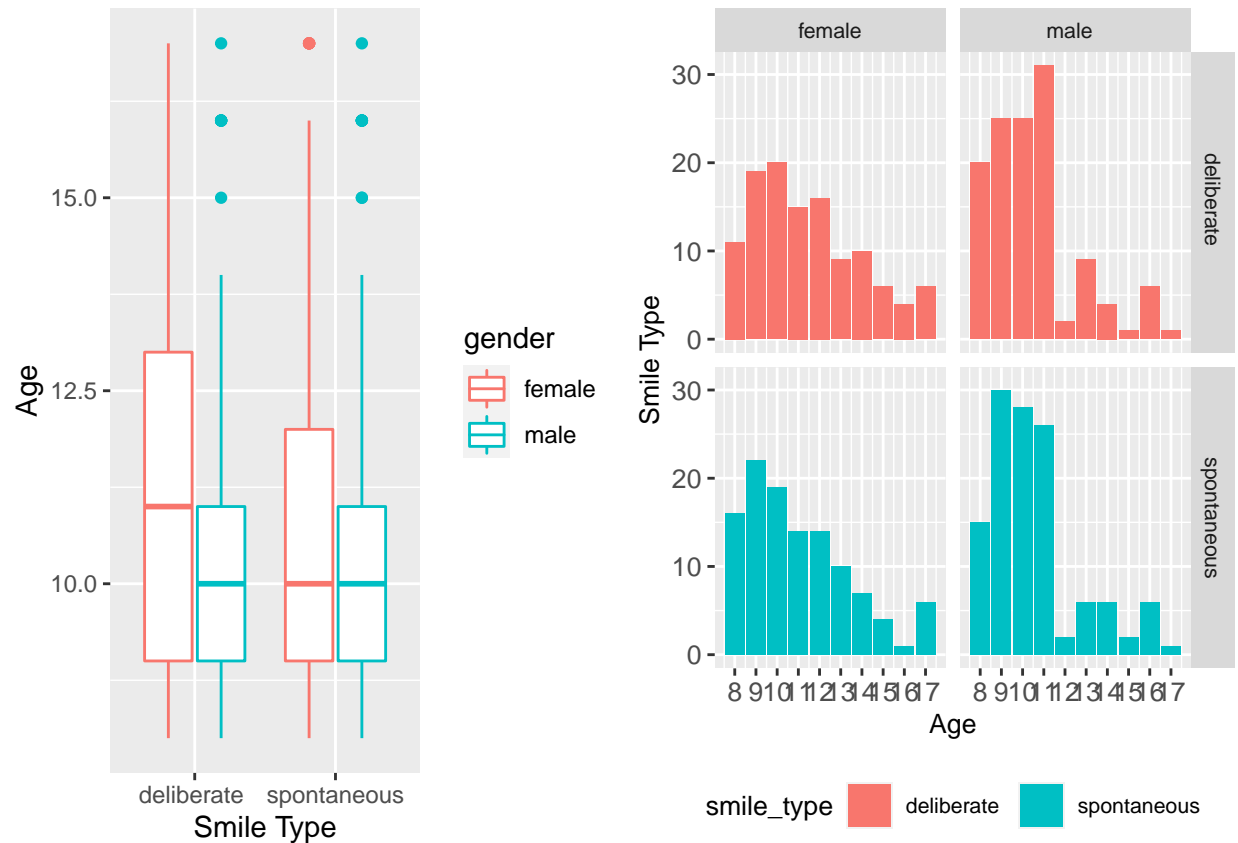


```
ggplot(data = UvA_sum, aes(x = age, fill = gender)) +
  geom_bar(stat = "count") +
  scale_x_continuous(
    name = "Age",
    breaks = c(8, 9, 10, 11, 12, 13, 14, 15, 16, 17)
  ) +
  scale_y_continuous(name = "Gender") +
  labs() +
  theme(
    legend.position = "bottom", text = element_text(size = 10),
    axis.text = element_text(size = 10)
  )
```



```
fig2 <- ggplot(data = UvA_sum, aes(x = age, fill = smile_type)) +
  geom_bar(stat = "count") +
  scale_x_continuous(
    name = "Age",
    breaks = c(8, 9, 10, 11, 12, 13, 14, 15, 16, 17)
  ) +
  scale_y_continuous(name = "Smile Type") +
  facet_grid(smile_type ~ gender) +
  labs() +
  theme(
    legend.position = "bottom", text = element_text(size = 10),
    axis.text = element_text(size = 10)
  )

# use the ggpubr package to combine multiple ggplot visualizations in one plot
figure <- ggarrange(fig1, fig2,
  # labels = c("1", "2"),
  ncol = 2, nrow = 1
)
figure
```

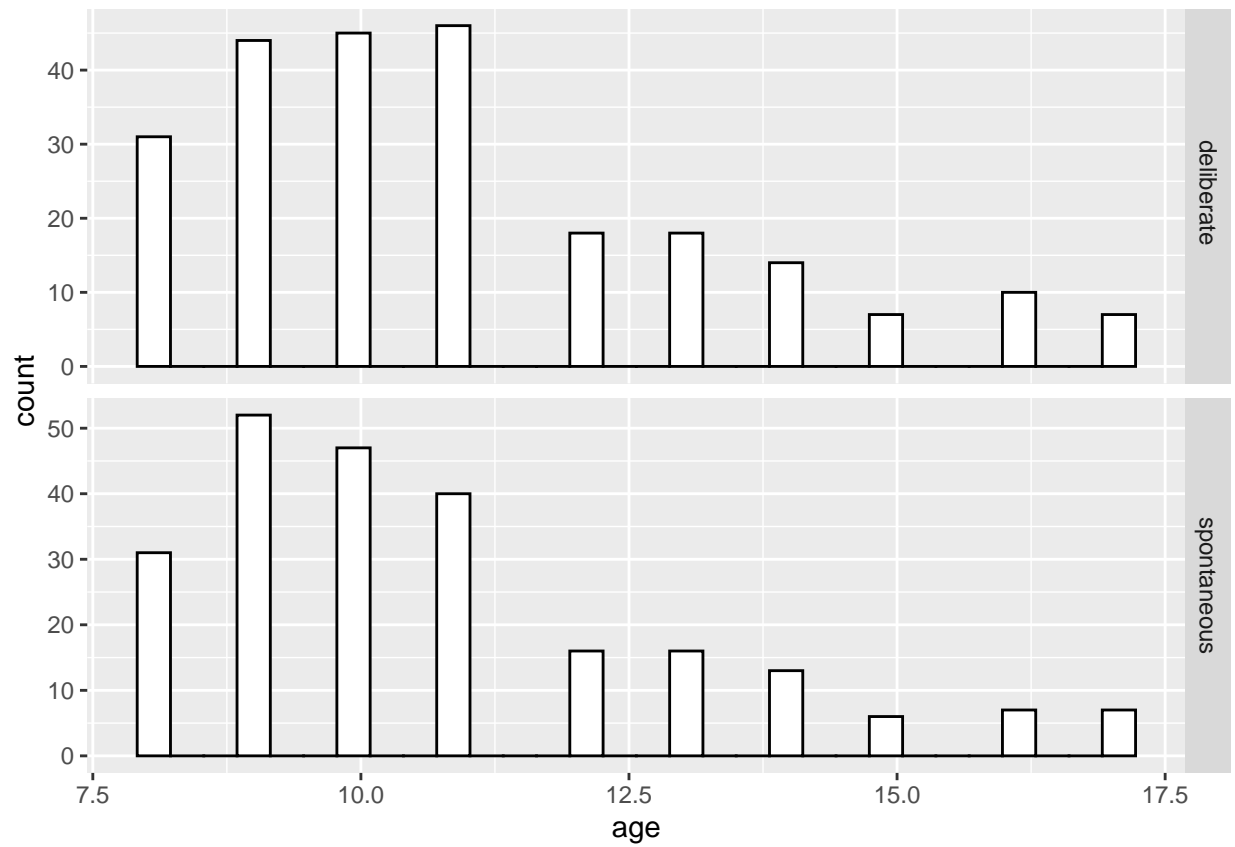


```
# citation("ggpubr")
```

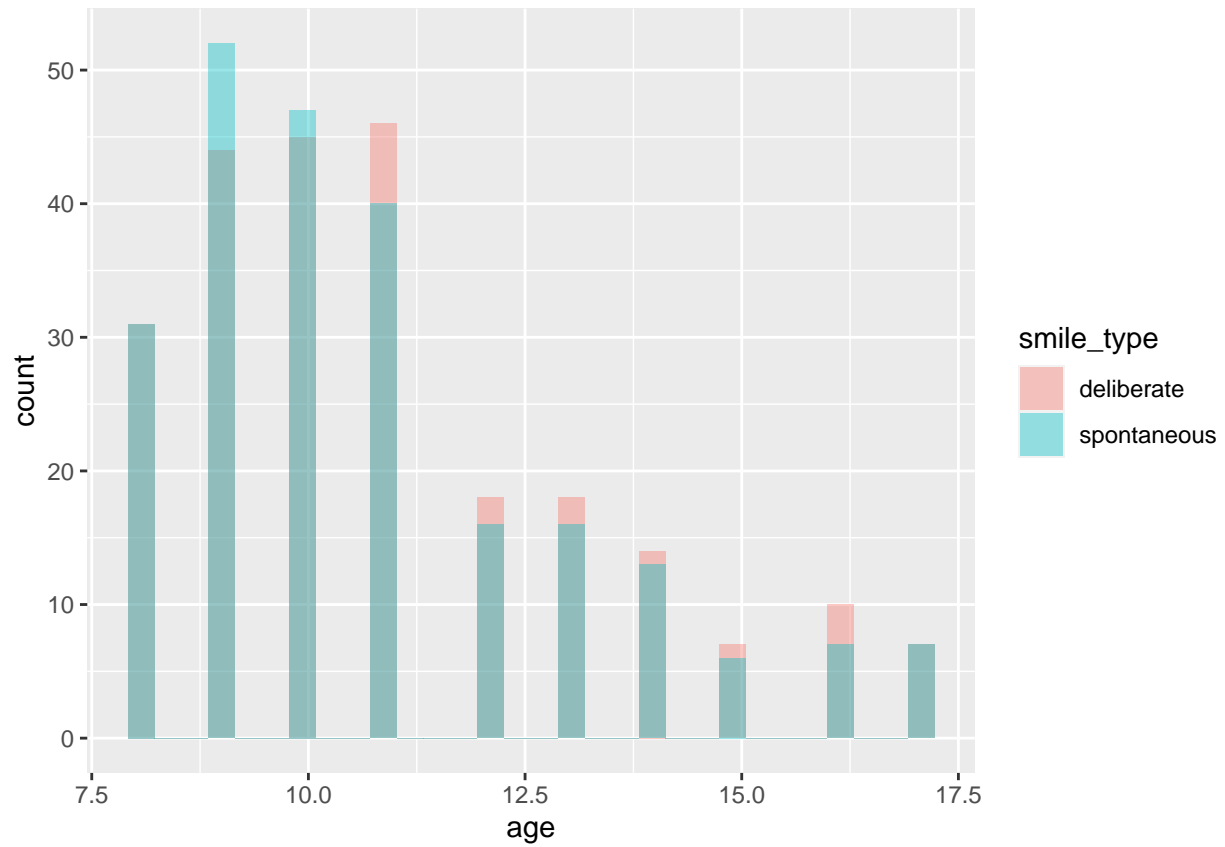
Check the distributions and any possible outliers, using the `mean()` and `sd()`.

```
# distribution per feature
```

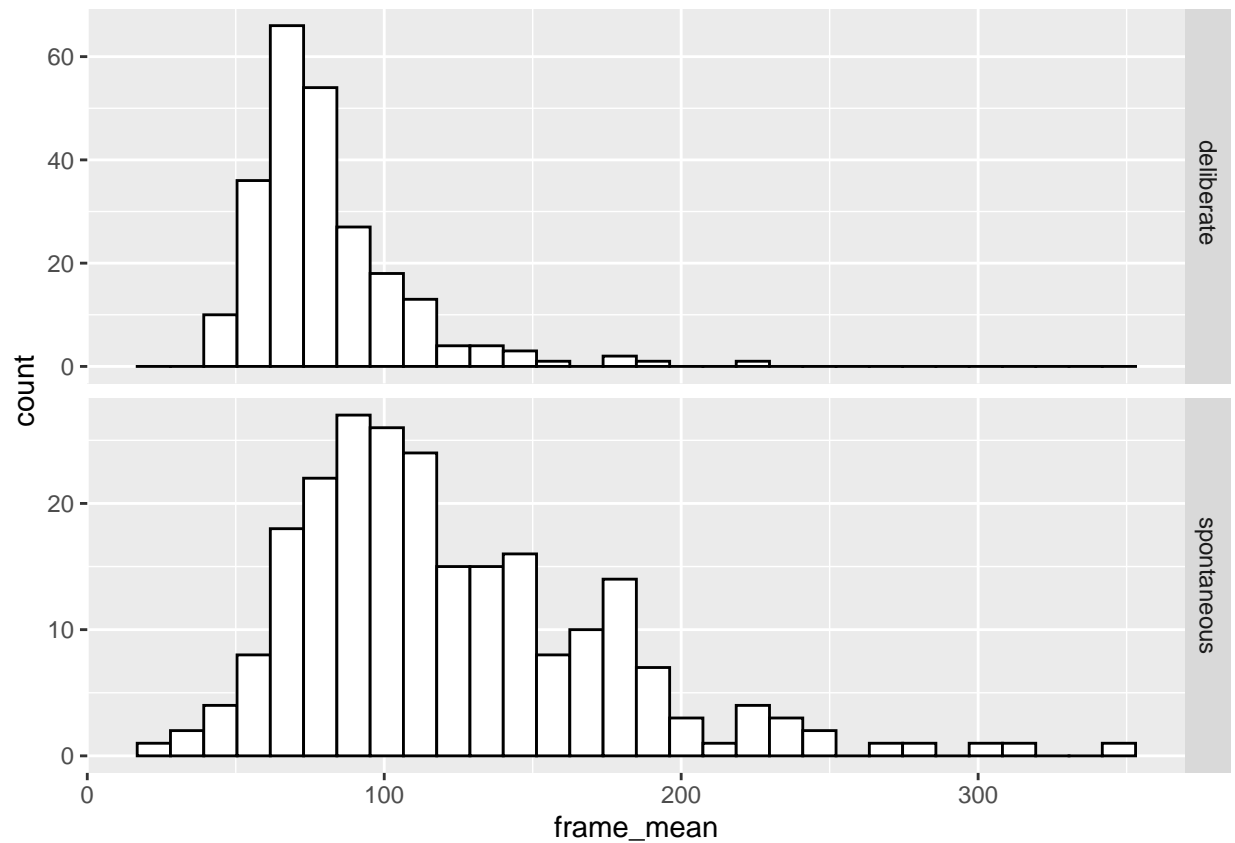
```
# age
ggplot(UvA_sum, aes(x = age)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

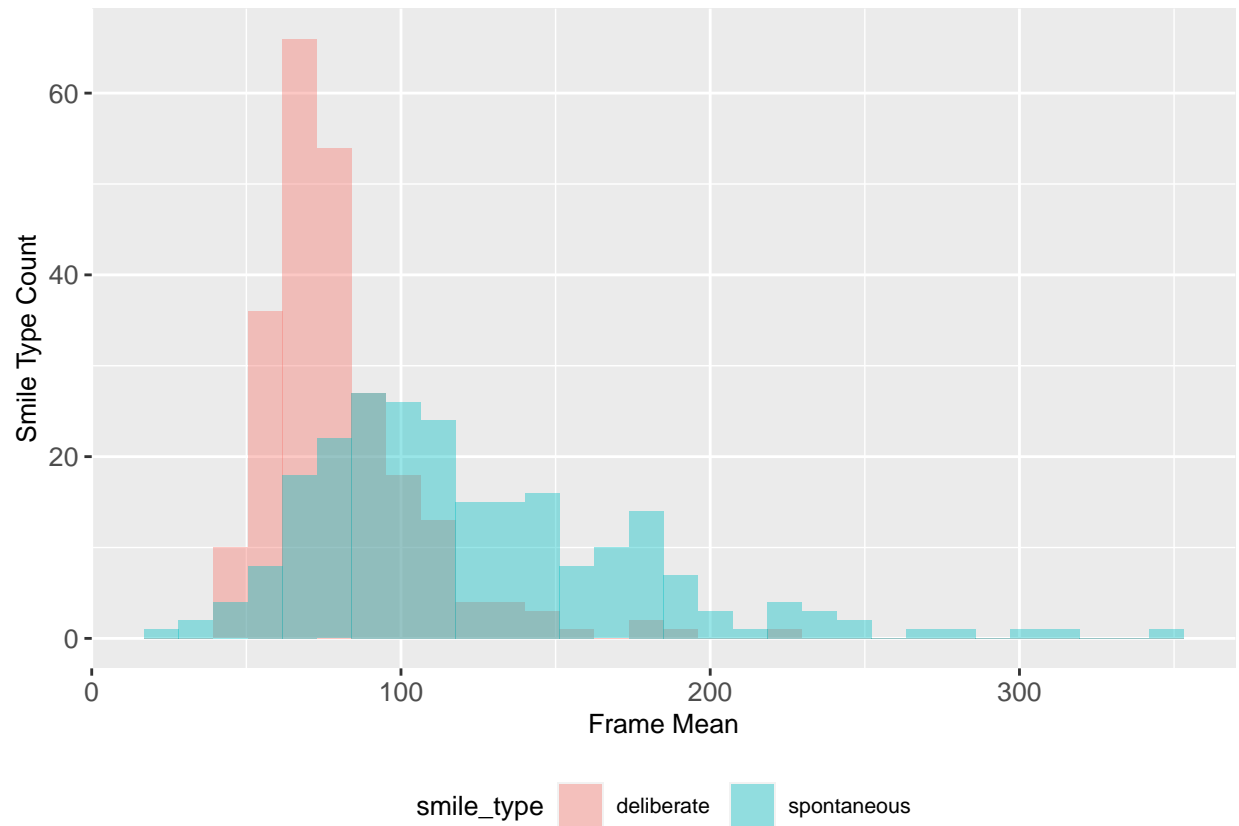
```
ggplot(UvA_sum, aes(x = age, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



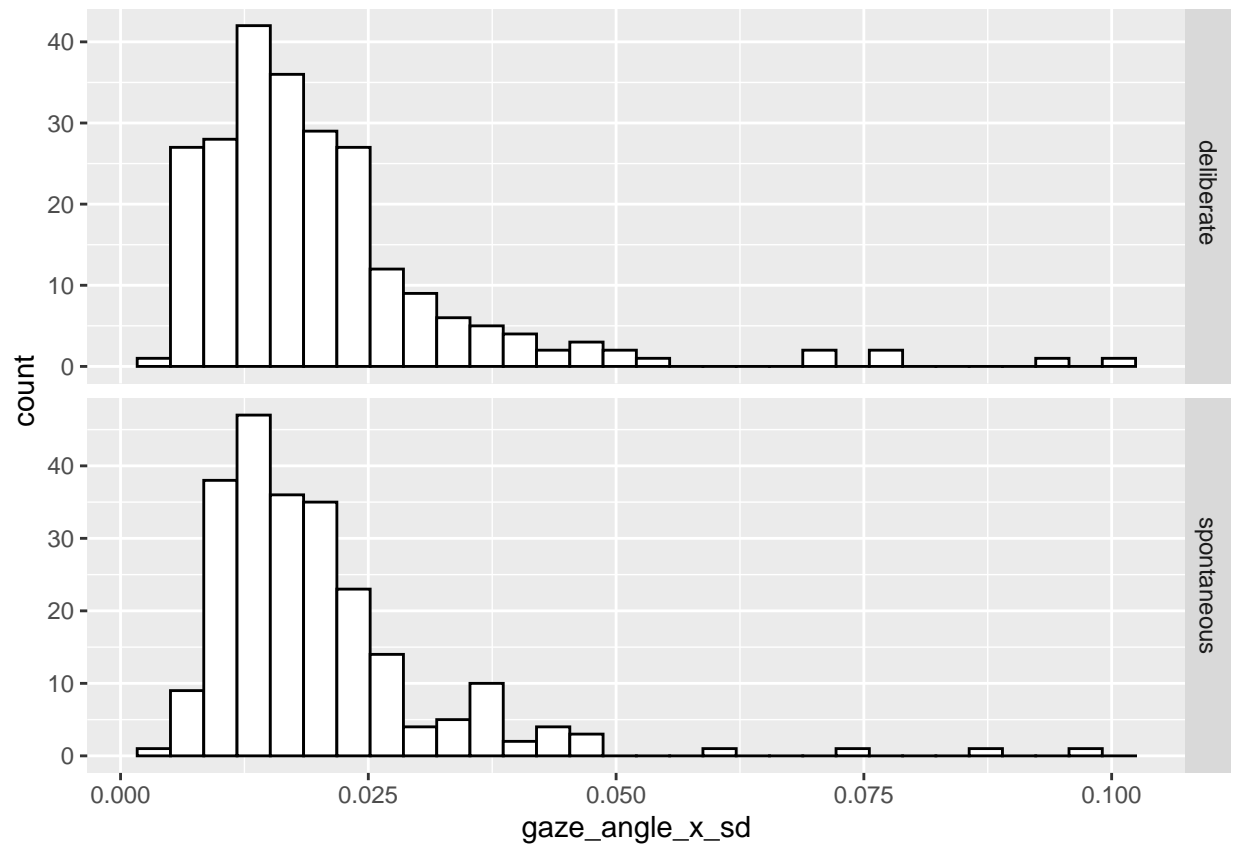
```
# frame time  
ggplot(UvA_sum, aes(x = frame_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



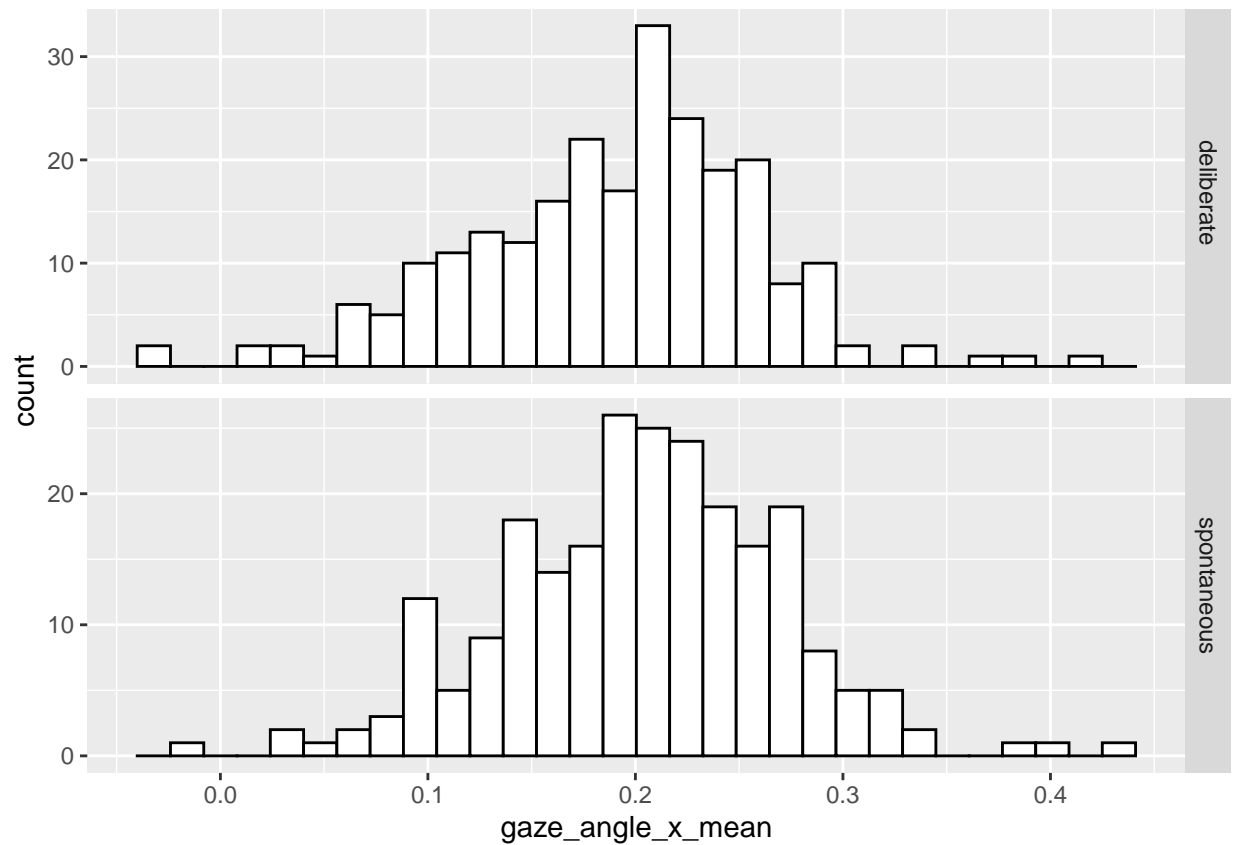
```
ggplot(UvA_sum, aes(x = frame_mean, fill = smile_type)) +
  geom_histogram(position = "identity", alpha = 0.4) +
  scale_x_continuous(name = "Frame Mean") +
  scale_y_continuous(name = "Smile Type Count") +
  theme(
    legend.position = "bottom", text = element_text(size = 10),
    axis.text = element_text(size = 10)
  )
```



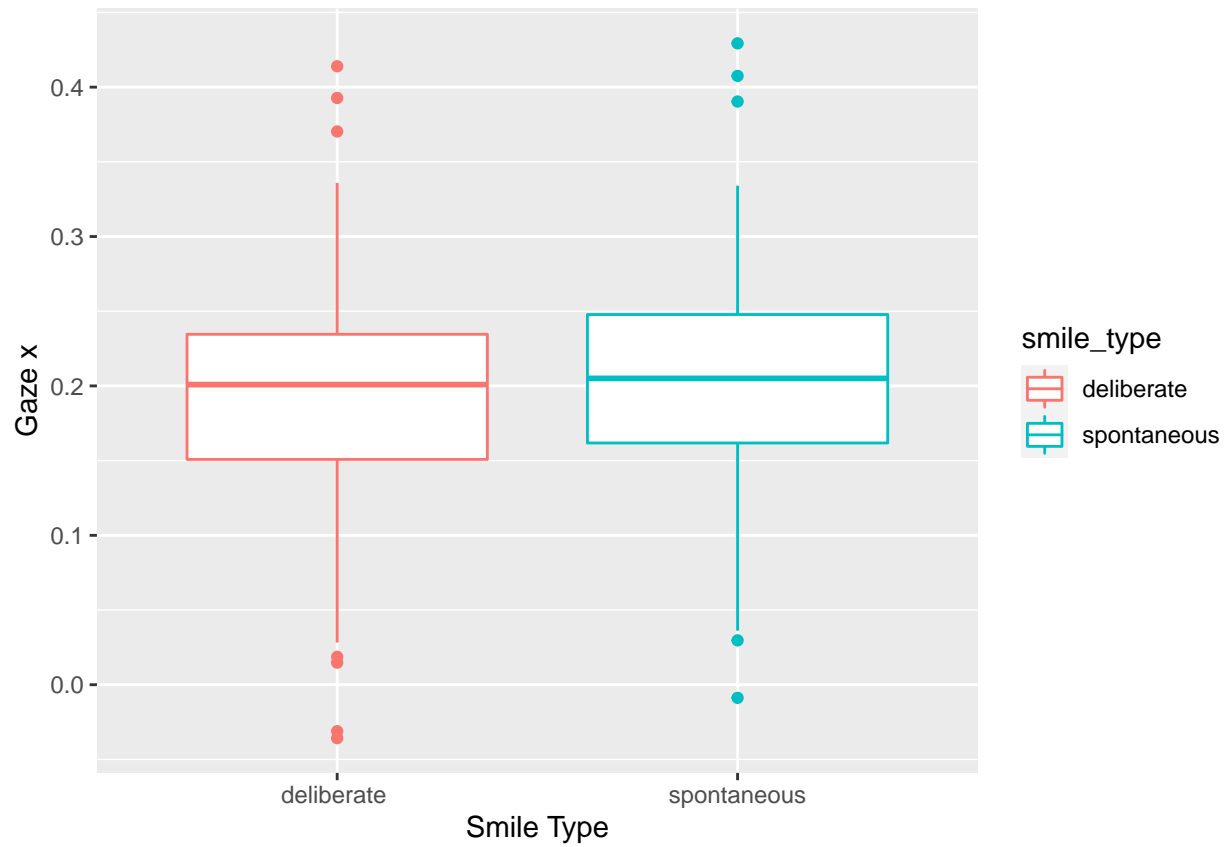
```
# gaze_angle_x
ggplot(UvA_sum, aes(x = gaze_angle_x_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



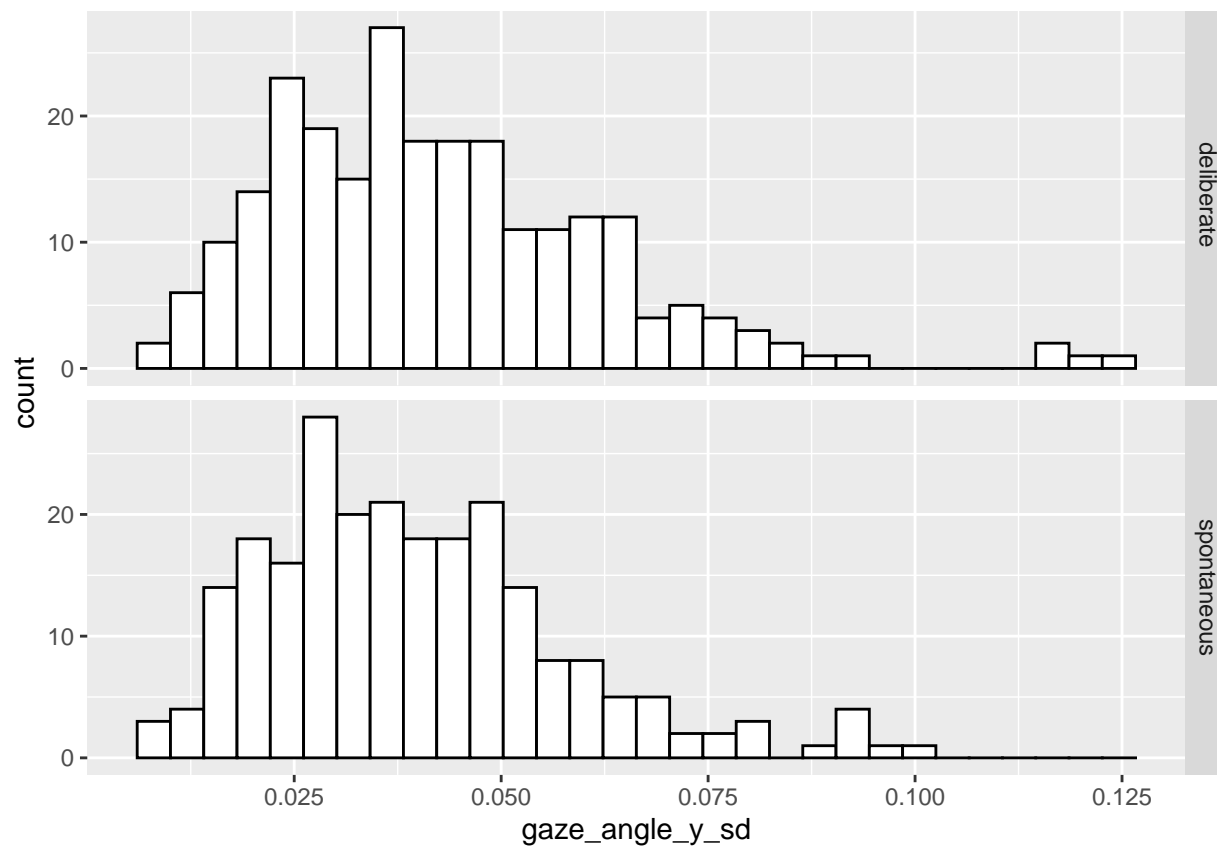
```
ggplot(UvA_sum, aes(x = gaze_angle_x_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



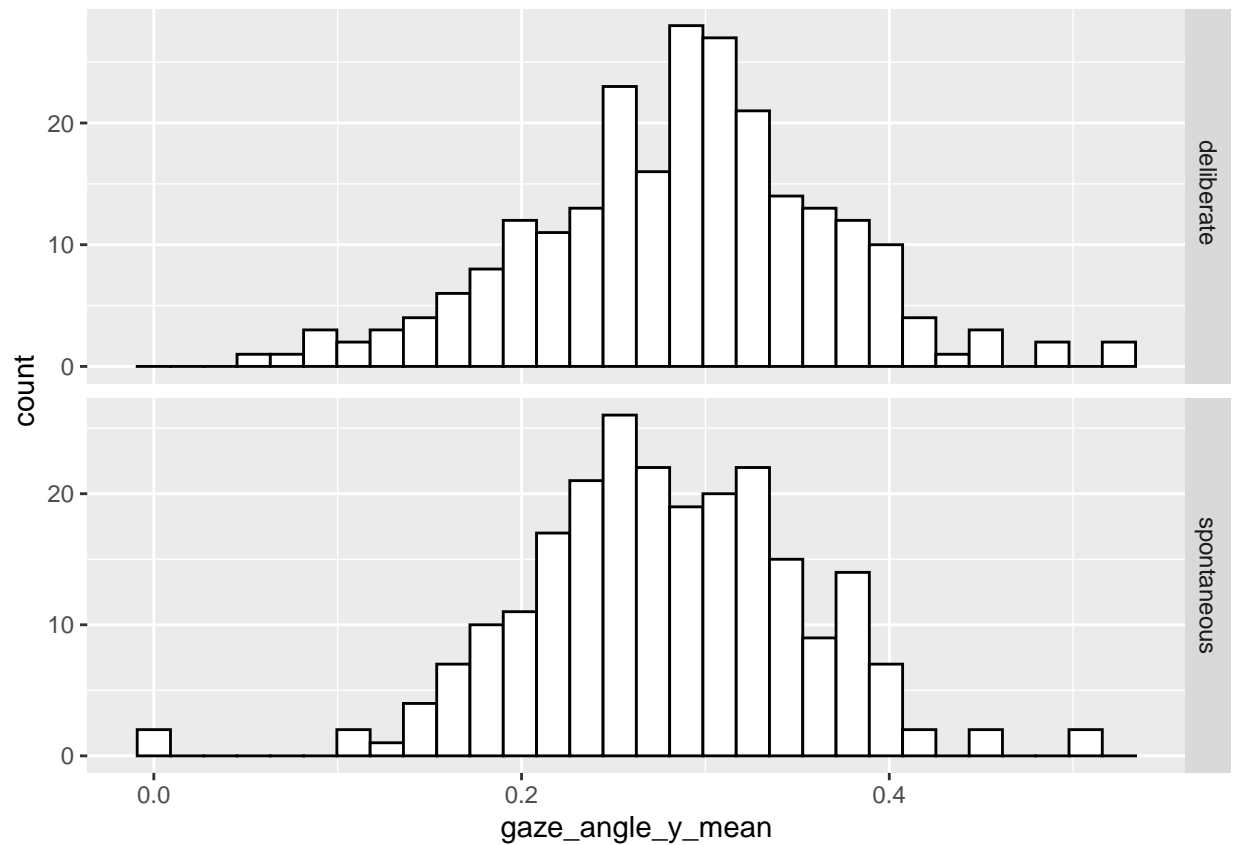
```
ggplot(
  UvA_sum,
  aes(x = smile_type, y = gaze_angle_x_mean, color = smile_type)
) +
  geom_boxplot() +
  scale_y_continuous(name = "Gaze x") +
  scale_x_discrete(name = "Smile Type")
```



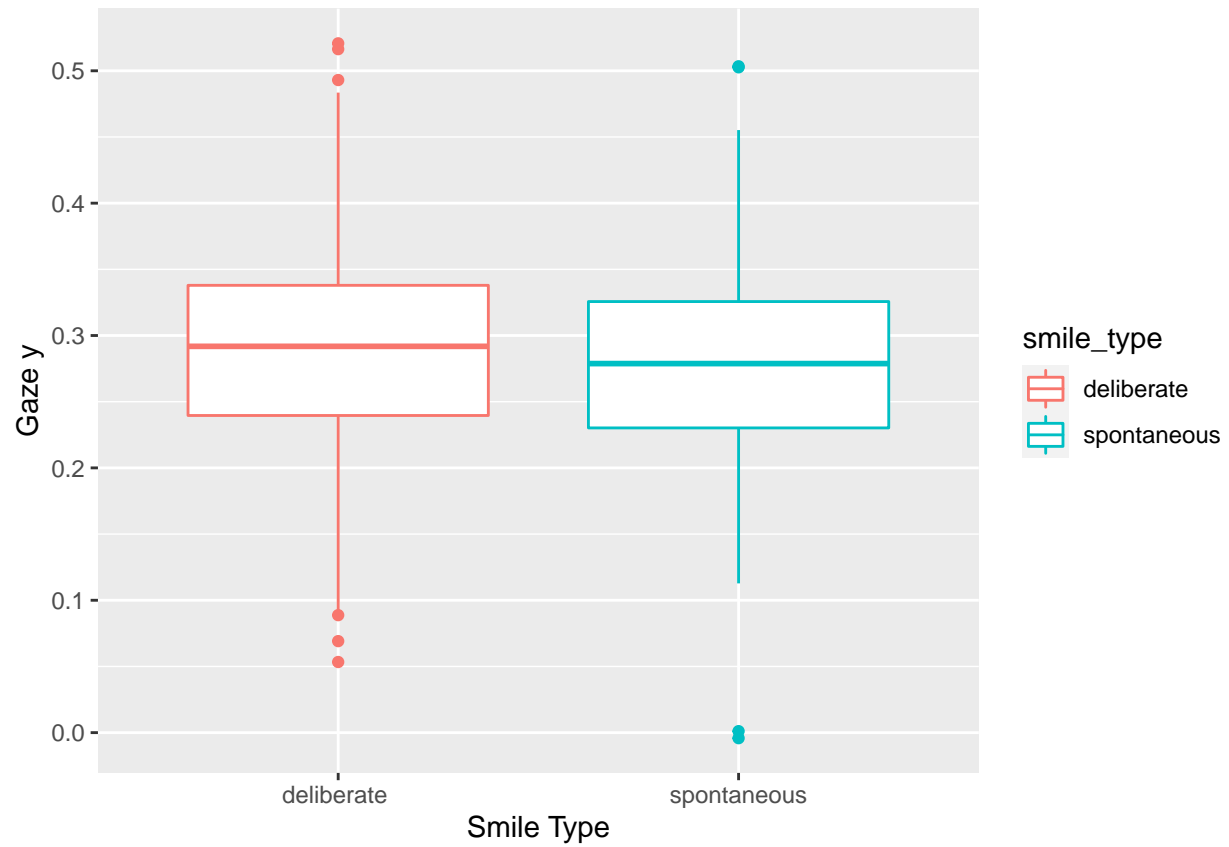
```
# gaze_angle_y
ggplot(UvA_sum, aes(x = gaze_angle_y_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



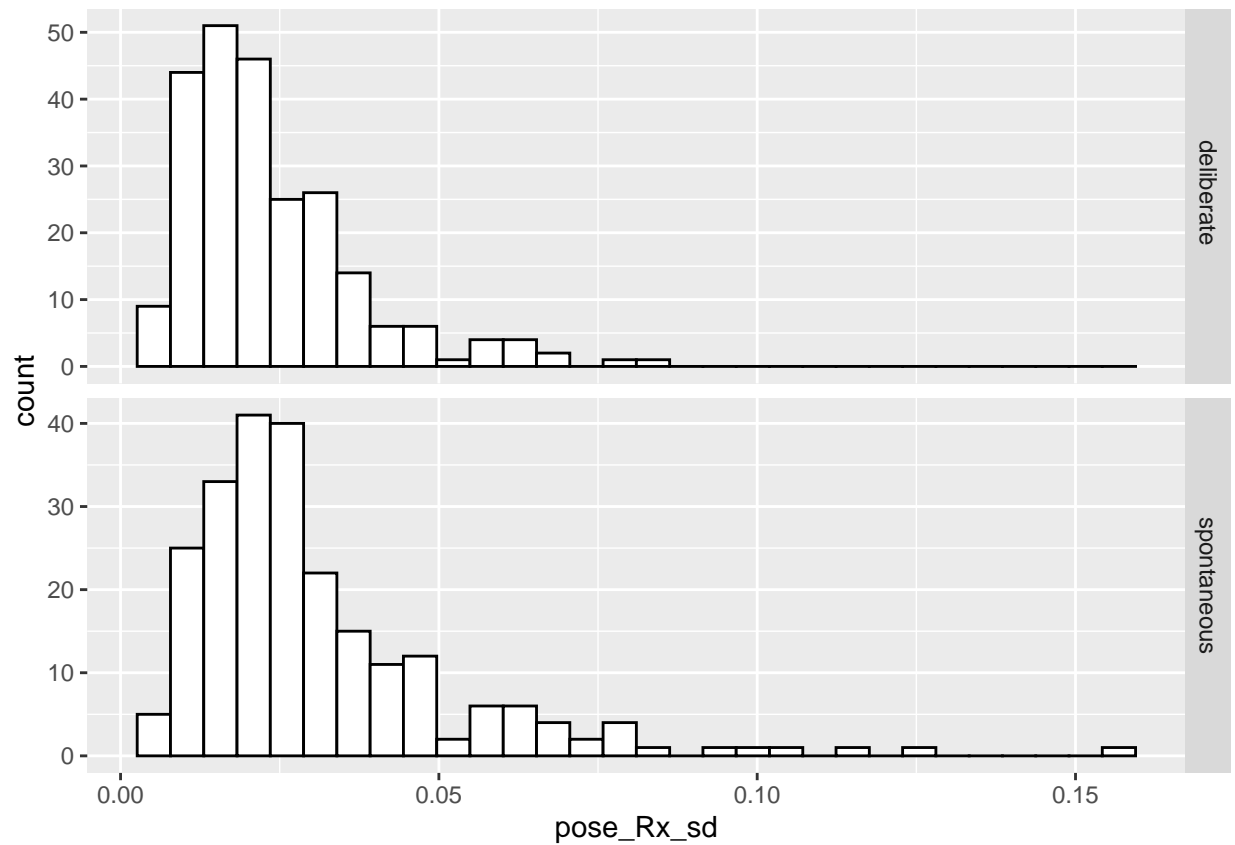
```
ggplot(UvA_sum, aes(x = gaze_angle_y_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

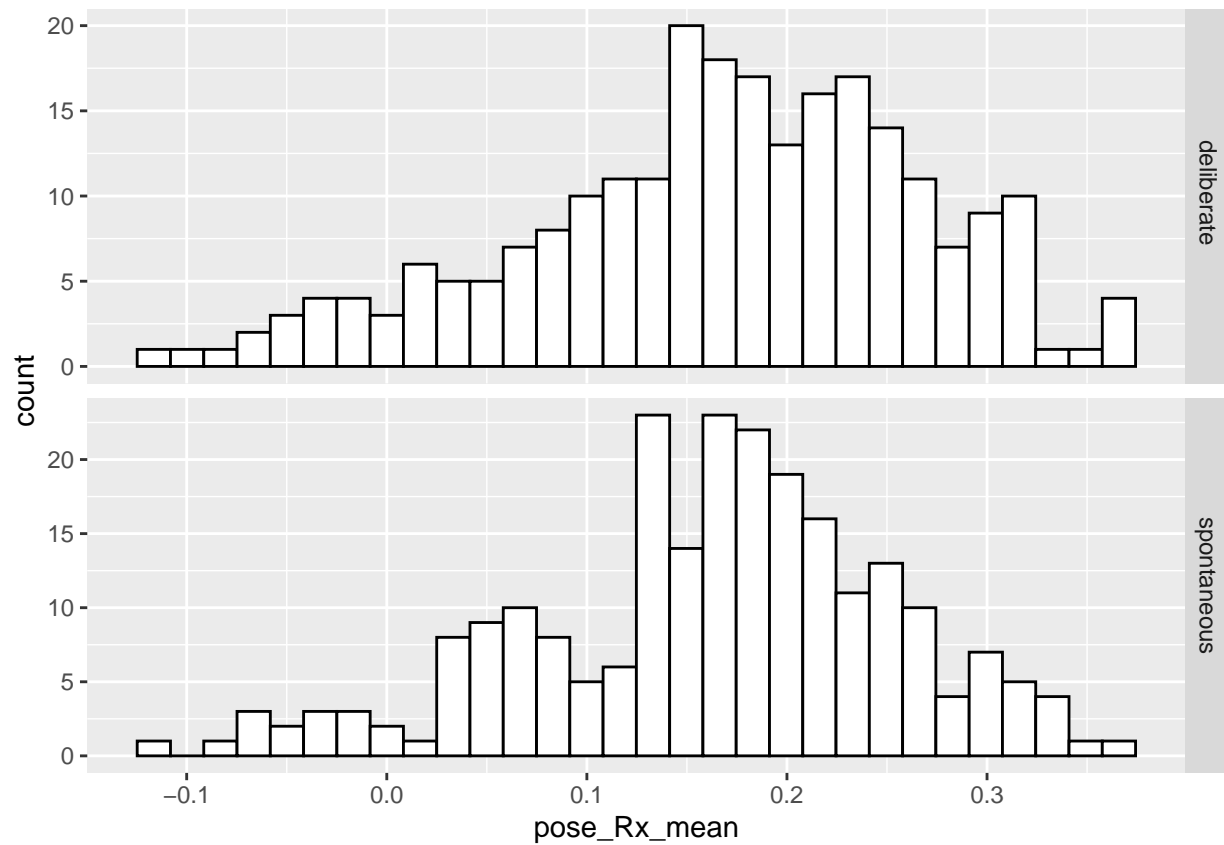
```
ggplot(
  UvA_sum,
  aes(x = smile_type, y = gaze_angle_y_mean, color = smile_type)
) +
  geom_boxplot() +
  scale_y_continuous(name = "Gaze y") +
  scale_x_discrete(name = "Smile Type")
```



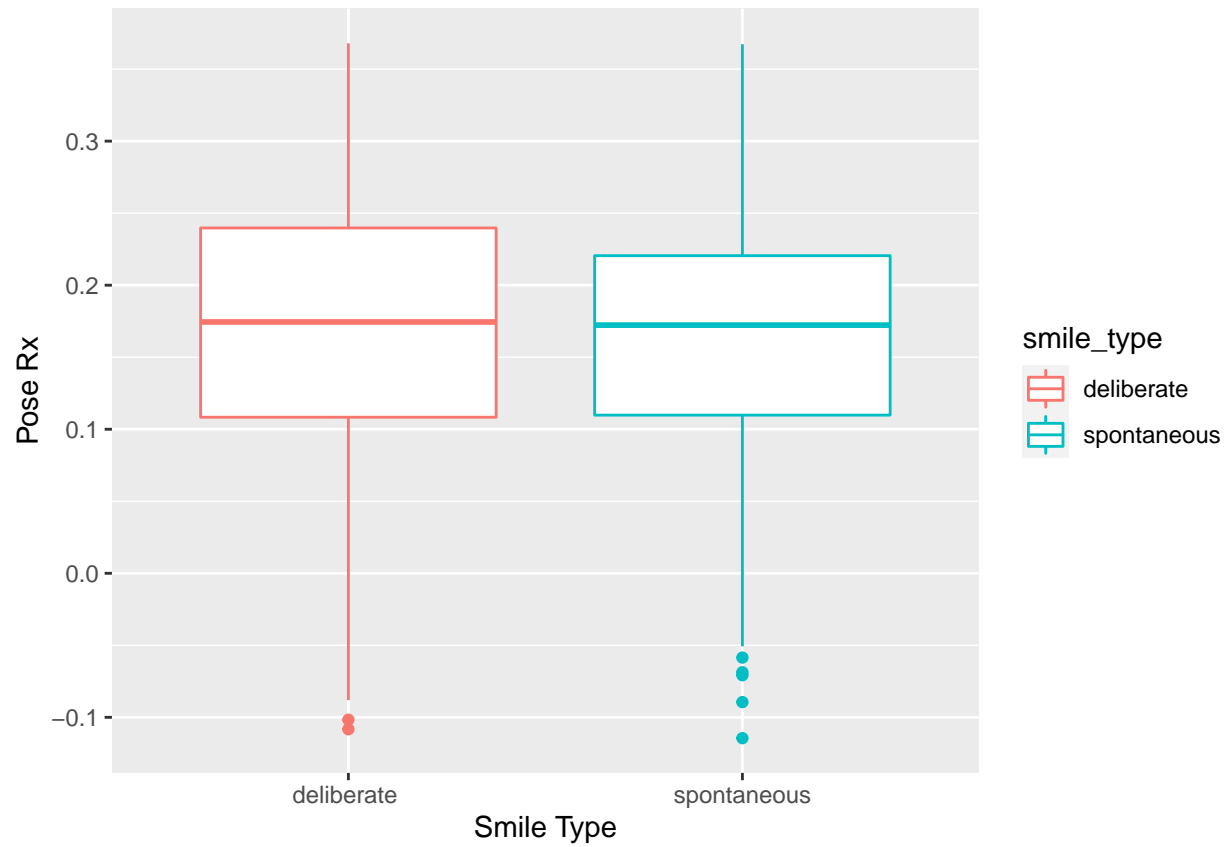
```
# pose_Rx
ggplot(UvA_sum, aes(x = pose_Rx_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



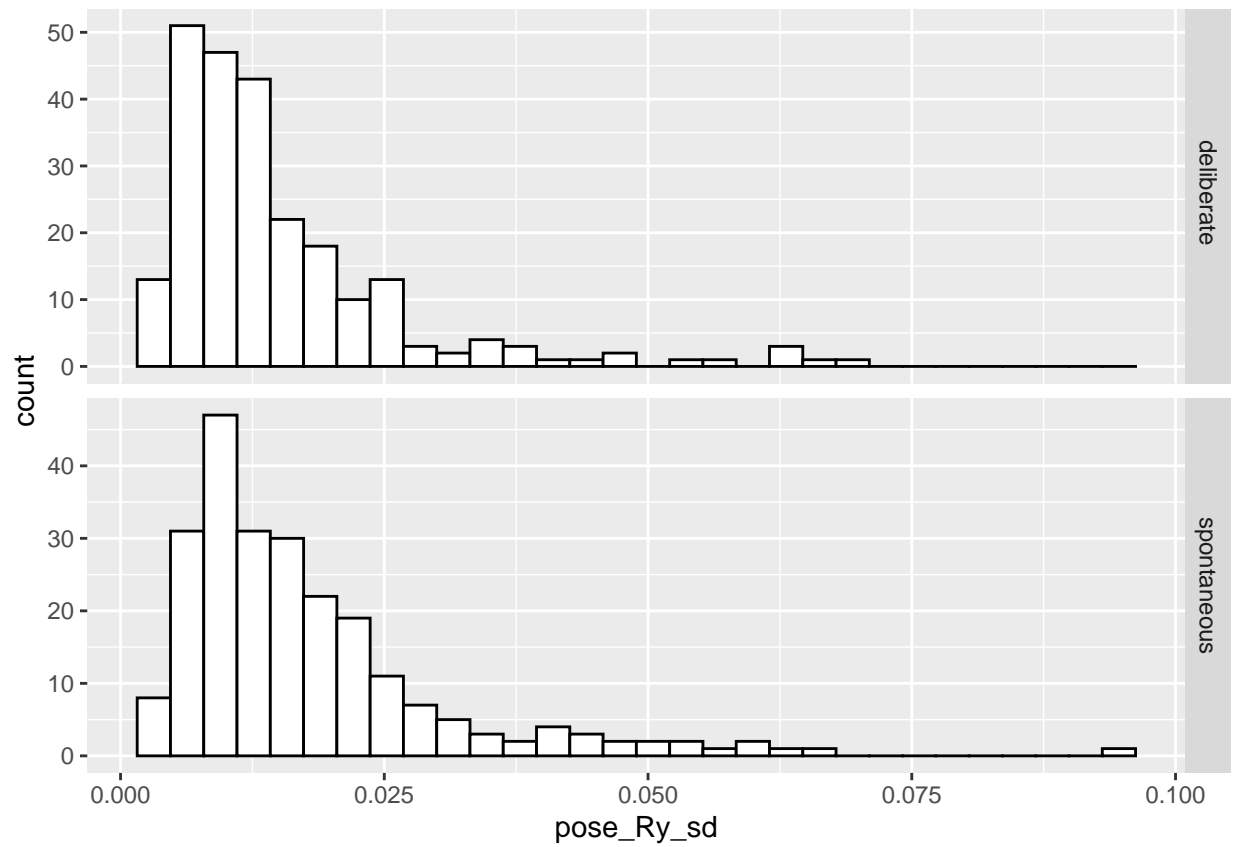
```
ggplot(UvA_sum, aes(x = pose_Rx_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



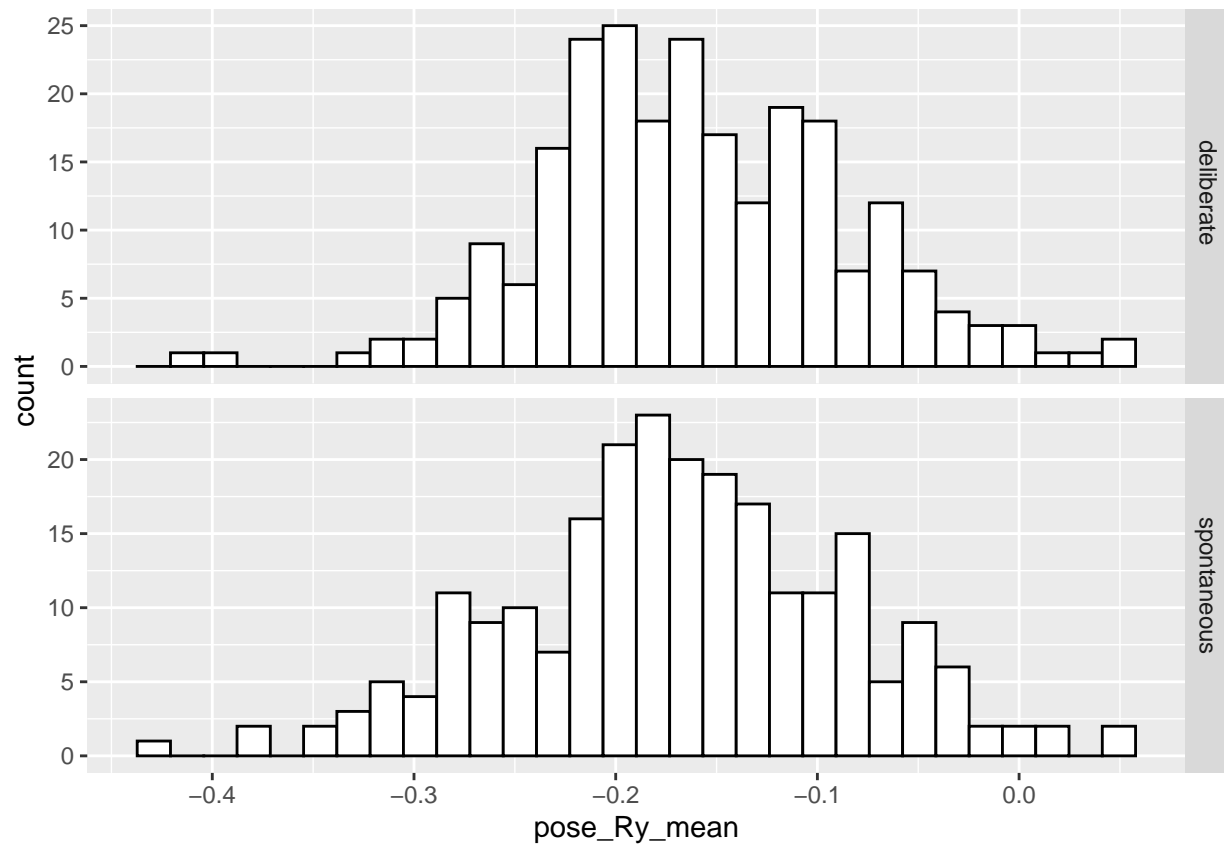
```
ggplot(UvA_sum, aes(x = smile_type, y = pose_Rx_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "Pose Rx") +
  scale_x_discrete(name = "Smile Type")
```



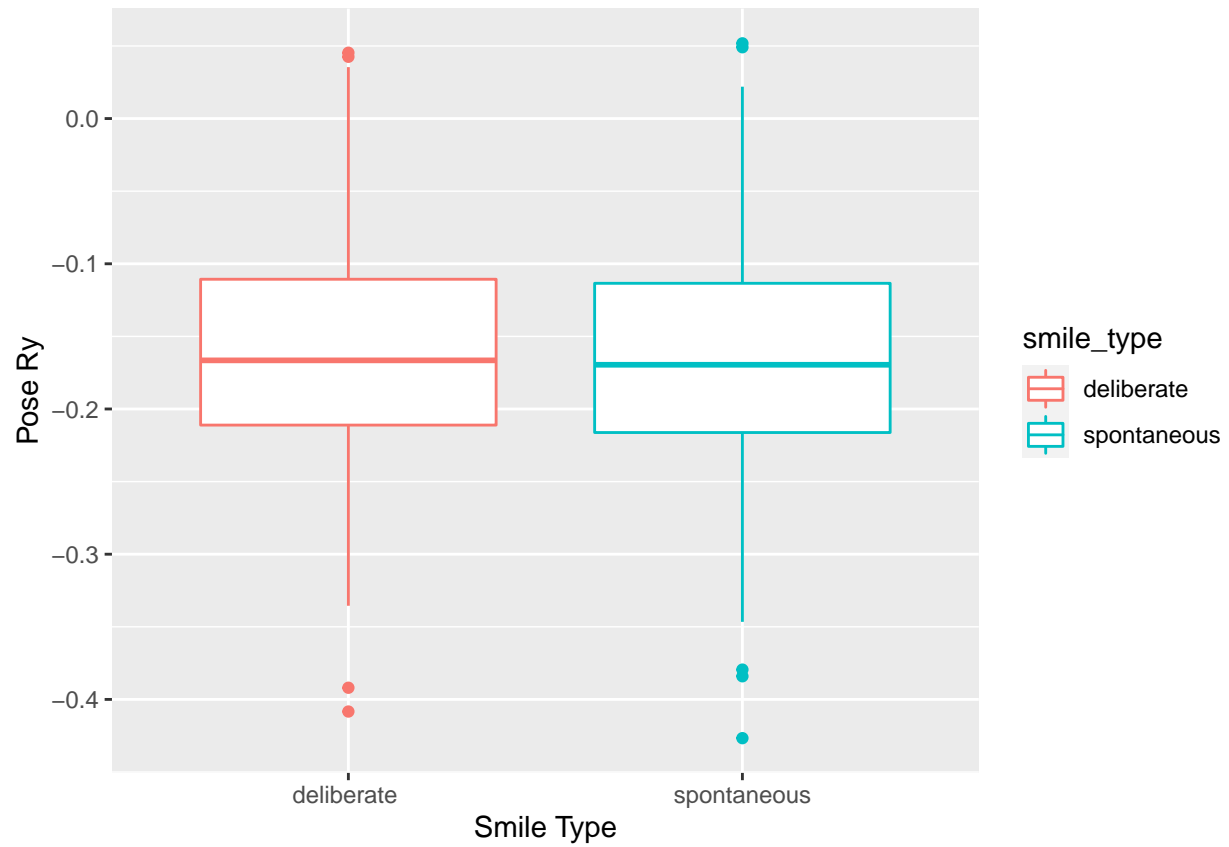
```
# pose_Ry  
ggplot(UvA_sum, aes(x = pose_Ry_sd)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



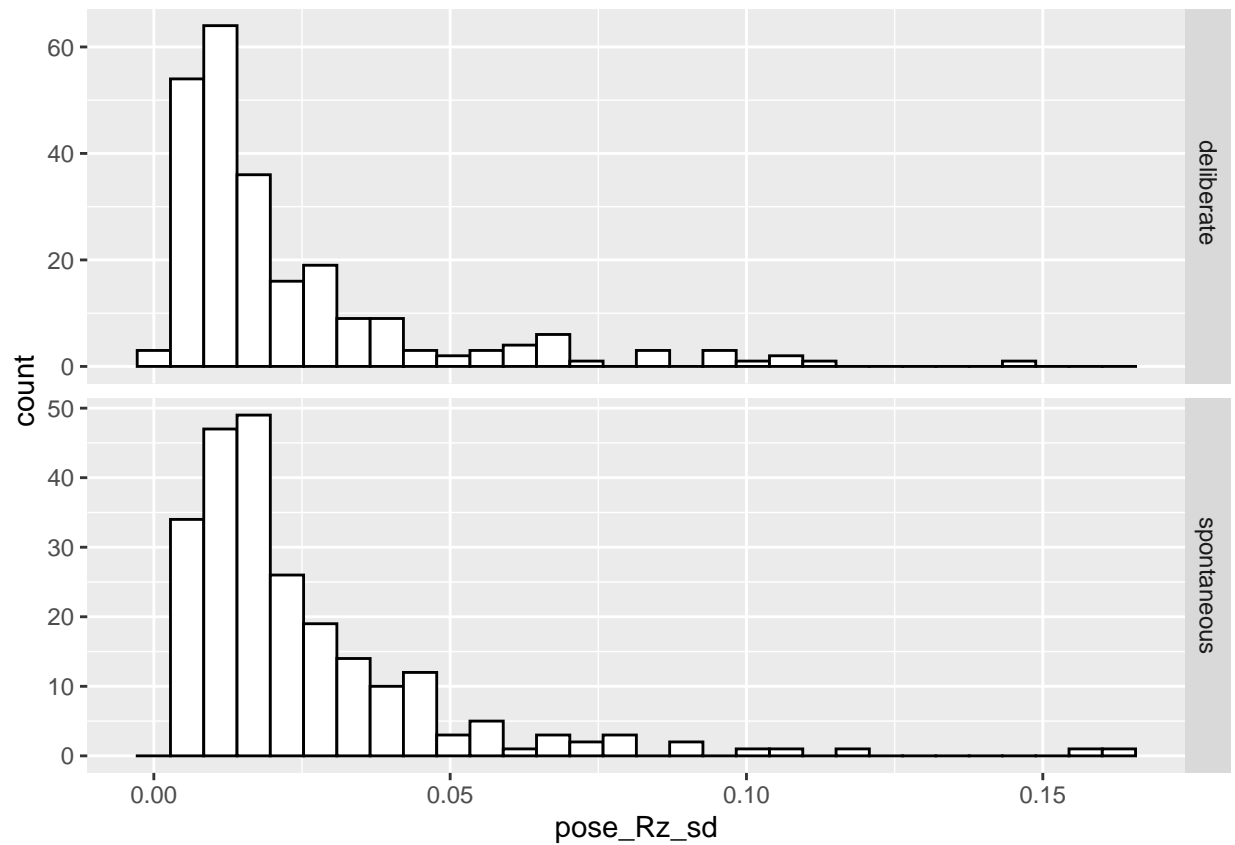
```
ggplot(UvA_sum, aes(x = pose_Ry_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



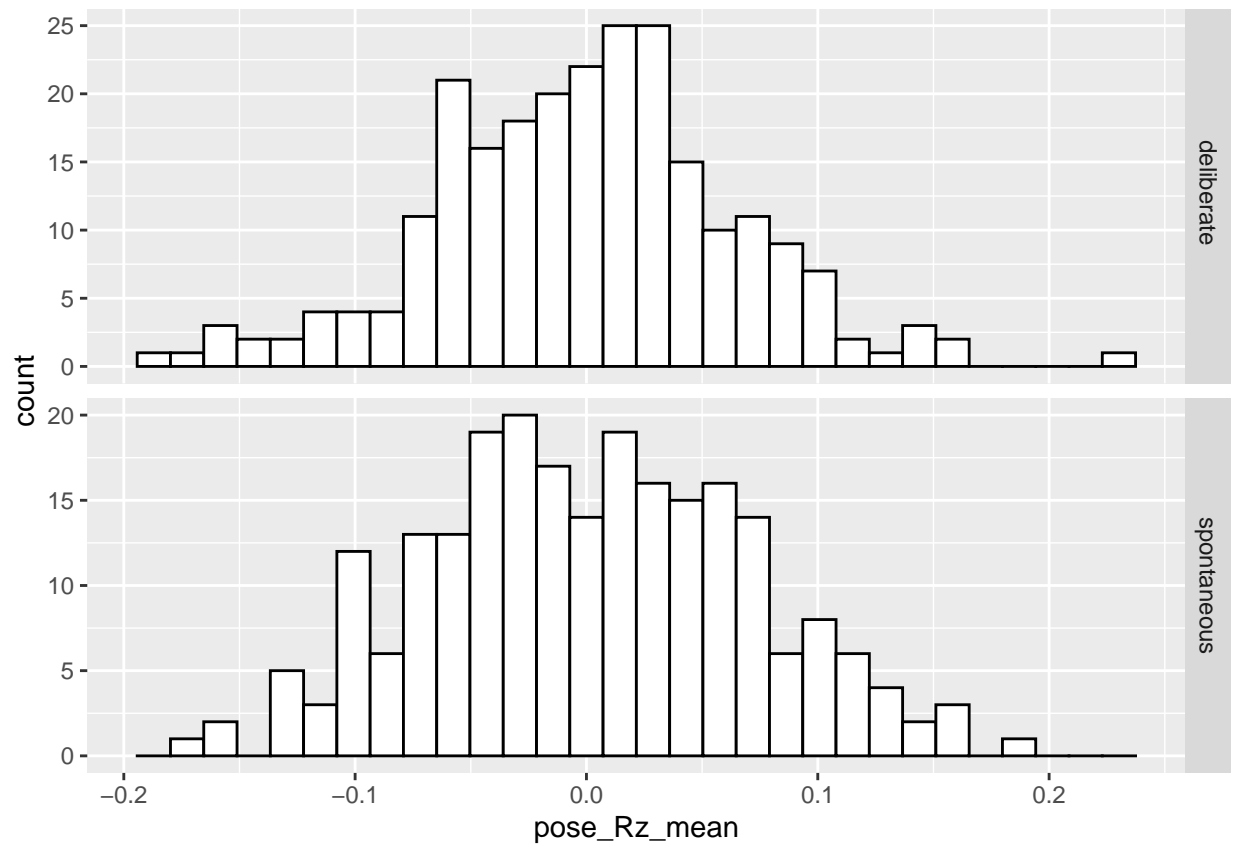
```
ggplot(UvA_sum, aes(x = smile_type, y = pose_Ry_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "Pose Ry") +
  scale_x_discrete(name = "Smile Type")
```



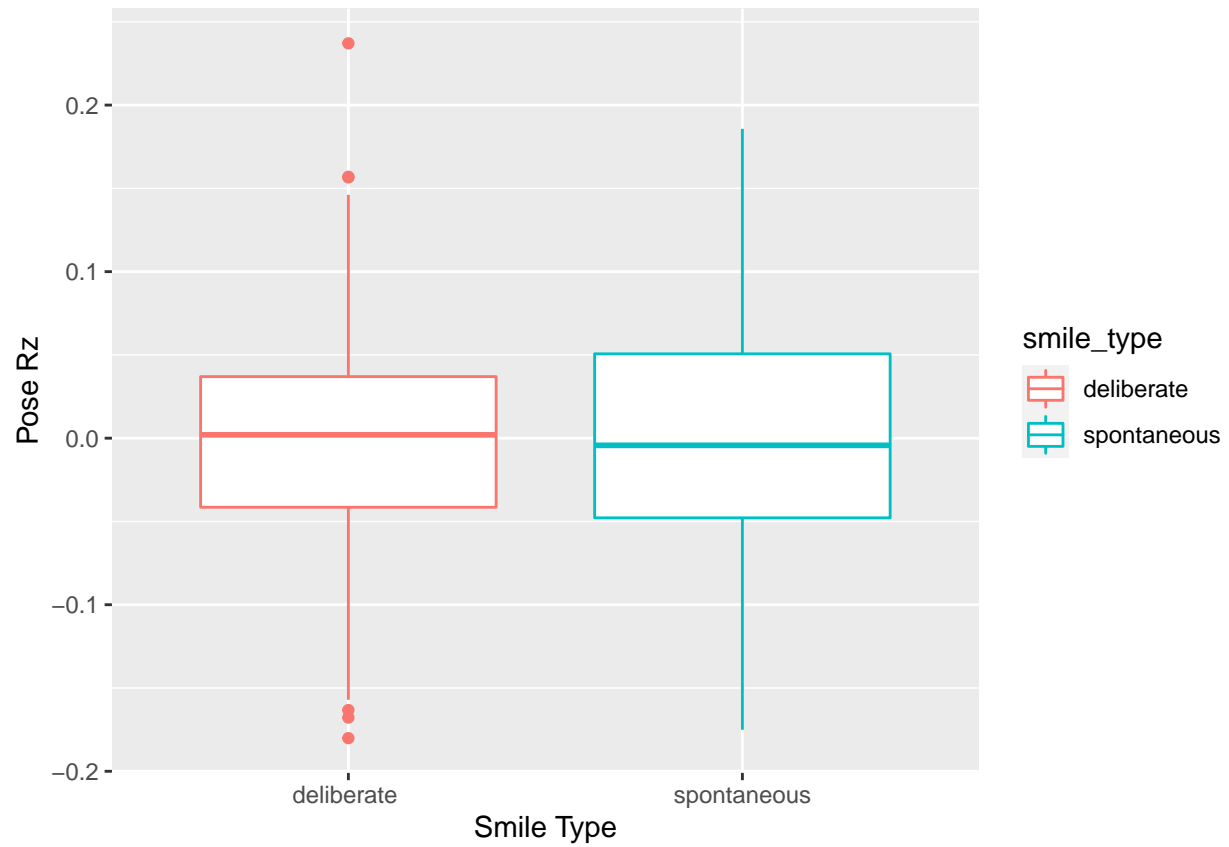
```
# pose_Rz
ggplot(UvA_sum, aes(x = pose_Rz_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

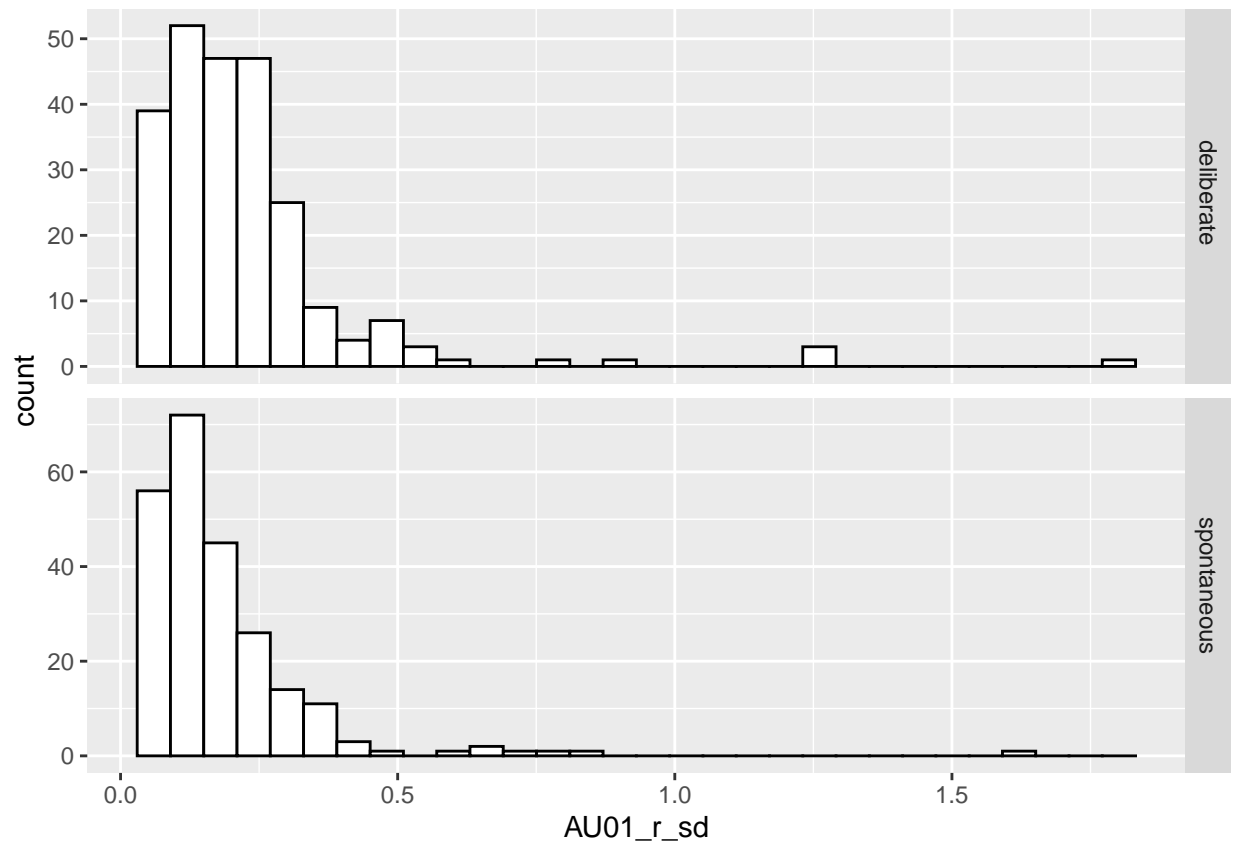
```
ggplot(UvA_sum, aes(x = pose_Rz_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



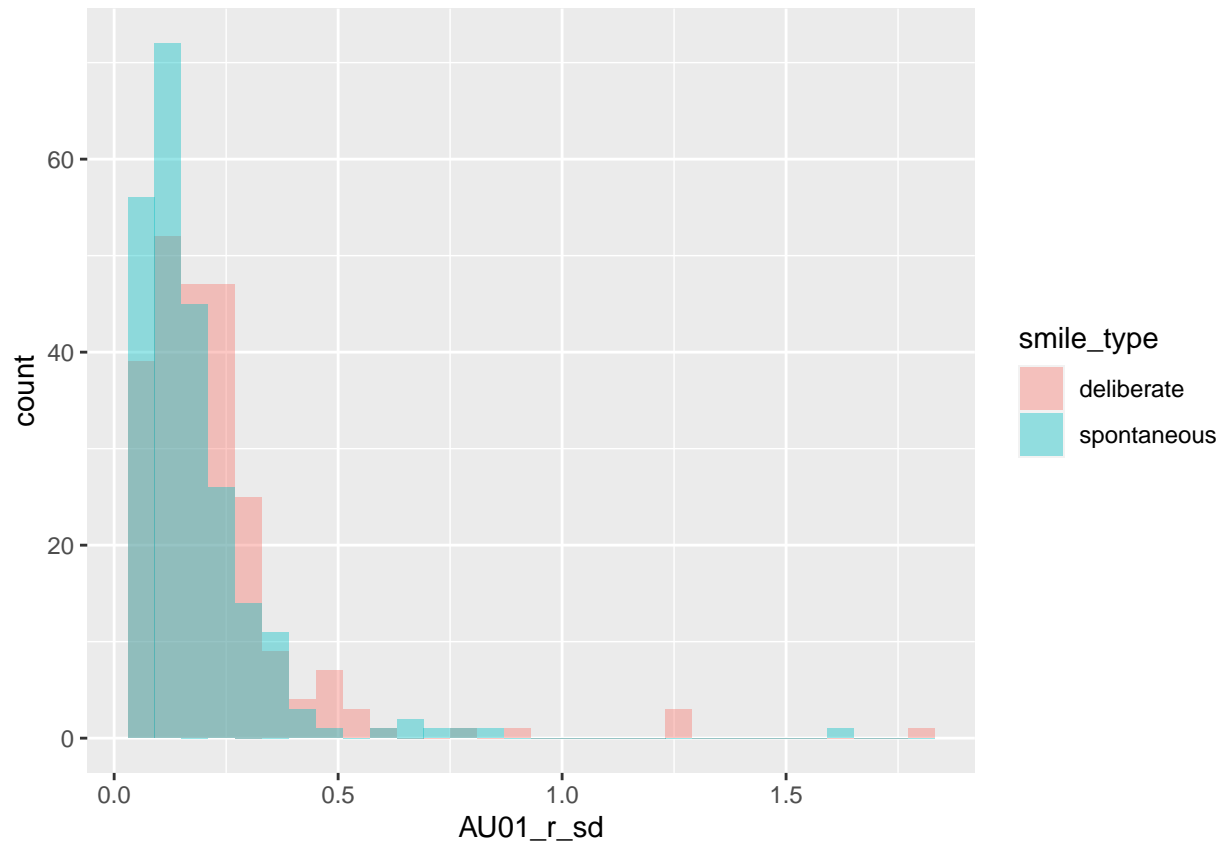
```
ggplot(UvA_sum, aes(x = smile_type, y = pose_Rz_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "Pose Rz") +
  scale_x_discrete(name = "Smile Type")
```



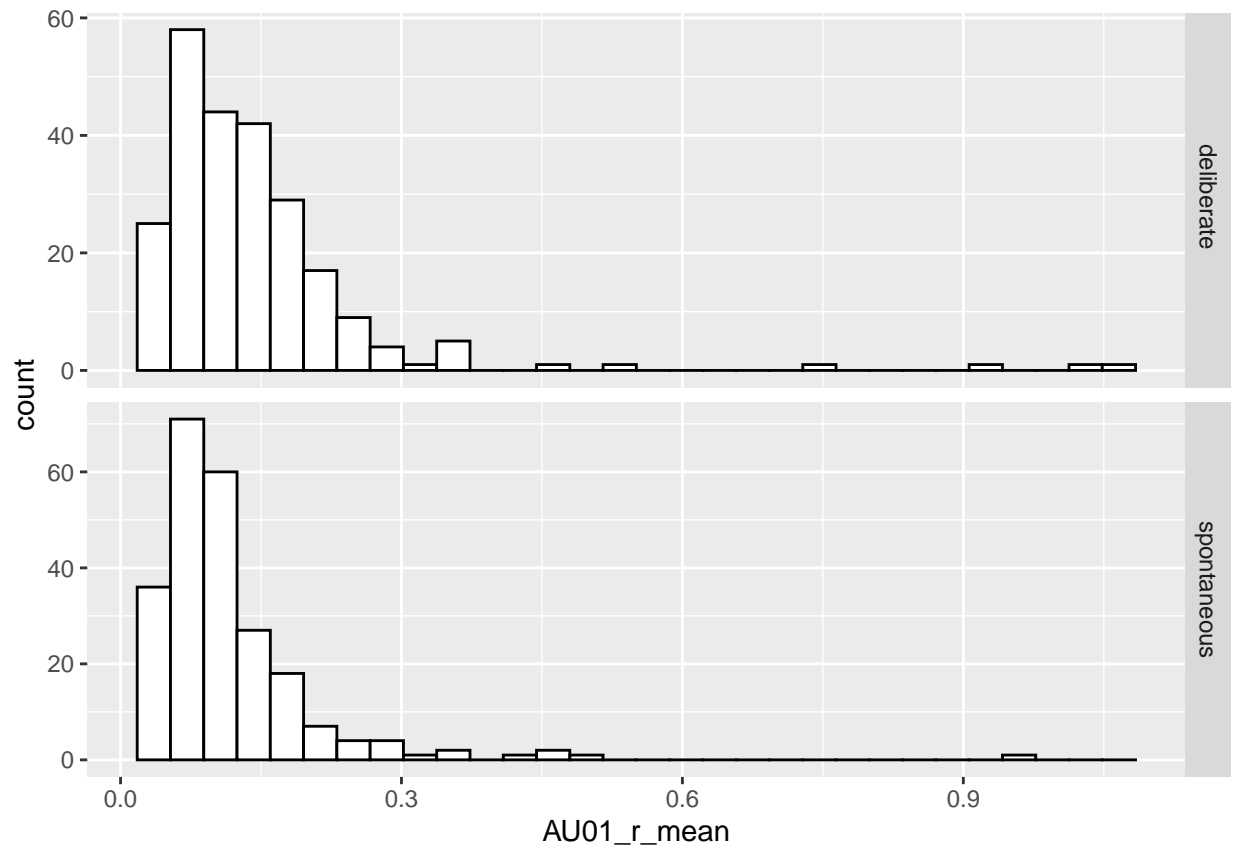
```
# AU01
ggplot(UvA_sum, aes(x = AU01_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



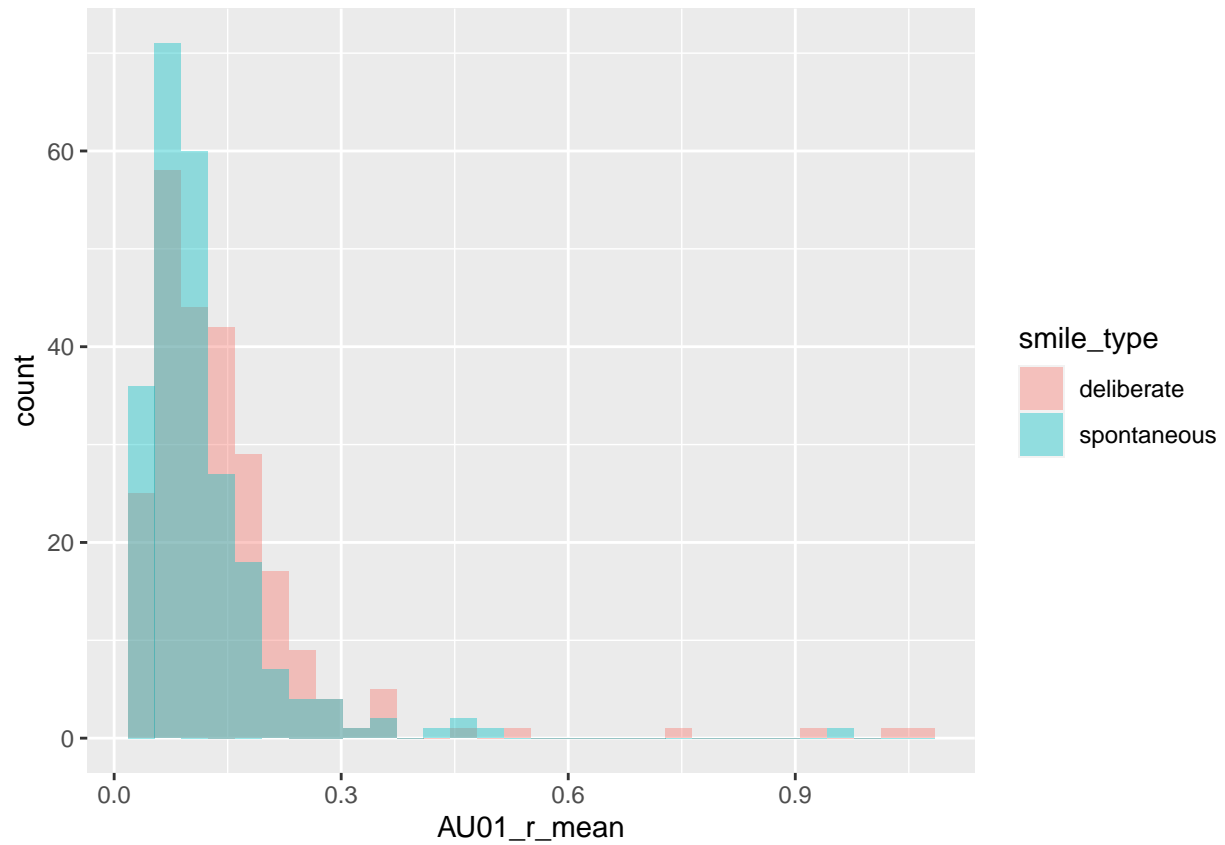
```
ggplot(UvA_sum, aes(x = AU01_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



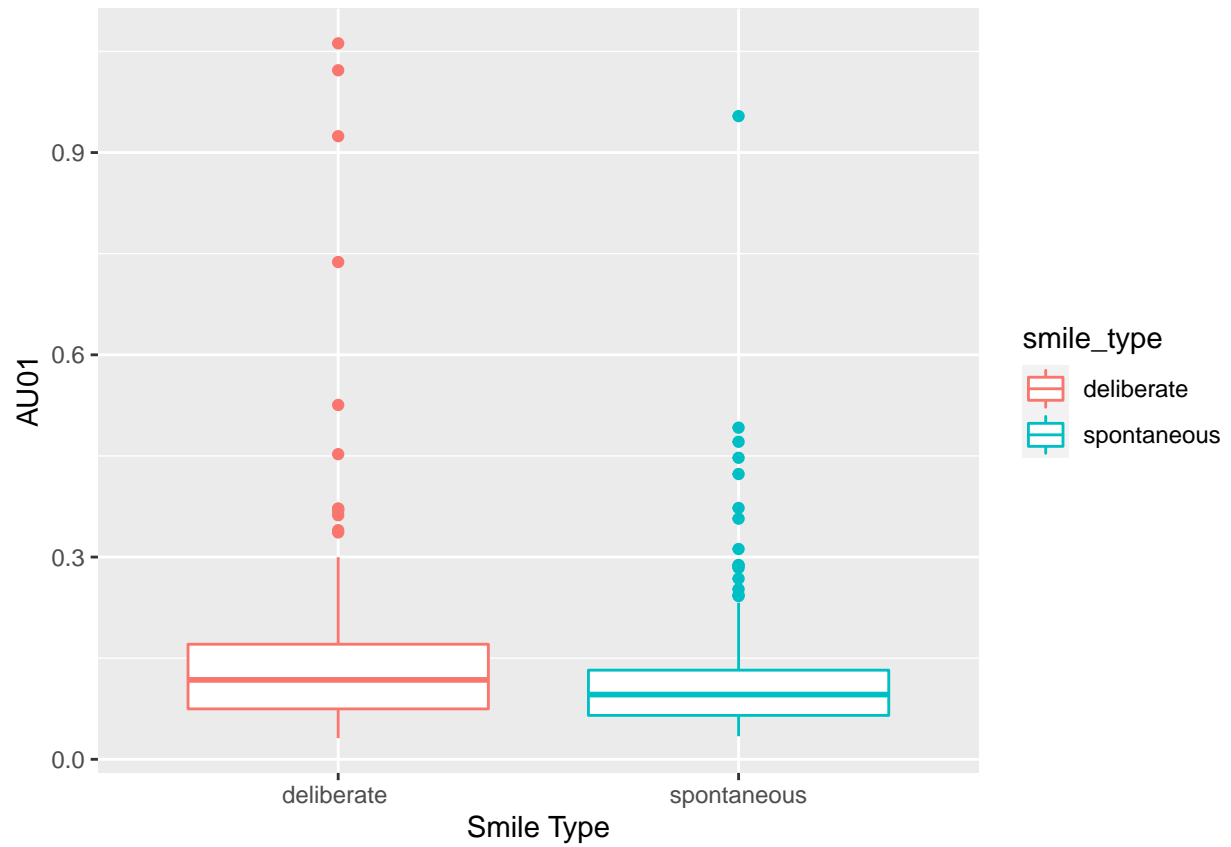
```
ggplot(UvA_sum, aes(x = AU01_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



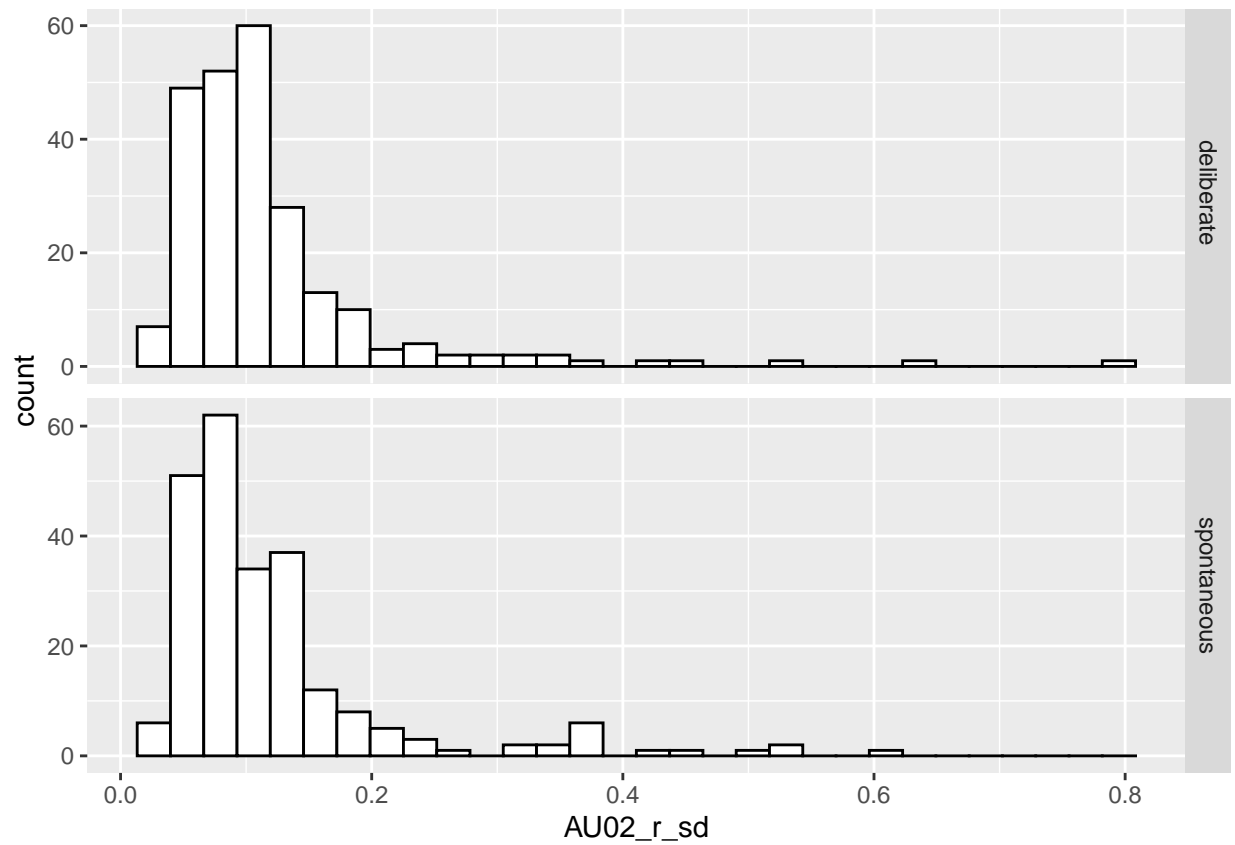
```
ggplot(UvA_sum, aes(x = AU01_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



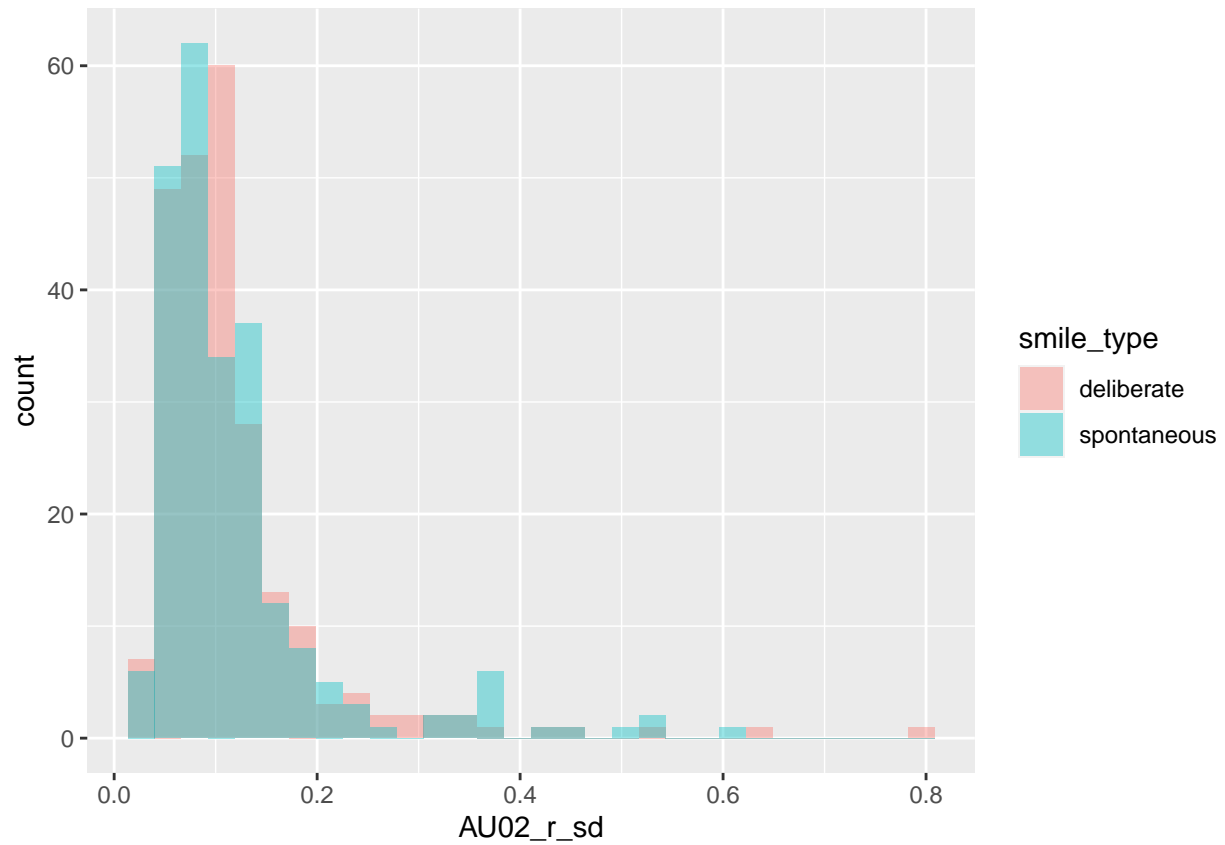
```
ggplot(UvA_sum, aes(x = smile_type, y = AU01_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU01") +  
  scale_x_discrete(name = "Smile Type")
```



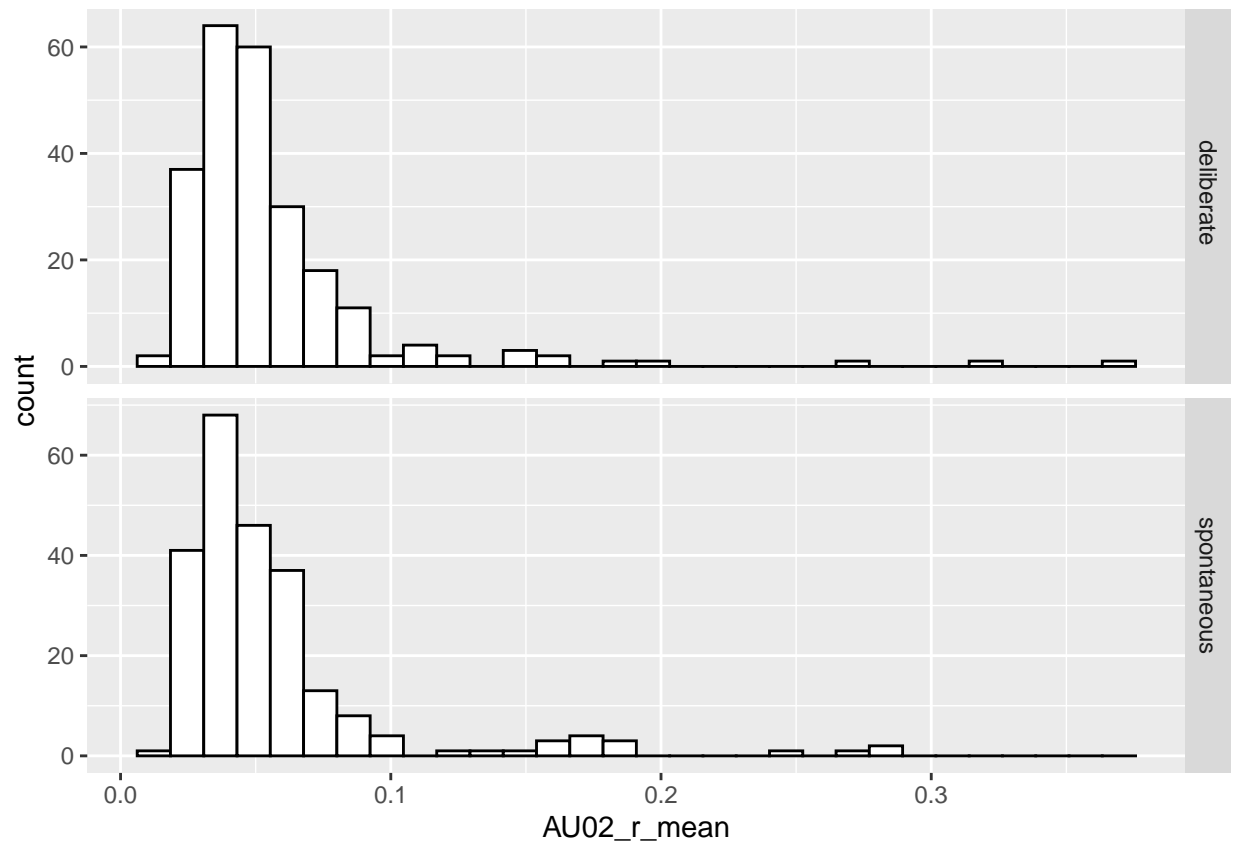
```
# AU02
ggplot(UvA_sum, aes(x = AU02_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

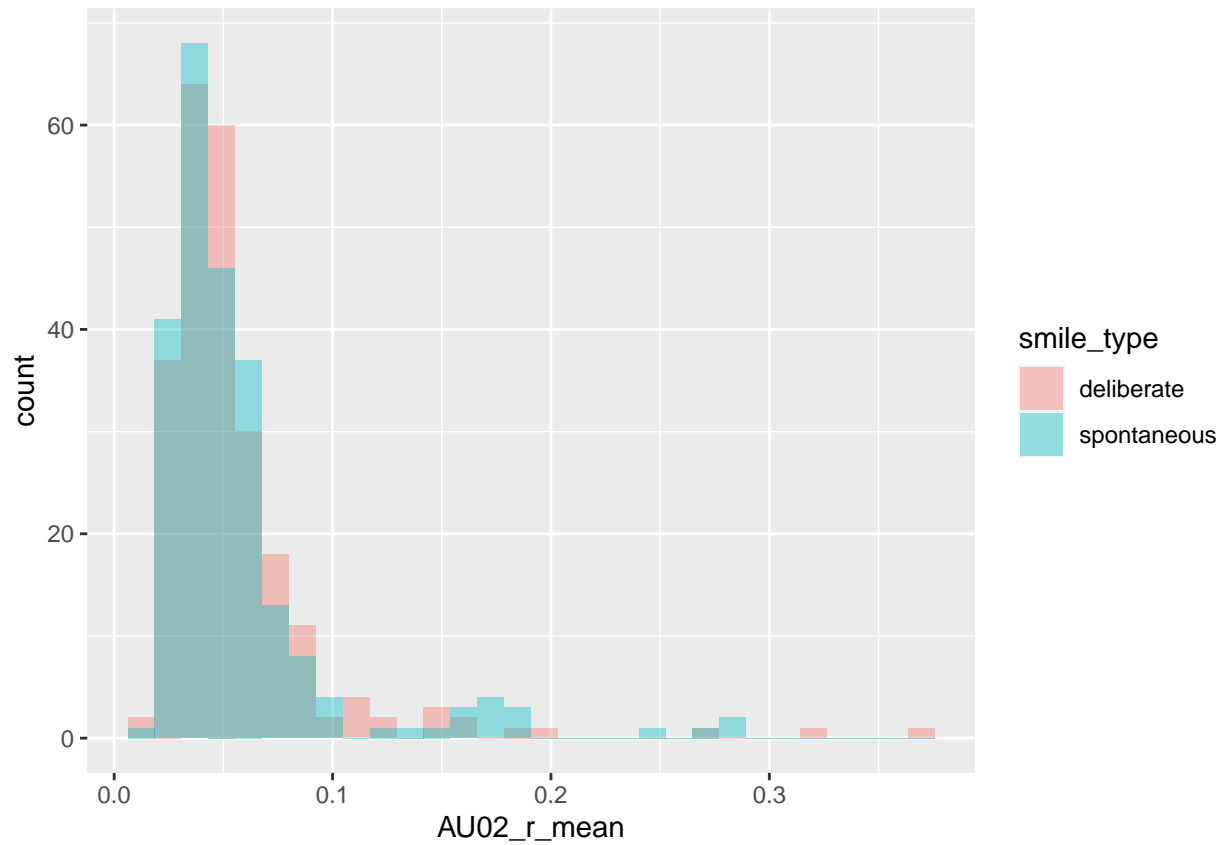
```
ggplot(UvA_sum, aes(x = AU02_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



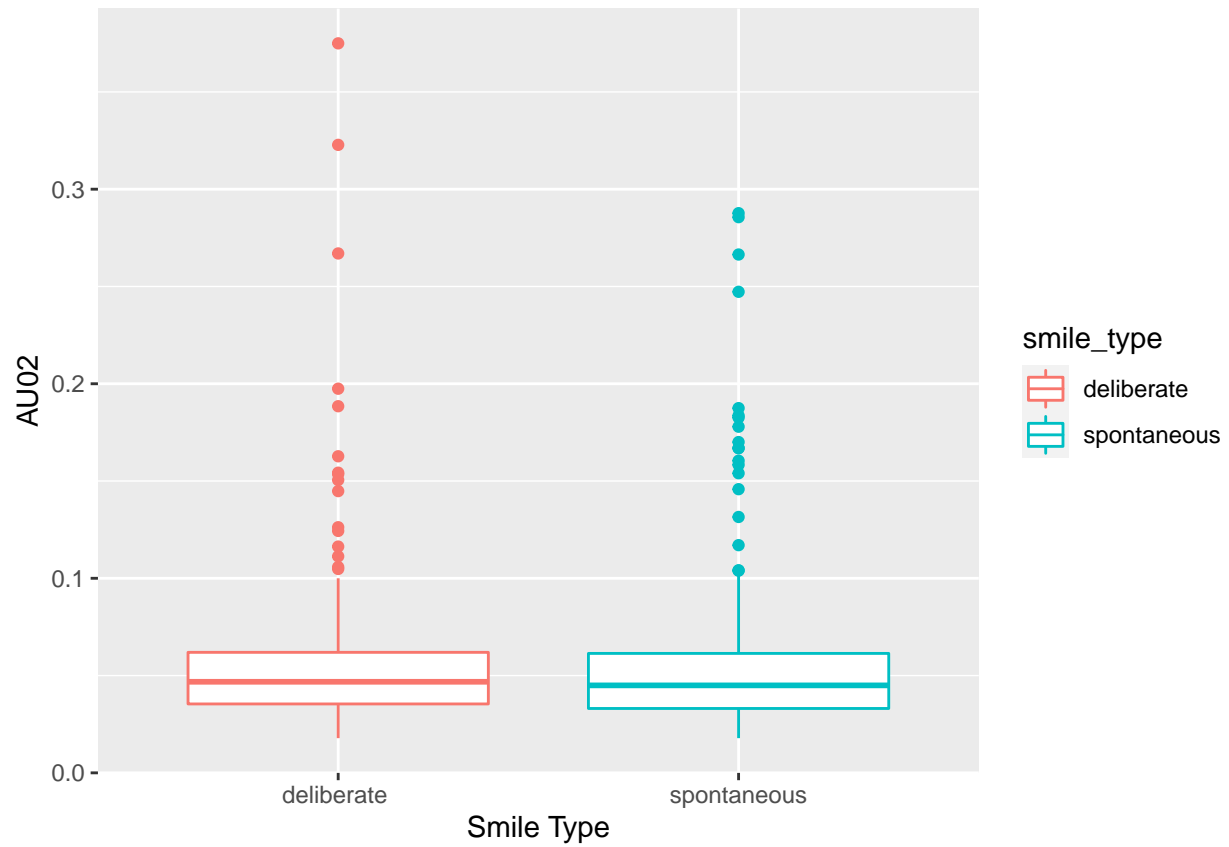
```
ggplot(UvA_sum, aes(x = AU02_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



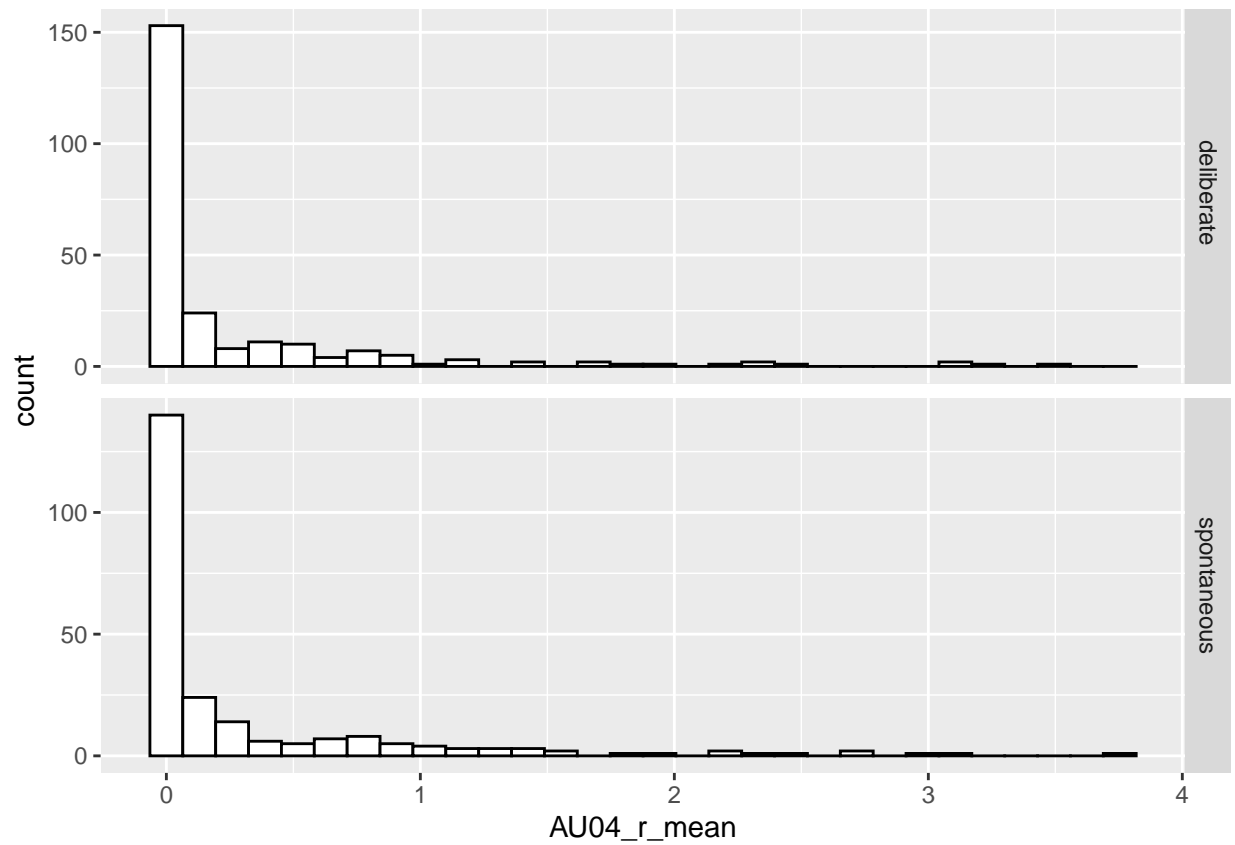
```
ggplot(UvA_sum, aes(x = AU02_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



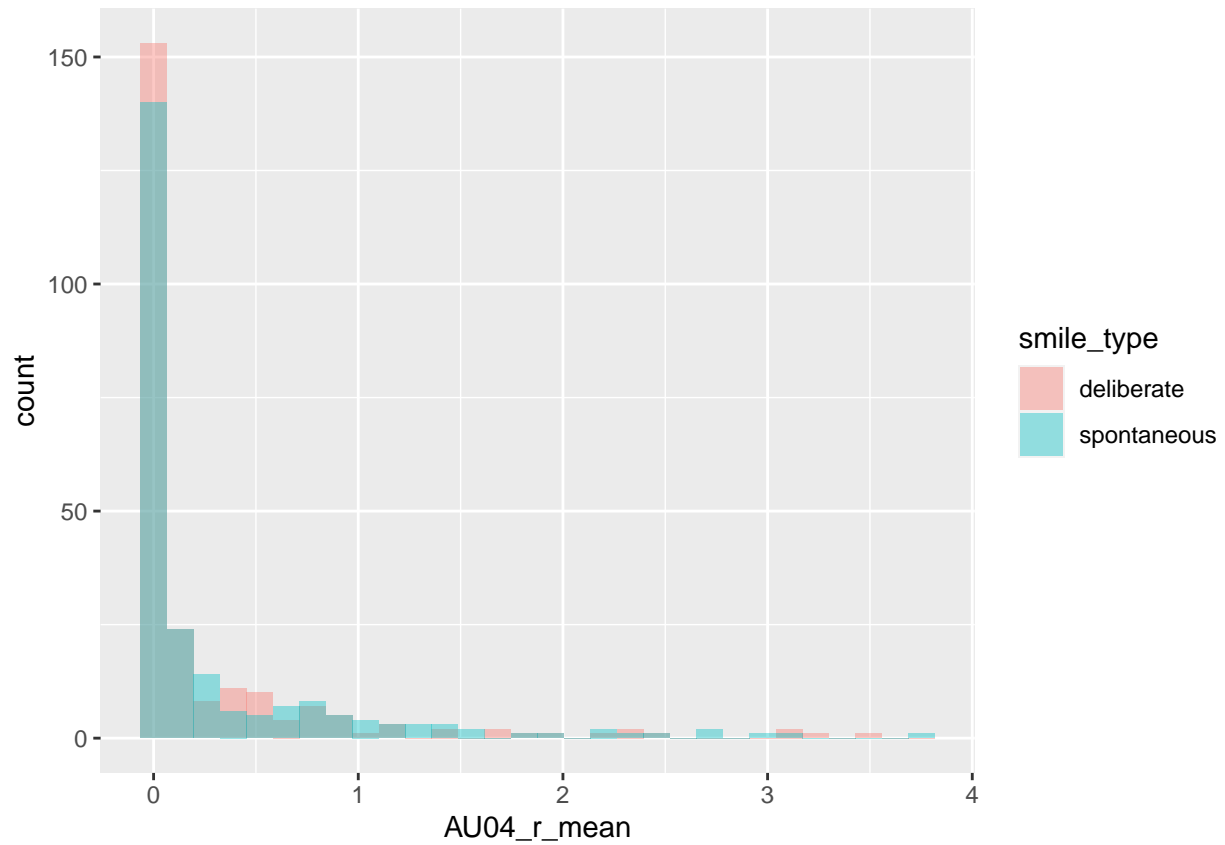
```
ggplot(UvA_sum, aes(x = smile_type, y = AU02_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU02") +  
  scale_x_discrete(name = "Smile Type")
```



```
# AU04
ggplot(UvA_sum, aes(x = AU04_r_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

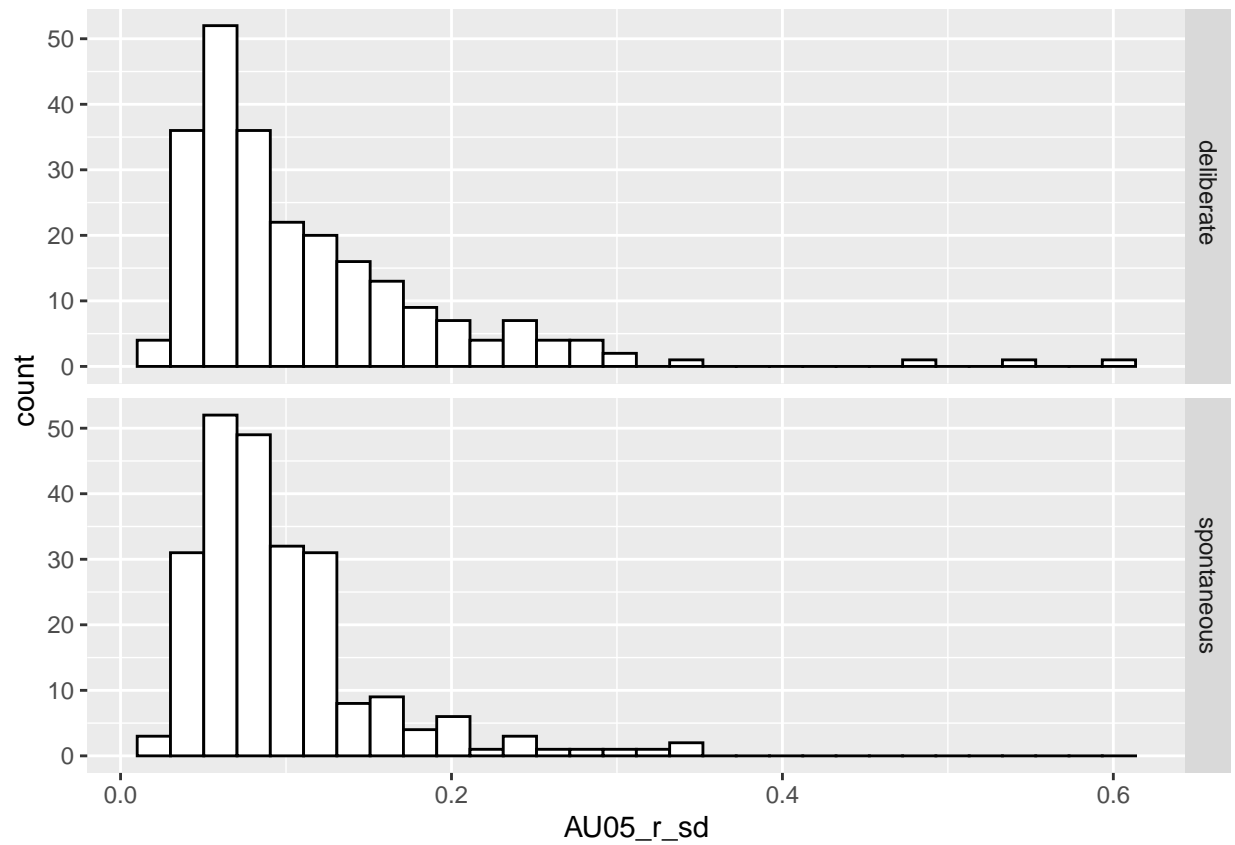


```
ggplot(UvA_sum, aes(x = AU04_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```

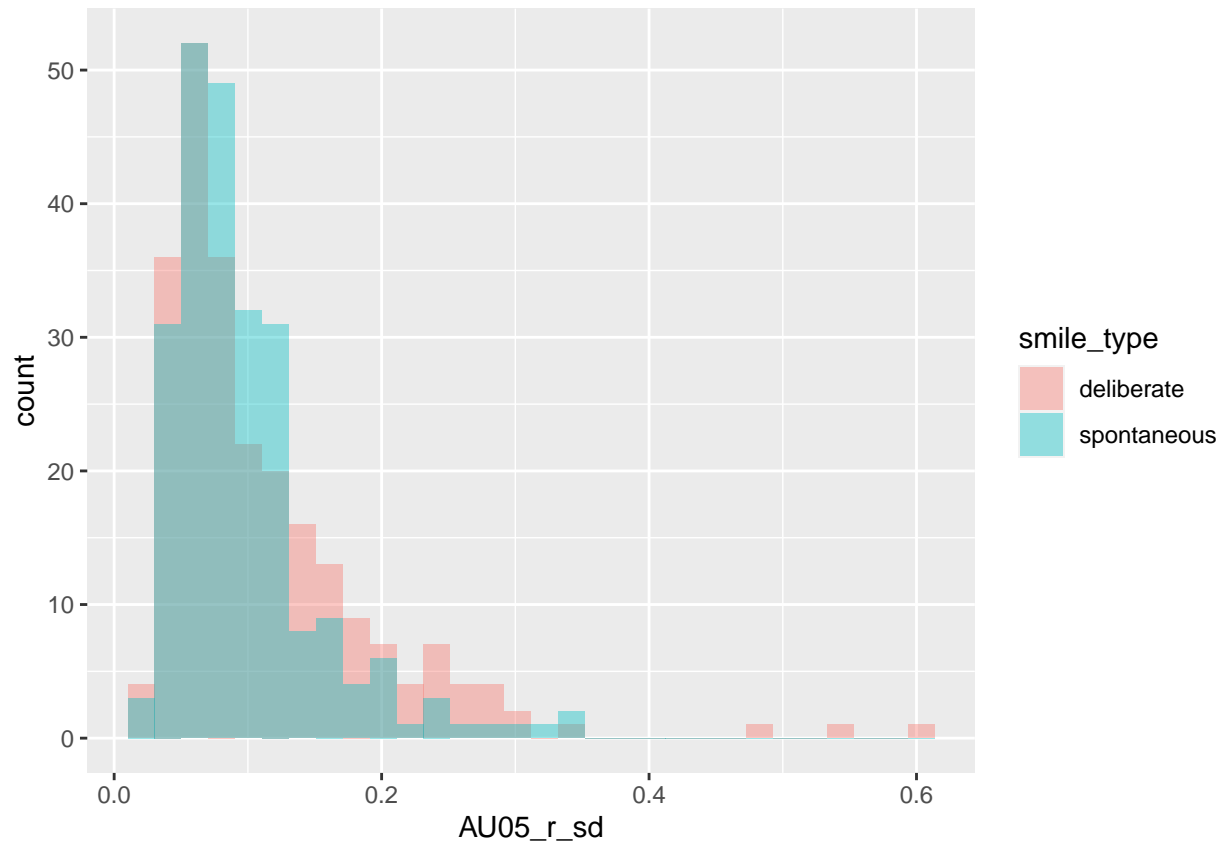


AU04 does not seem to have an impact, as most values show zero value

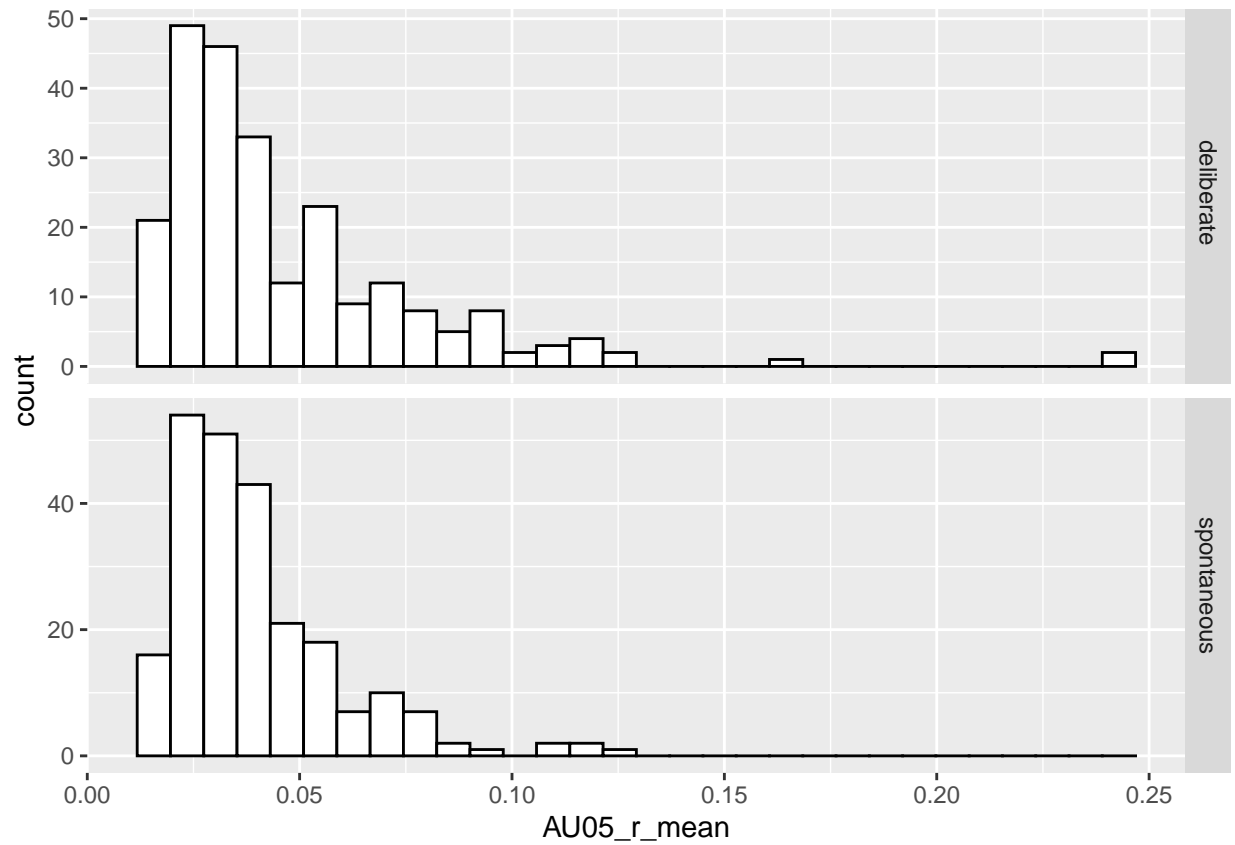
```
# AU05
ggplot(UvA_sum, aes(x = AU05_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



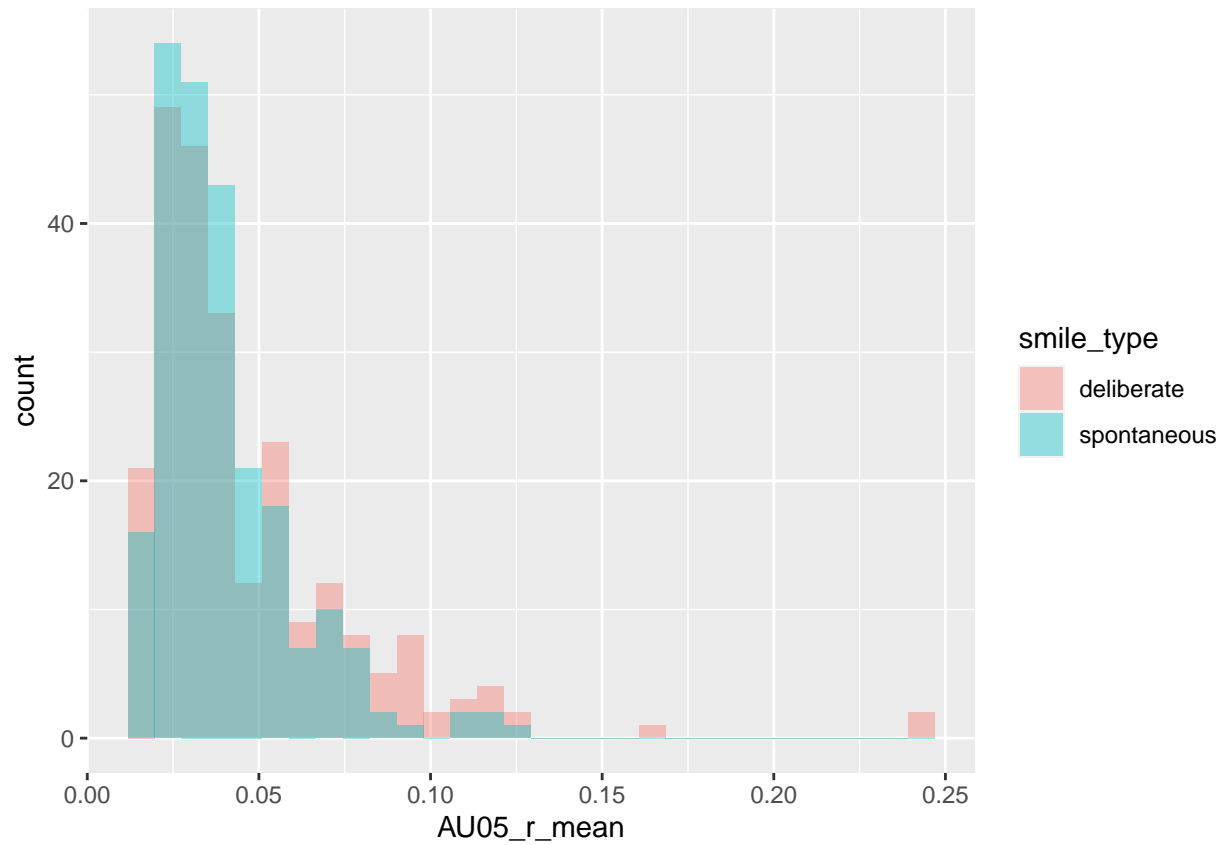
```
ggplot(UvA_sum, aes(x = AU05_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```

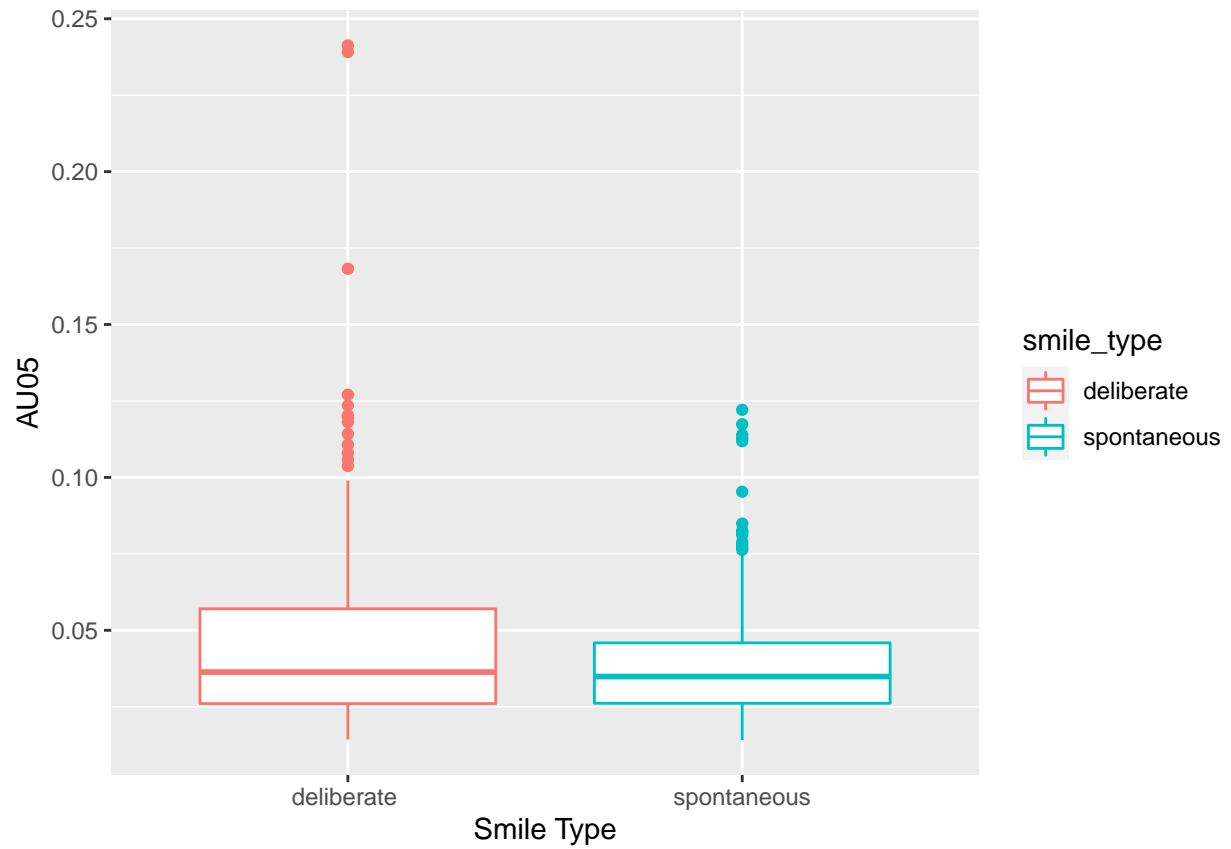
```
ggplot(UvA_sum, aes(x = AU05_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



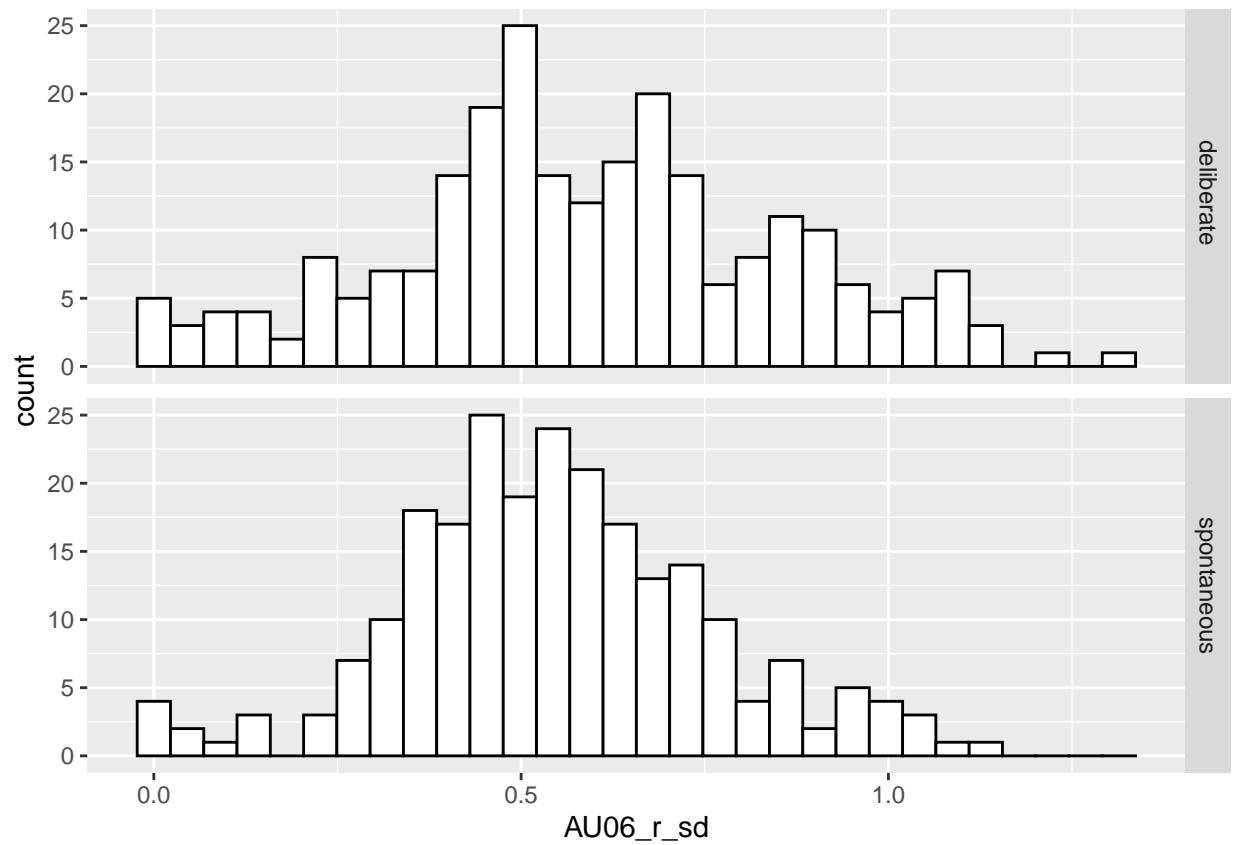
```
ggplot(UvA_sum, aes(x = AU05_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



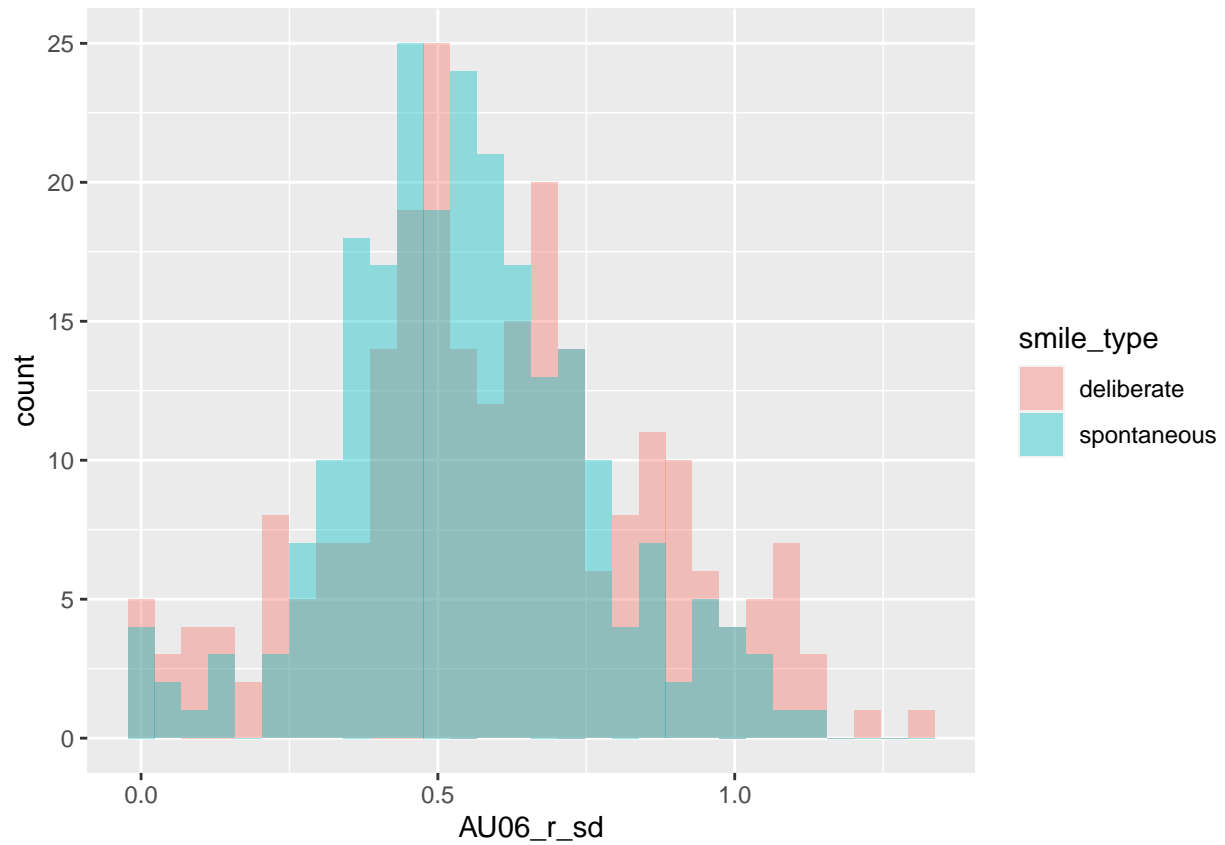
```
ggplot(UvA_sum, aes(x = smile_type, y = AU05_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU05") +
  scale_x_discrete(name = "Smile Type")
```



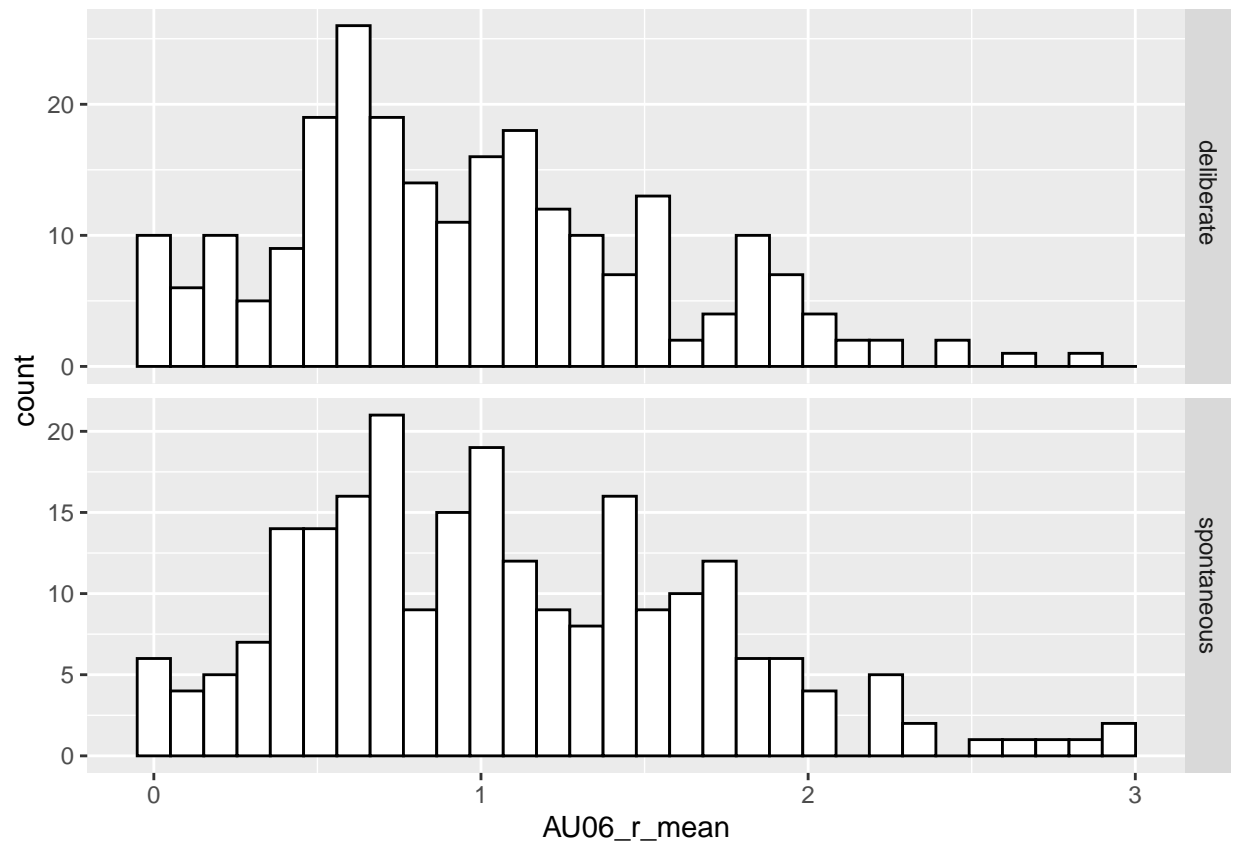
```
# AU06
ggplot(UvA_sum, aes(x = AU06_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



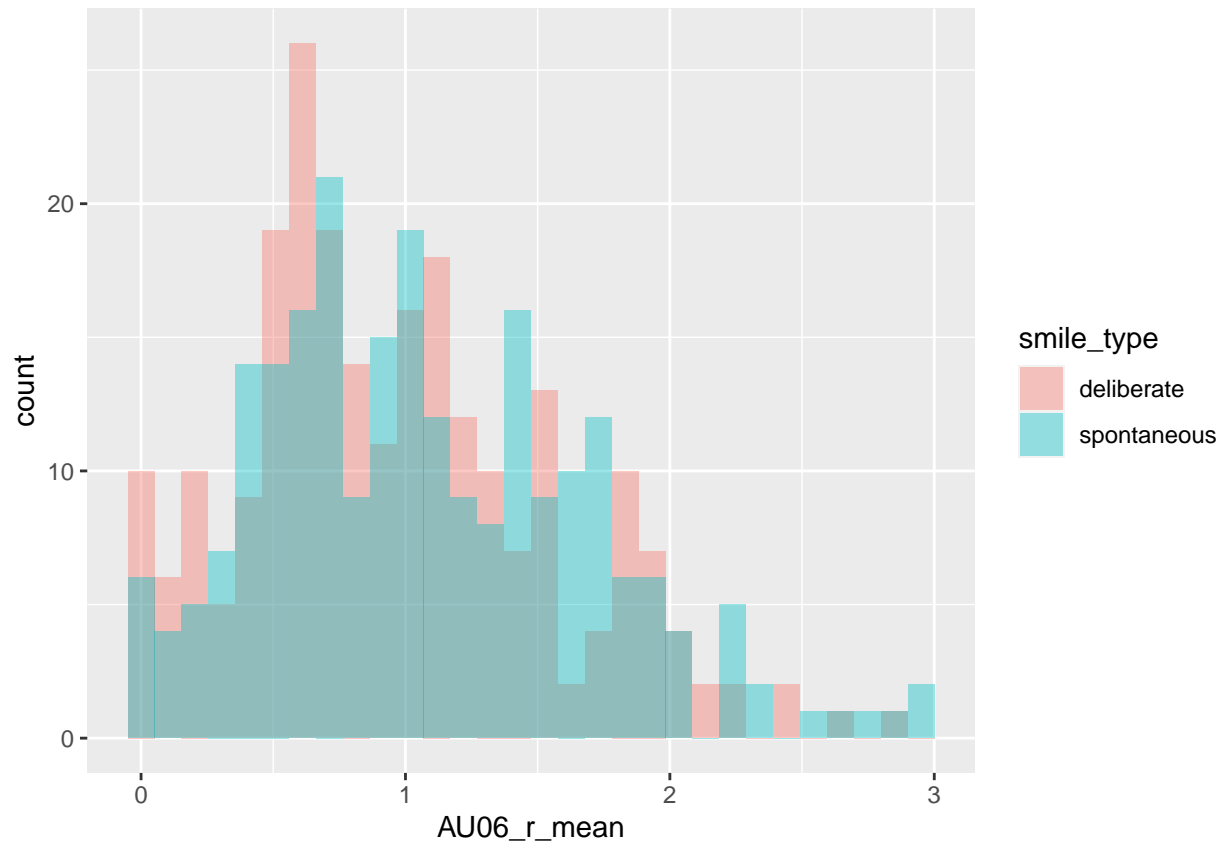
```
ggplot(UvA_sum, aes(x = AU06_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



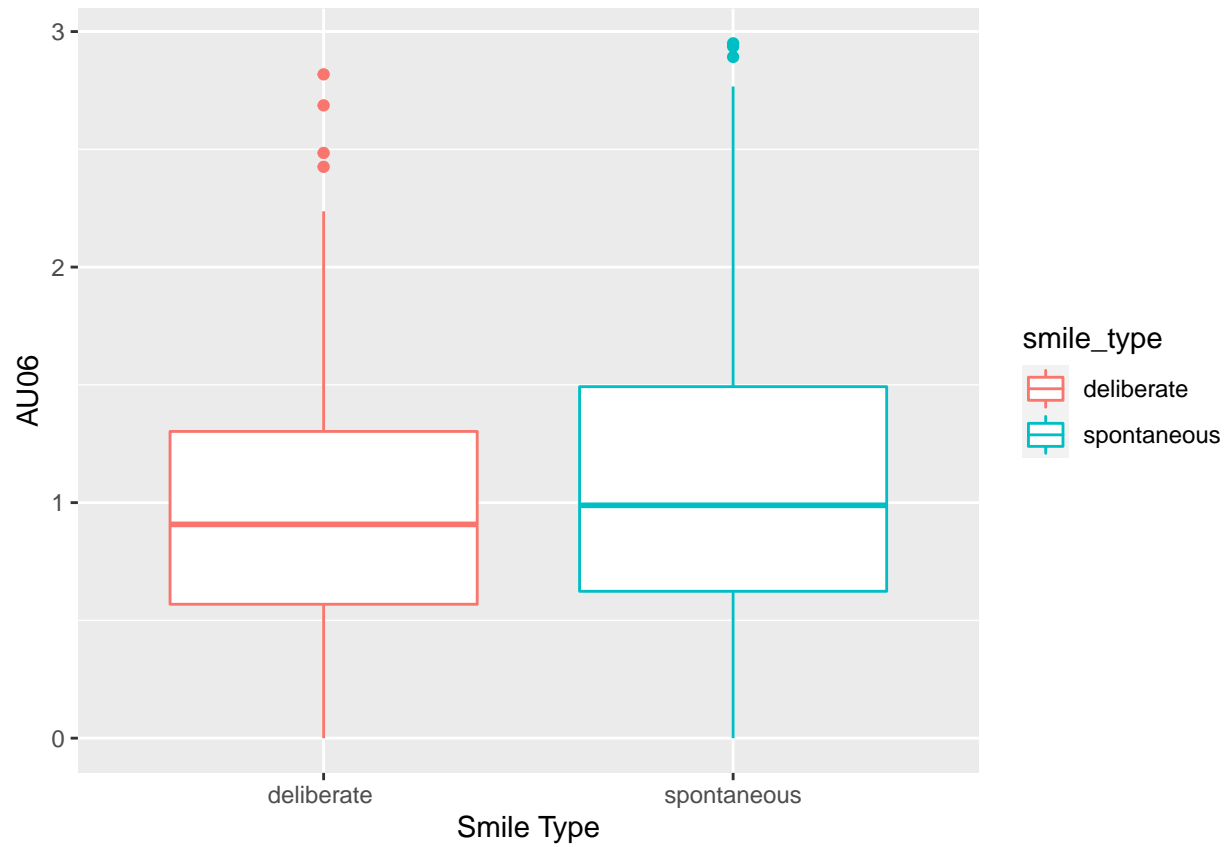
```
ggplot(UvA_sum, aes(x = AU06_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



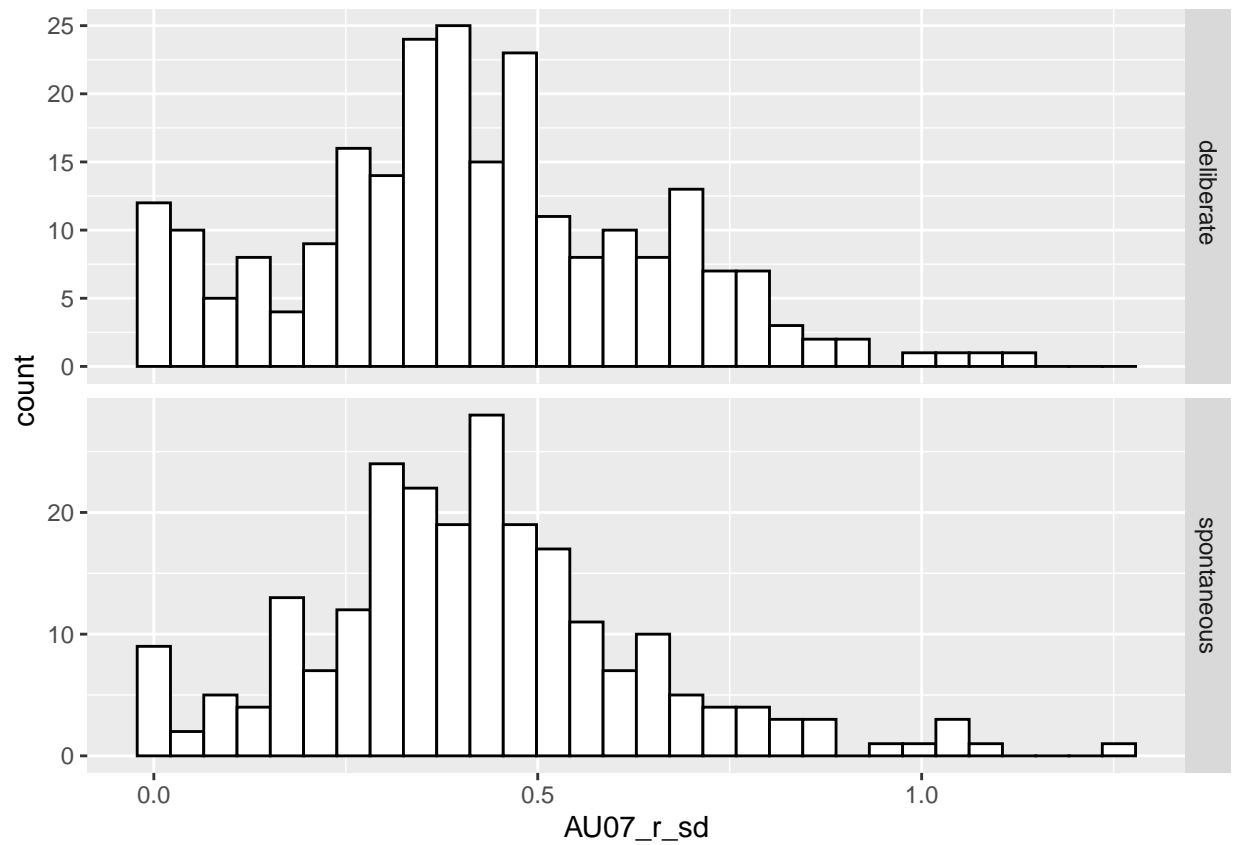
```
ggplot(UvA_sum, aes(x = AU06_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



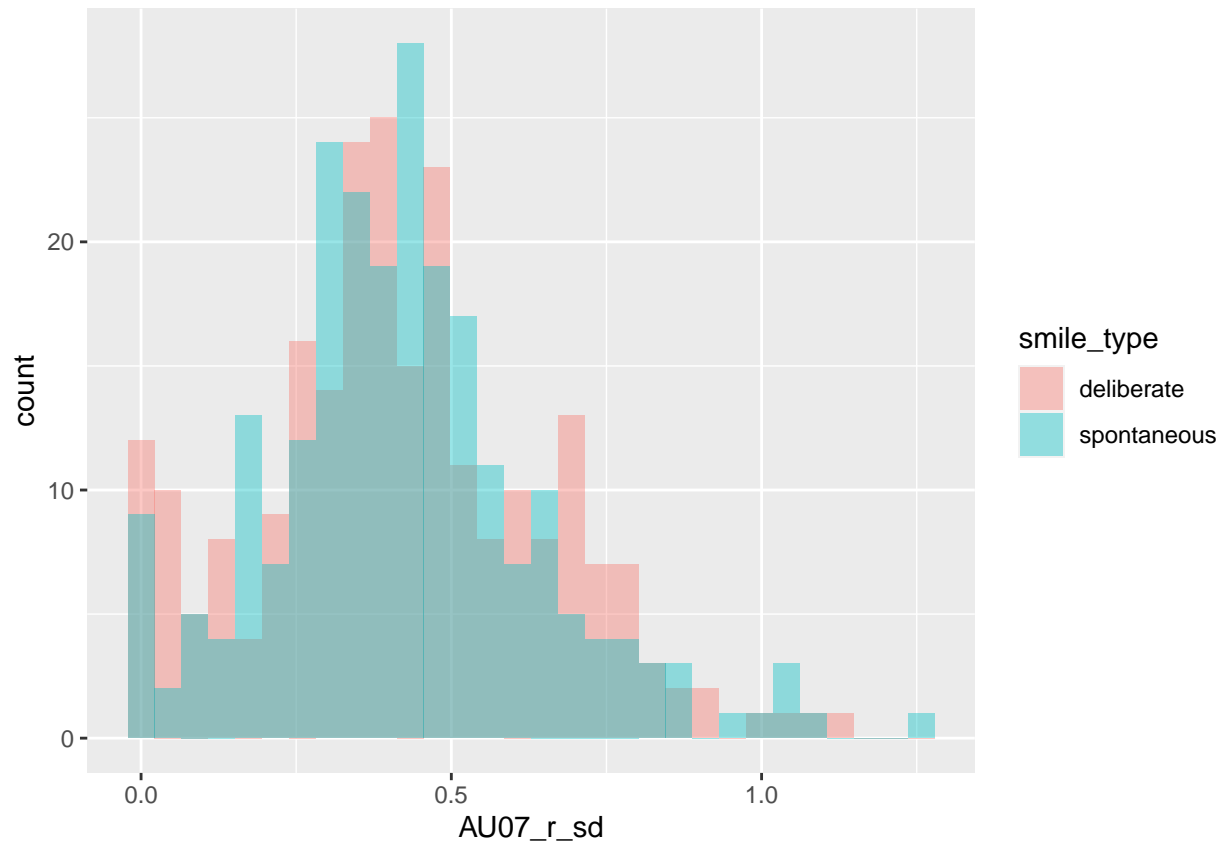
```
ggplot(UvA_sum, aes(x = smile_type, y = AU06_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU06") +  
  scale_x_discrete(name = "Smile Type")
```

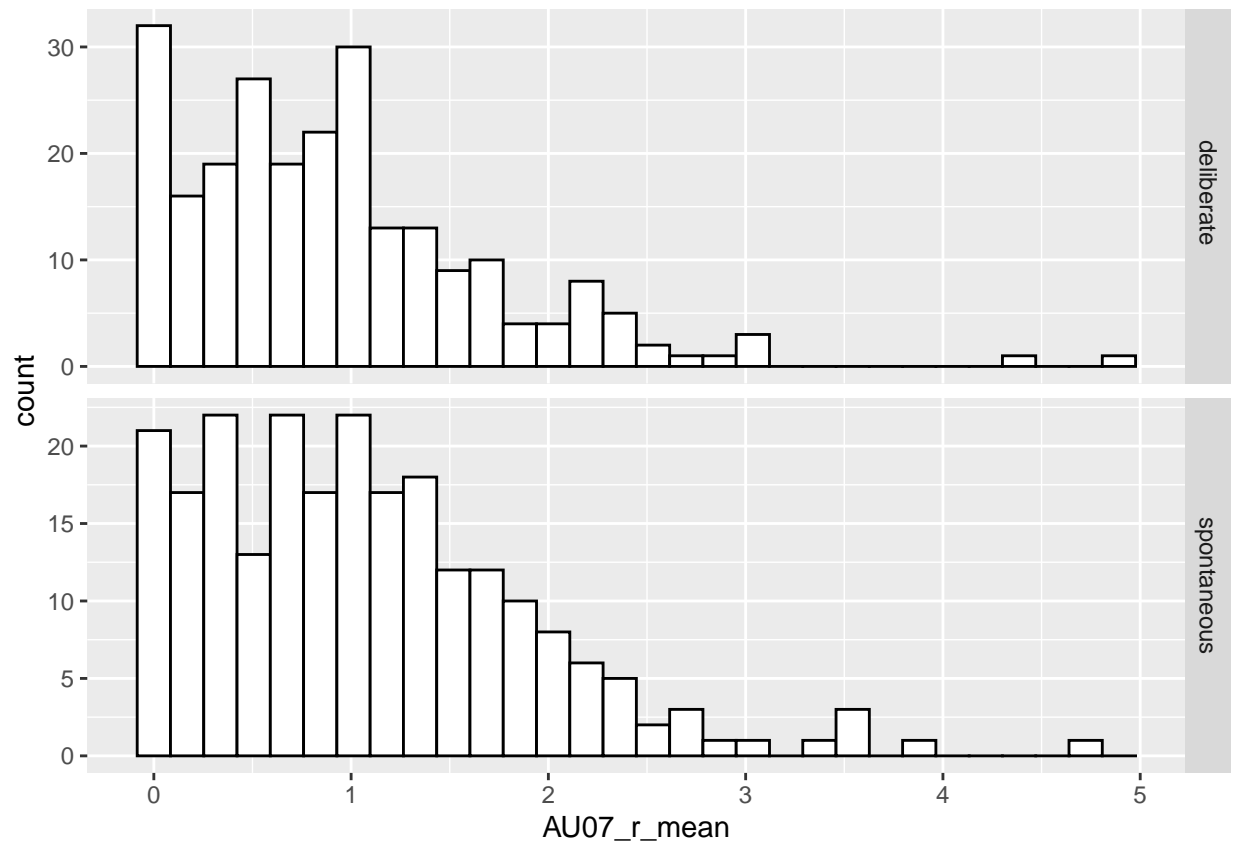
```
# AU07
ggplot(UvA_sum, aes(x = AU07_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



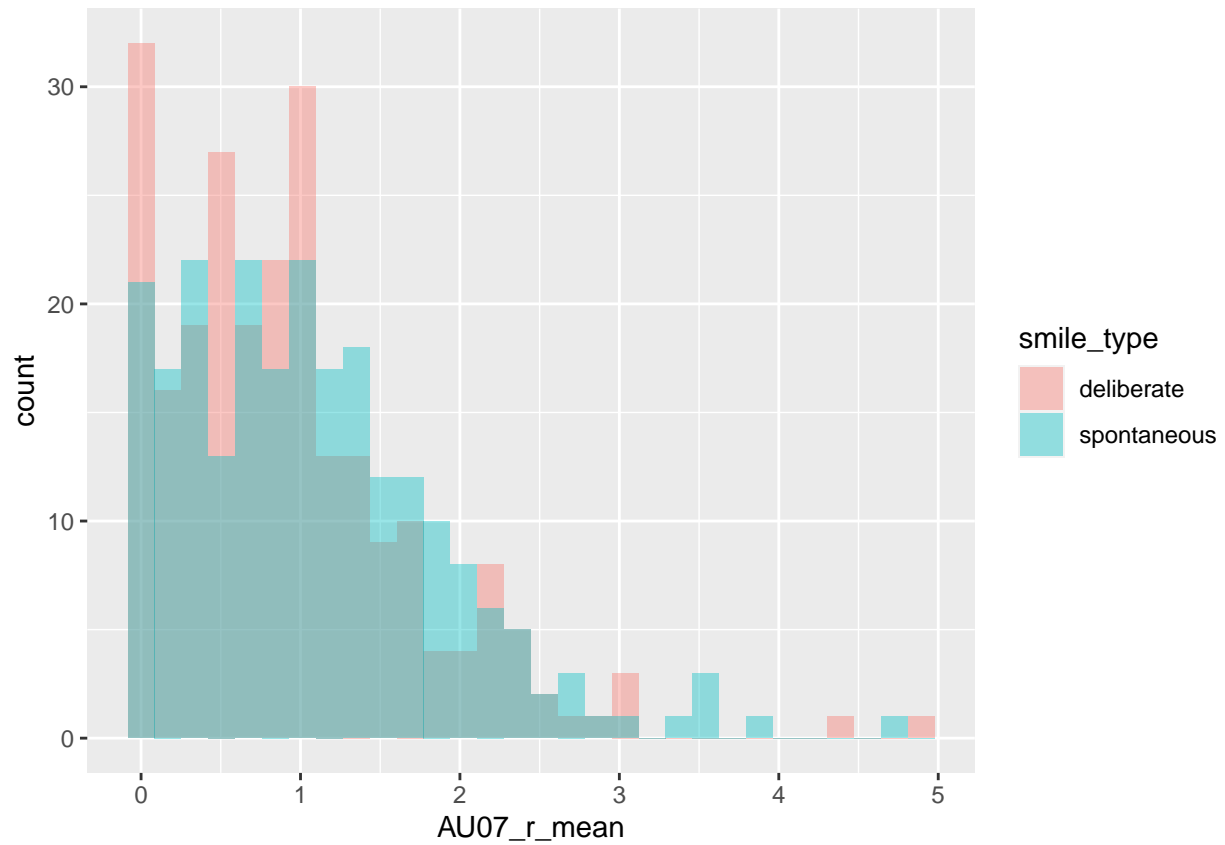
```
ggplot(UvA_sum, aes(x = AU07_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



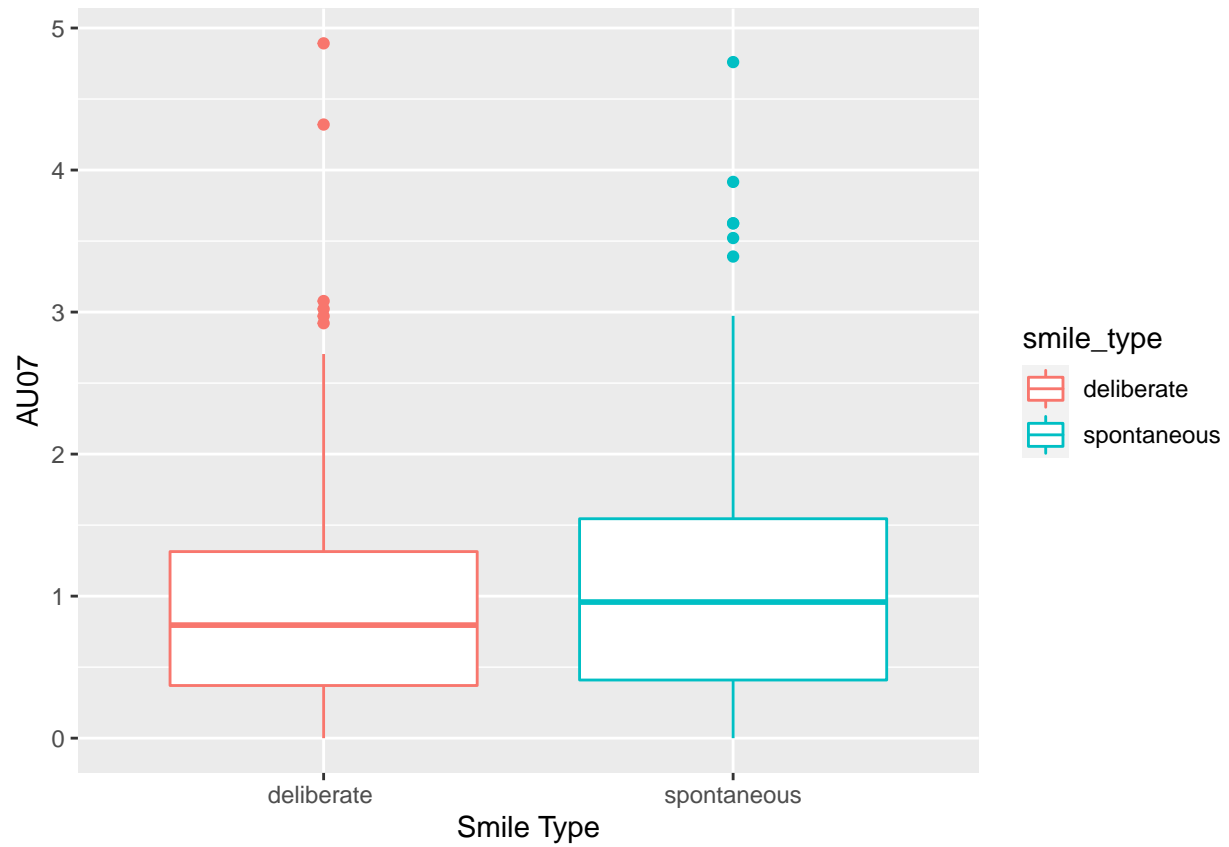
```
ggplot(UvA_sum, aes(x = AU07_r_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



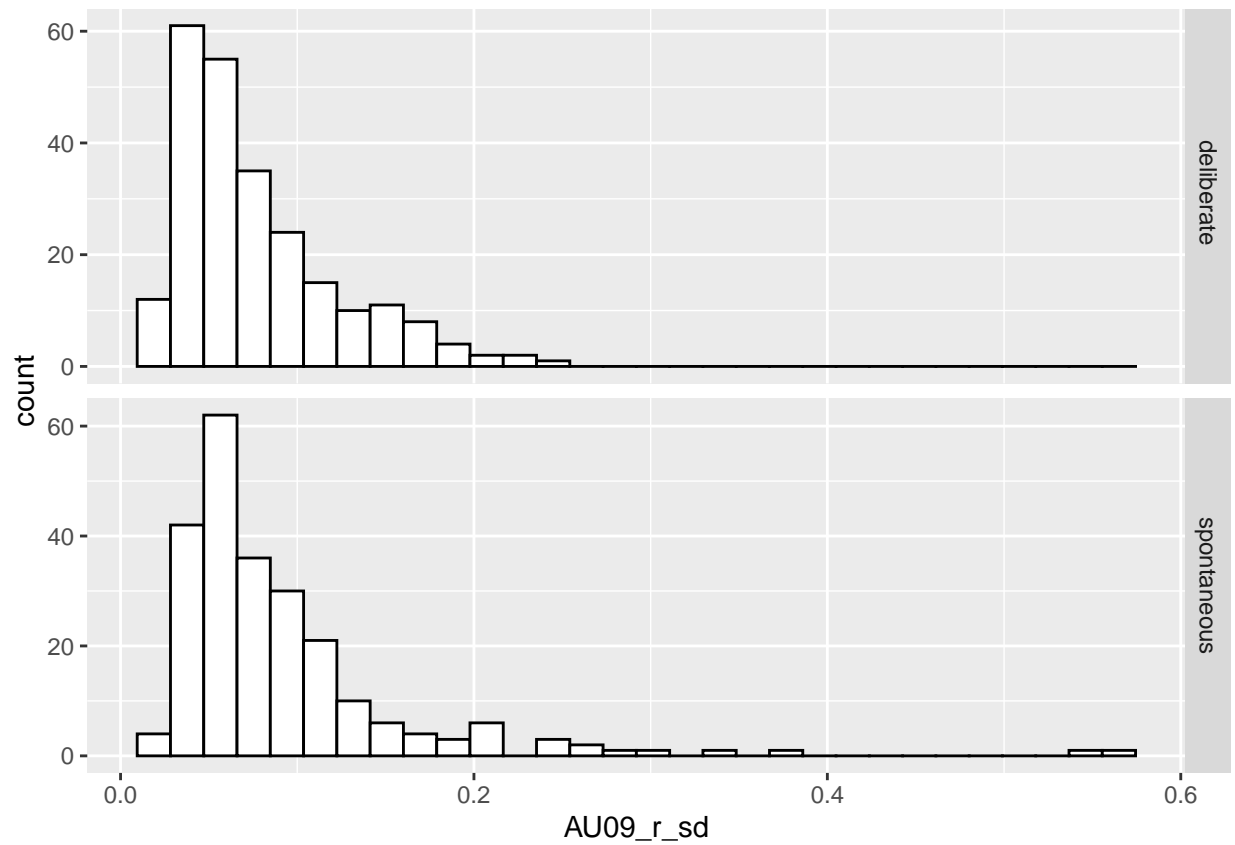
```
ggplot(UvA_sum, aes(x = AU07_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



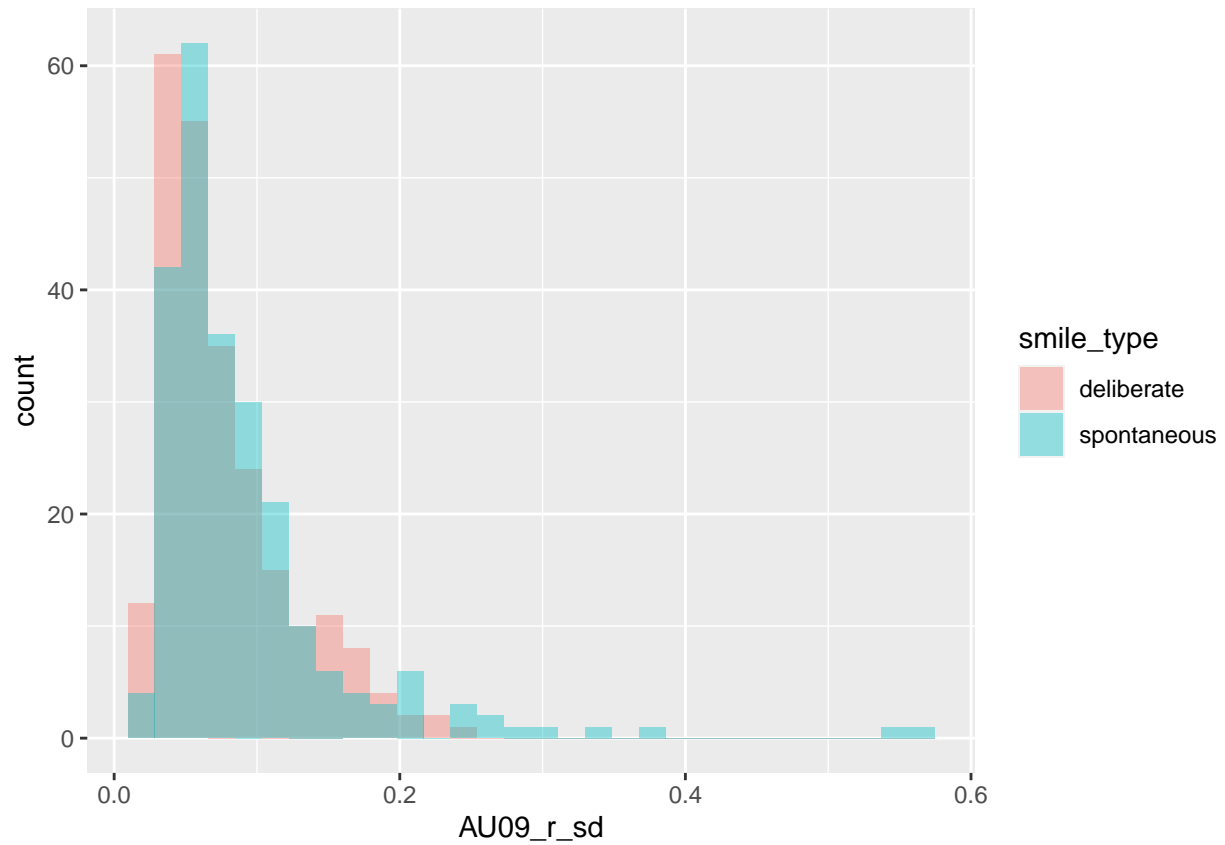
```
ggplot(UvA_sum, aes(x = smile_type, y = AU07_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU07") +
  scale_x_discrete(name = "Smile Type")
```



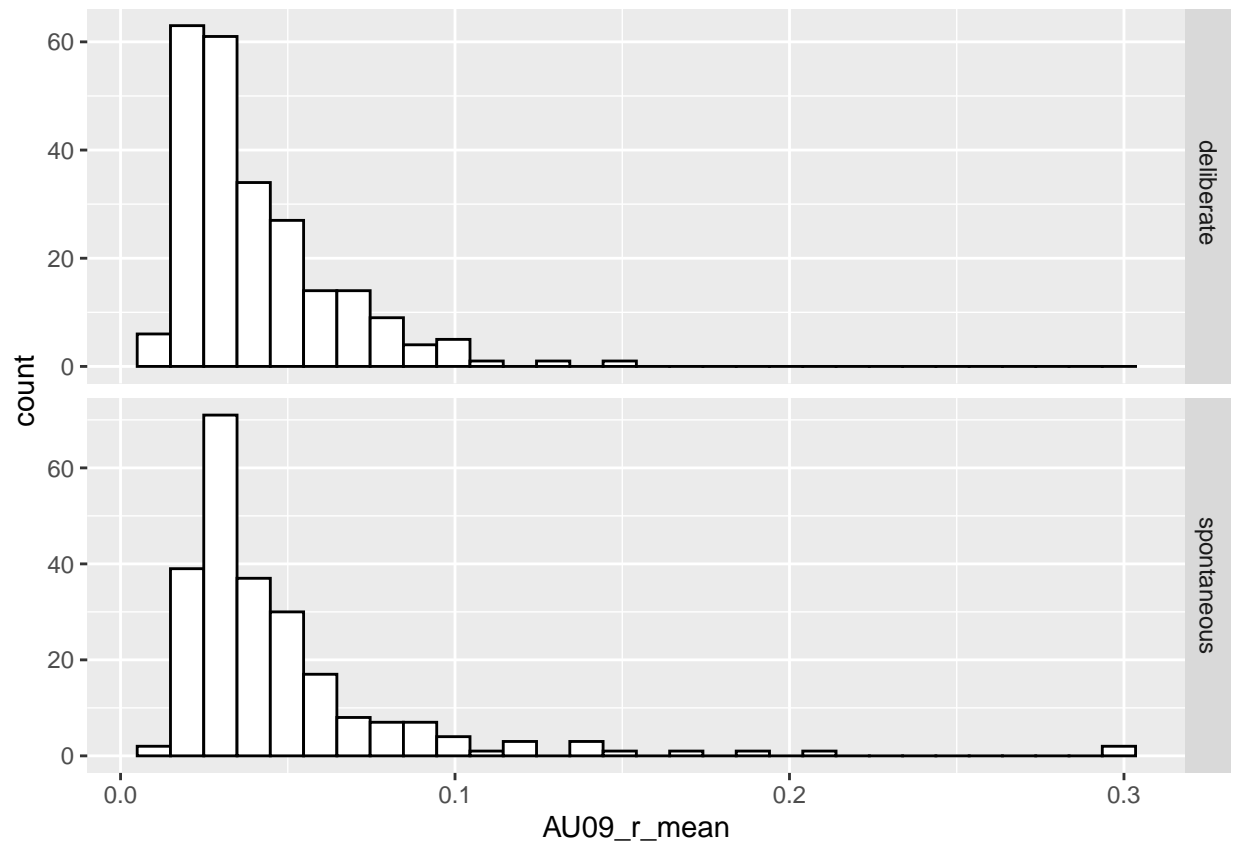
```
# AU09
ggplot(UvA_sum, aes(x = AU09_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



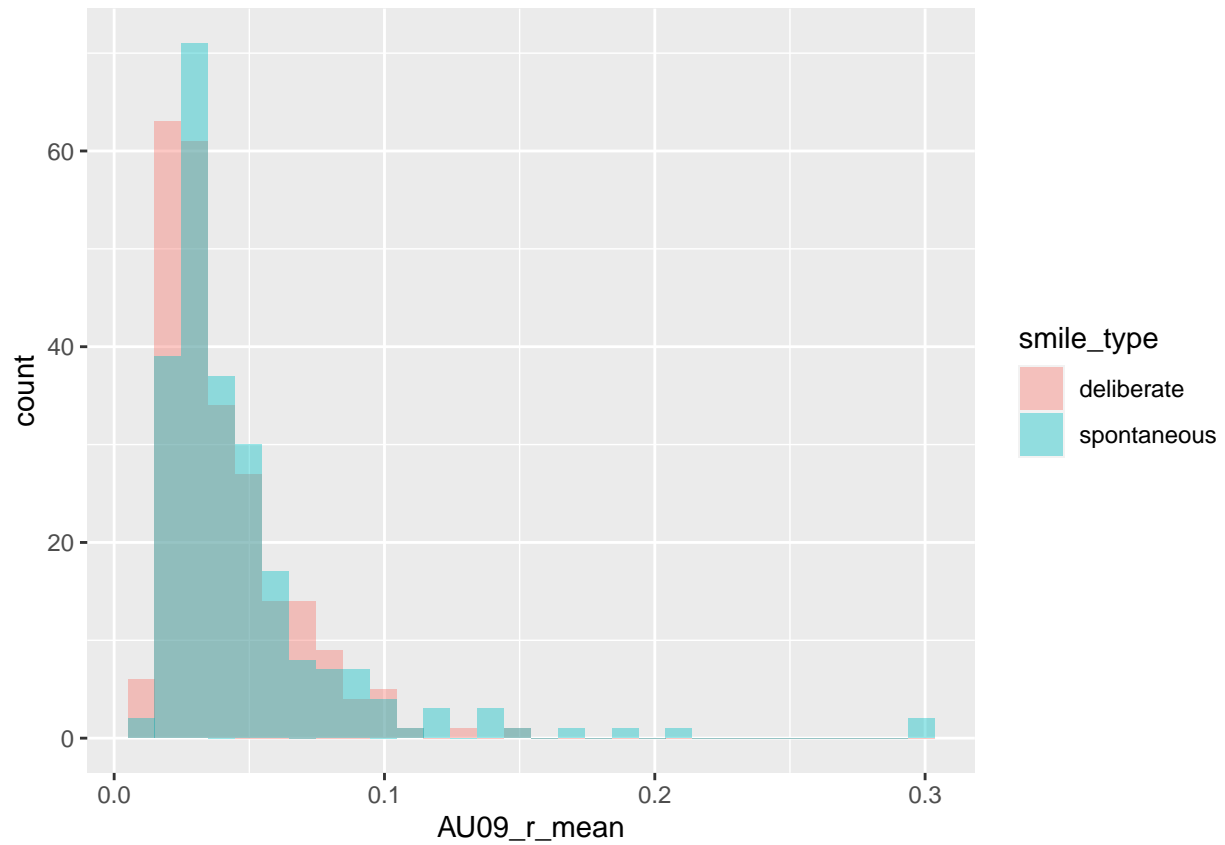
```
ggplot(UvA_sum, aes(x = AU09_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



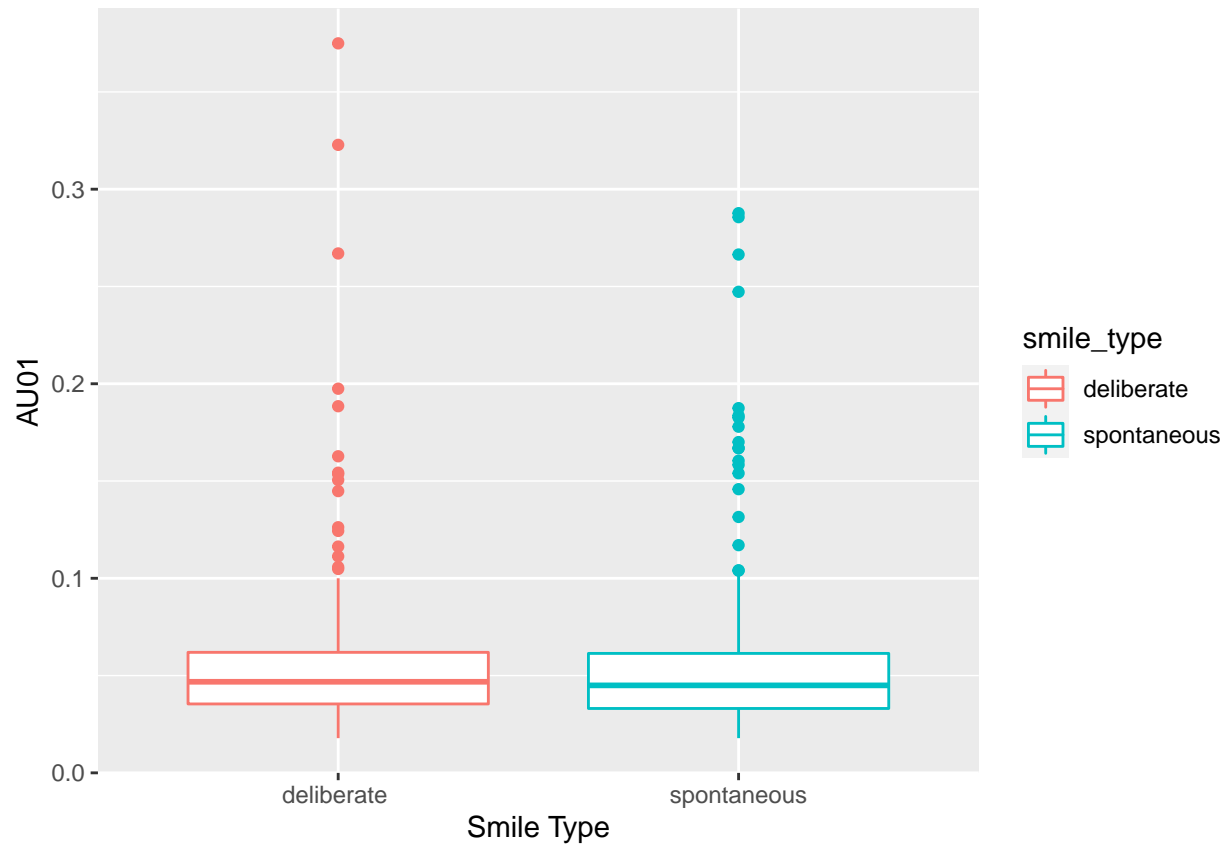
```
ggplot(UvA_sum, aes(x = AU09_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```

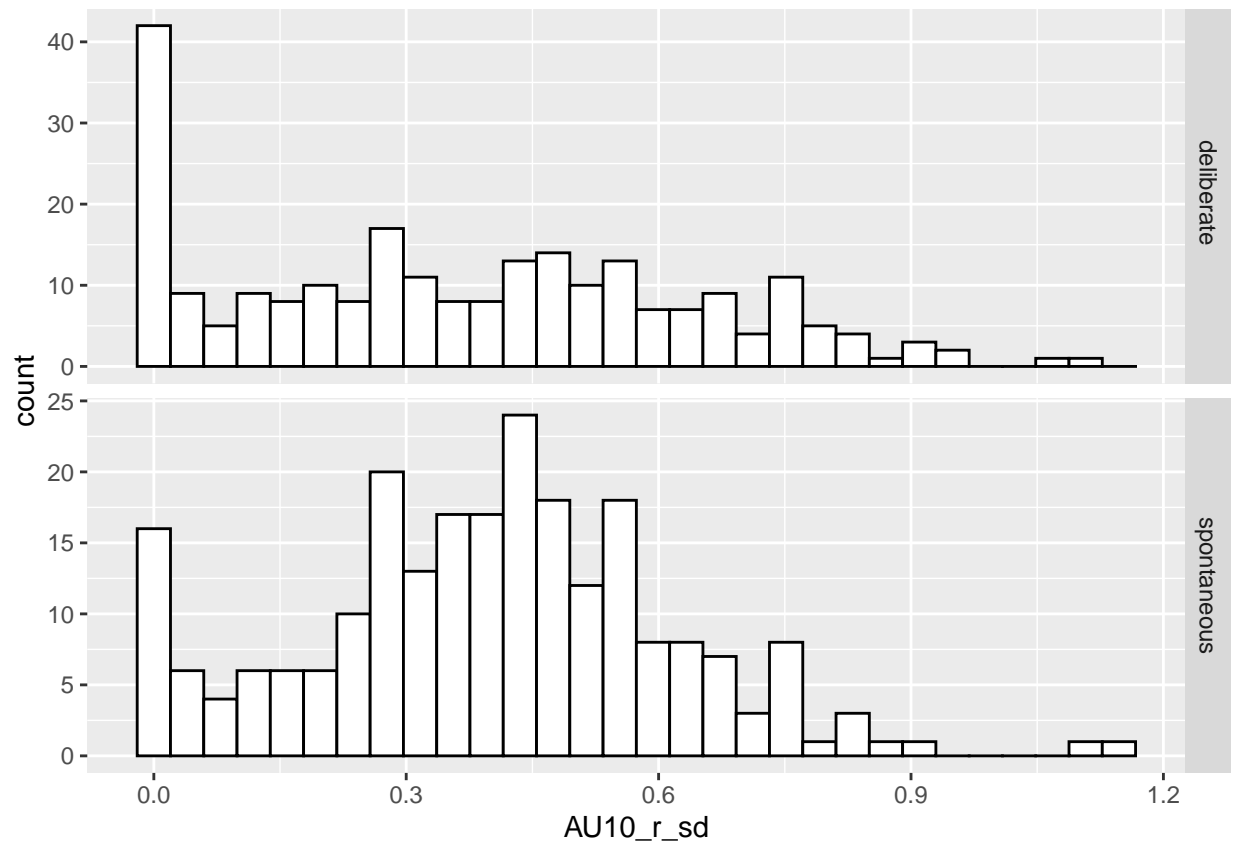
```
ggplot(UvA_sum, aes(x = AU09_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



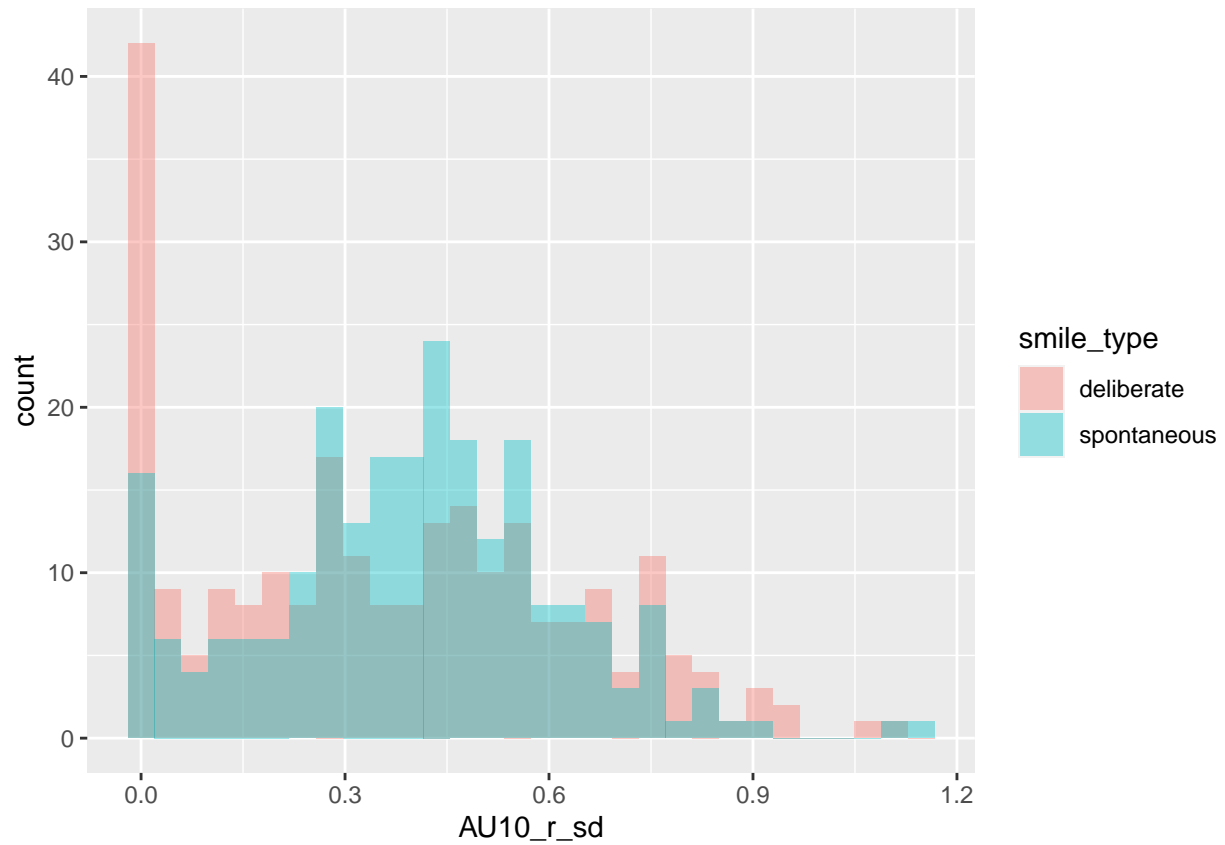
```
ggplot(UvA_sum, aes(x = smile_type, y = AU02_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU01") +
  scale_x_discrete(name = "Smile Type")
```



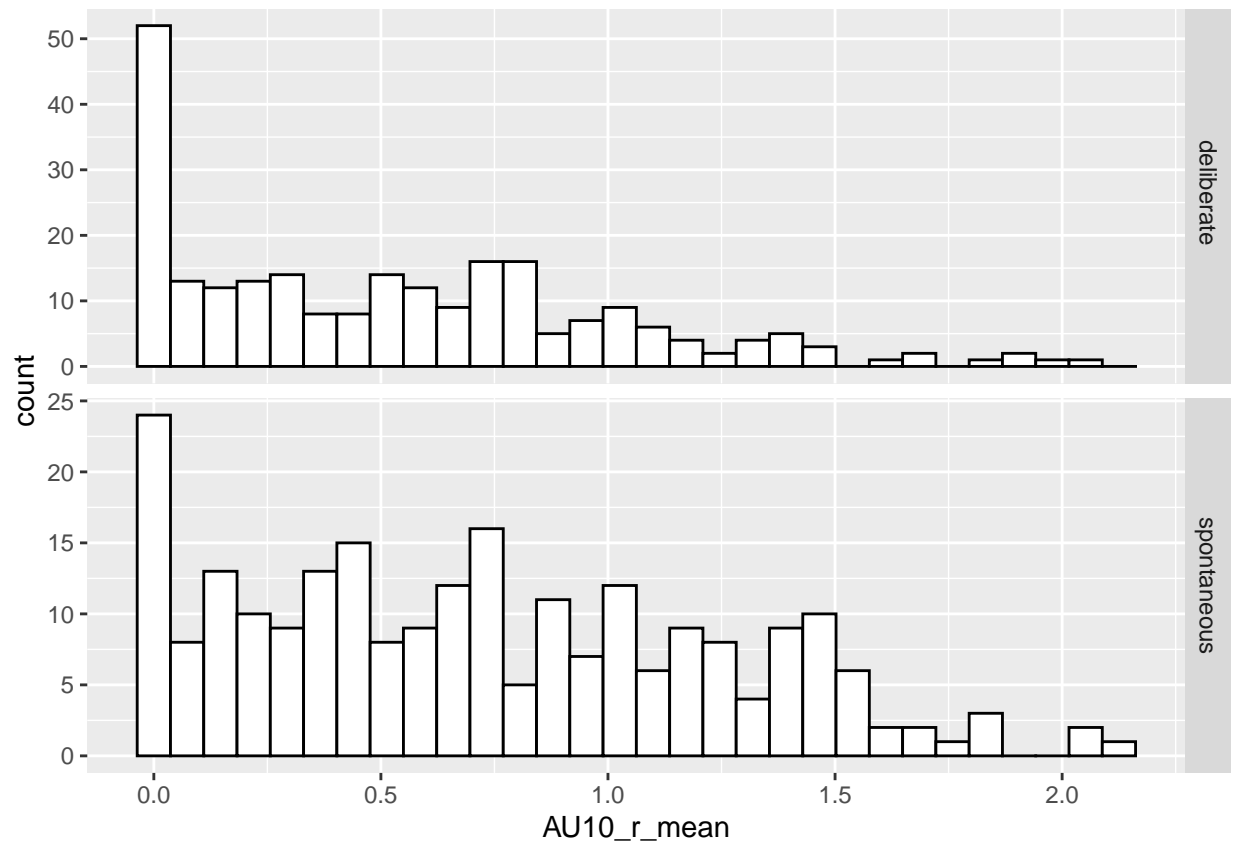
```
# AU10
ggplot(UvA_sum, aes(x = AU10_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



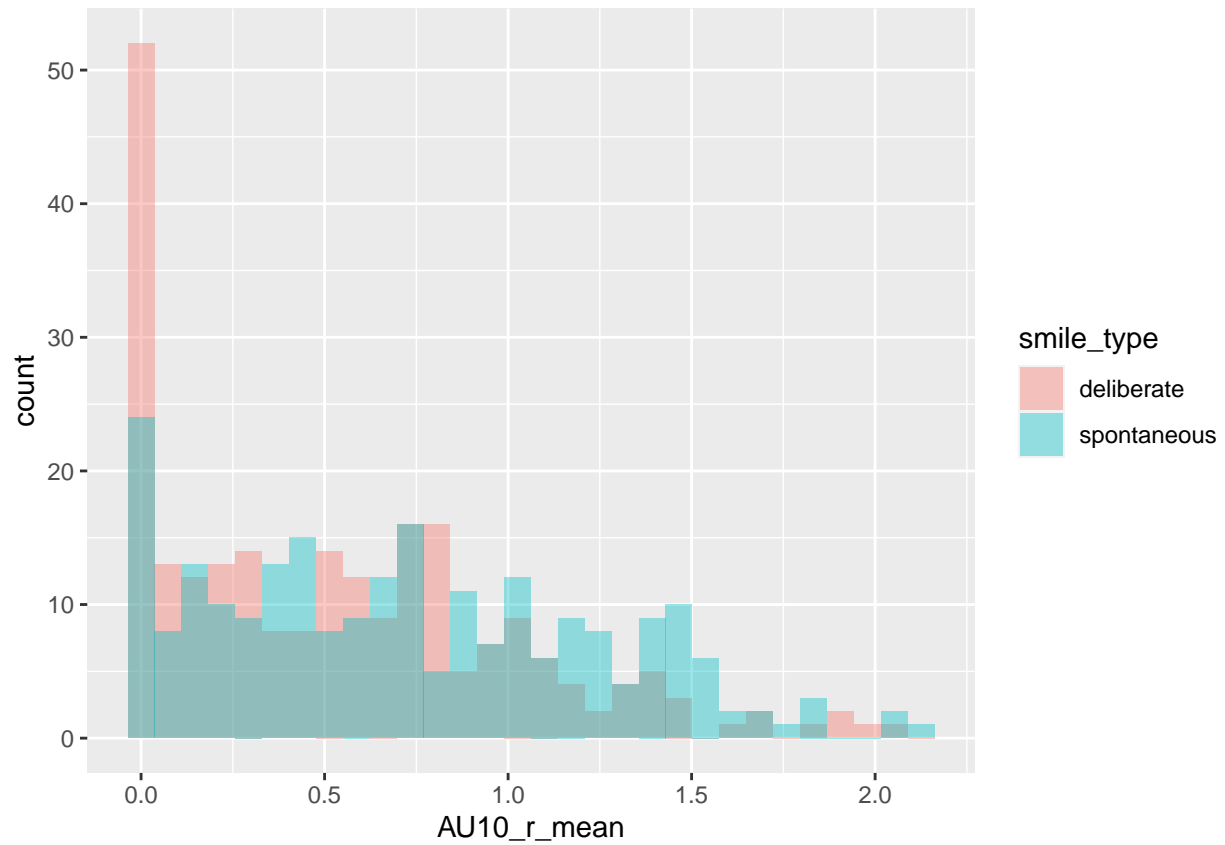
```
ggplot(UvA_sum, aes(x = AU10_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



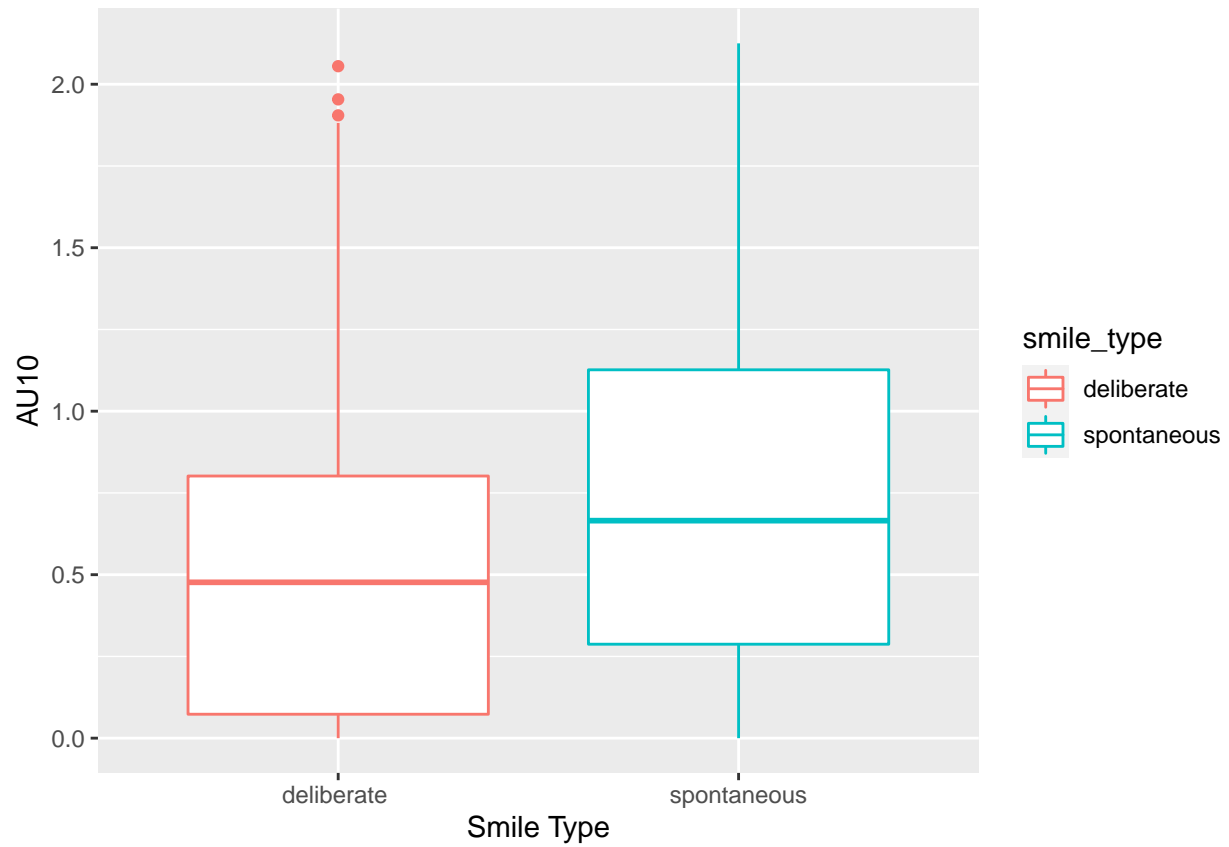
```
ggplot(UvA_sum, aes(x = AU10_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



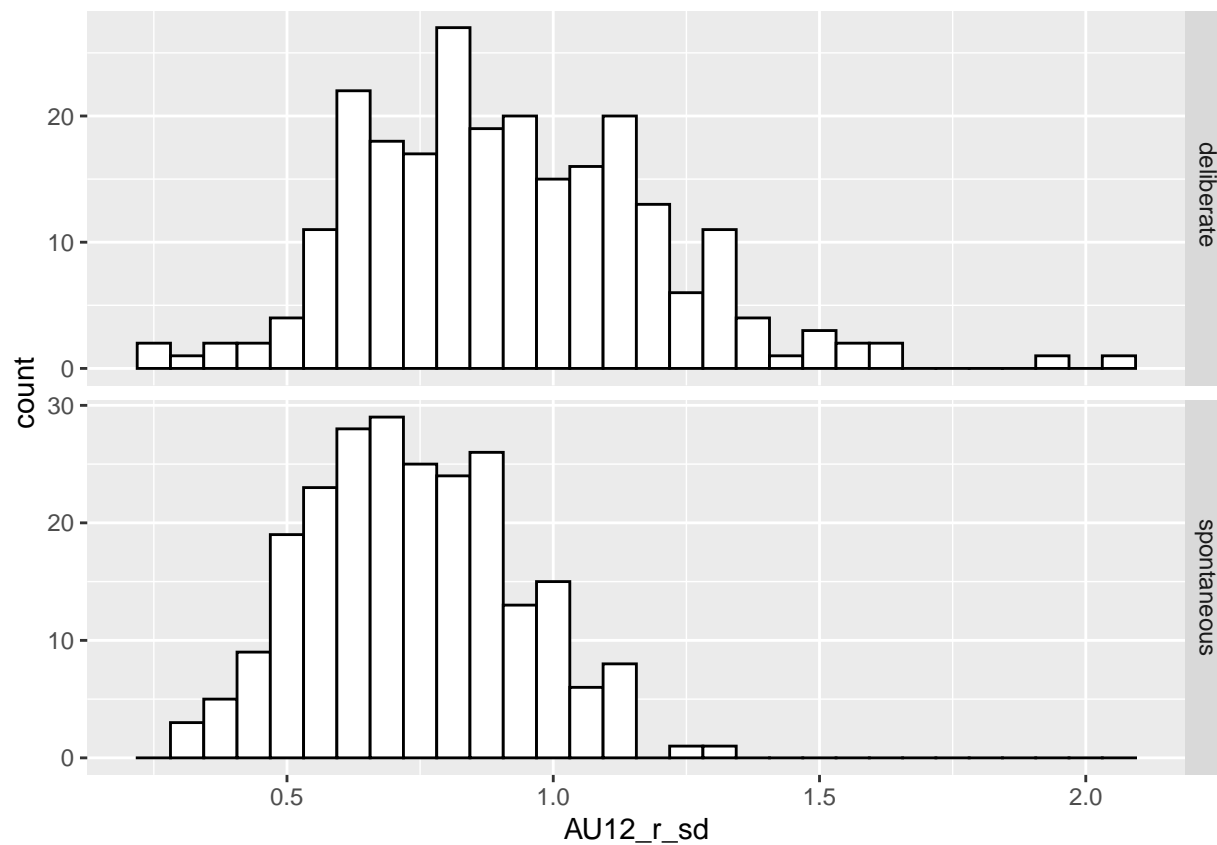
```
ggplot(UvA_sum, aes(x = AU10_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



```
ggplot(UvA_sum, aes(x = smile_type, y = AU10_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU10") +  
  scale_x_discrete(name = "Smile Type")
```

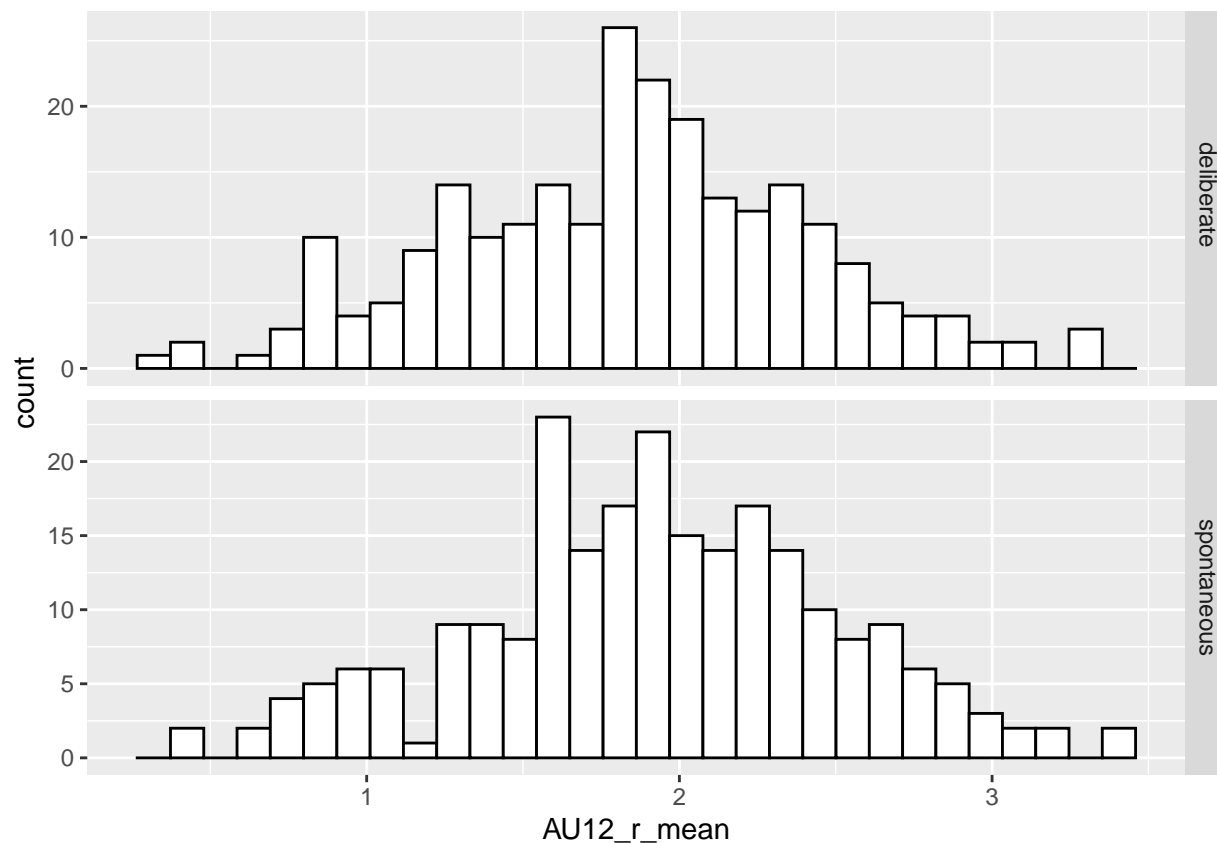


```
# AU12
ggplot(UvA_sum, aes(x = AU12_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

```
fig5 <- ggplot(UvA_sum, aes(x = AU12_r_sd, fill = smile_type)) +
  geom_histogram(position = "identity", alpha = 0.4)

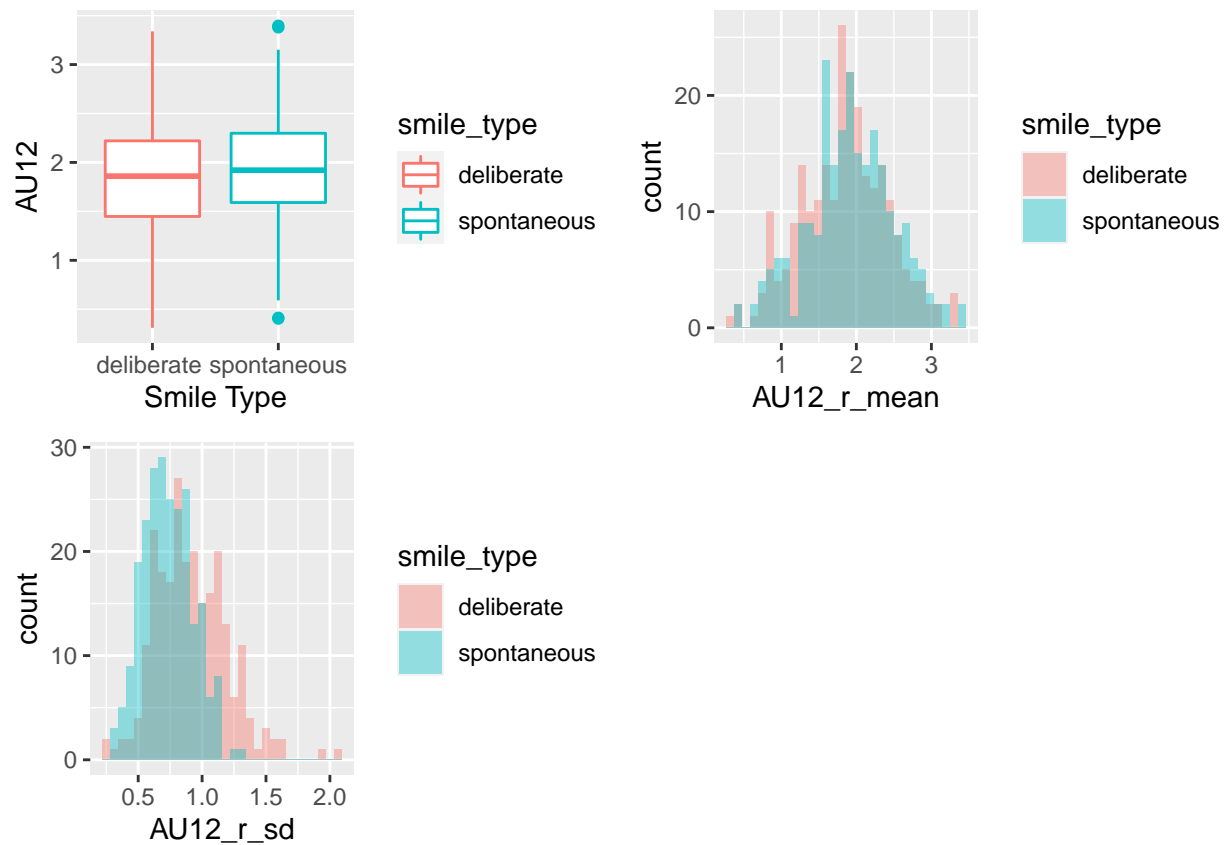
ggplot(UvA_sum, aes(x = AU12_r_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



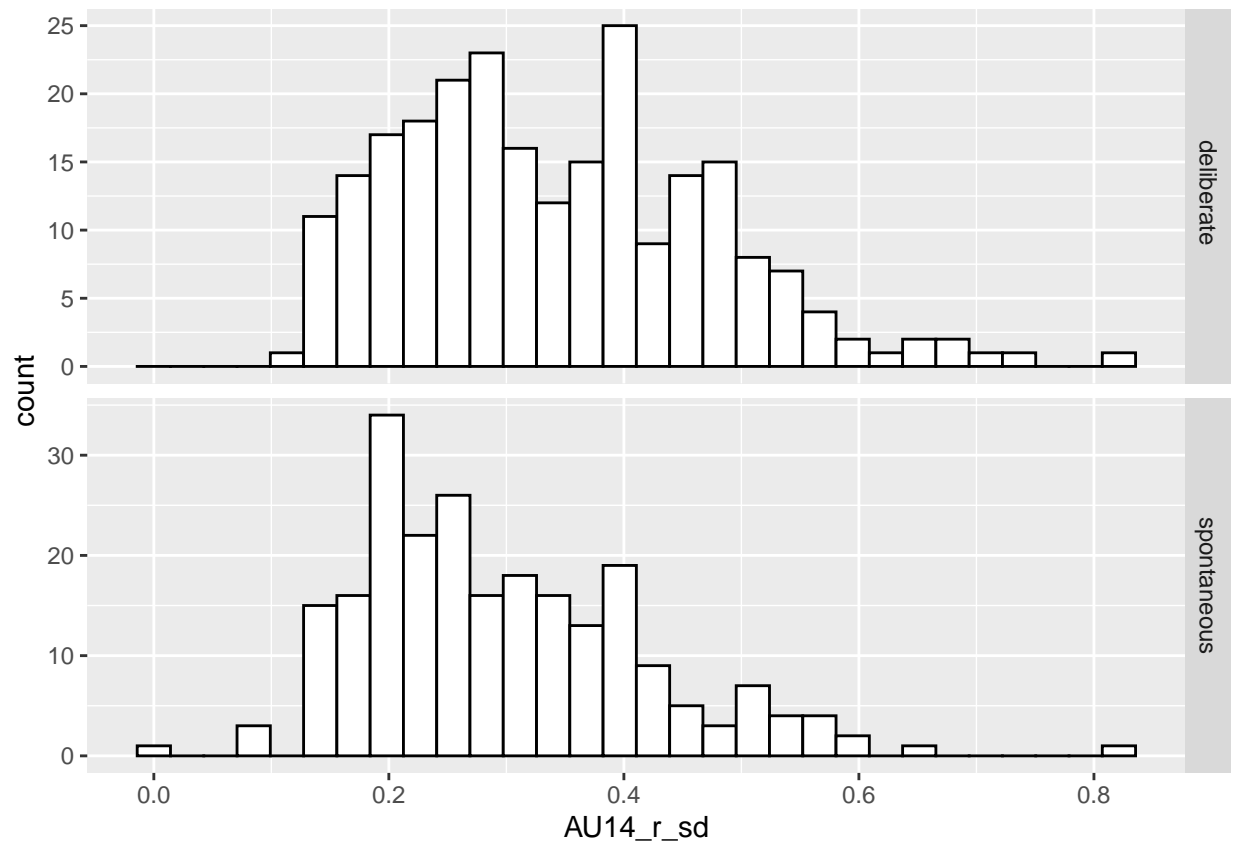
```
fig4 <- ggplot(UvA_sum, aes(x = AU12_r_mean, fill = smile_type)) +
  geom_histogram(position = "identity", alpha = 0.4)

fig3 <- ggplot(
  UvA_sum,
  aes(x = smile_type, y = AU12_r_mean, color = smile_type)
) +
  geom_boxplot() +
  scale_y_continuous(name = "AU12") +
  scale_x_discrete(name = "Smile Type")

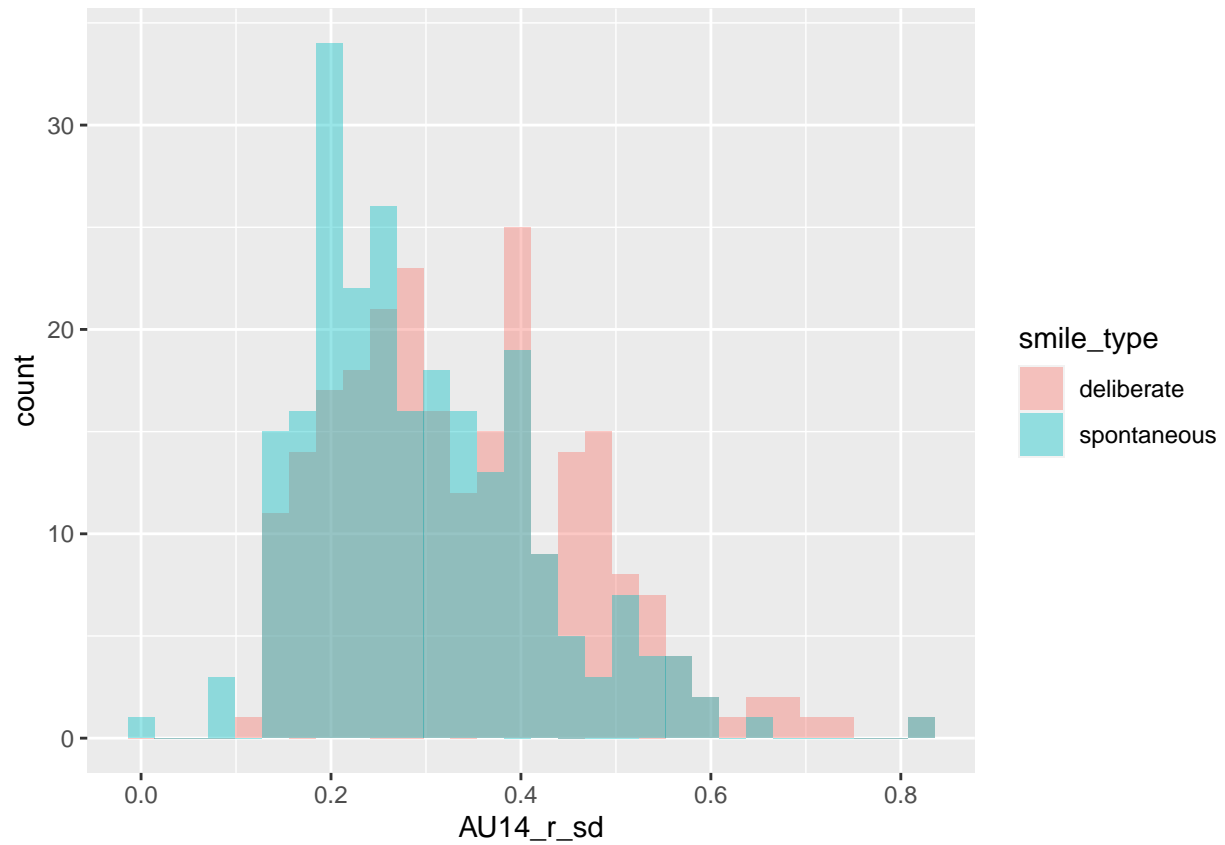
figure1 <- ggarrange(fig3, fig4, fig5,
  # labels = c("1", "2"),
  ncol = 2, nrow = 2
)
figure1
```



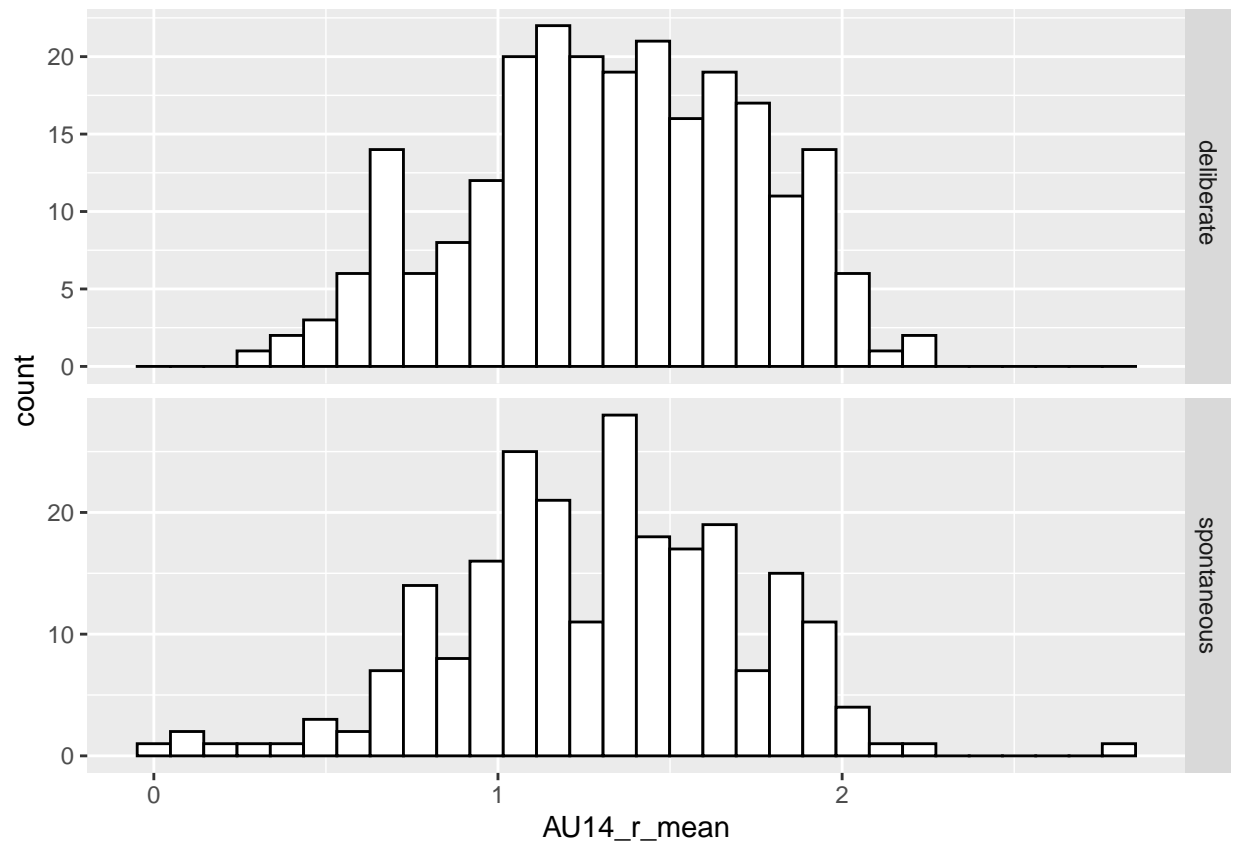
```
# AU14
ggplot(UvA_sum, aes(x = AU14_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



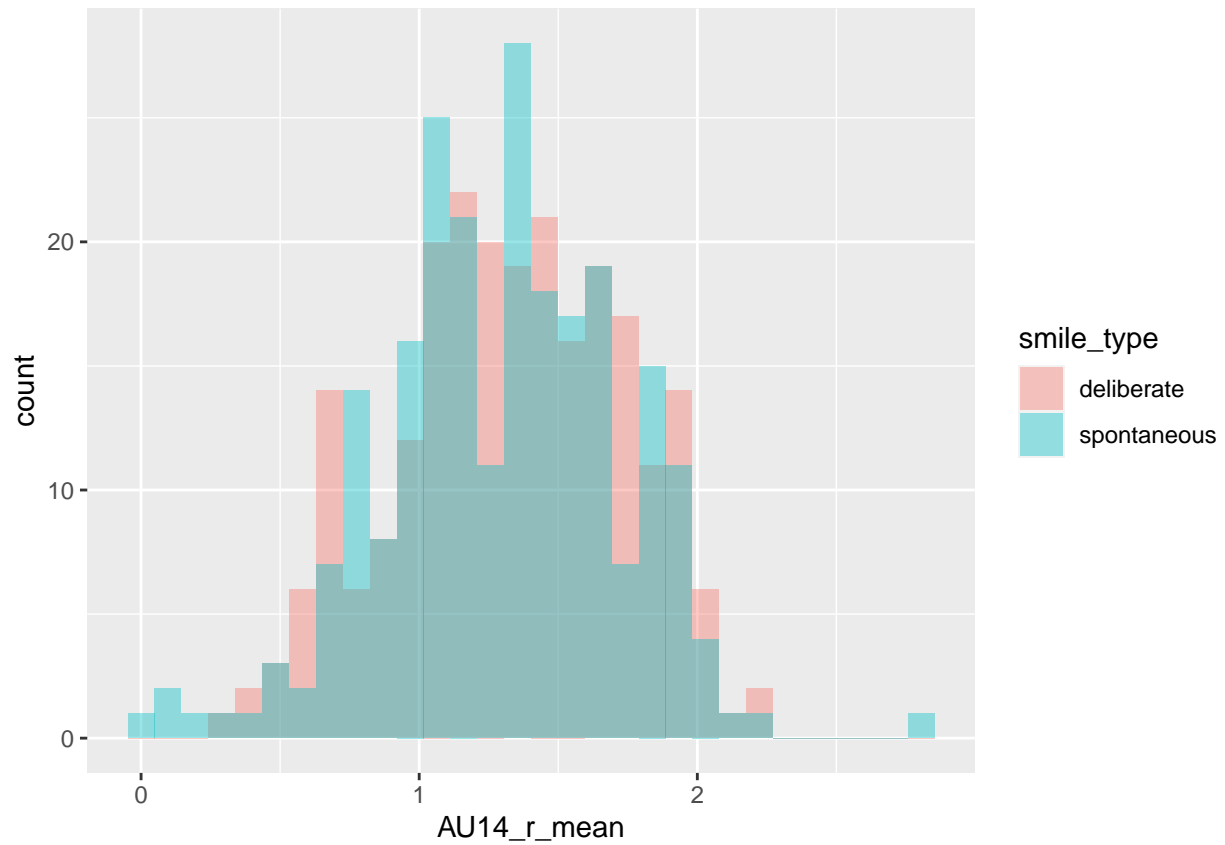
```
ggplot(UvA_sum, aes(x = AU14_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



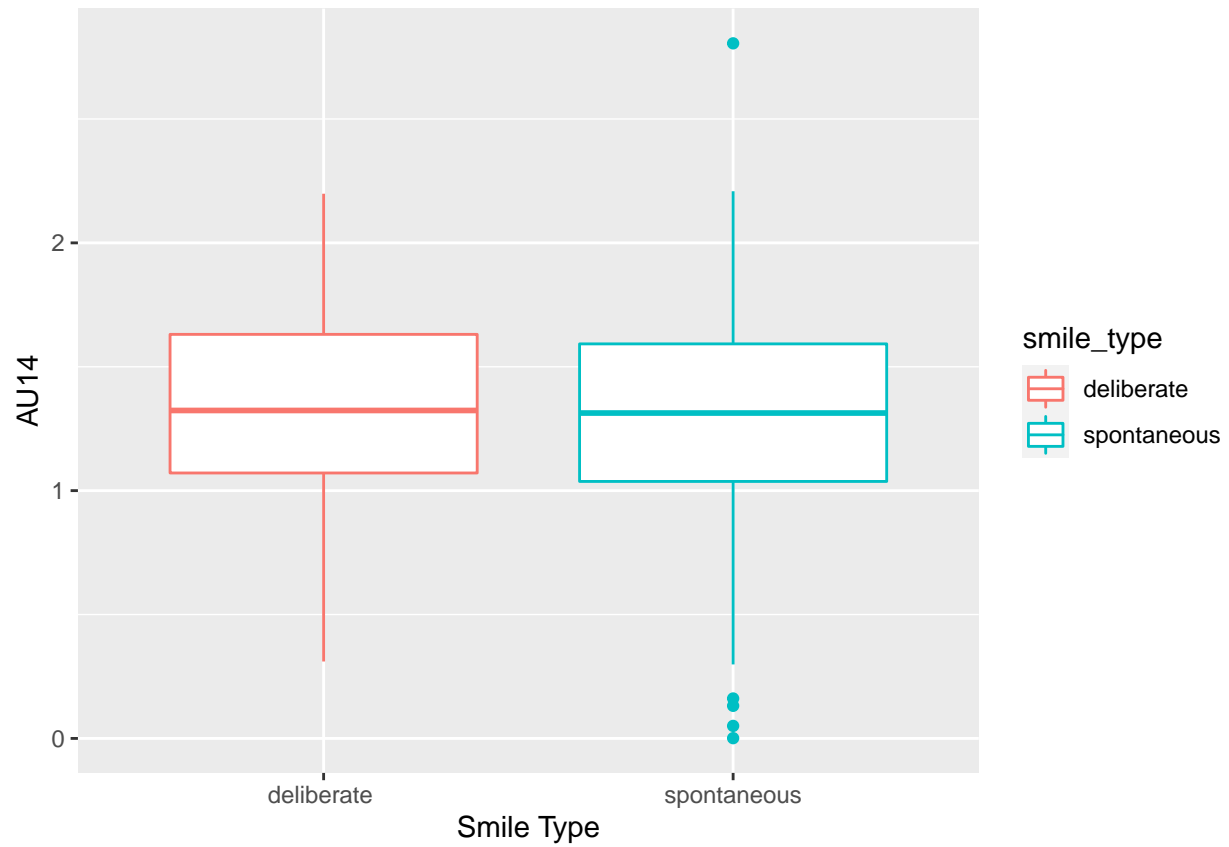
```
ggplot(UvA_sum, aes(x = AU14_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



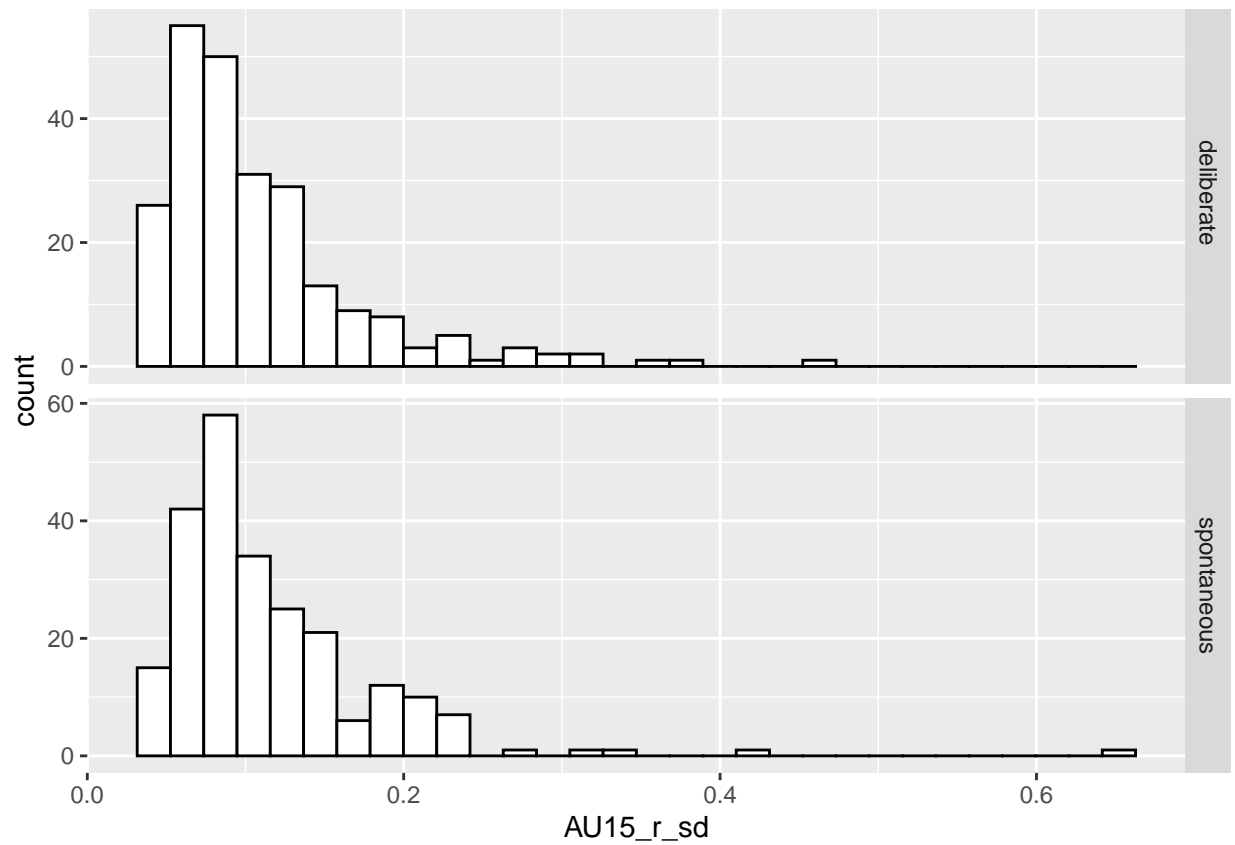
```
ggplot(UvA_sum, aes(x = AU14_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



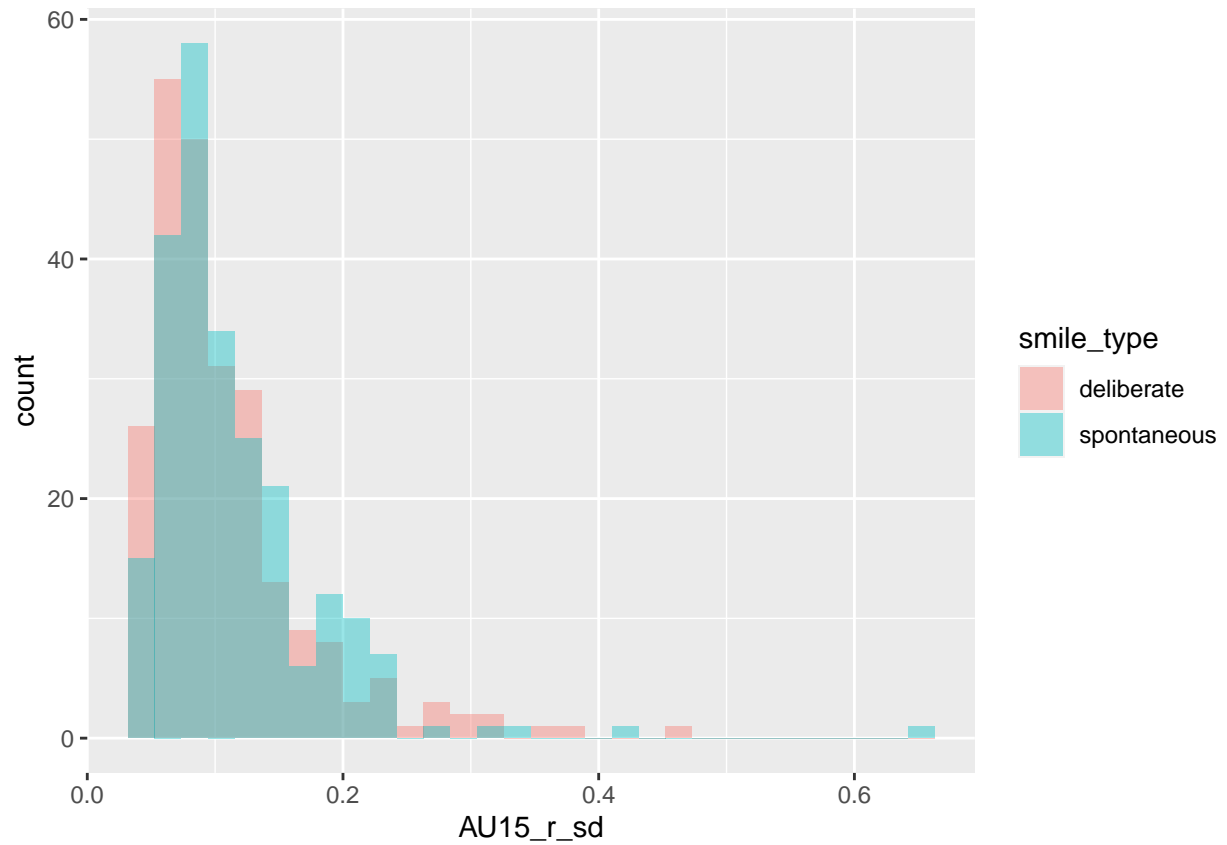
```
ggplot(UvA_sum, aes(x = smile_type, y = AU14_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU14") +
  scale_x_discrete(name = "Smile Type")
```



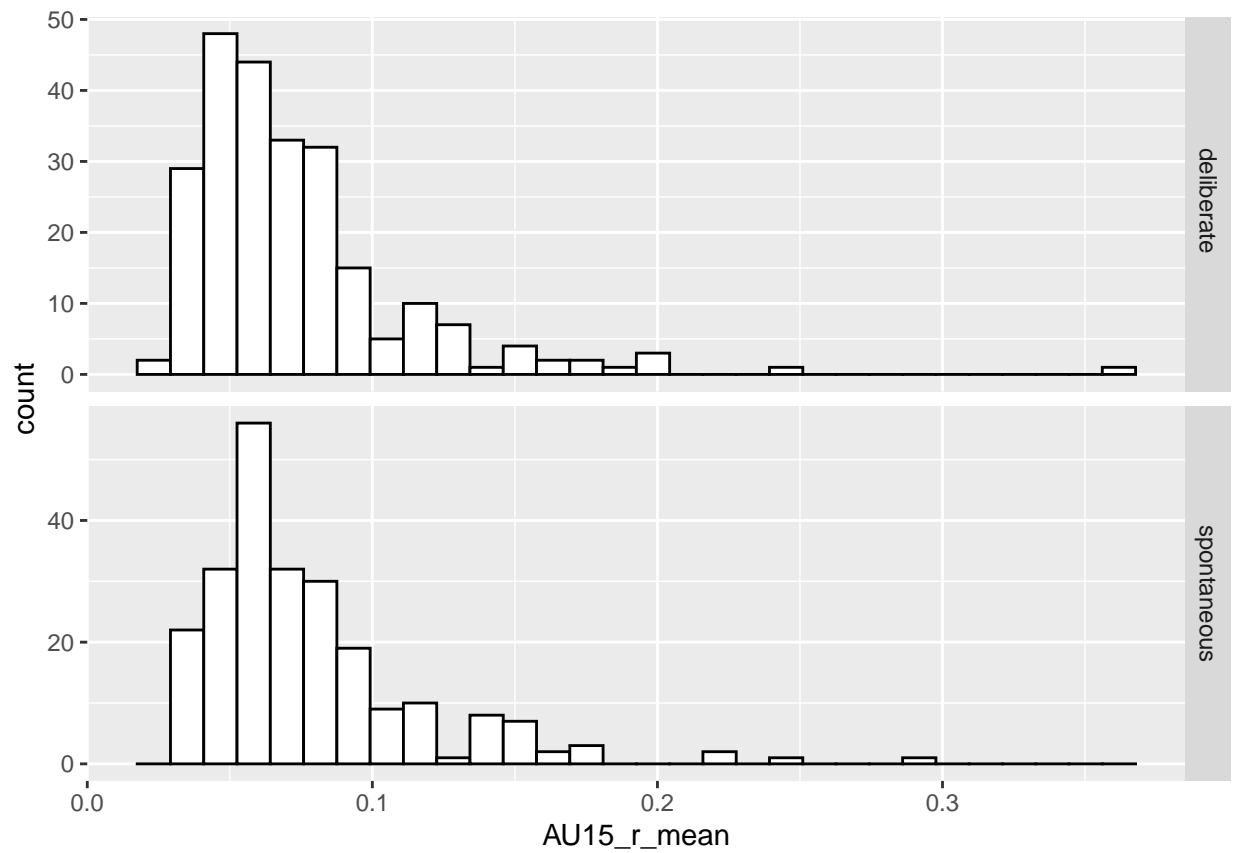
```
# AU15
ggplot(UvA_sum, aes(x = AU15_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

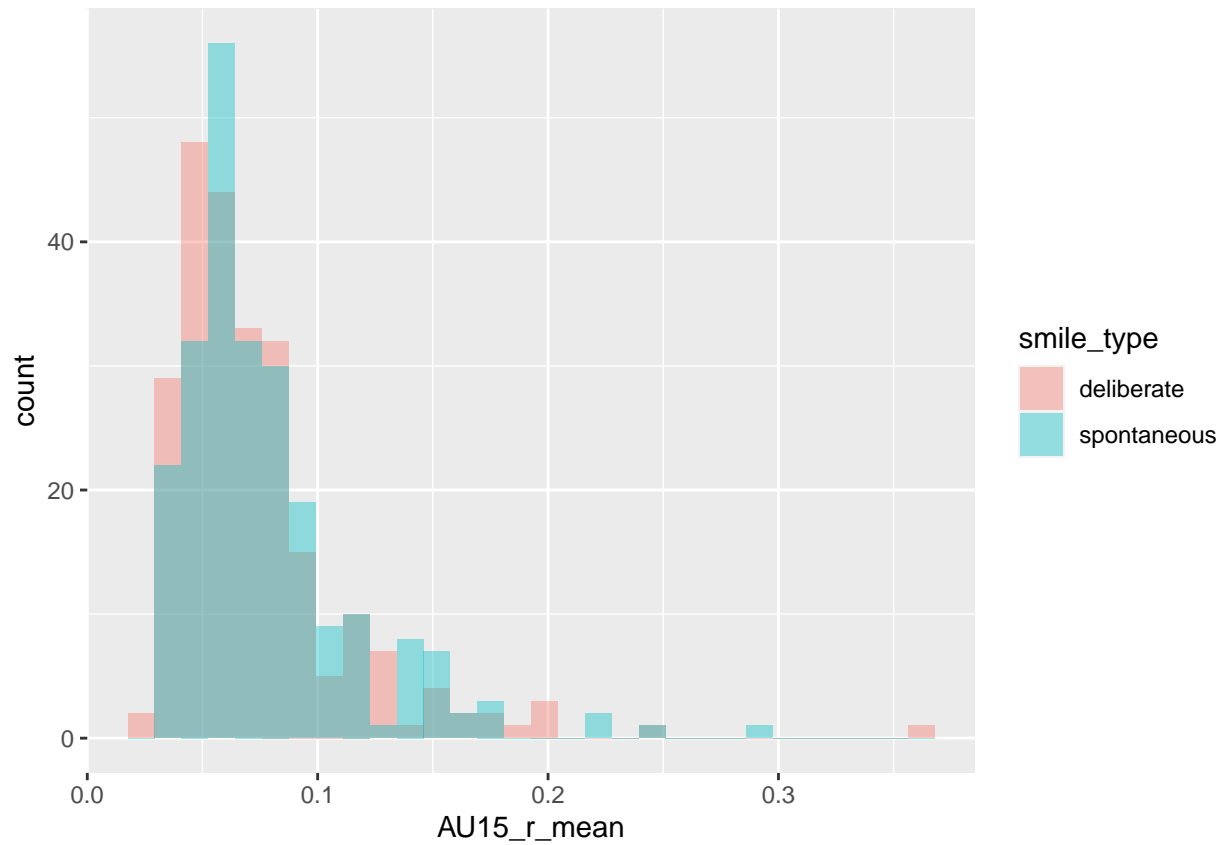
```
ggplot(UvA_sum, aes(x = AU15_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



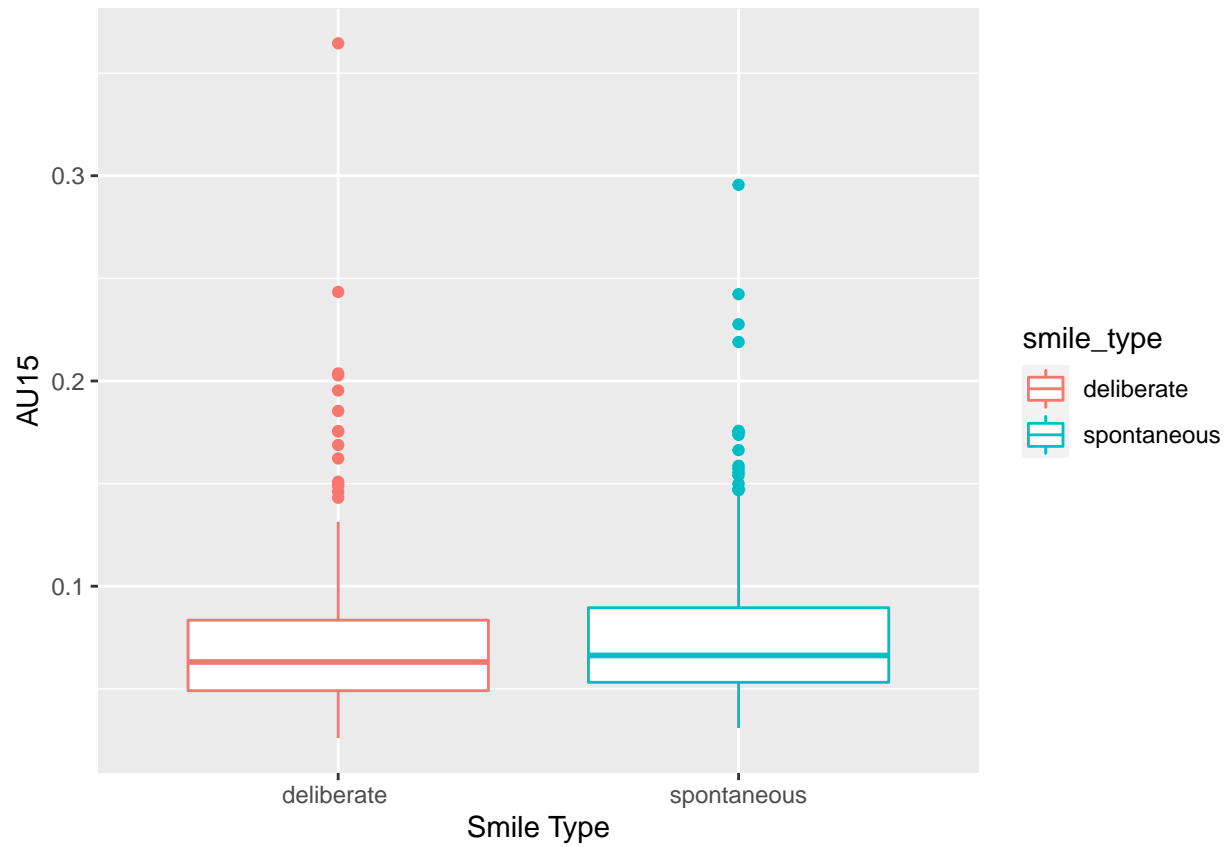
```
ggplot(UvA_sum, aes(x = AU15_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



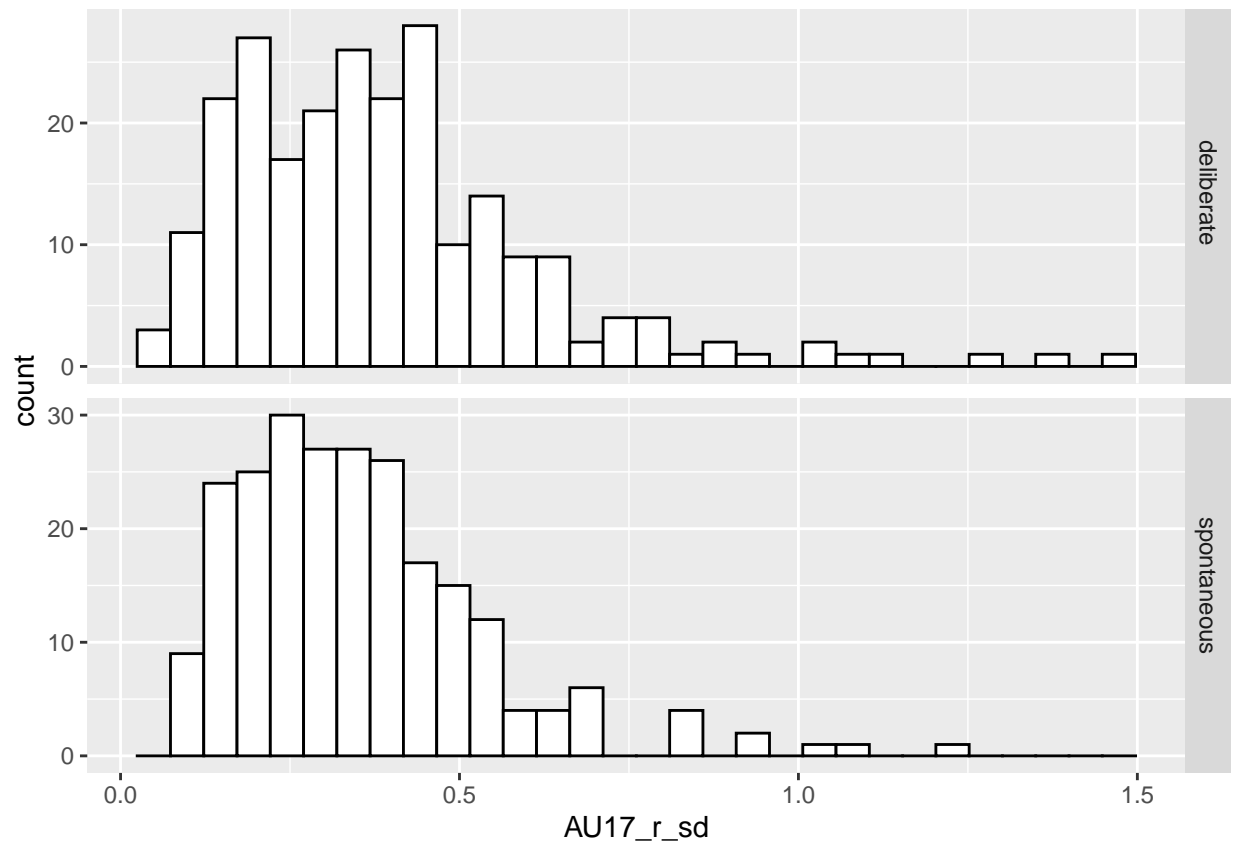
```
ggplot(UvA_sum, aes(x = AU15_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



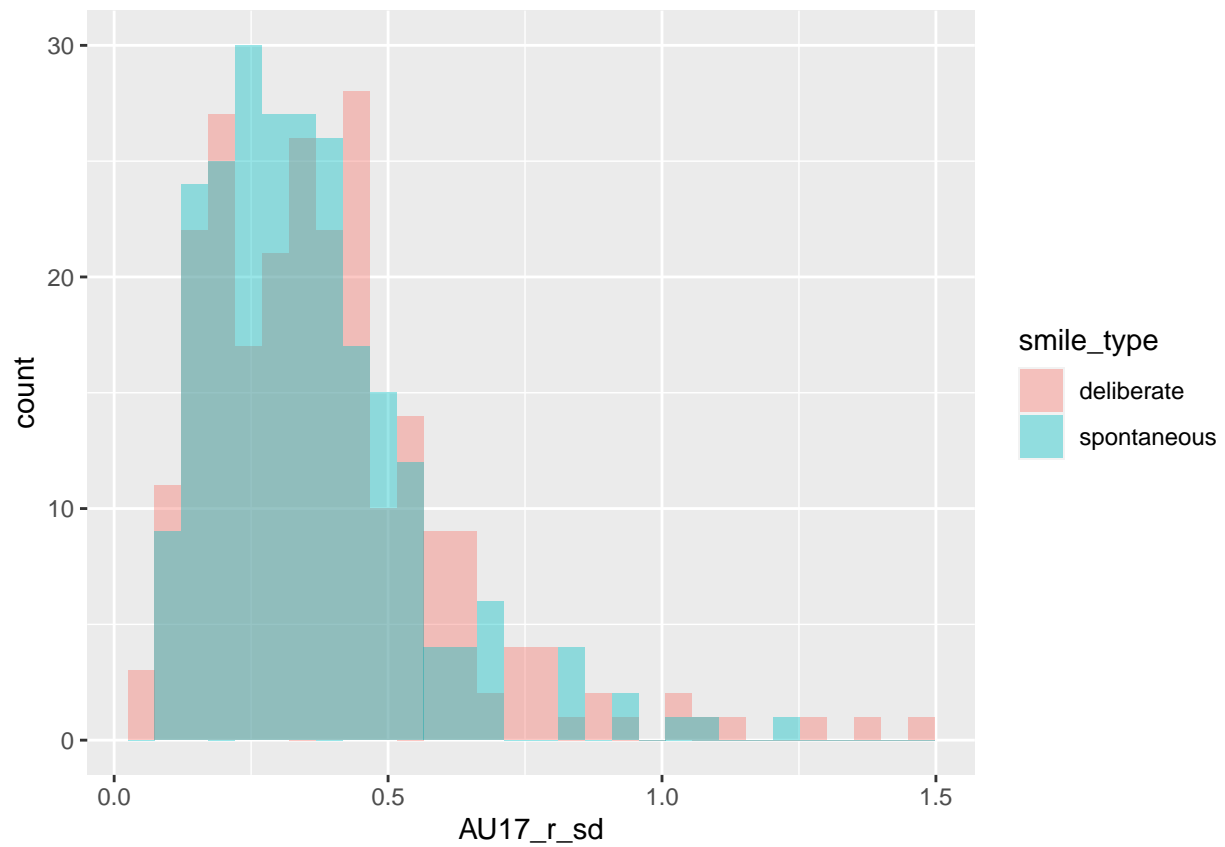
```
ggplot(UvA_sum, aes(x = smile_type, y = AU15_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU15") +
  scale_x_discrete(name = "Smile Type")
```



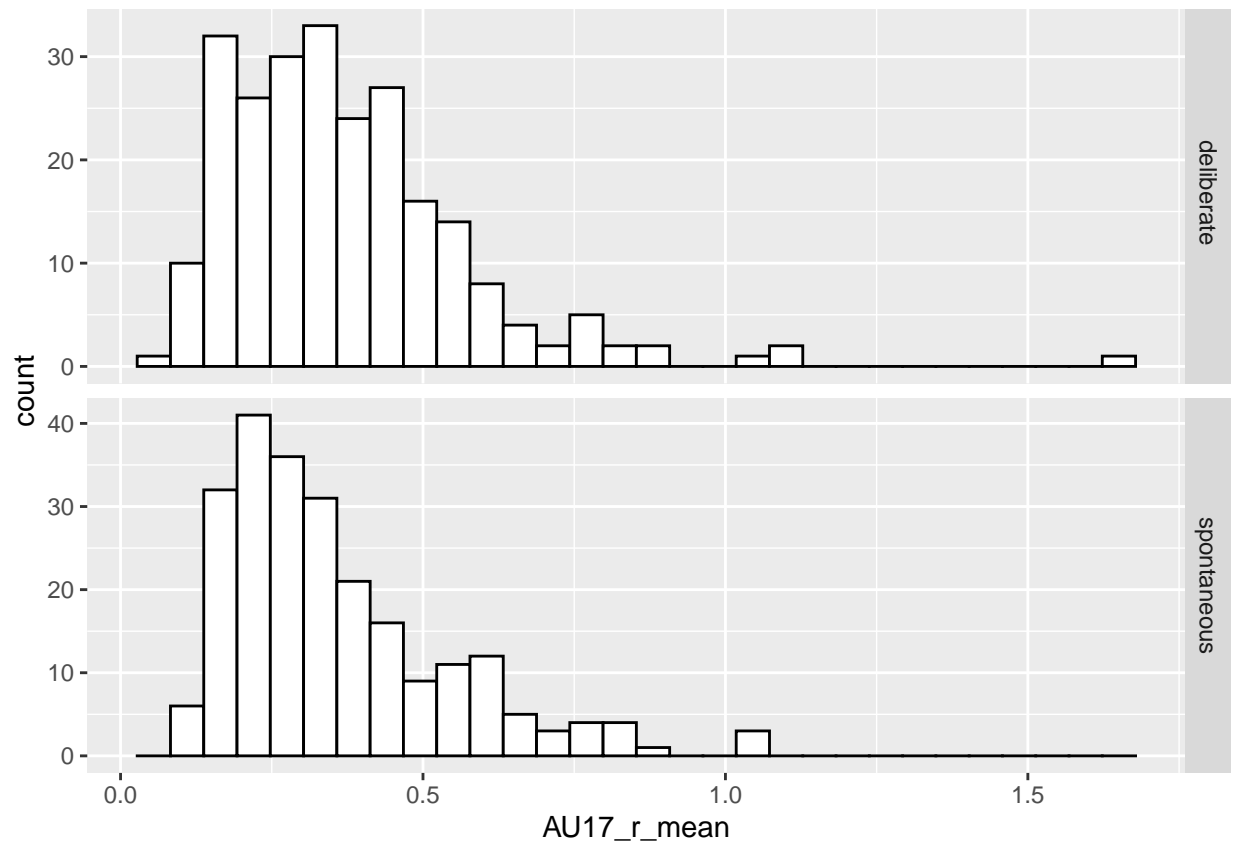
```
# AU17
ggplot(UvA_sum, aes(x = AU17_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



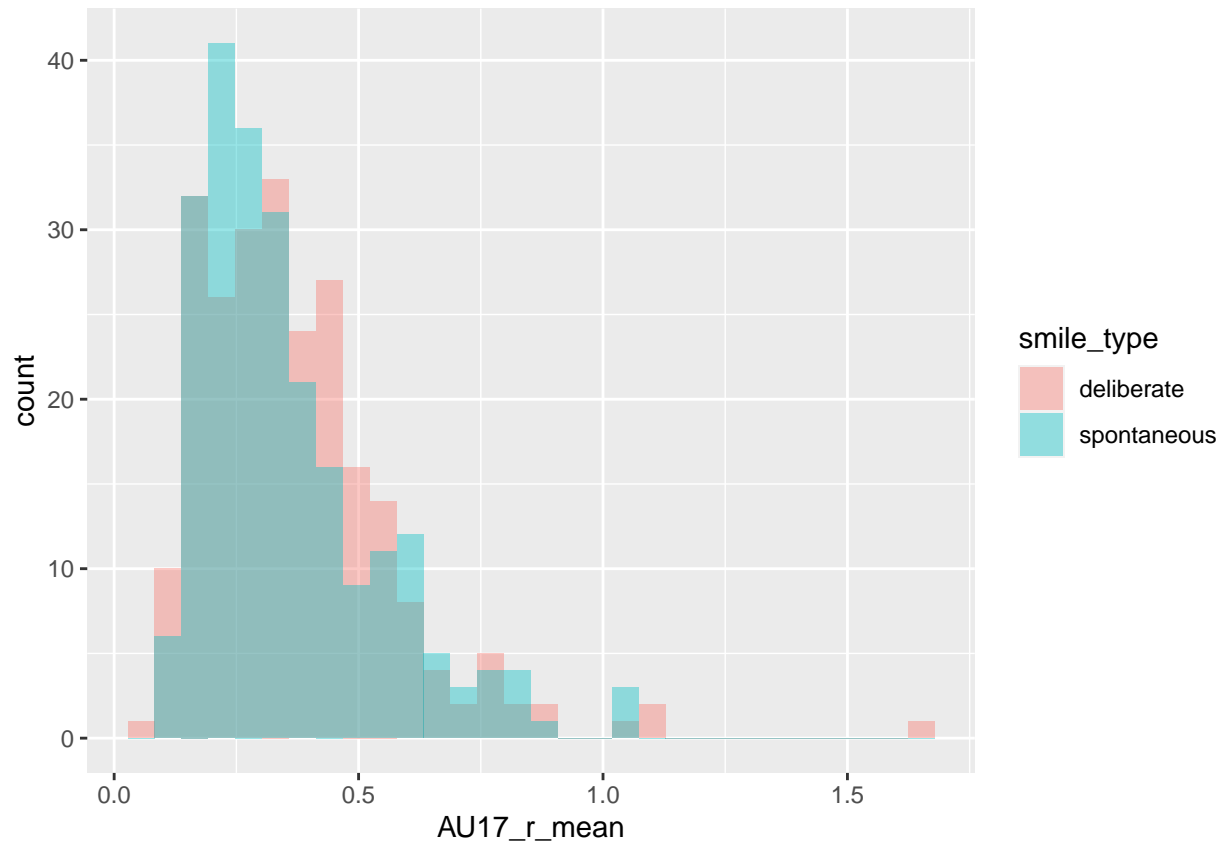
```
ggplot(UvA_sum, aes(x = AU17_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



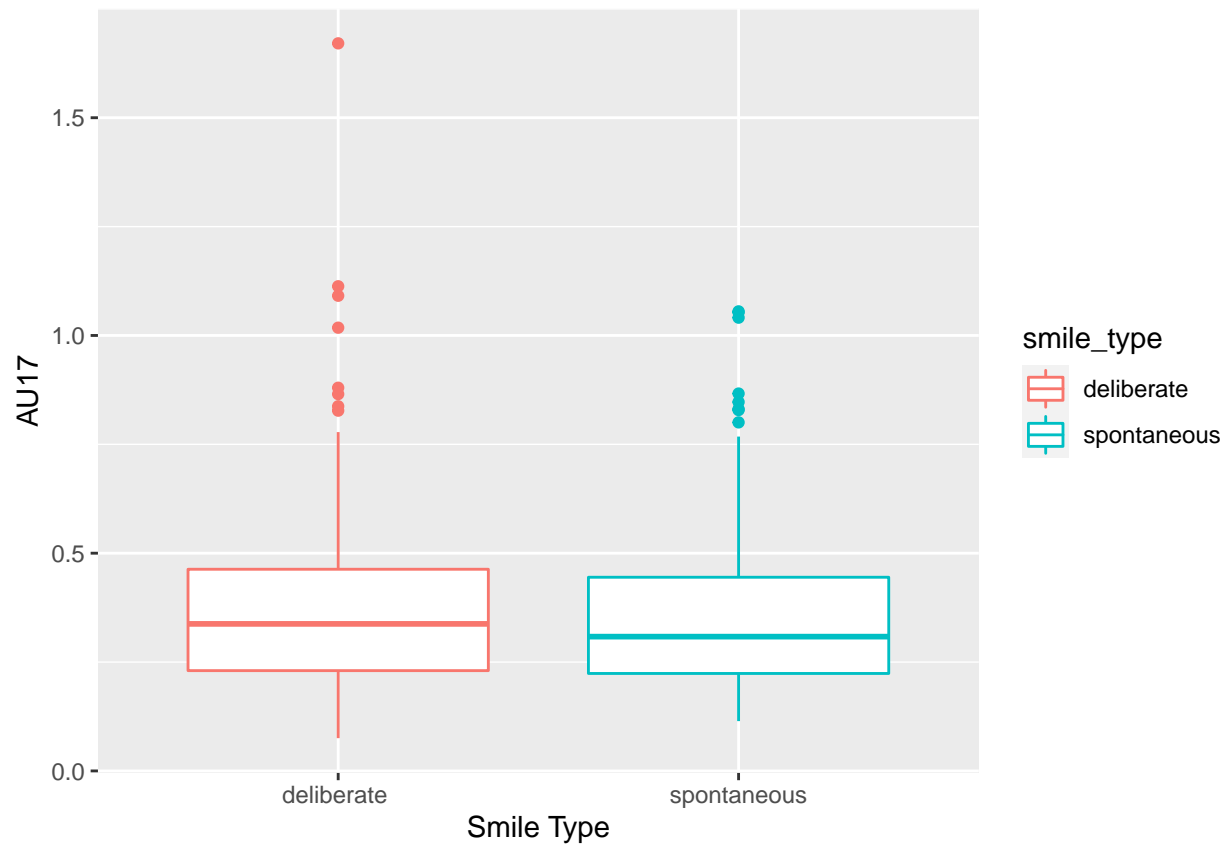
```
ggplot(UvA_sum, aes(x = AU17_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



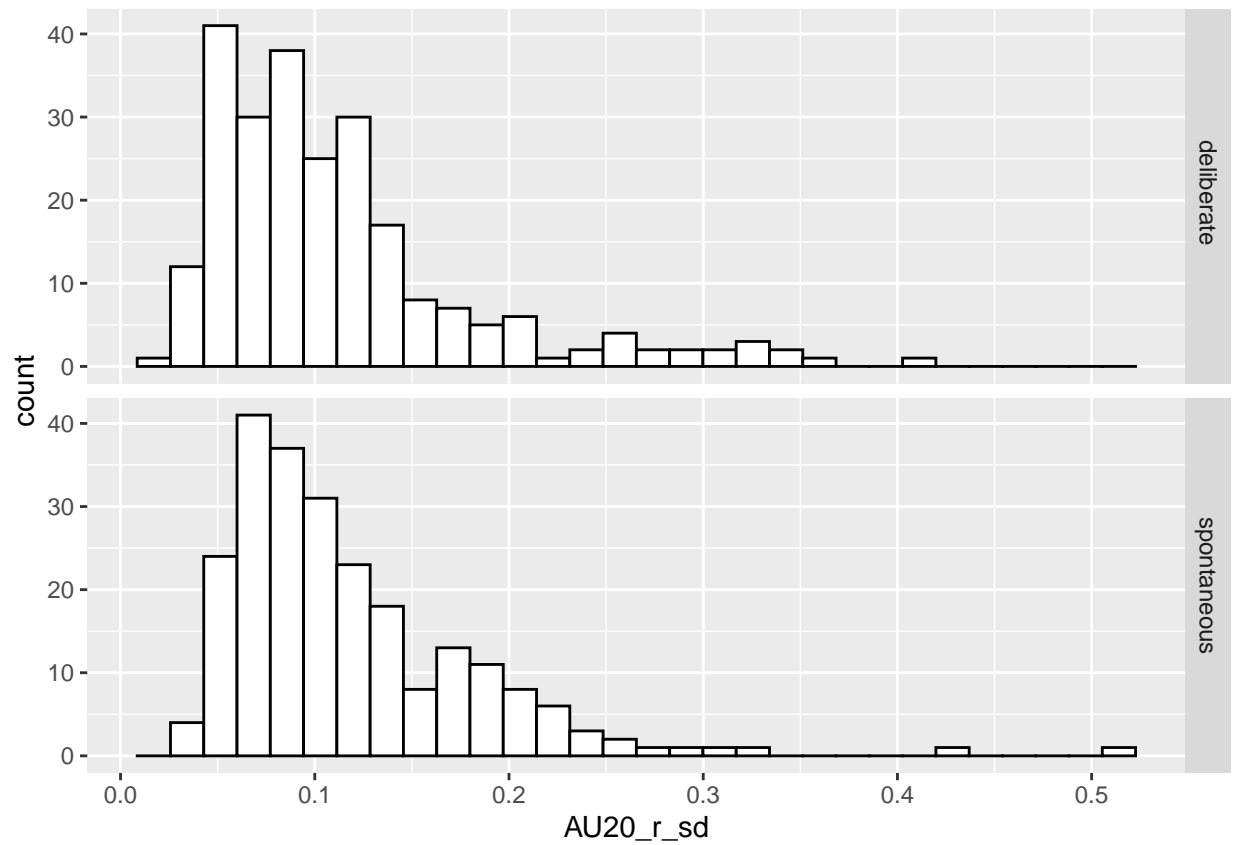
```
ggplot(UvA_sum, aes(x = AU17_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```

```
ggplot(UvA_sum, aes(x = smile_type, y = AU17_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU17") +  
  scale_x_discrete(name = "Smile Type")
```



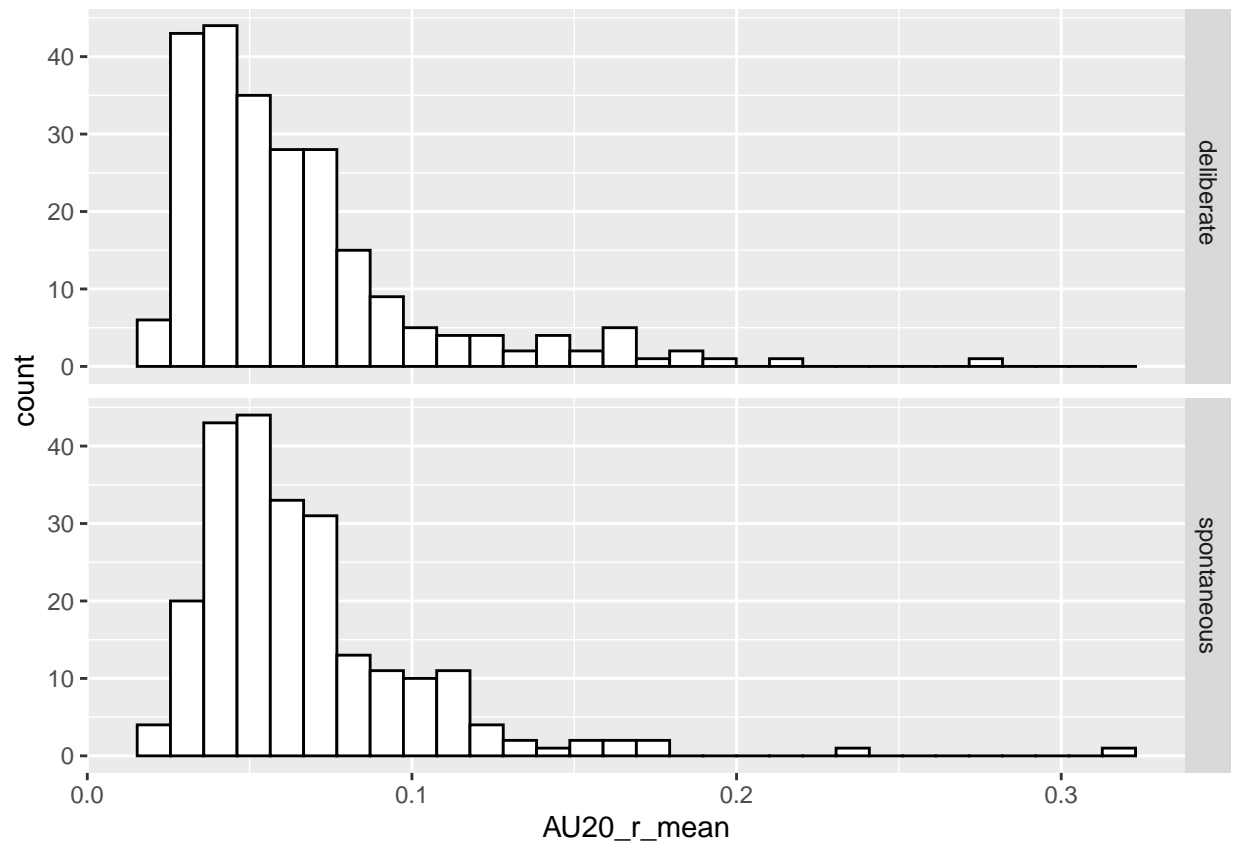
```
# AU20
ggplot(UvA_sum, aes(x = AU20_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



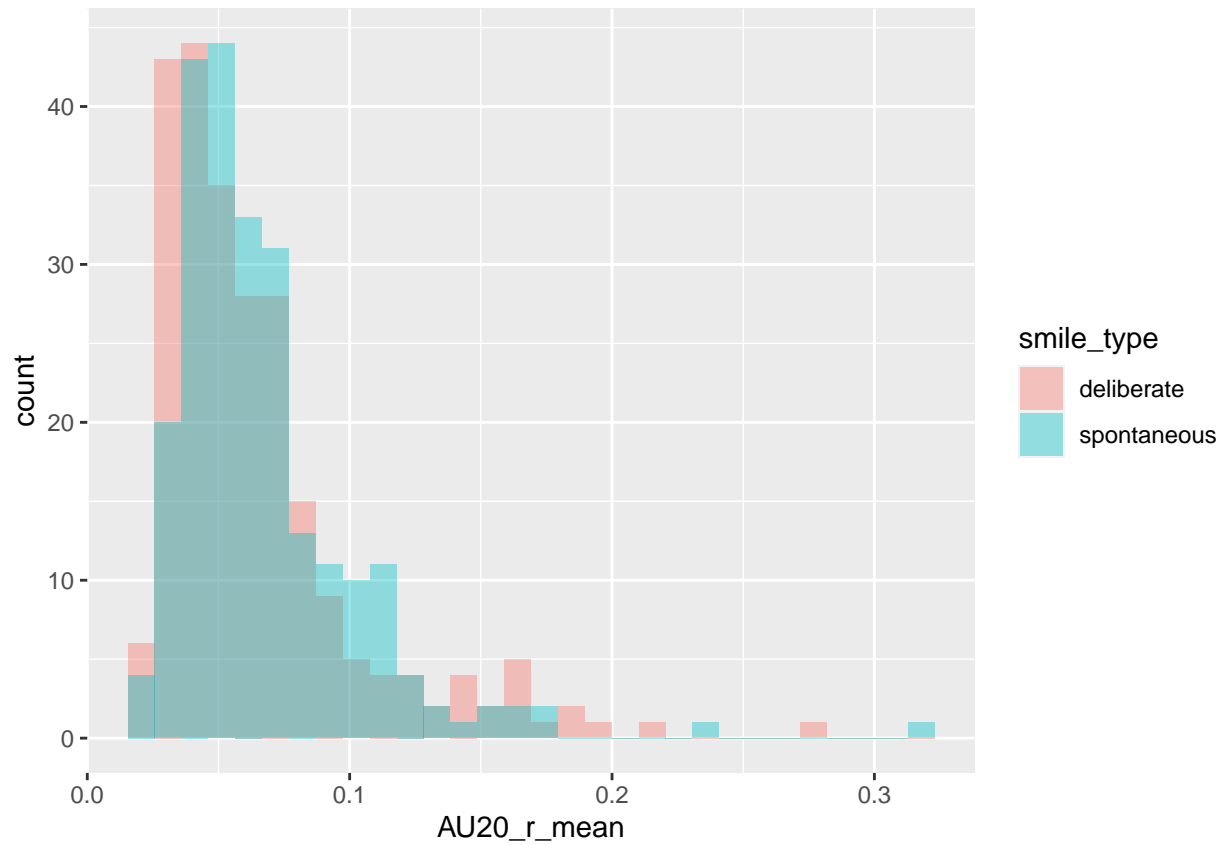
```
ggplot(UvA_sum, aes(x = AU20_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



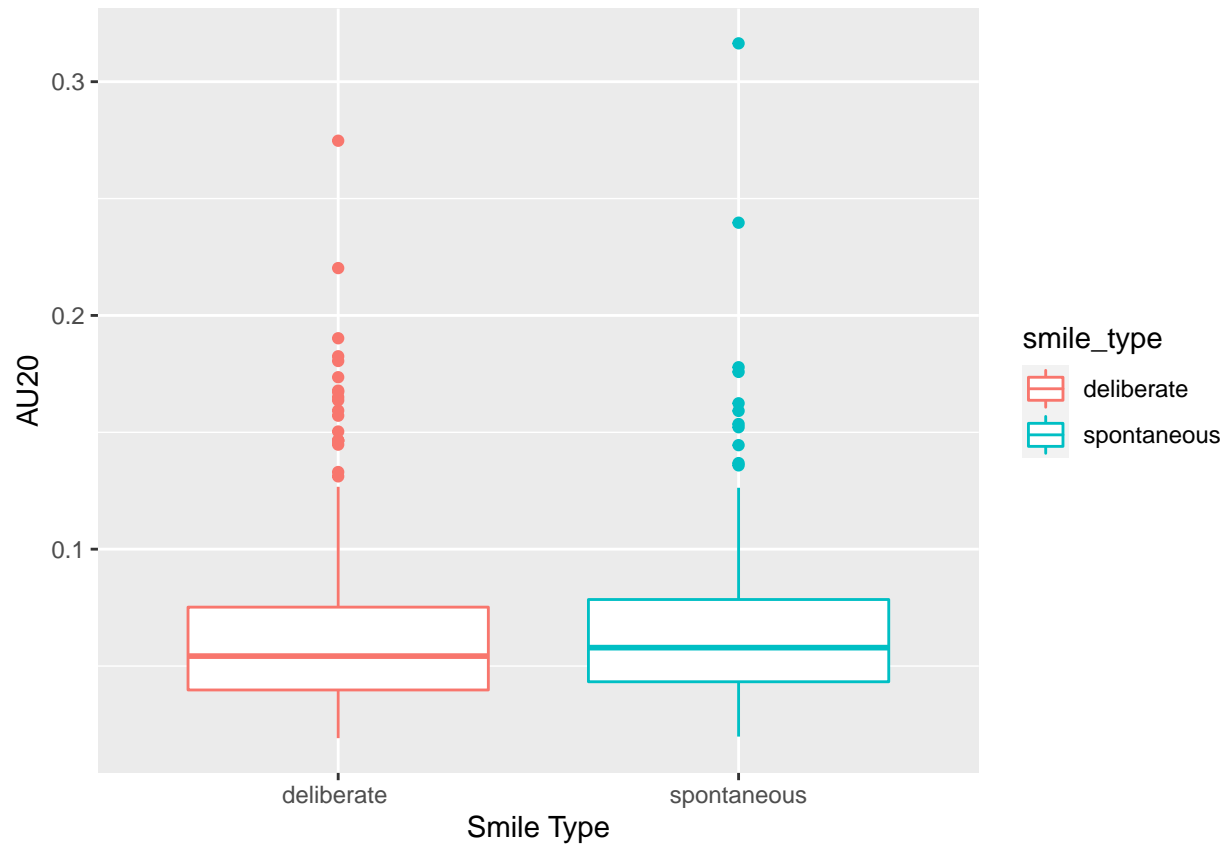
```
ggplot(UvA_sum, aes(x = AU20_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



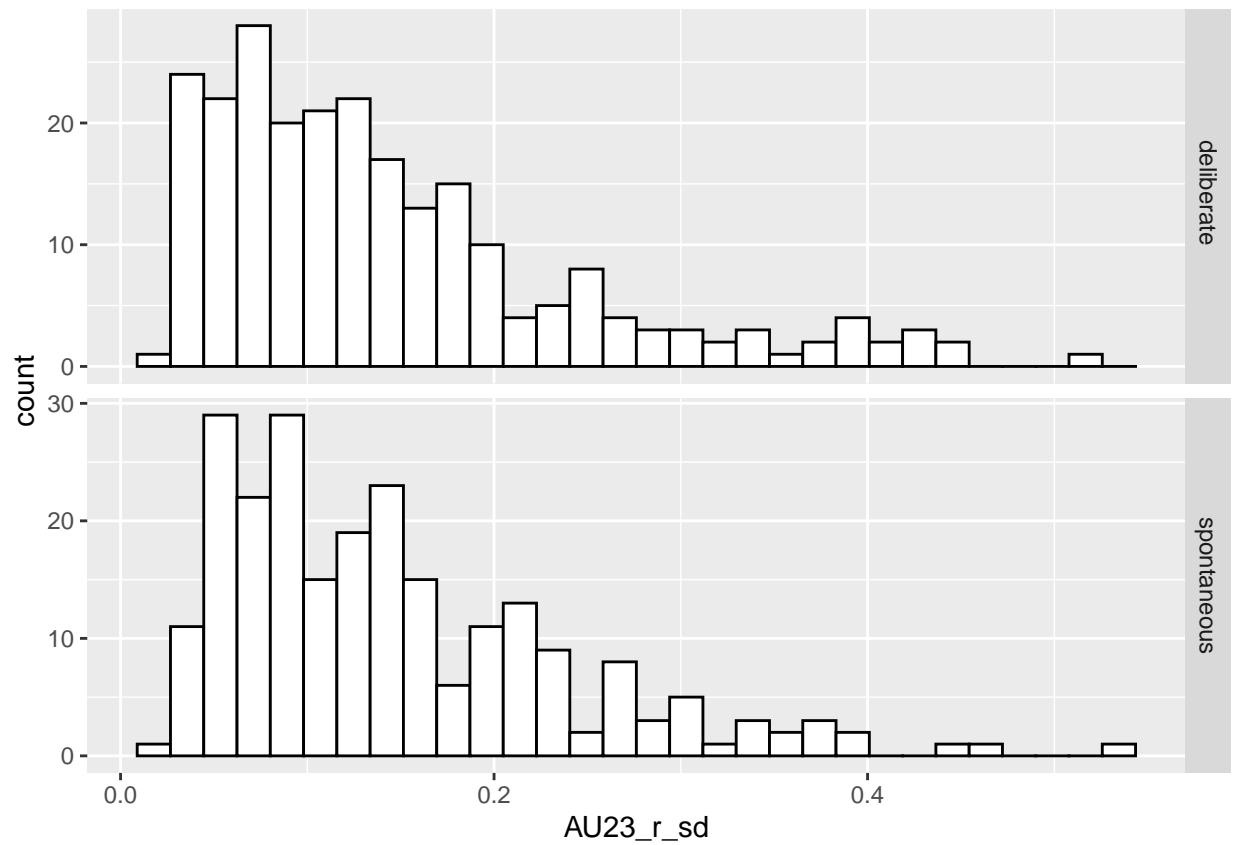
```
ggplot(UvA_sum, aes(x = AU20_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



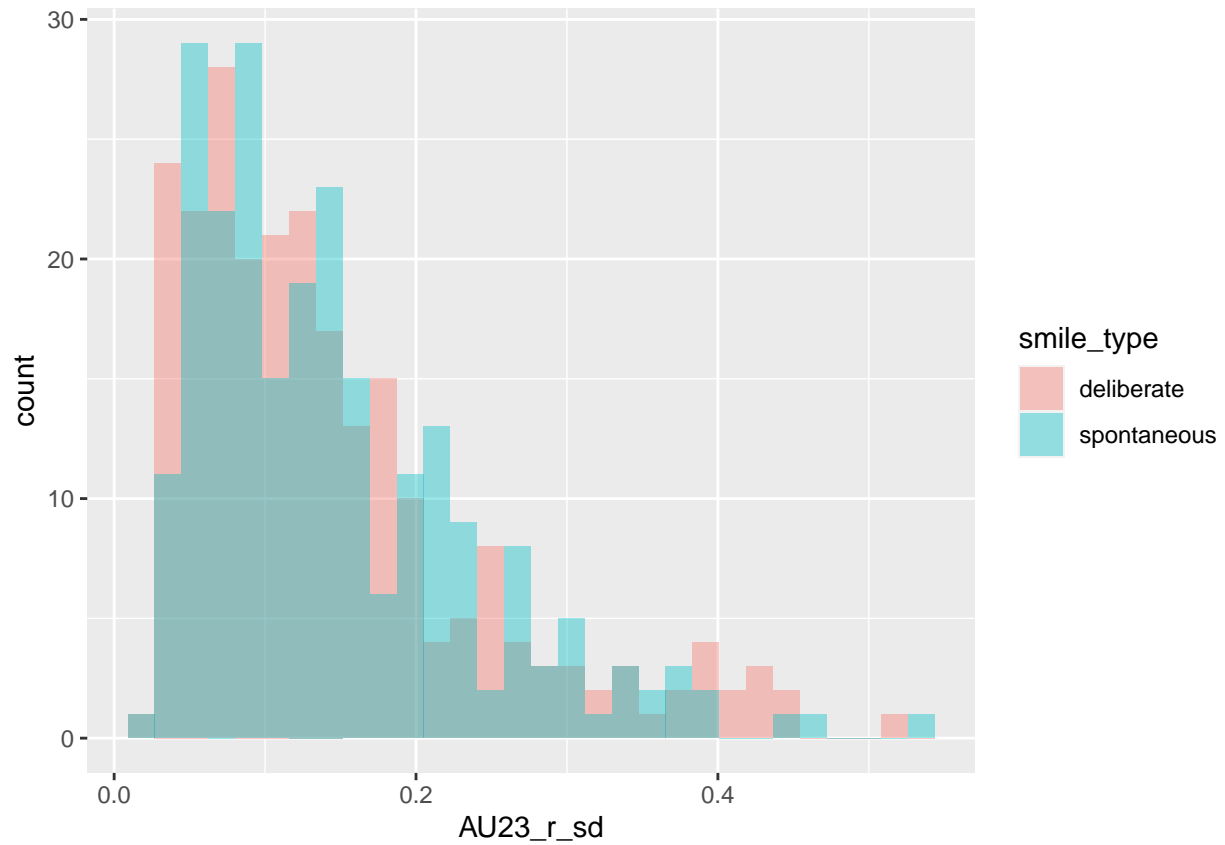
```
ggplot(UvA_sum, aes(x = smile_type, y = AU20_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU20") +  
  scale_x_discrete(name = "Smile Type")
```



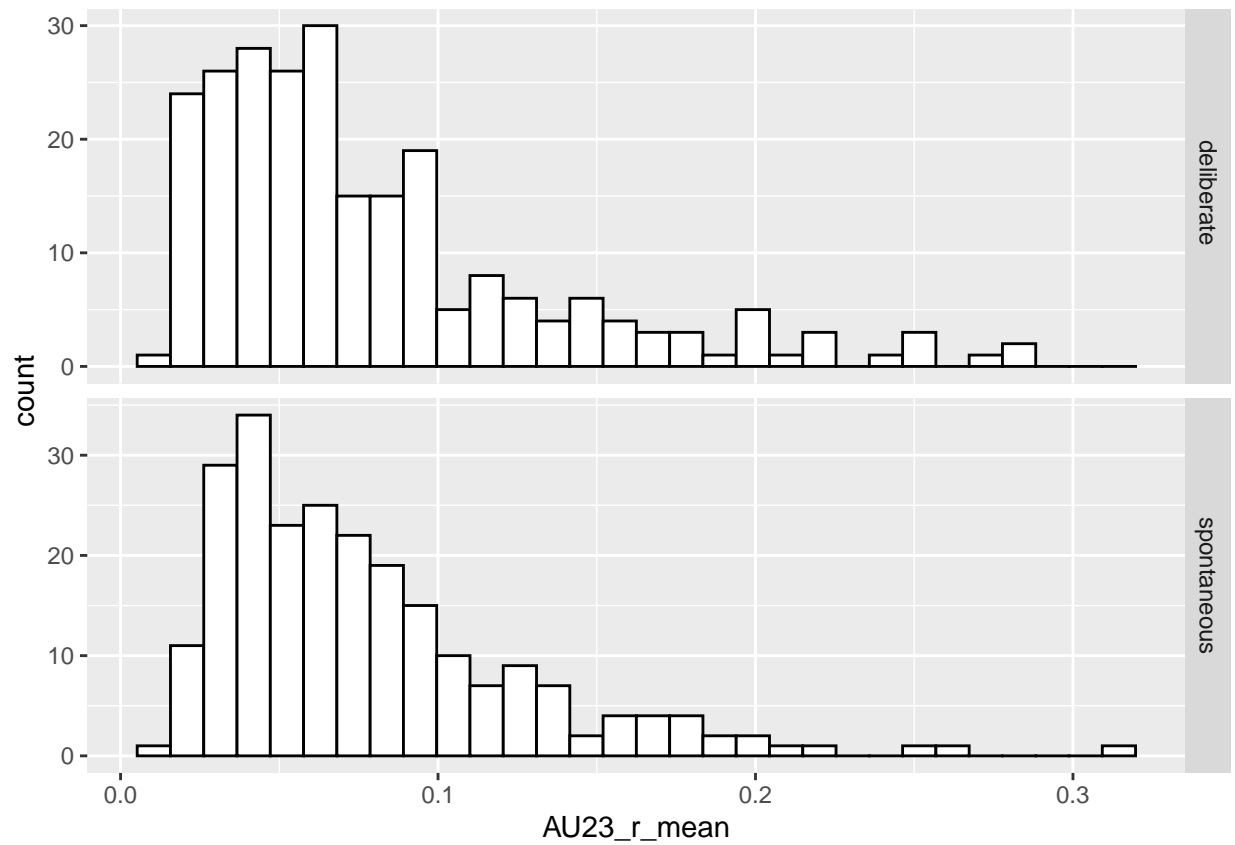
```
# AU23
ggplot(UvA_sum, aes(x = AU23_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



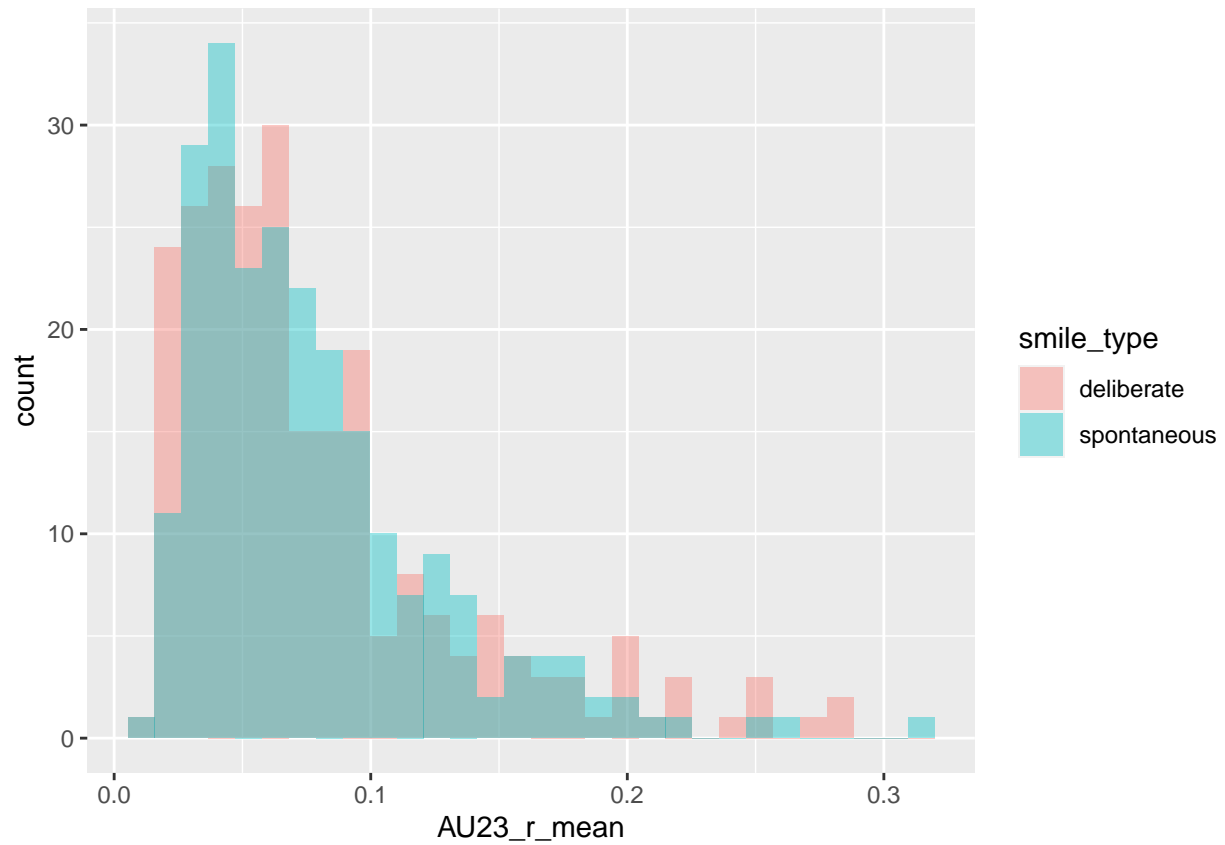
```
ggplot(UvA_sum, aes(x = AU23_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```

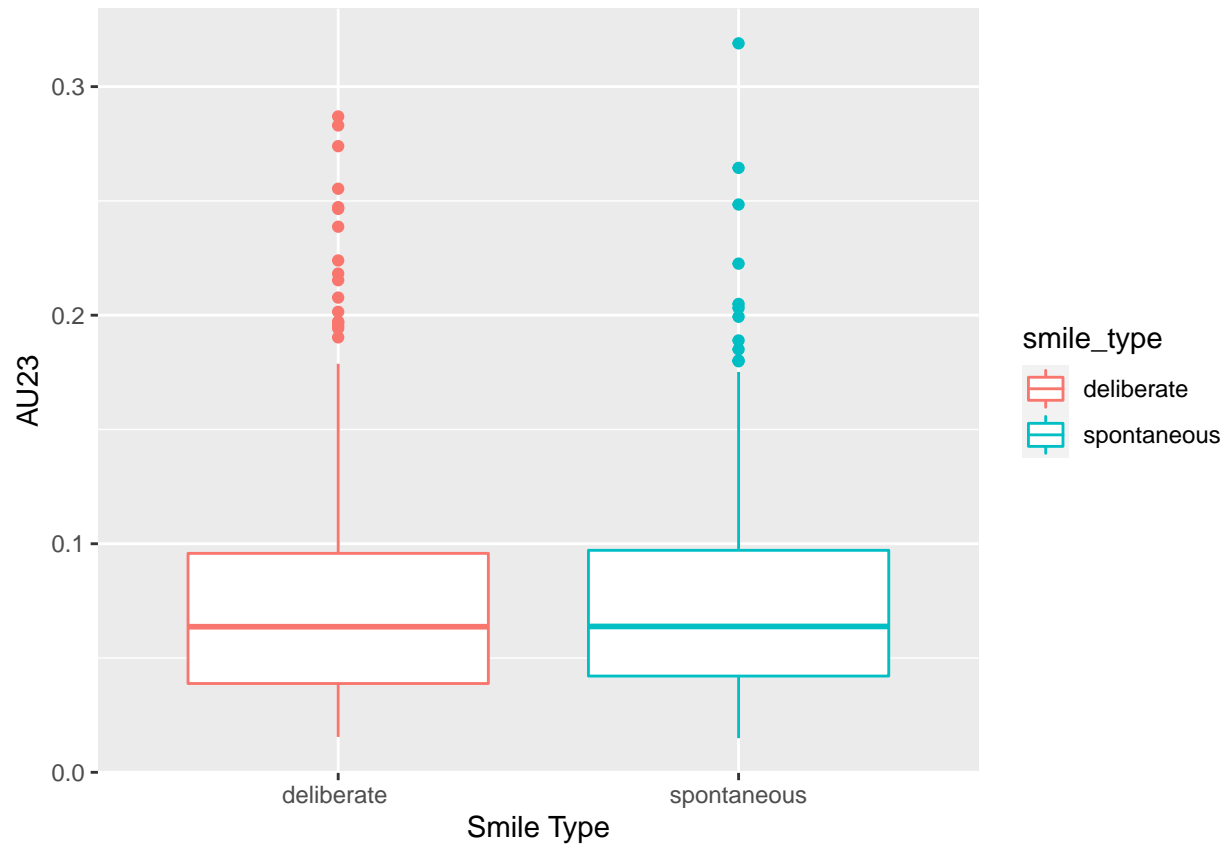
```
ggplot(UvA_sum, aes(x = AU23_r_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



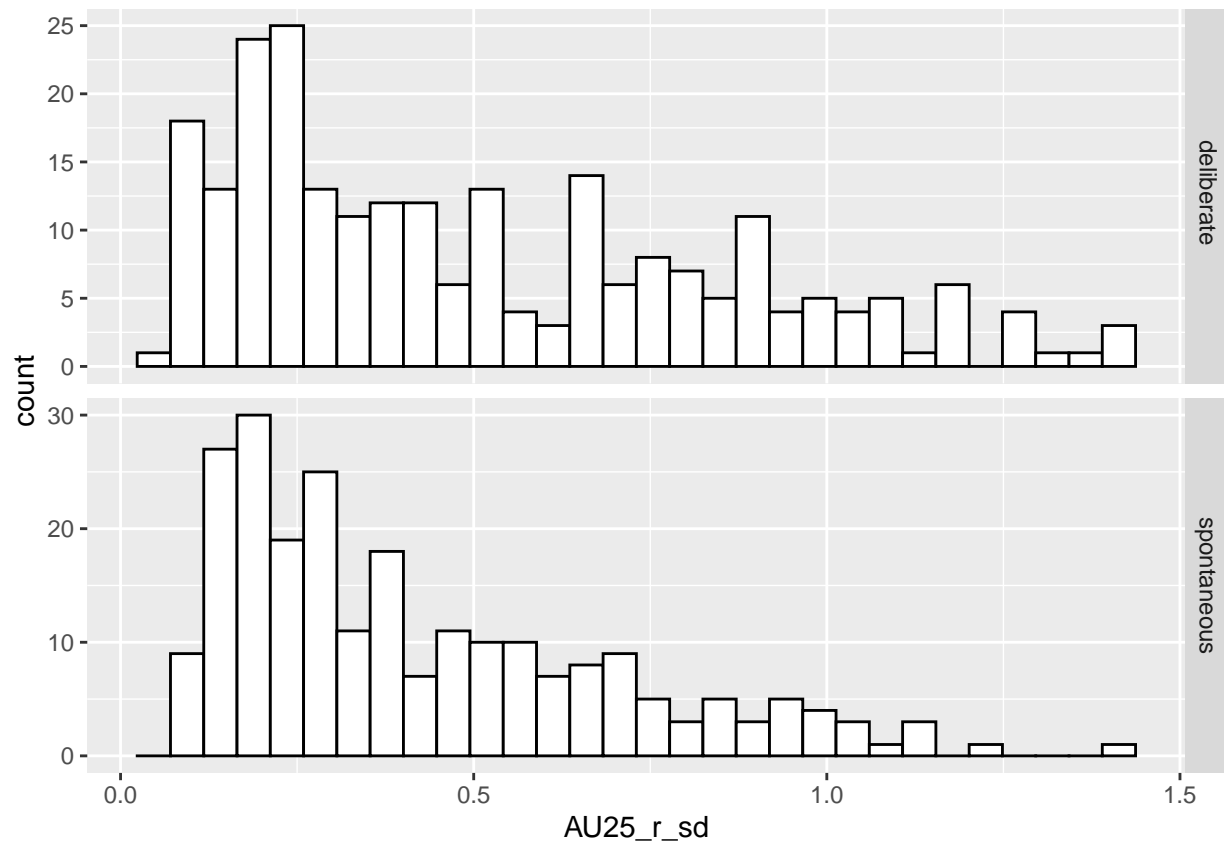
```
ggplot(UvA_sum, aes(x = AU23_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



```
ggplot(UvA_sum, aes(x = smile_type, y = AU23_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU23") +
  scale_x_discrete(name = "Smile Type")
```

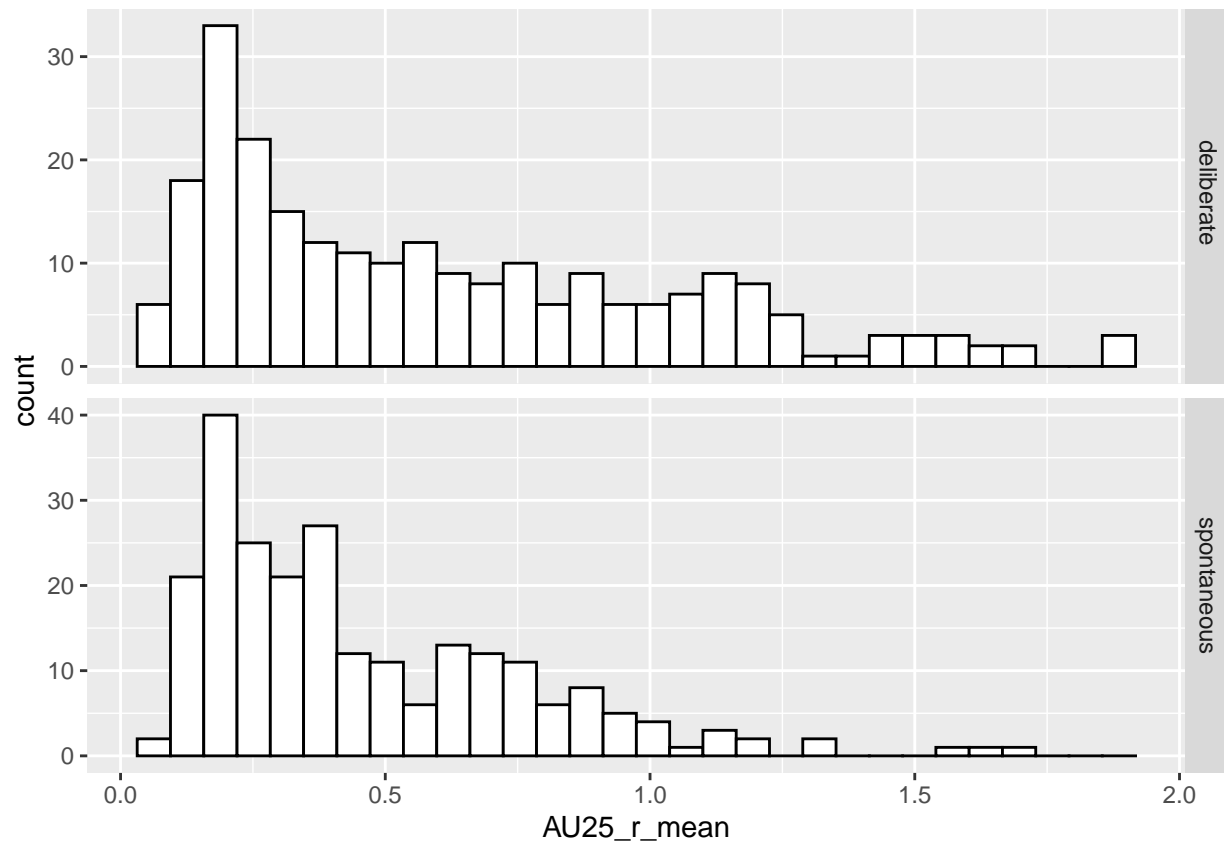


```
# AU25
ggplot(UvA_sum, aes(x = AU25_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



```
fig8 <- ggplot(UvA_sum, aes(x = AU25_r_sd, fill = smile_type)) +
  geom_histogram(position = "identity", alpha = 0.4)

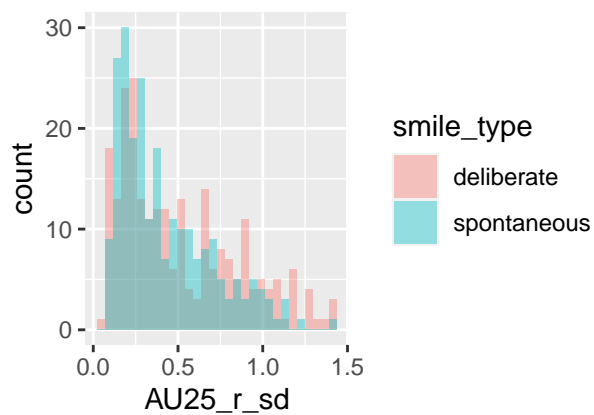
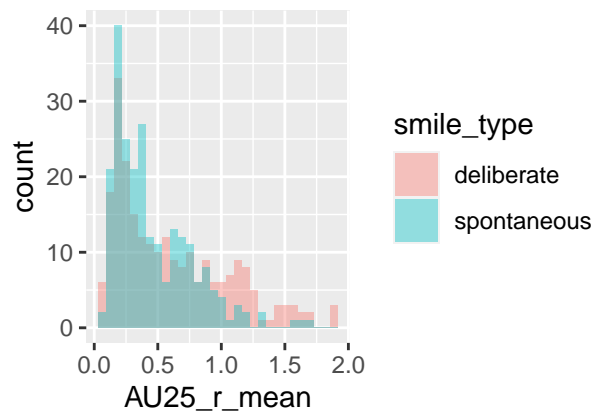
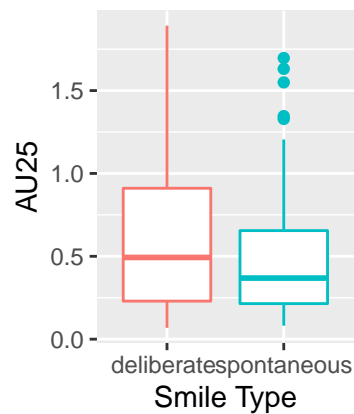
ggplot(UvA_sum, aes(x = AU25_r_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



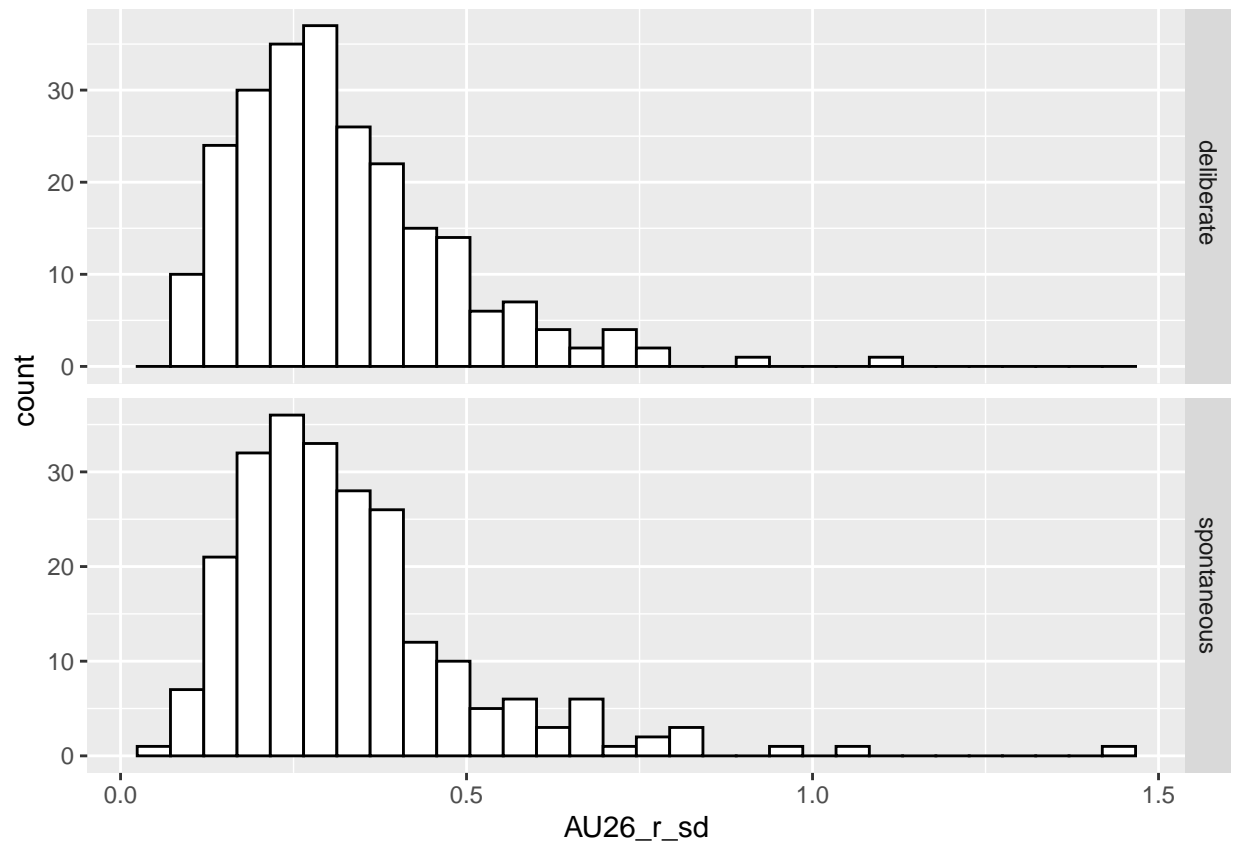
```
fig7 <- ggplot(UvA_sum, aes(x = AU25_r_mean, fill = smile_type)) +
  geom_histogram(position = "identity", alpha = 0.4)

fig6 <- ggplot(
  UvA_sum,
  aes(x = smile_type, y = AU25_r_mean, color = smile_type)
) +
  geom_boxplot() +
  scale_y_continuous(name = "AU25") +
  scale_x_discrete(name = "Smile Type")

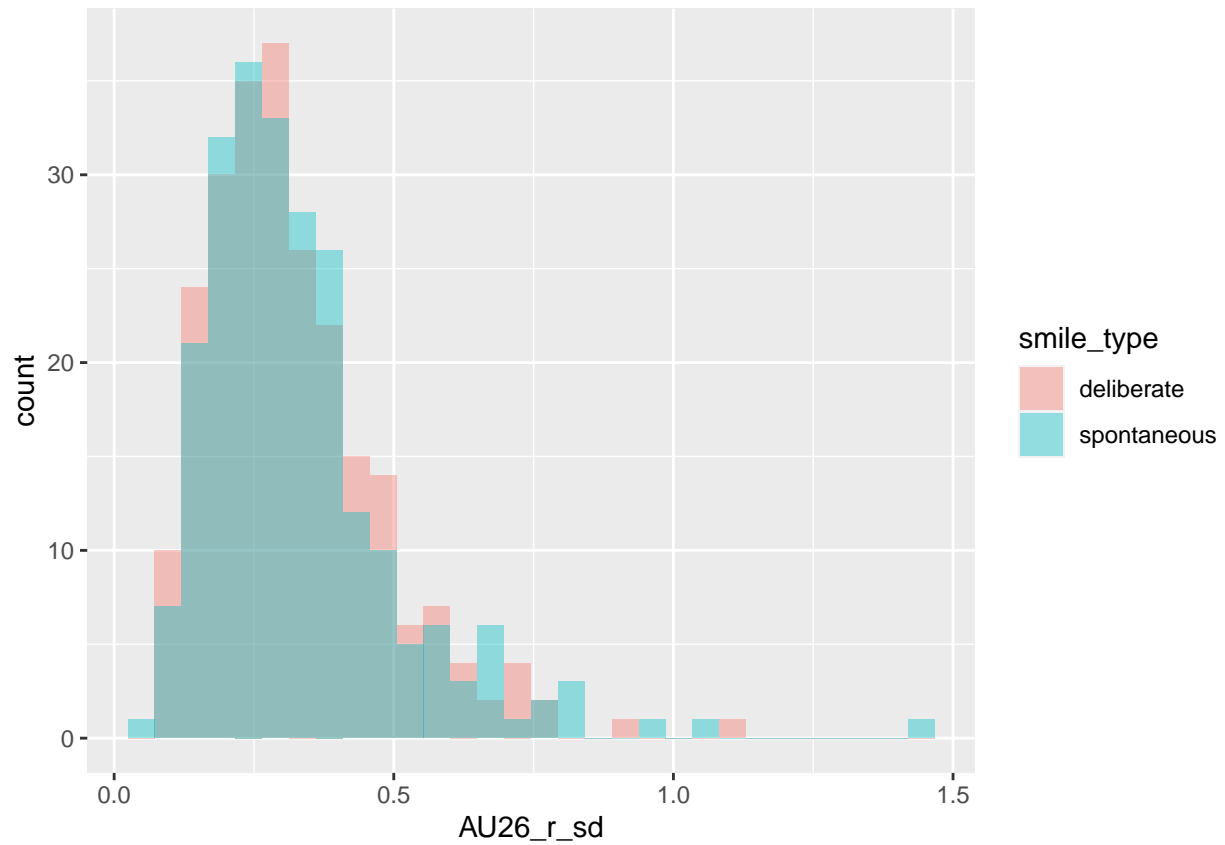
figure2 <- ggarrange(fig6, fig7, fig8,
  # labels = c("1", "2"),
  ncol = 2, nrow = 2
)
figure2
```



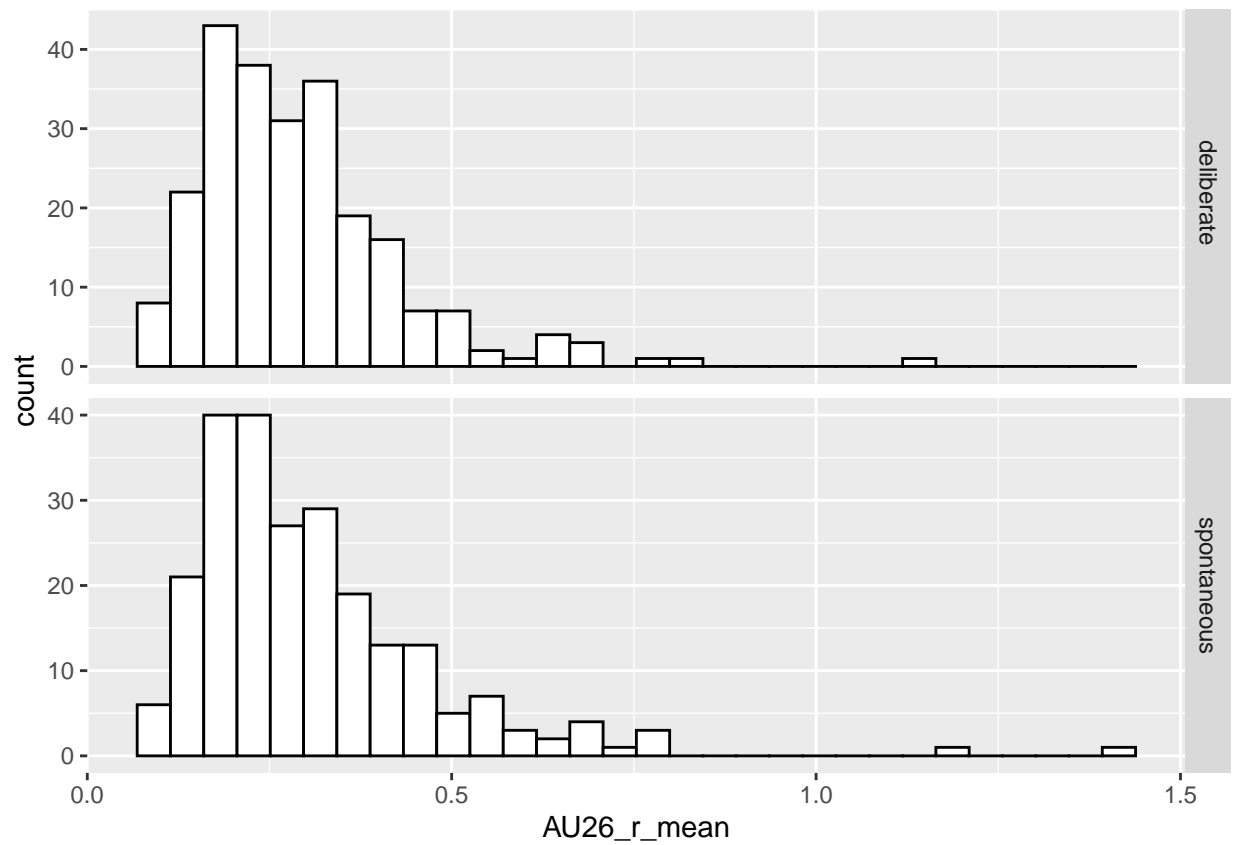
```
# AU26
ggplot(UvA_sum, aes(x = AU26_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



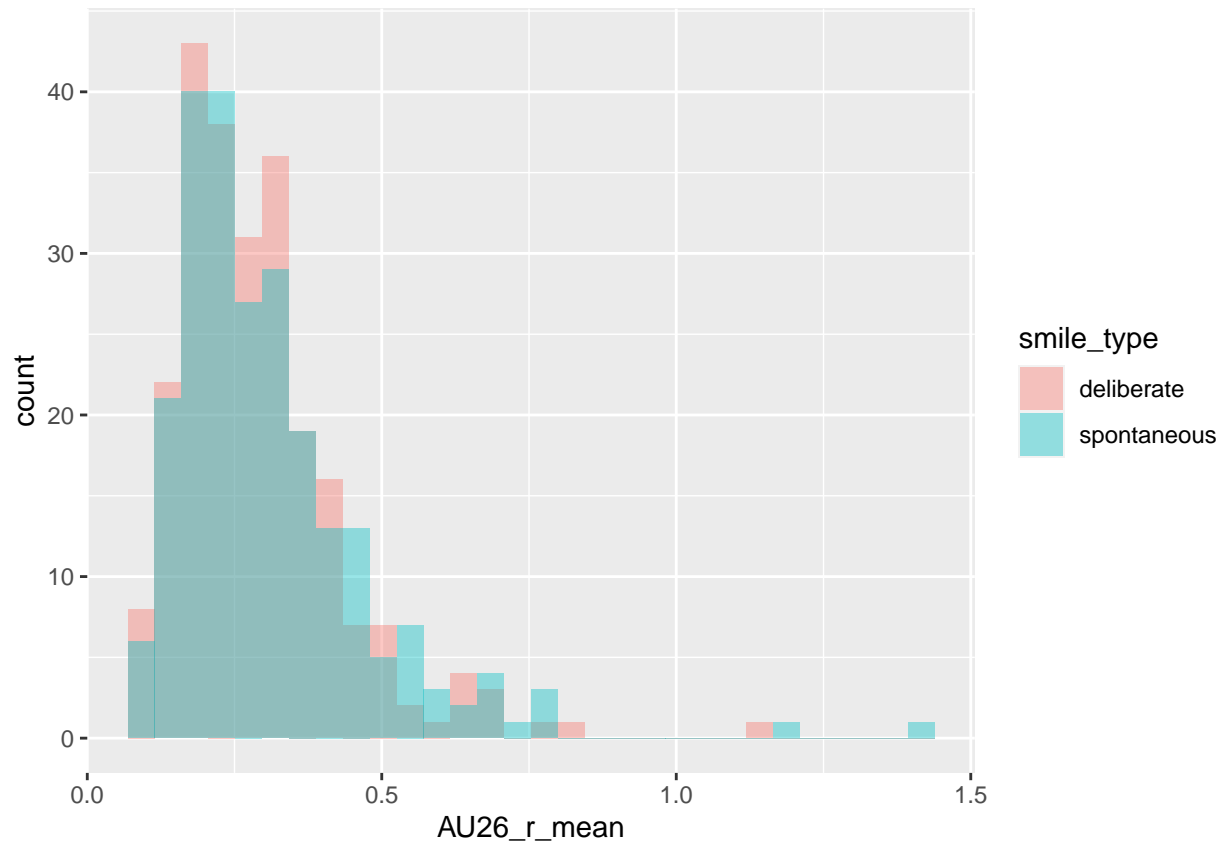
```
ggplot(UvA_sum, aes(x = AU26_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```

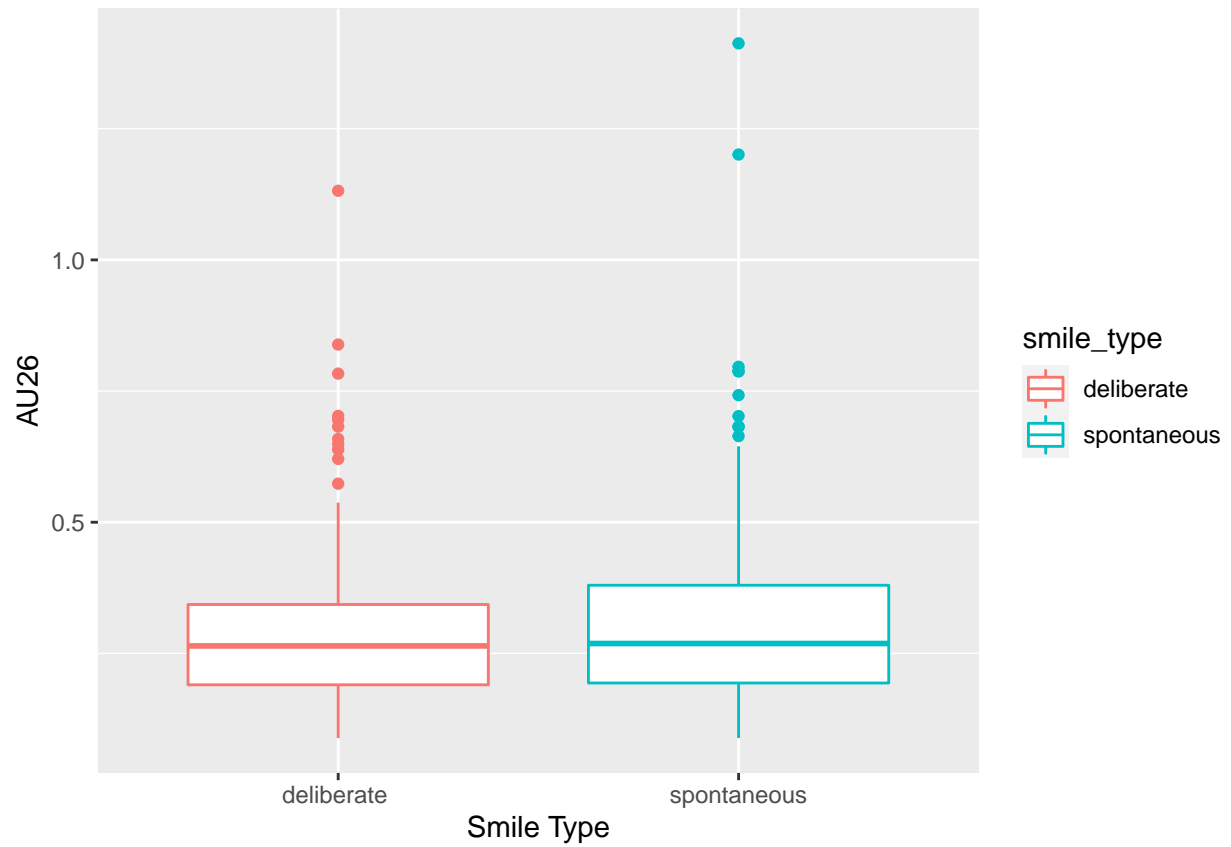
```
ggplot(UvA_sum, aes(x = AU26_r_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



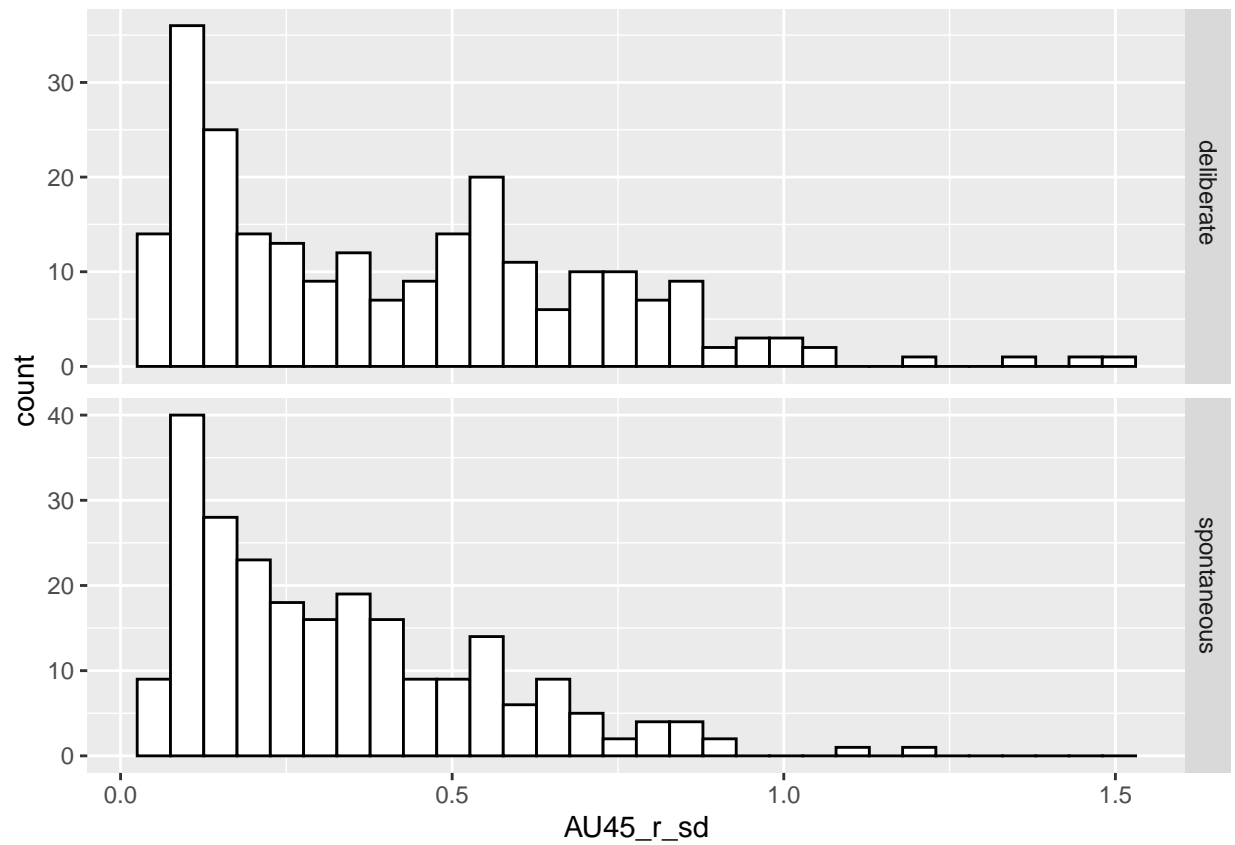
```
ggplot(UvA_sum, aes(x = AU26_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



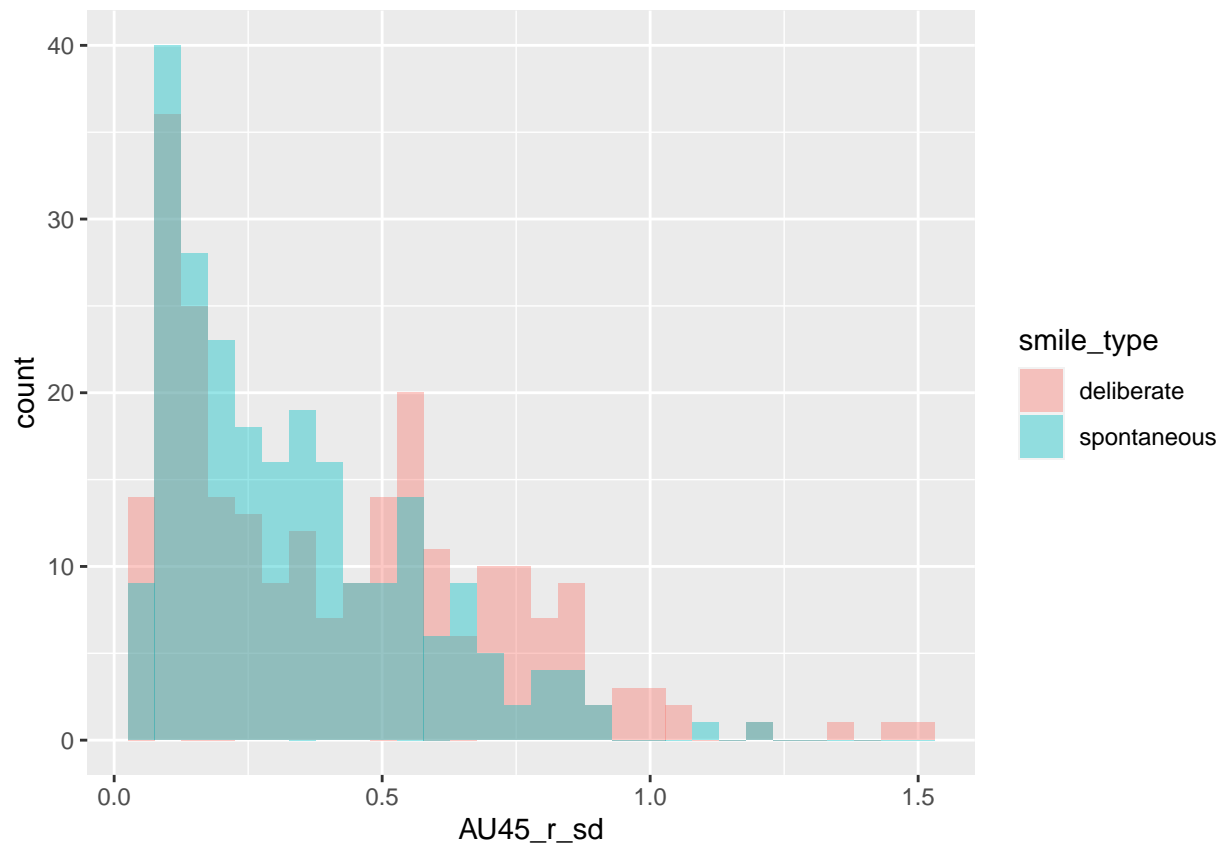
```
ggplot(UvA_sum, aes(x = smile_type, y = AU26_r_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU26") +
  scale_x_discrete(name = "Smile Type")
```



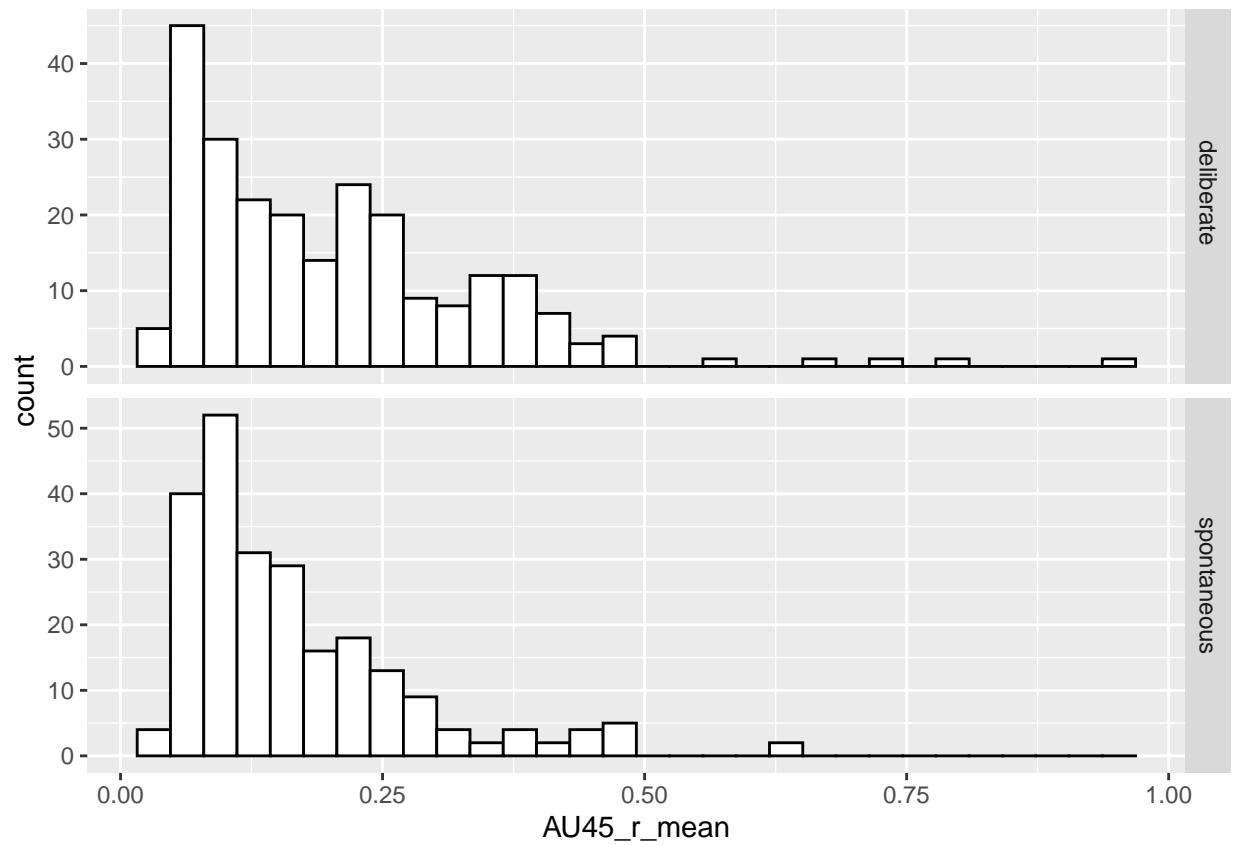
```
# AU45
ggplot(UvA_sum, aes(x = AU45_r_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



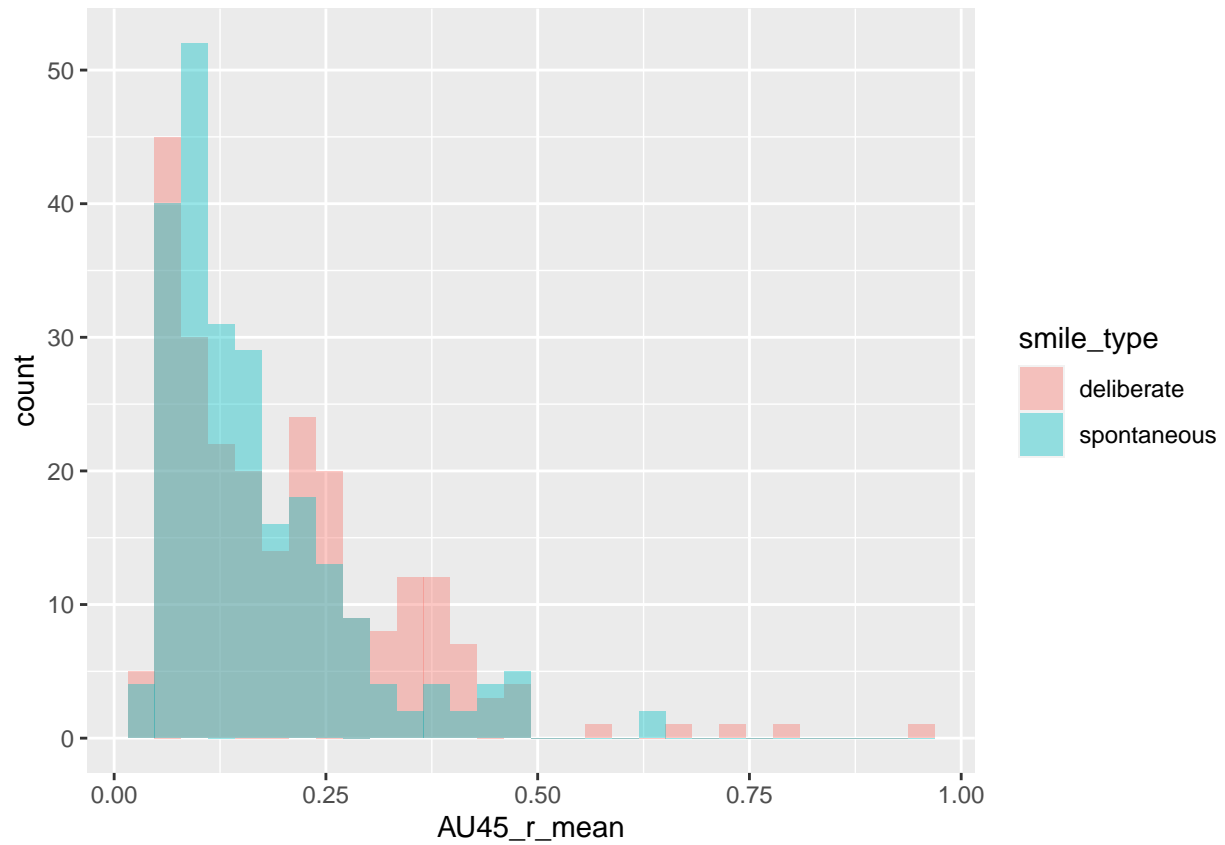
```
ggplot(UvA_sum, aes(x = AU45_r_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



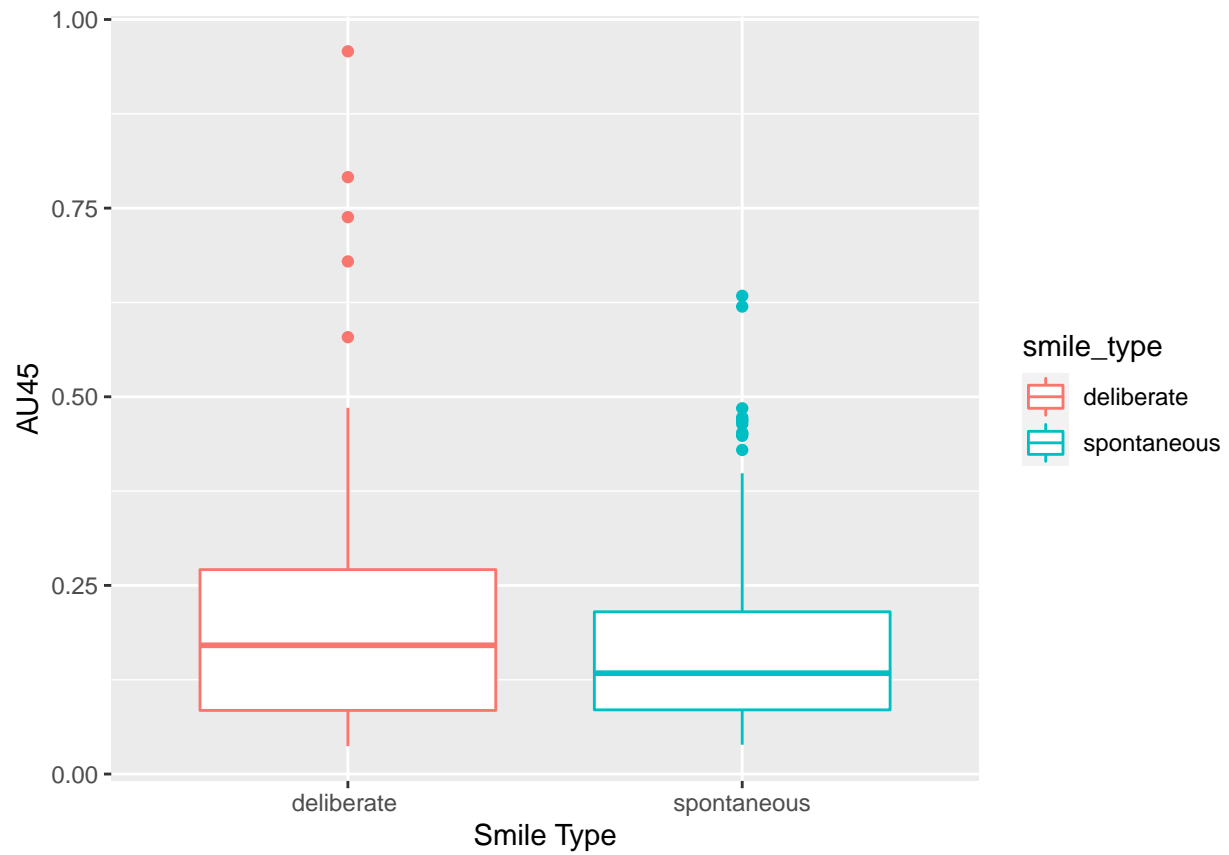
```
ggplot(UvA_sum, aes(x = AU45_r_mean)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



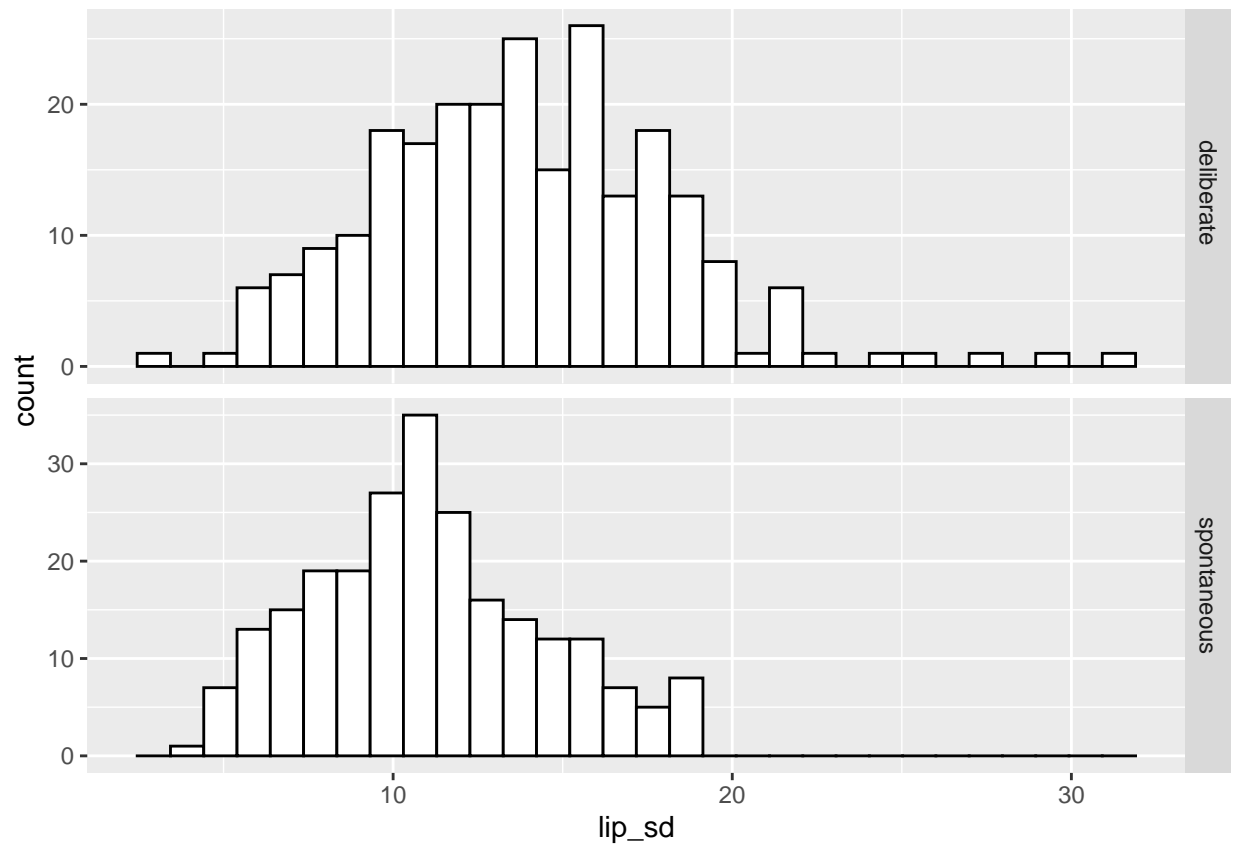
```
ggplot(UvA_sum, aes(x = AU45_r_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



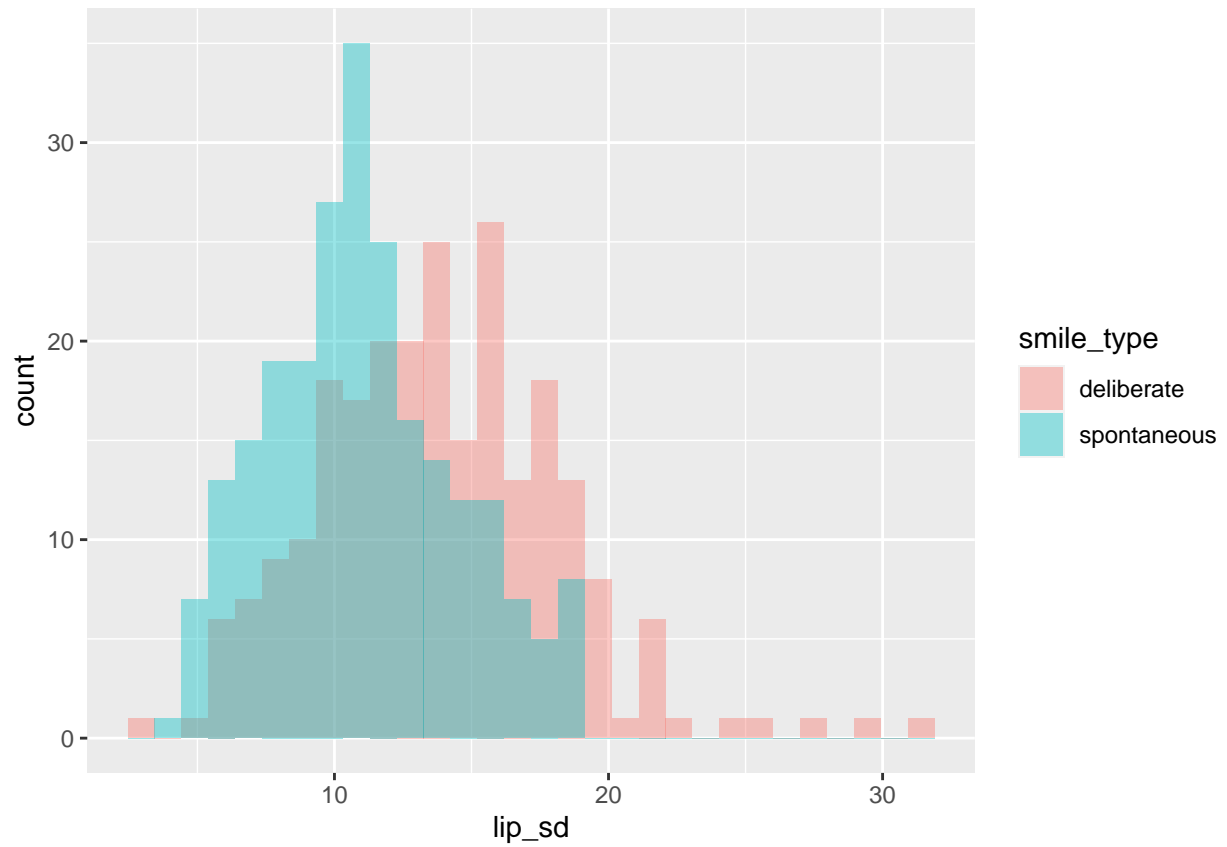
```
ggplot(UvA_sum, aes(x = smile_type, y = AU45_r_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "AU45") +  
  scale_x_discrete(name = "Smile Type")
```

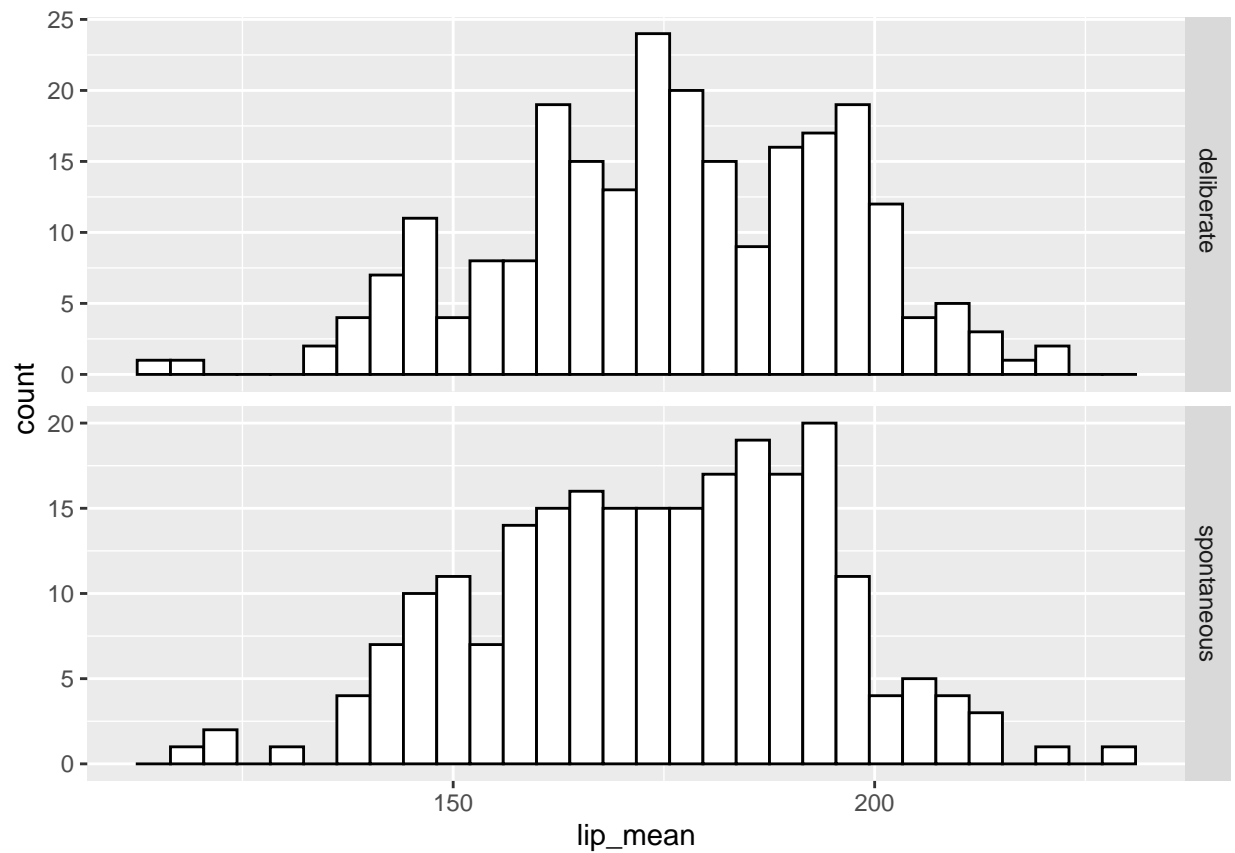
```
# lip
ggplot(UvA_sum, aes(x = lip_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



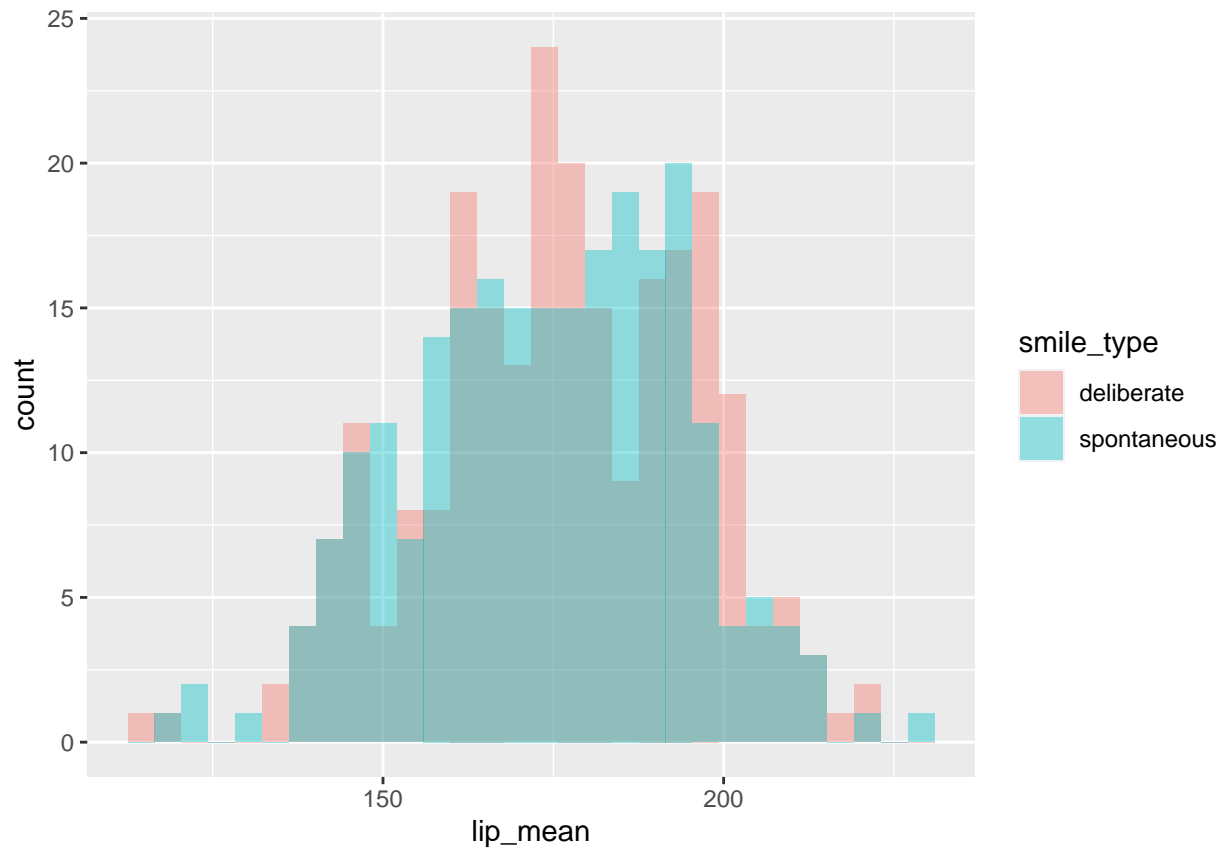
```
ggplot(UvA_sum, aes(x = lip_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



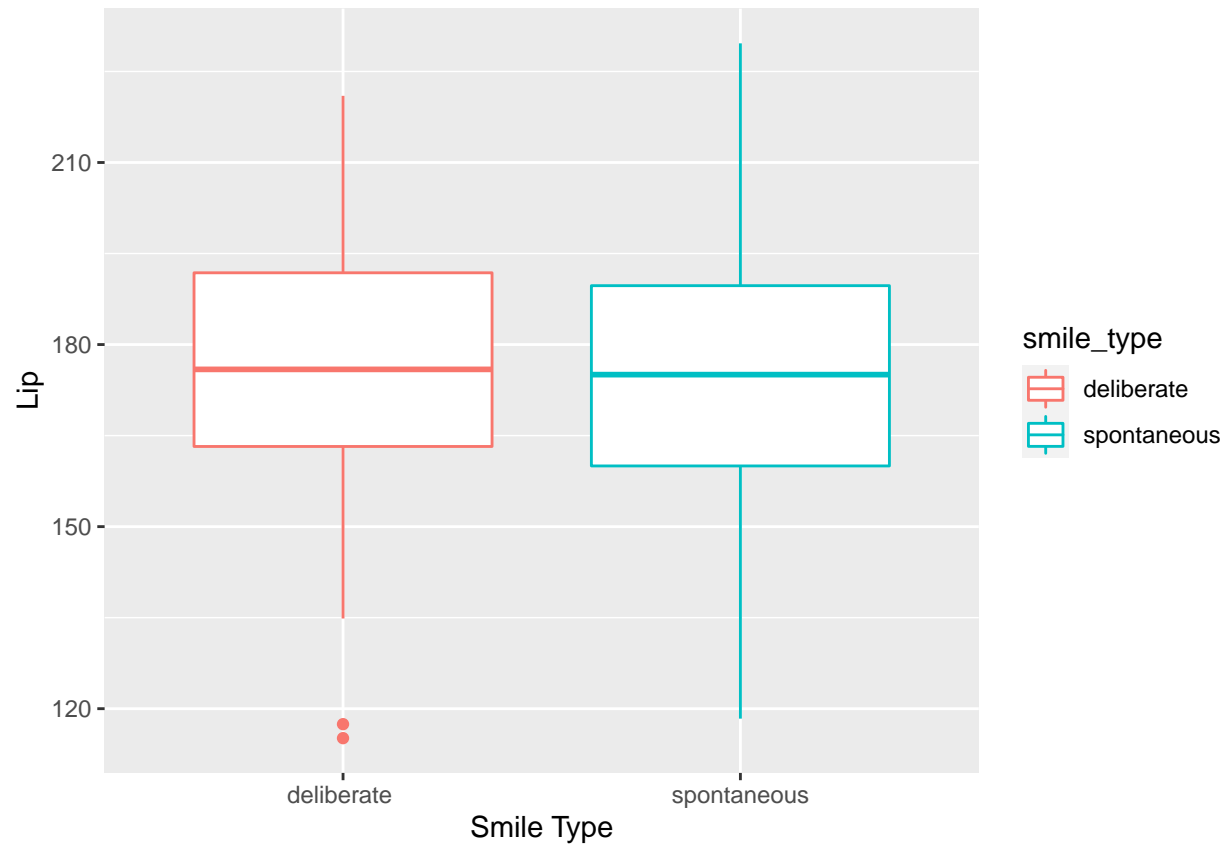
```
ggplot(UvA_sum, aes(x = lip_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



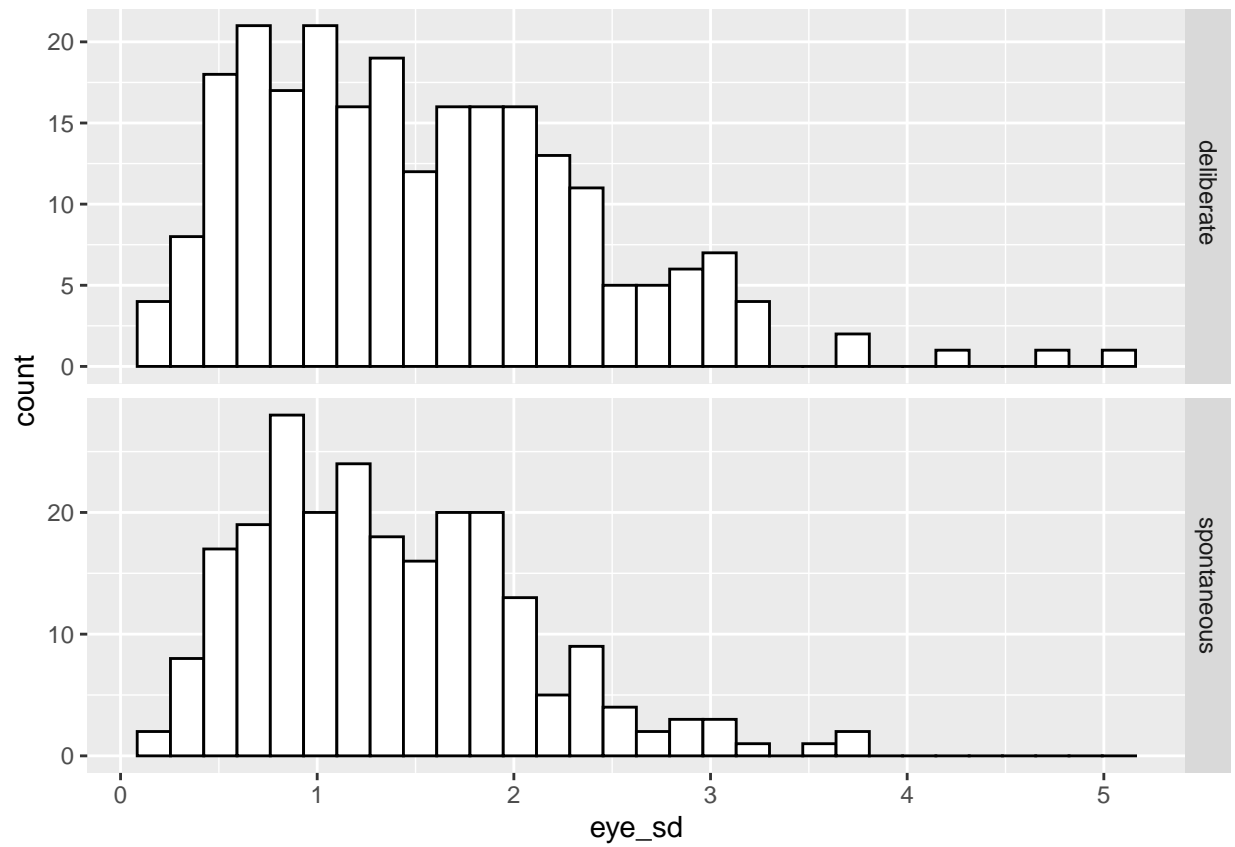
```
ggplot(UvA_sum, aes(x = lip_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



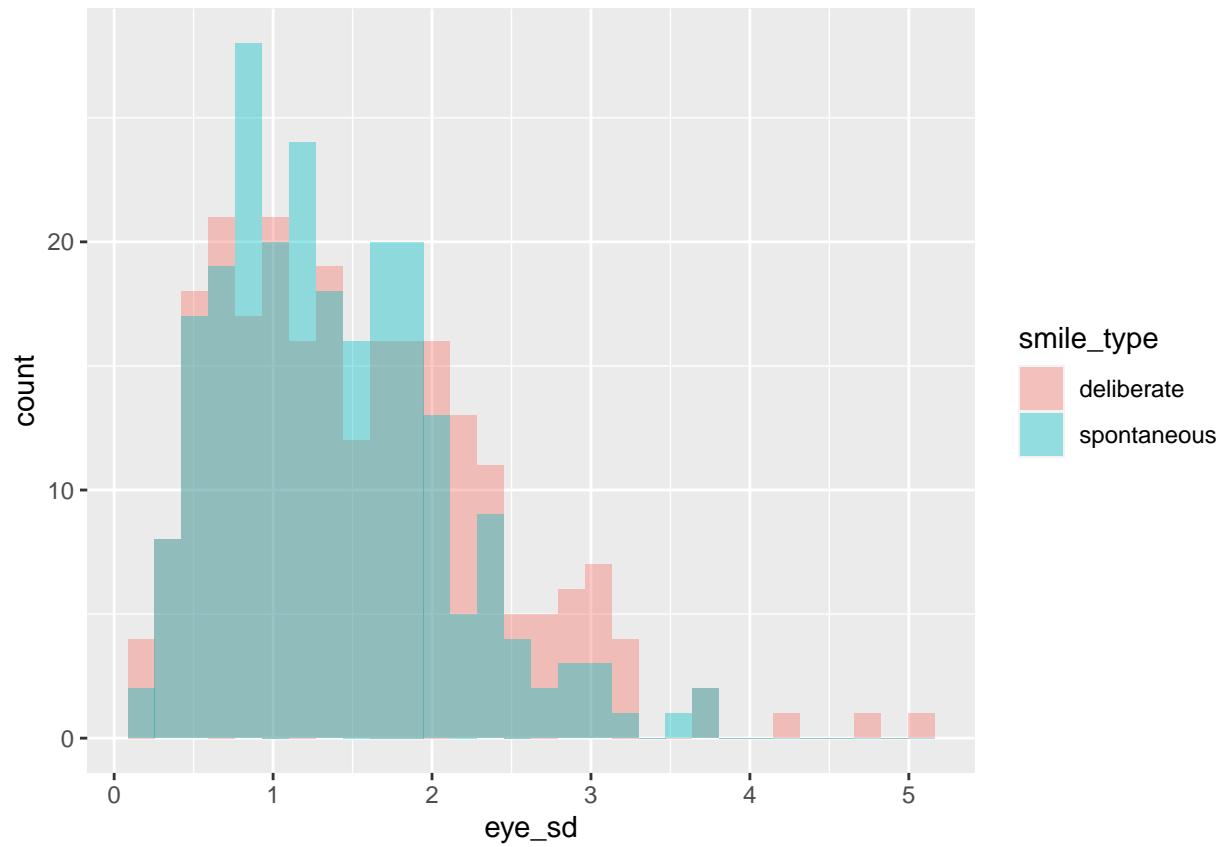
```
ggplot(UvA_sum, aes(x = smile_type, y = lip_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "Lip") +
  scale_x_discrete(name = "Smile Type")
```



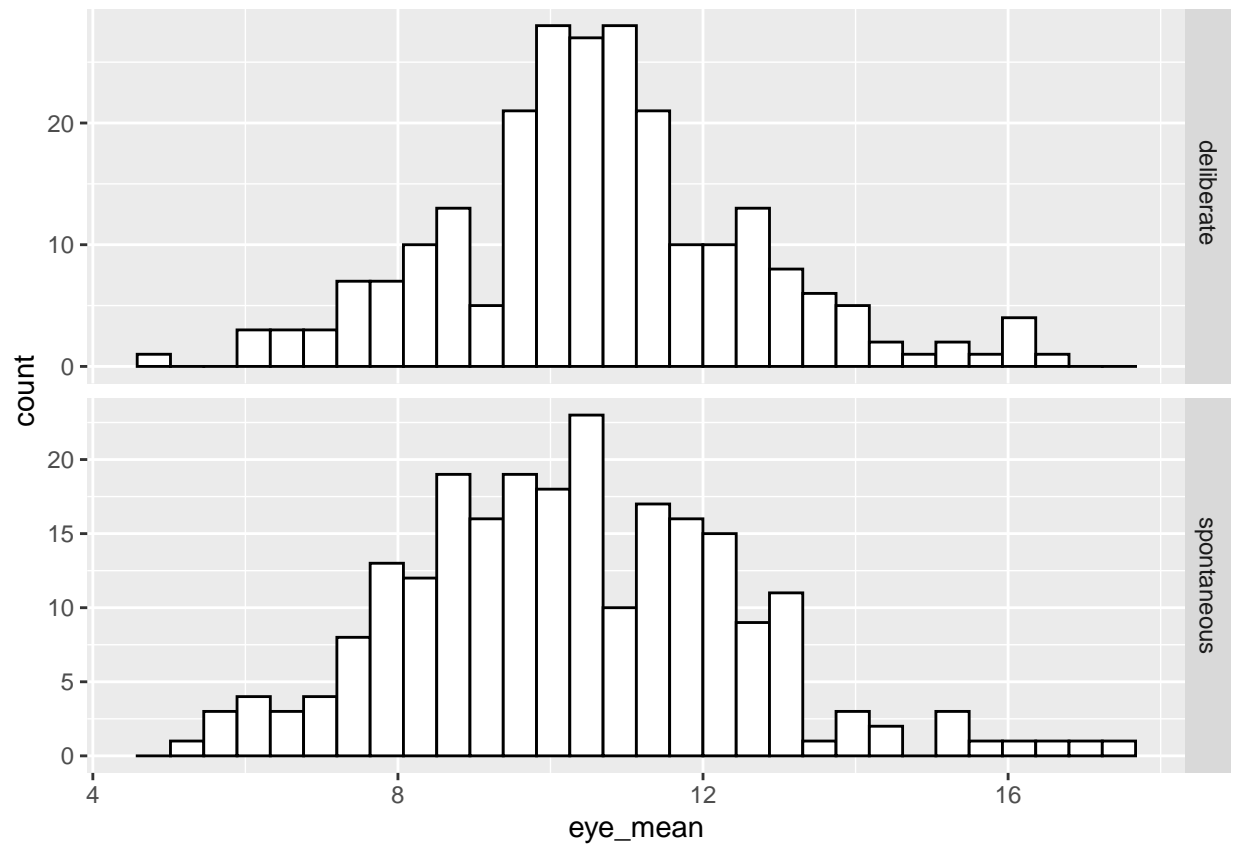
```
# eye
ggplot(UvA_sum, aes(x = eye_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



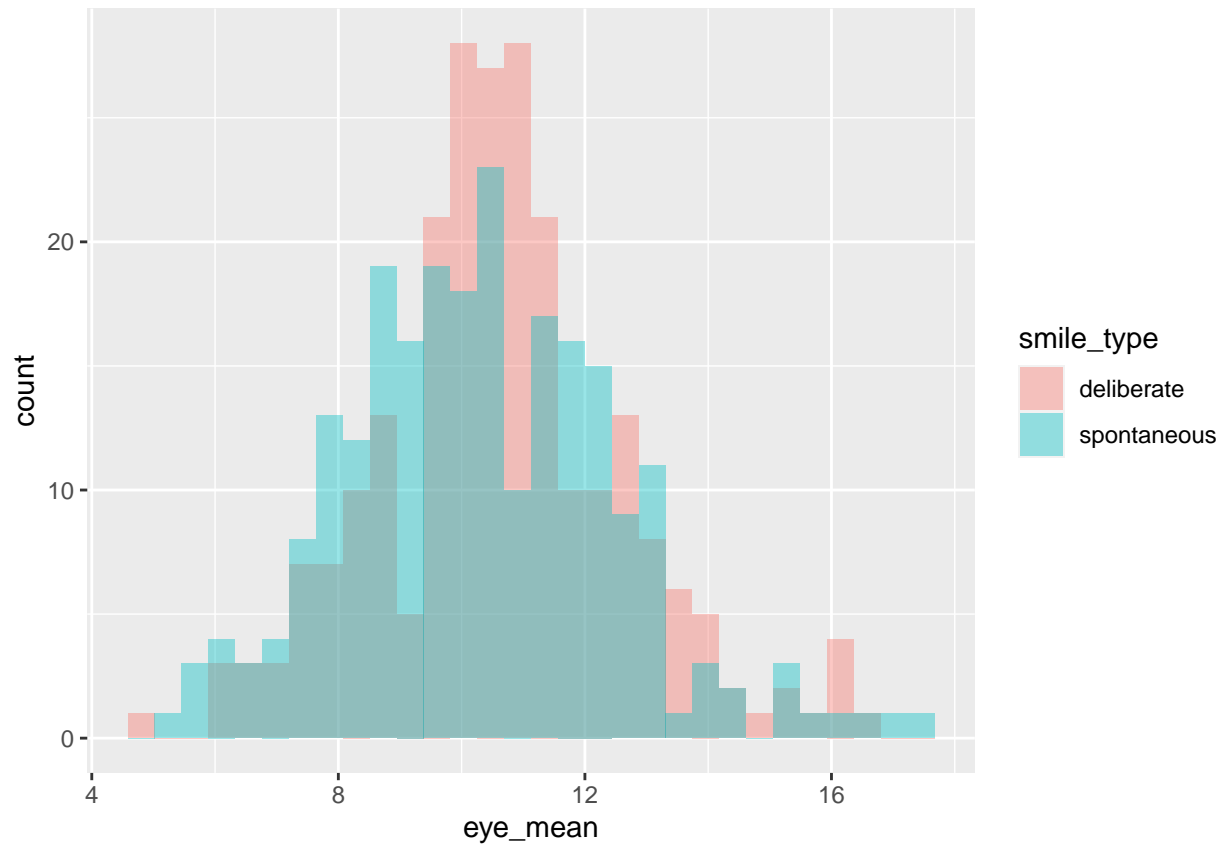
```
ggplot(UvA_sum, aes(x = eye_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



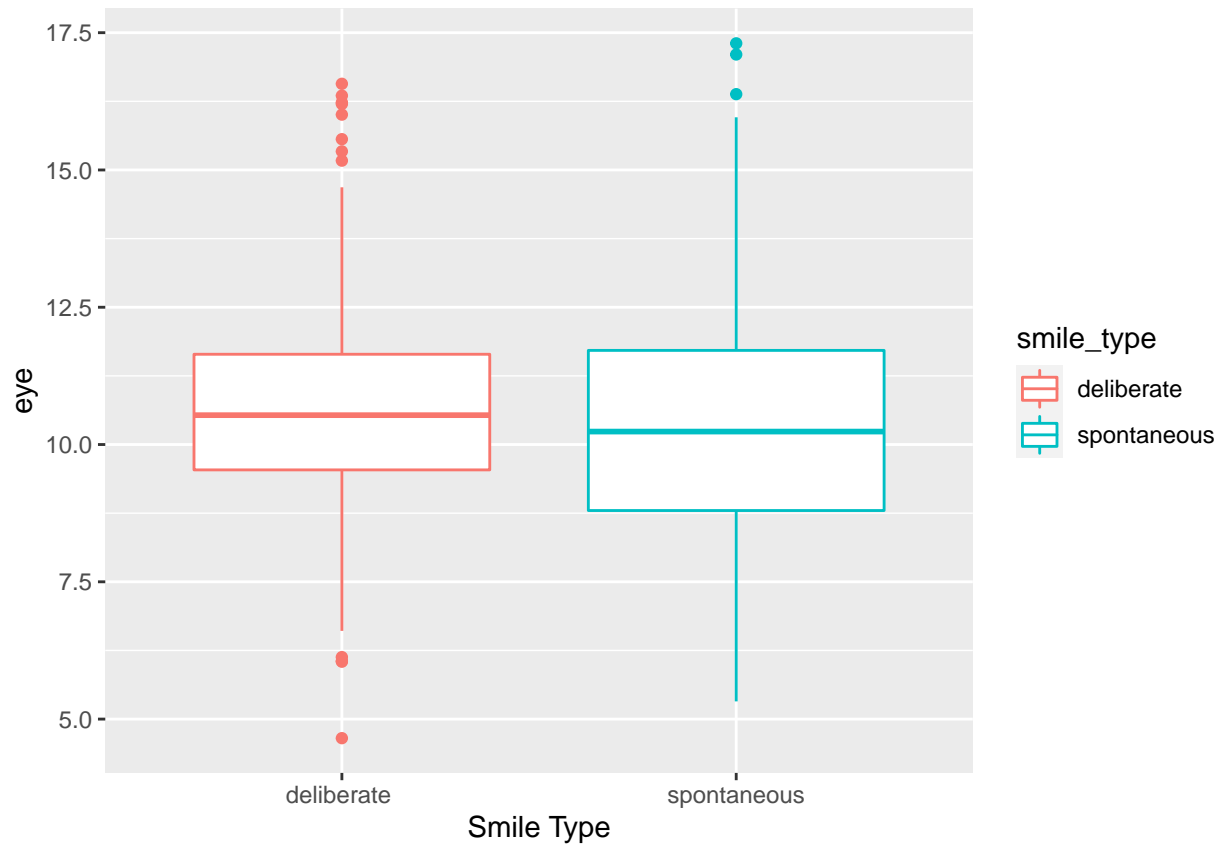
```
ggplot(UvA_sum, aes(x = eye_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```

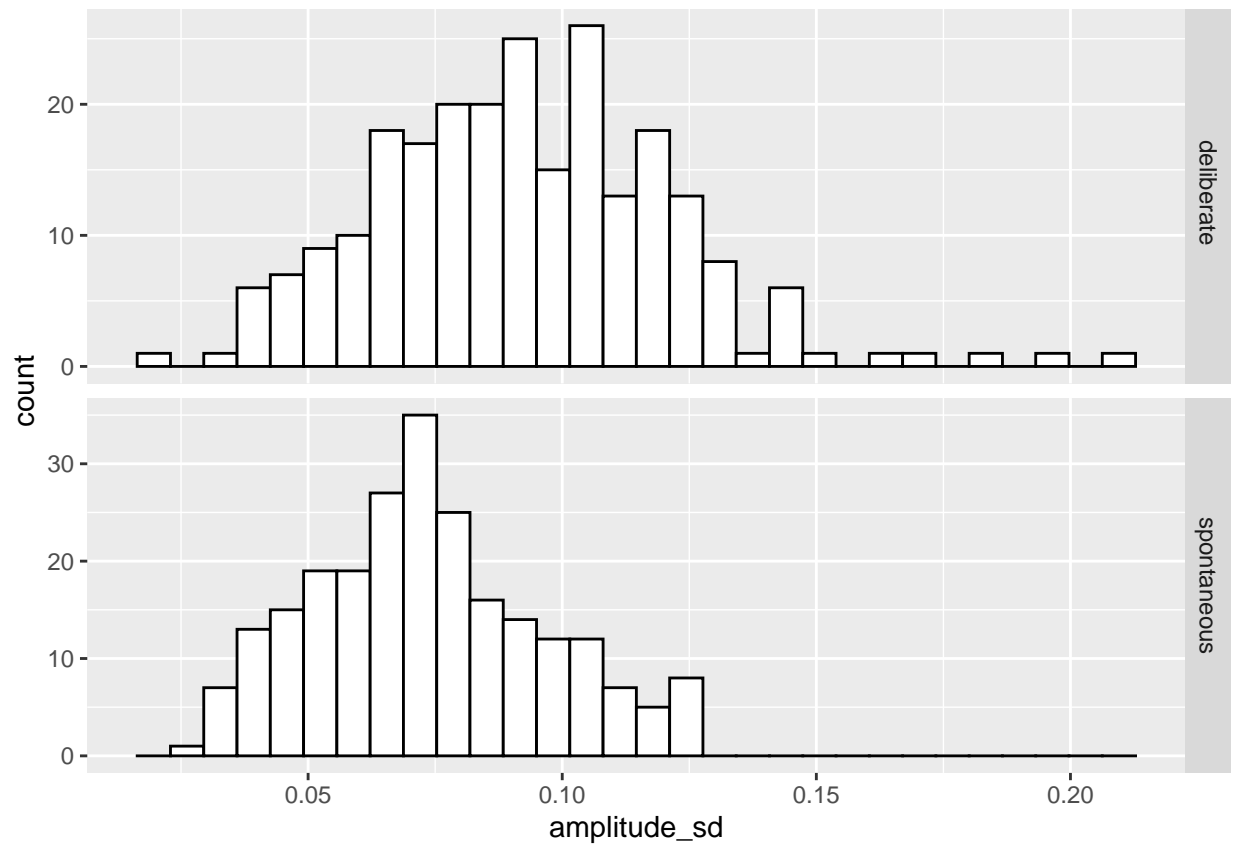
```
ggplot(UvA_sum, aes(x = eye_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



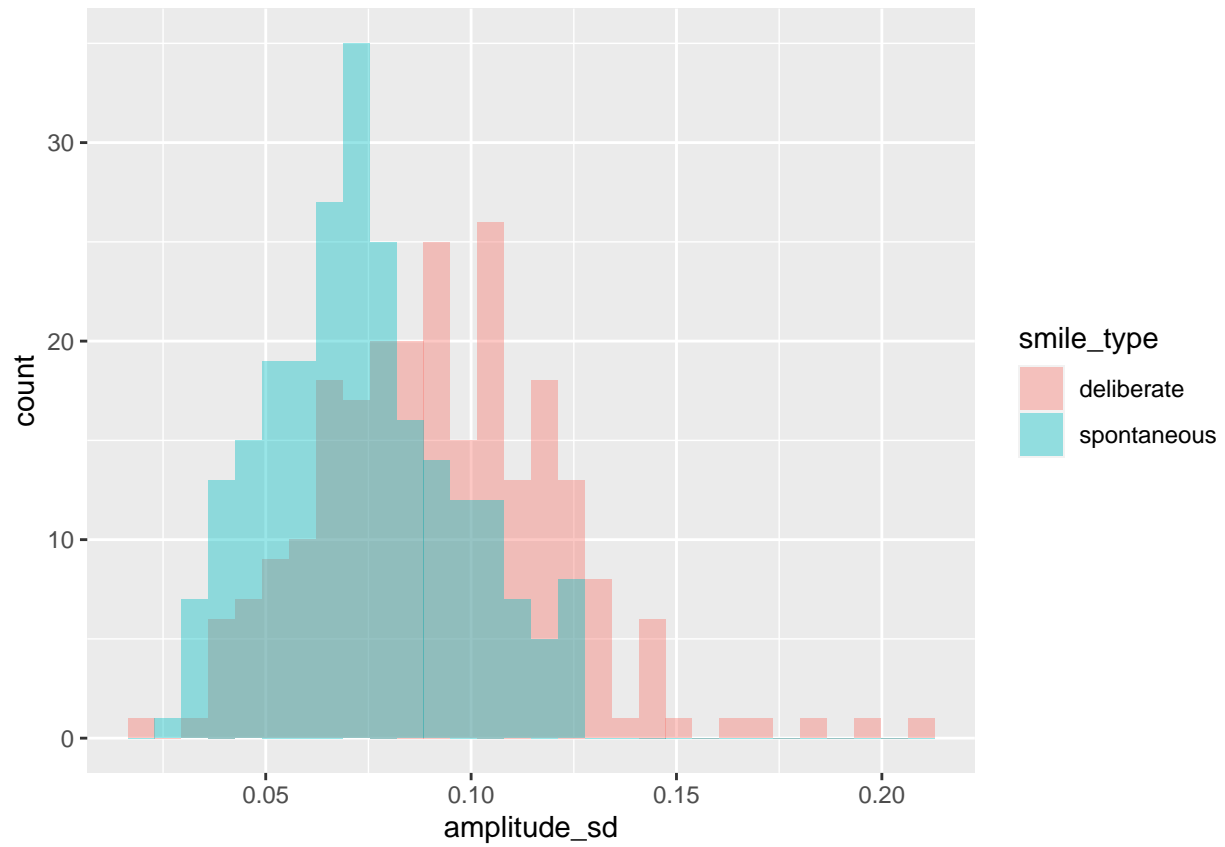
```
ggplot(UvA_sum, aes(x = smile_type, y = eye_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "eye") +  
  scale_x_discrete(name = "Smile Type")
```



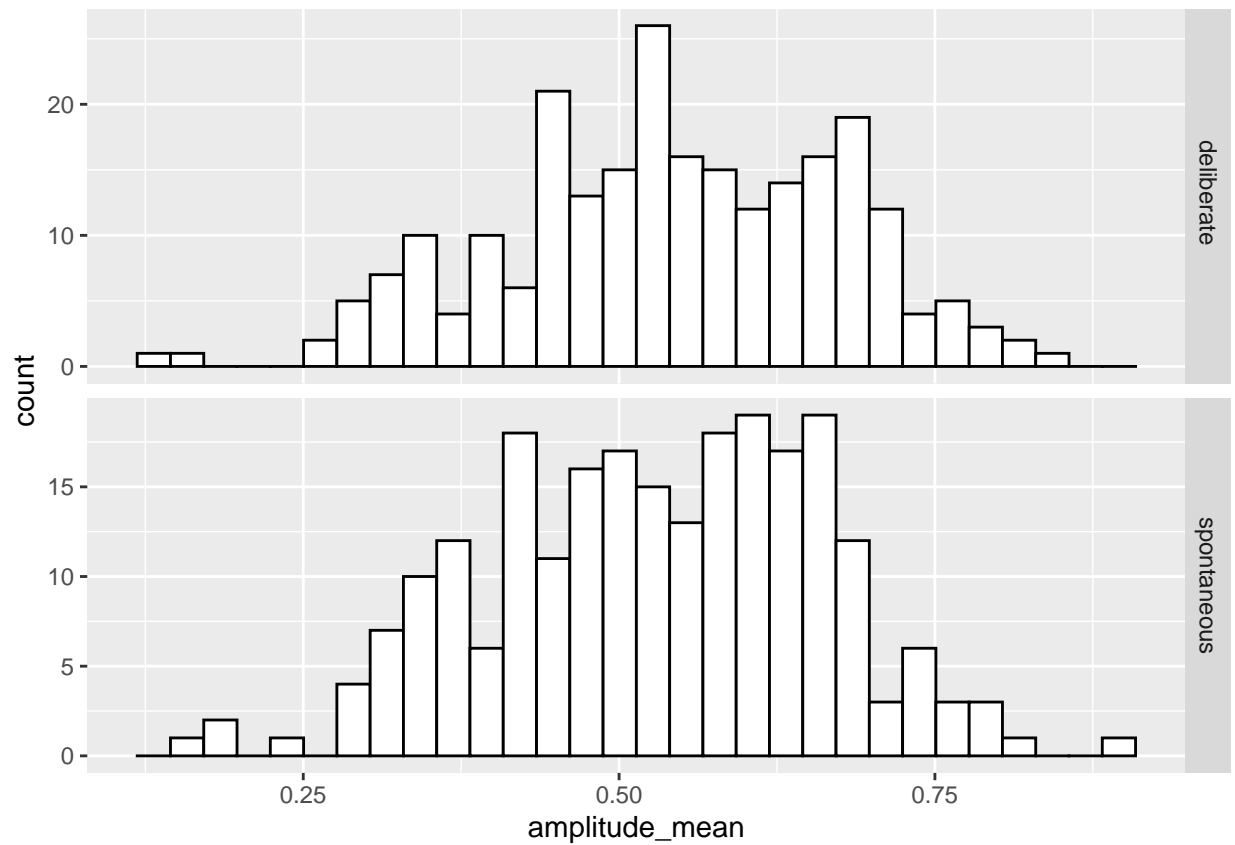
```
# amplitude for onset, apex and offset  
ggplot(UvA_sum, aes(x = amplitude_sd)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



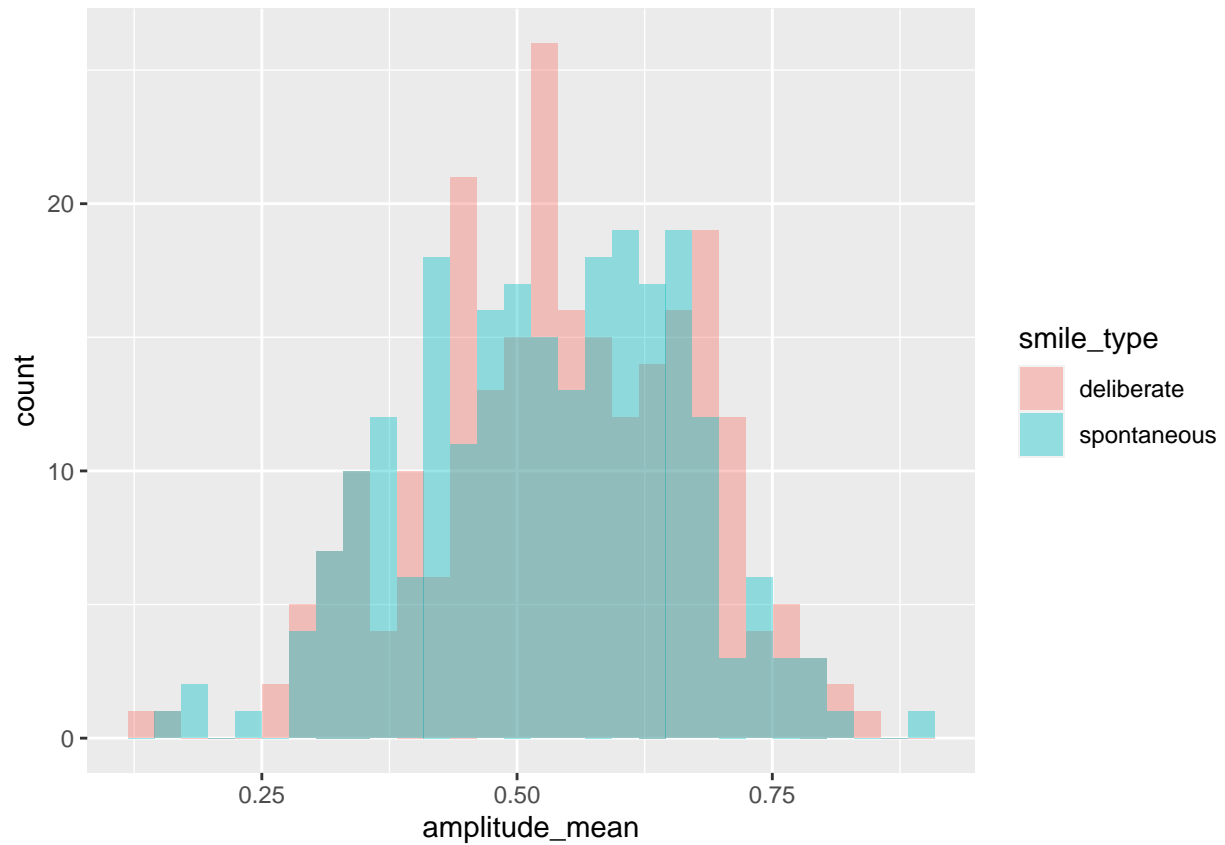
```
ggplot(UvA_sum, aes(x = amplitude_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



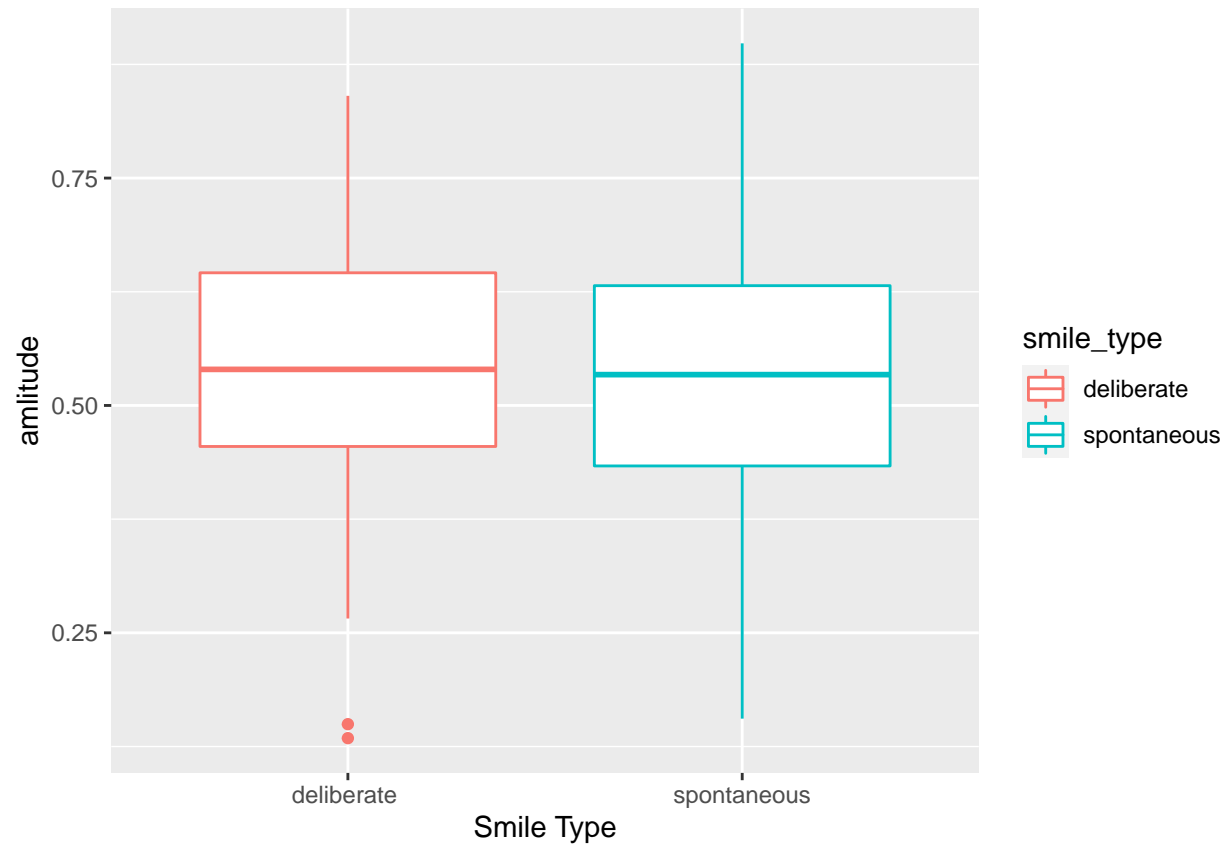
```
ggplot(UvA_sum, aes(x = amplitude_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



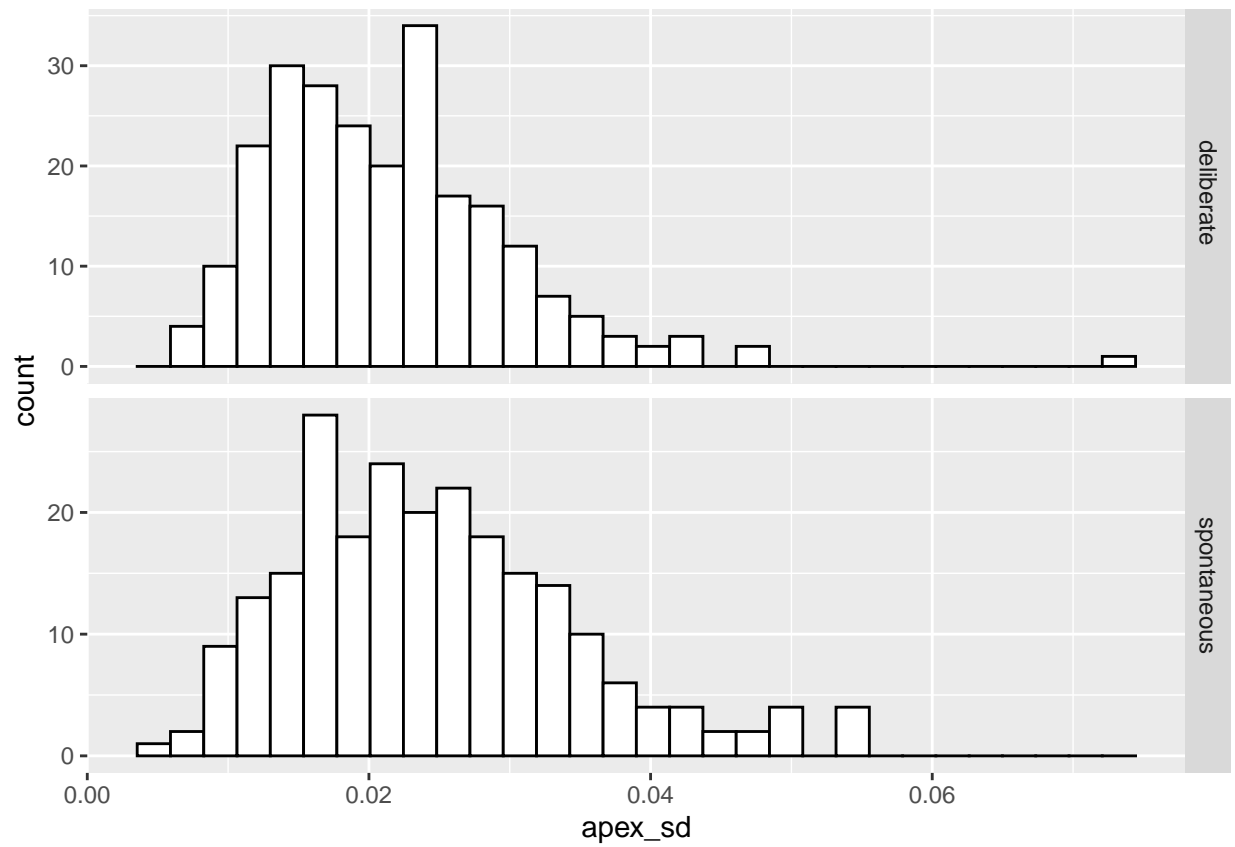
```
ggplot(UvA_sum, aes(x = amplitude_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



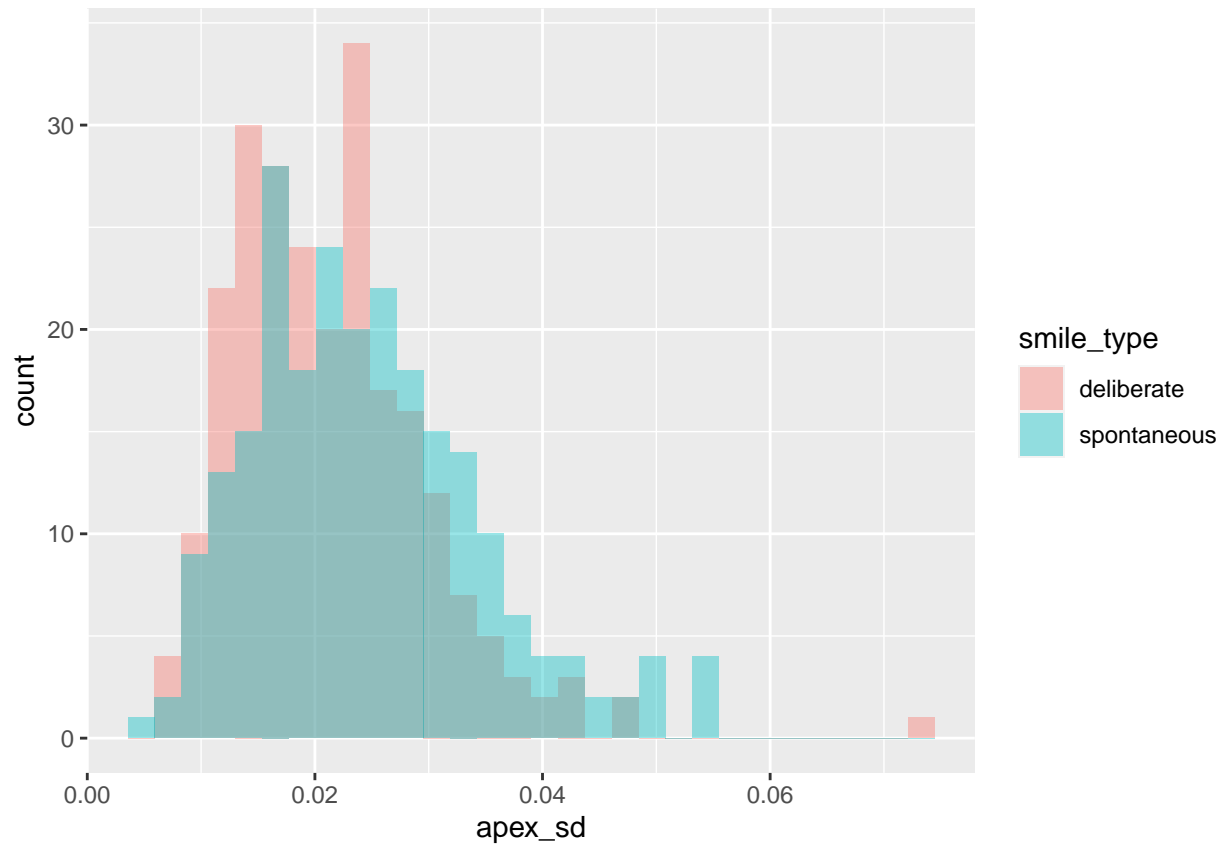
```
ggplot(UvA_sum, aes(x = smile_type, y = amplitude_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "amplitude") +
  scale_x_discrete(name = "Smile Type")
```



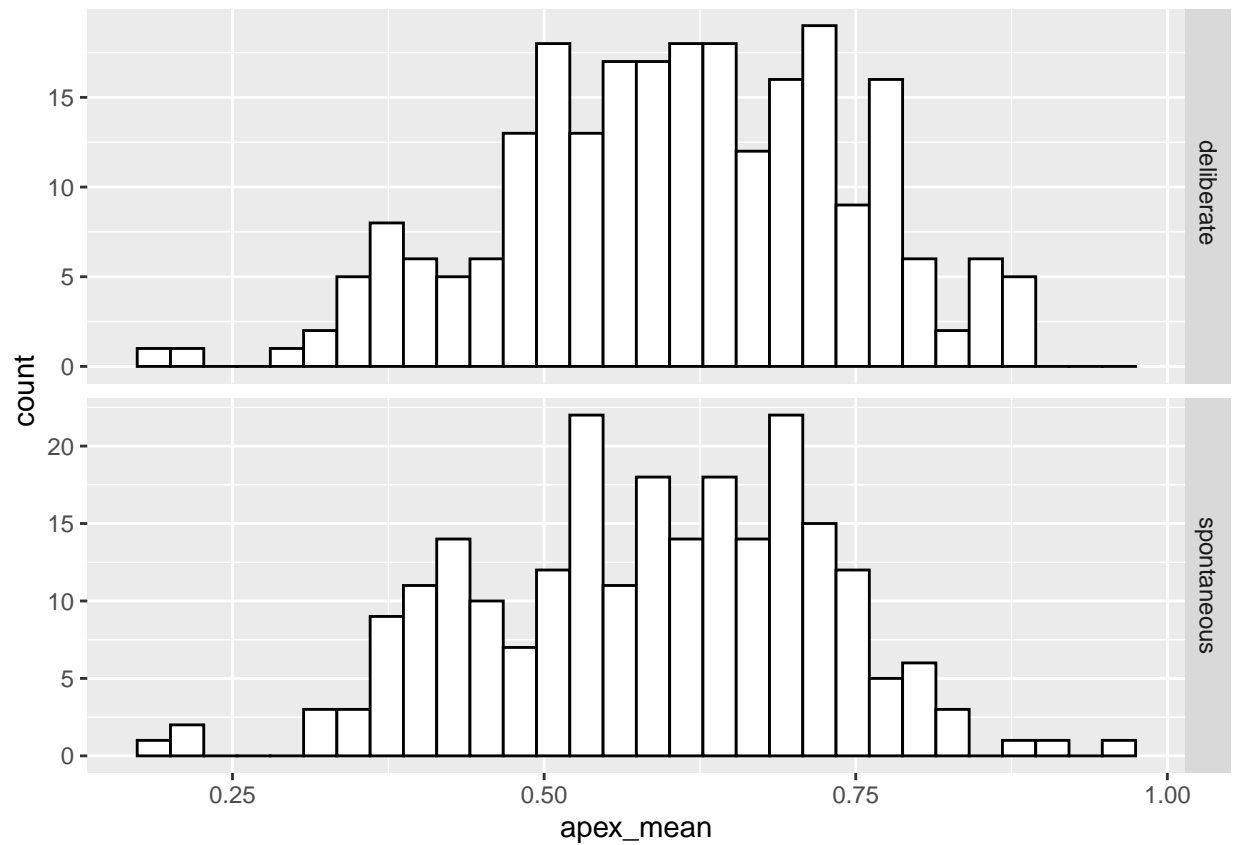
```
# apex
ggplot(UvA_sum, aes(x = apex_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```

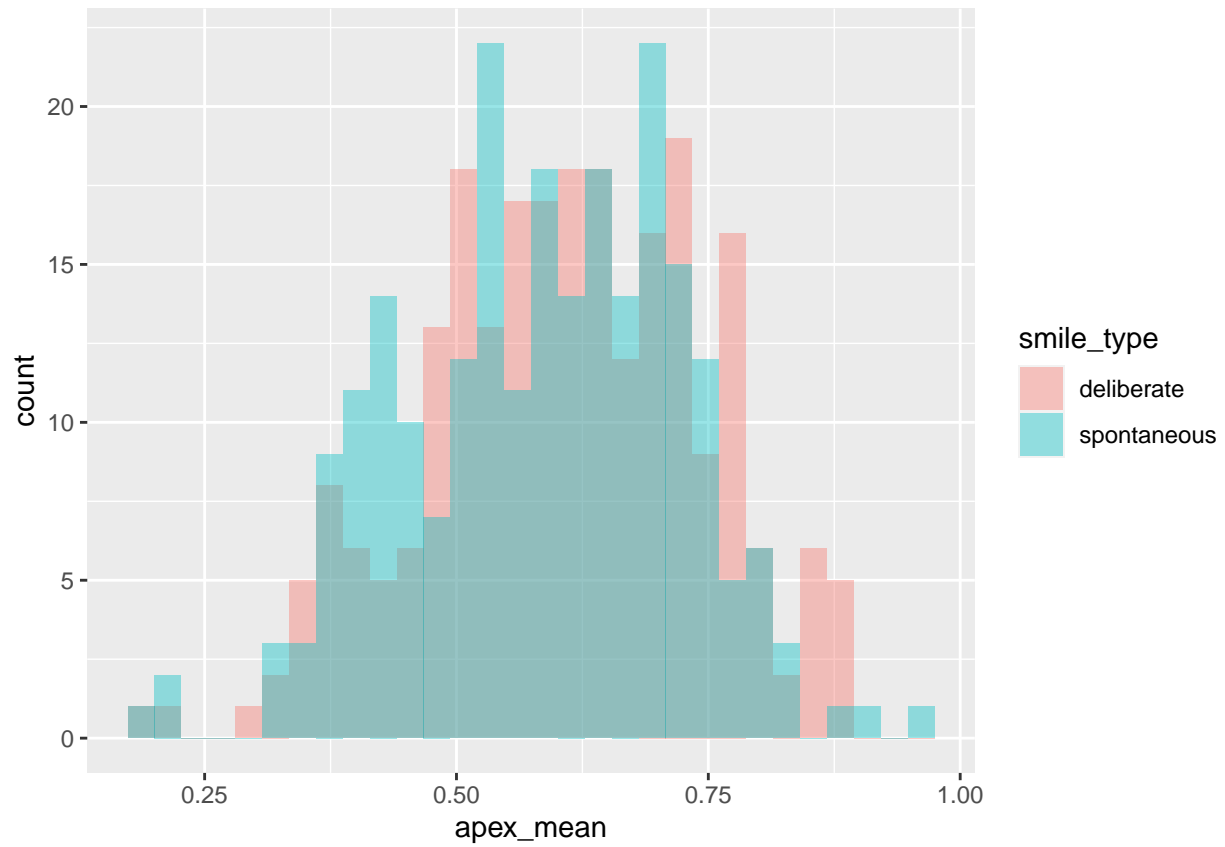
```
ggplot(UvA_sum, aes(x = apex_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



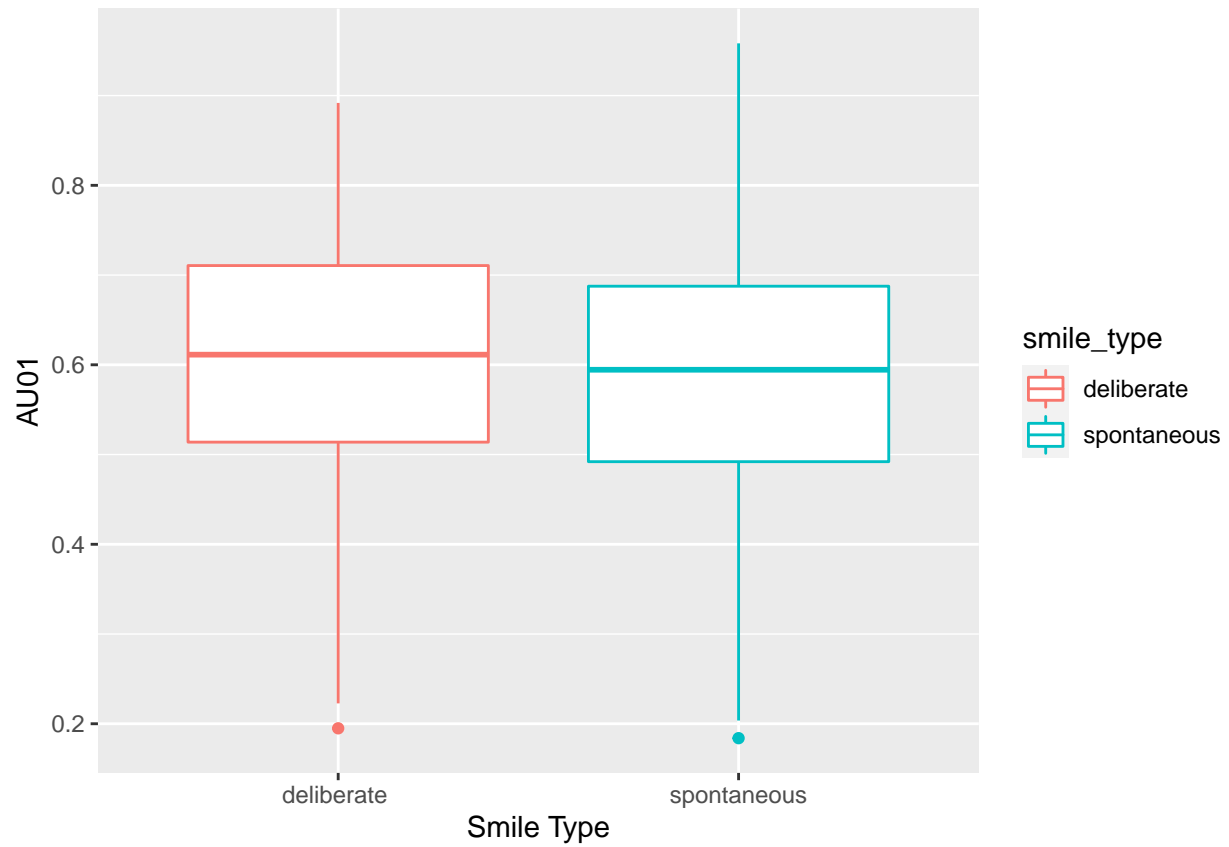
```
ggplot(UvA_sum, aes(x = apex_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



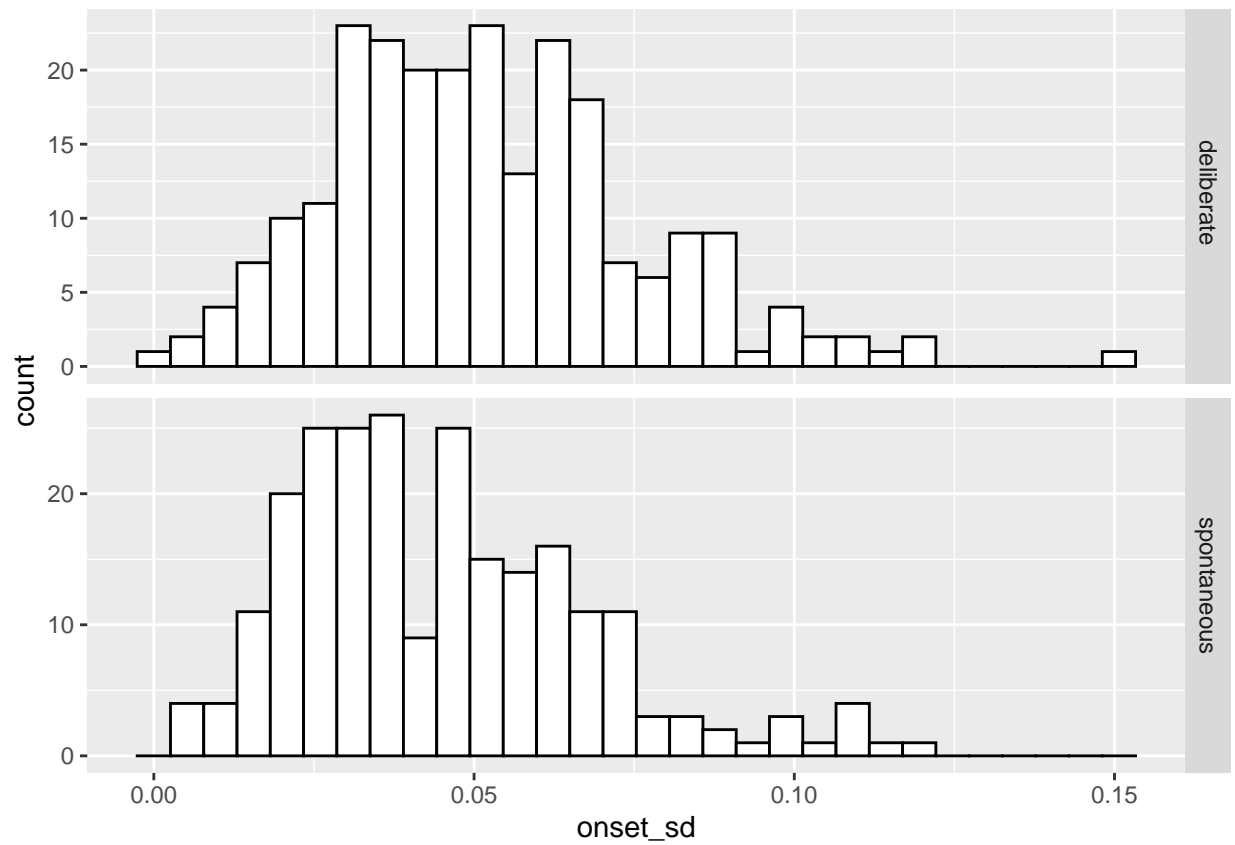
```
ggplot(UvA_sum, aes(x = apex_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



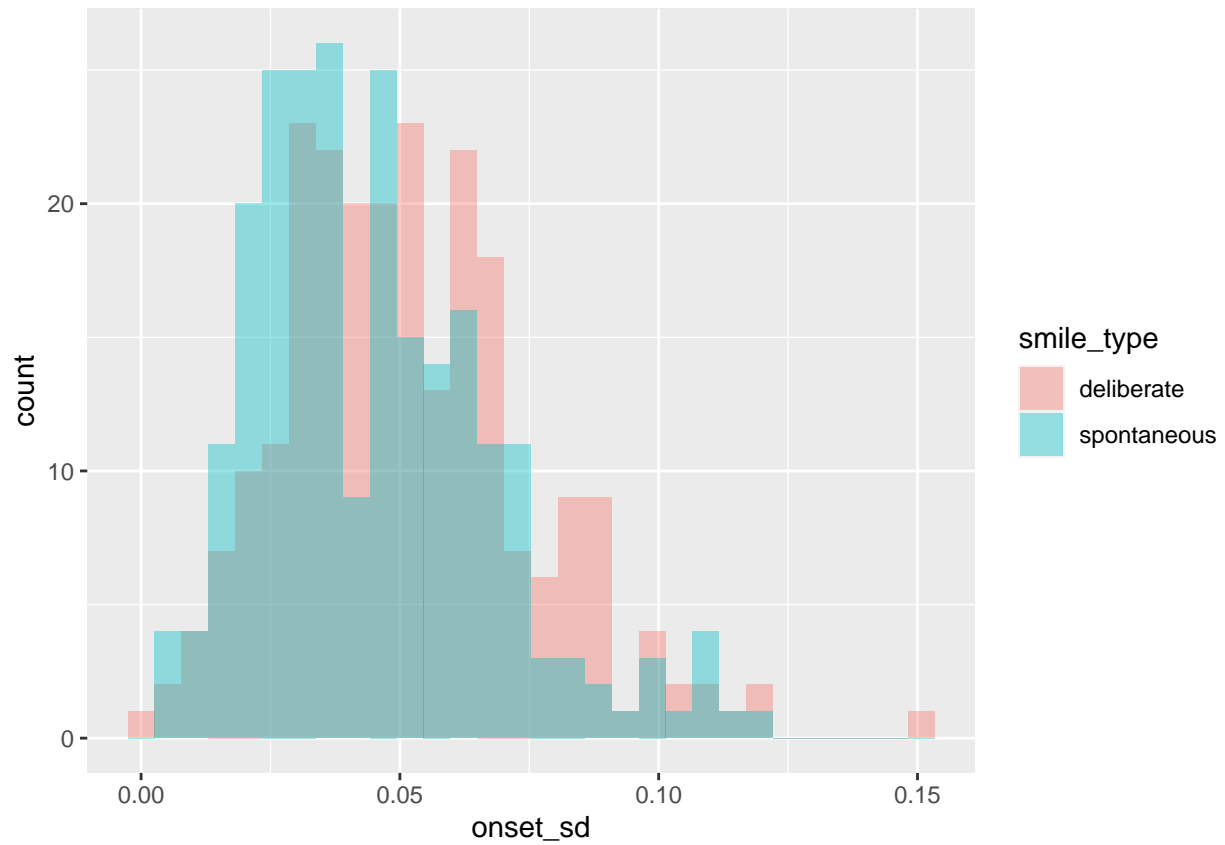
```
ggplot(UvA_sum, aes(x = smile_type, y = apex_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU01") +
  scale_x_discrete(name = "Smile Type")
```



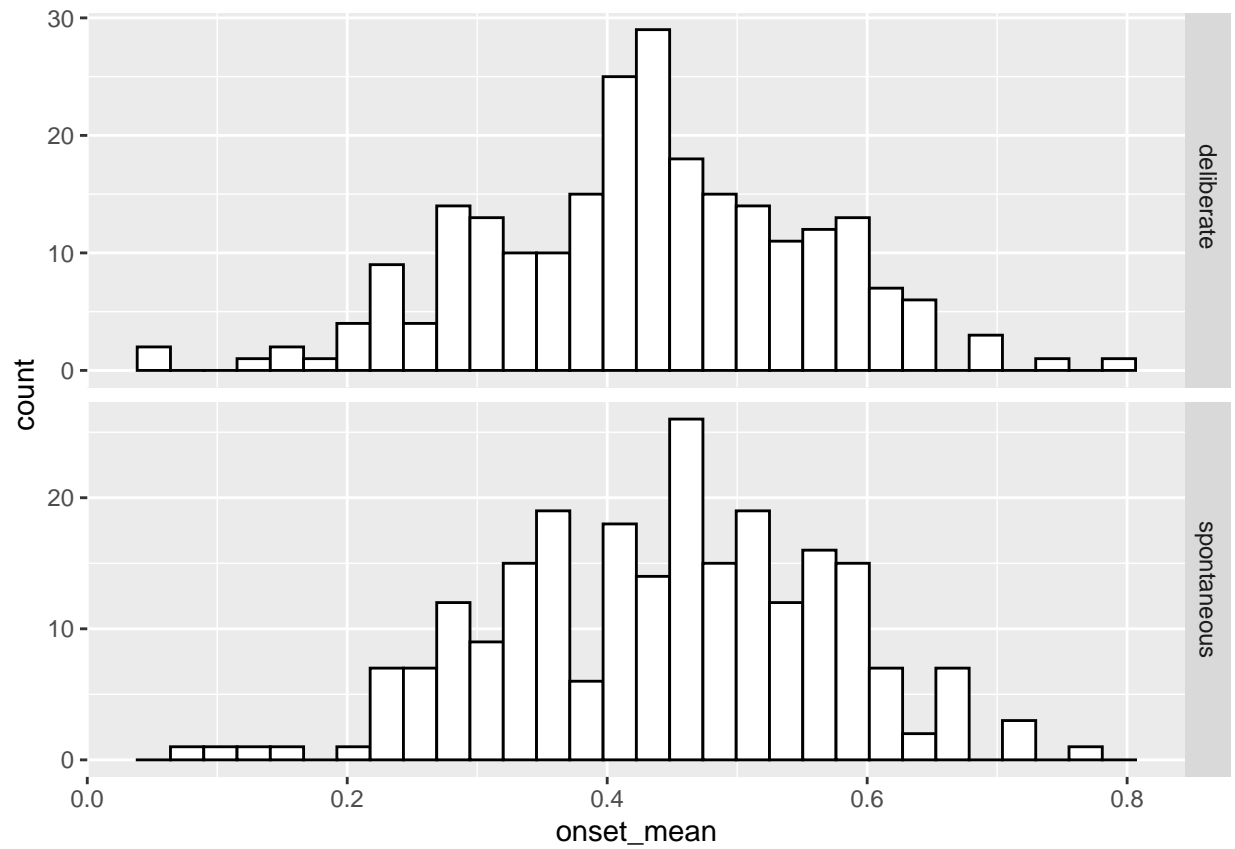
```
# onset  
ggplot(UvA_sum, aes(x = onset_sd)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



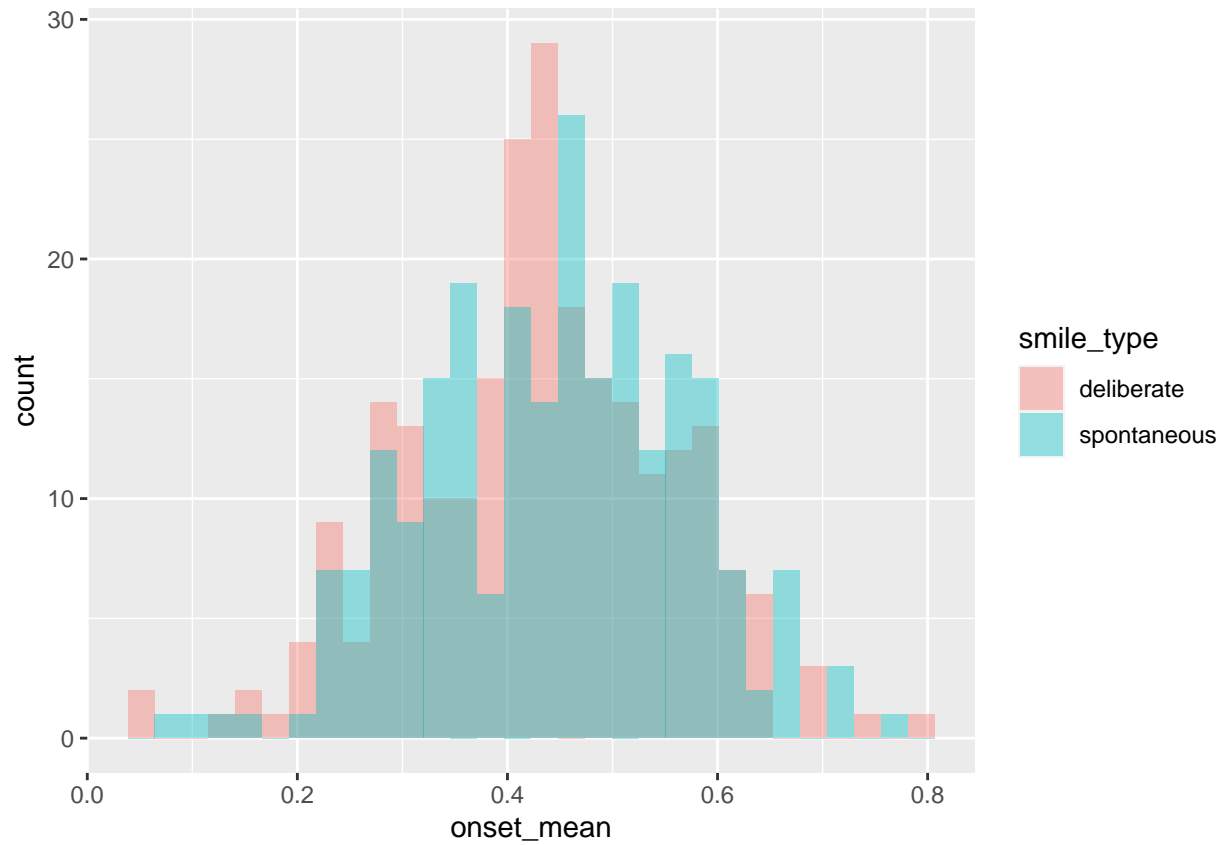
```
ggplot(UvA_sum, aes(x = onset_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



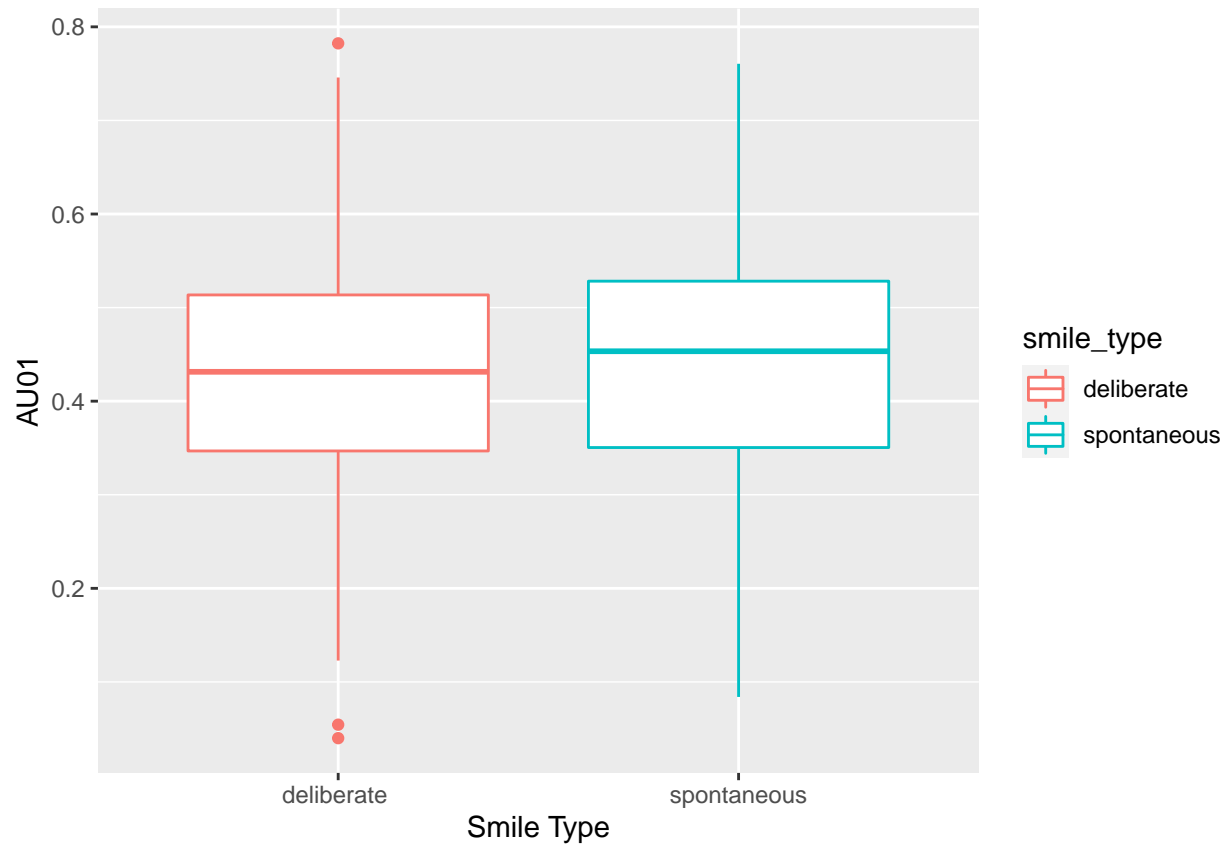
```
ggplot(UvA_sum, aes(x = onset_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



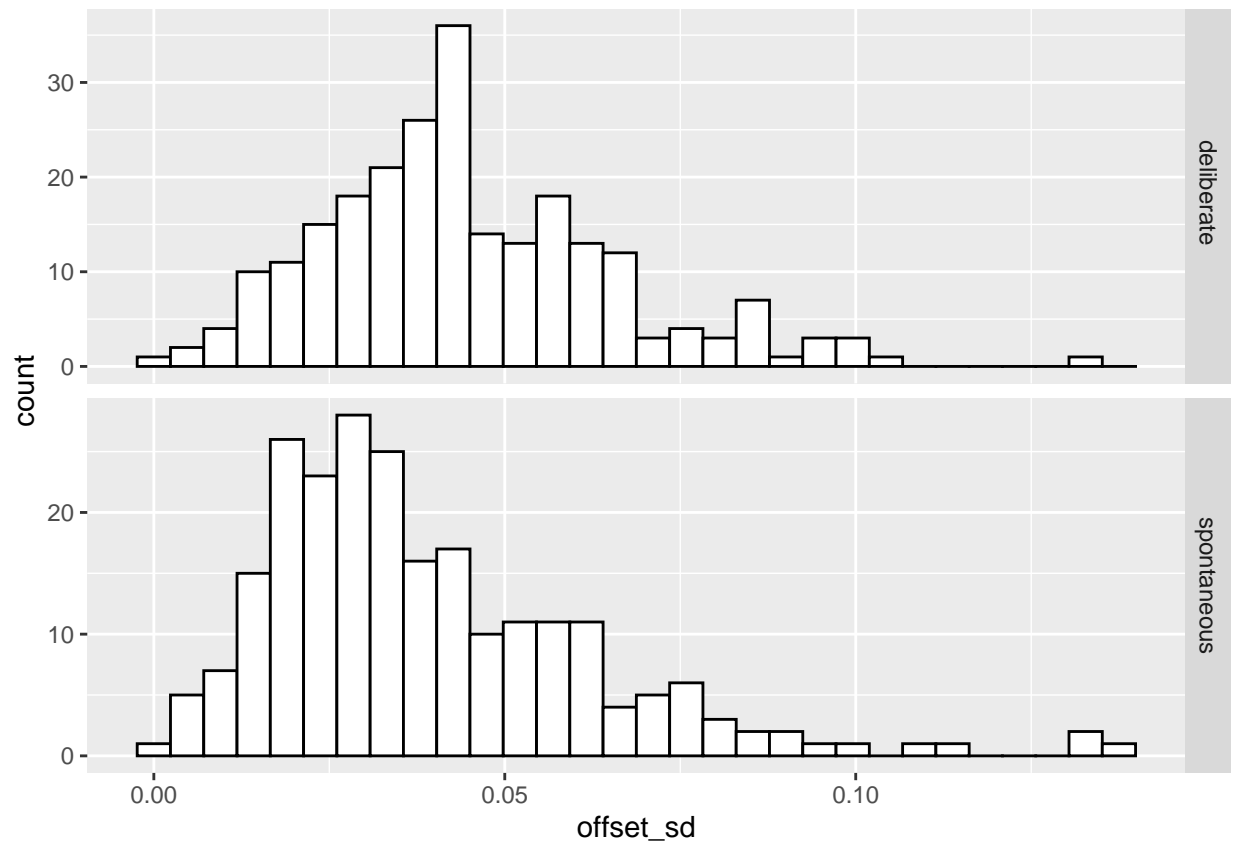
```
ggplot(UvA_sum, aes(x = onset_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```

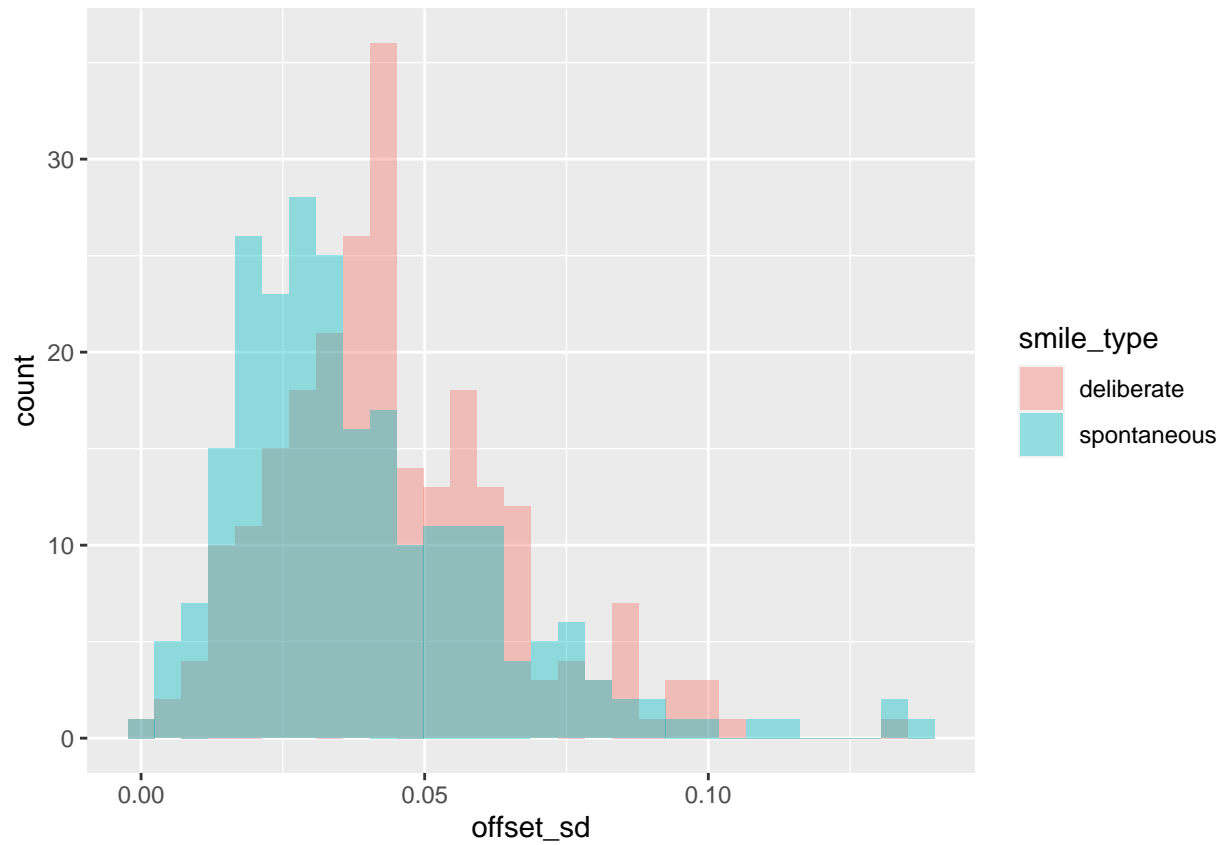
```
ggplot(UvA_sum, aes(x = smile_type, y = onset_mean, color = smile_type)) +
  geom_boxplot() +
  scale_y_continuous(name = "AU01") +
  scale_x_discrete(name = "Smile Type")
```



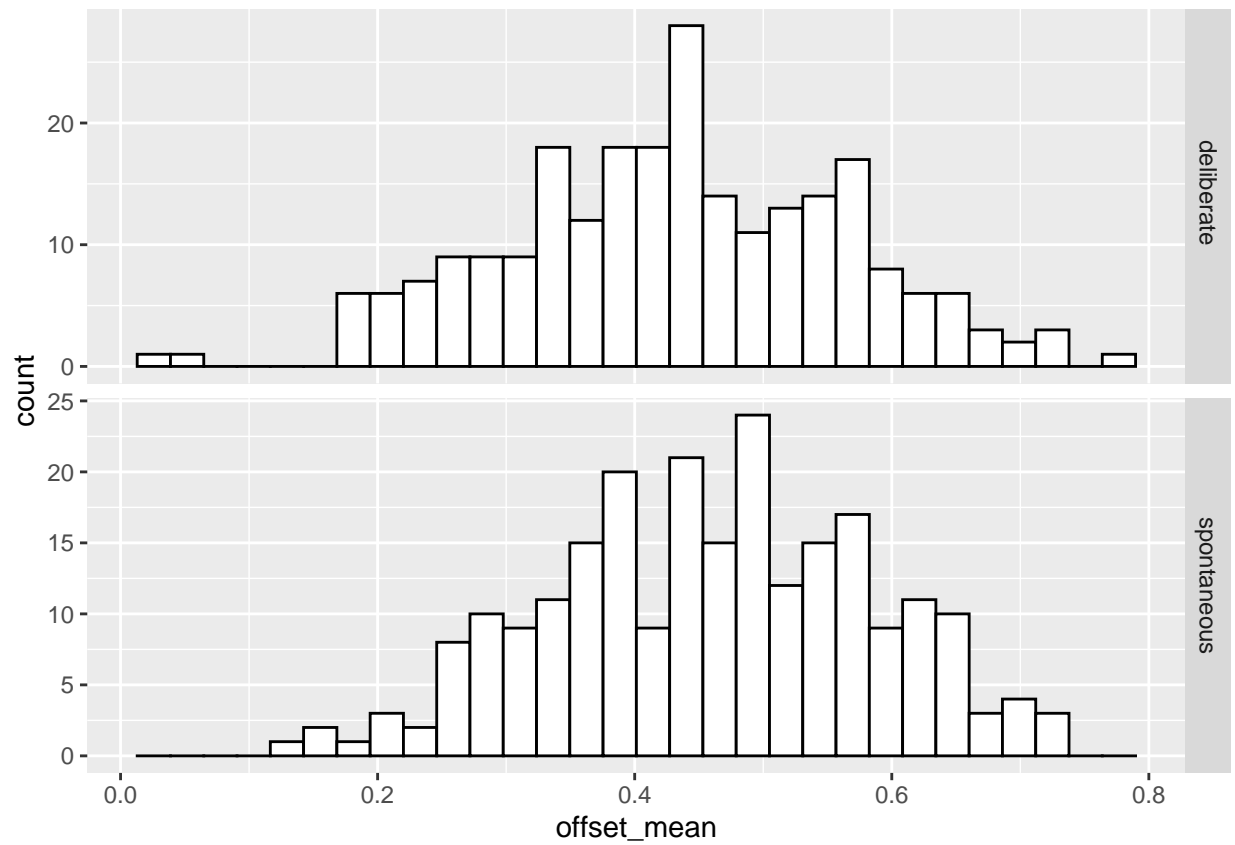
```
# offset
ggplot(UvA_sum, aes(x = offset_sd)) +
  geom_histogram(fill = "white", colour = "black") +
  facet_grid(smile_type ~ ., scales = "free")
```



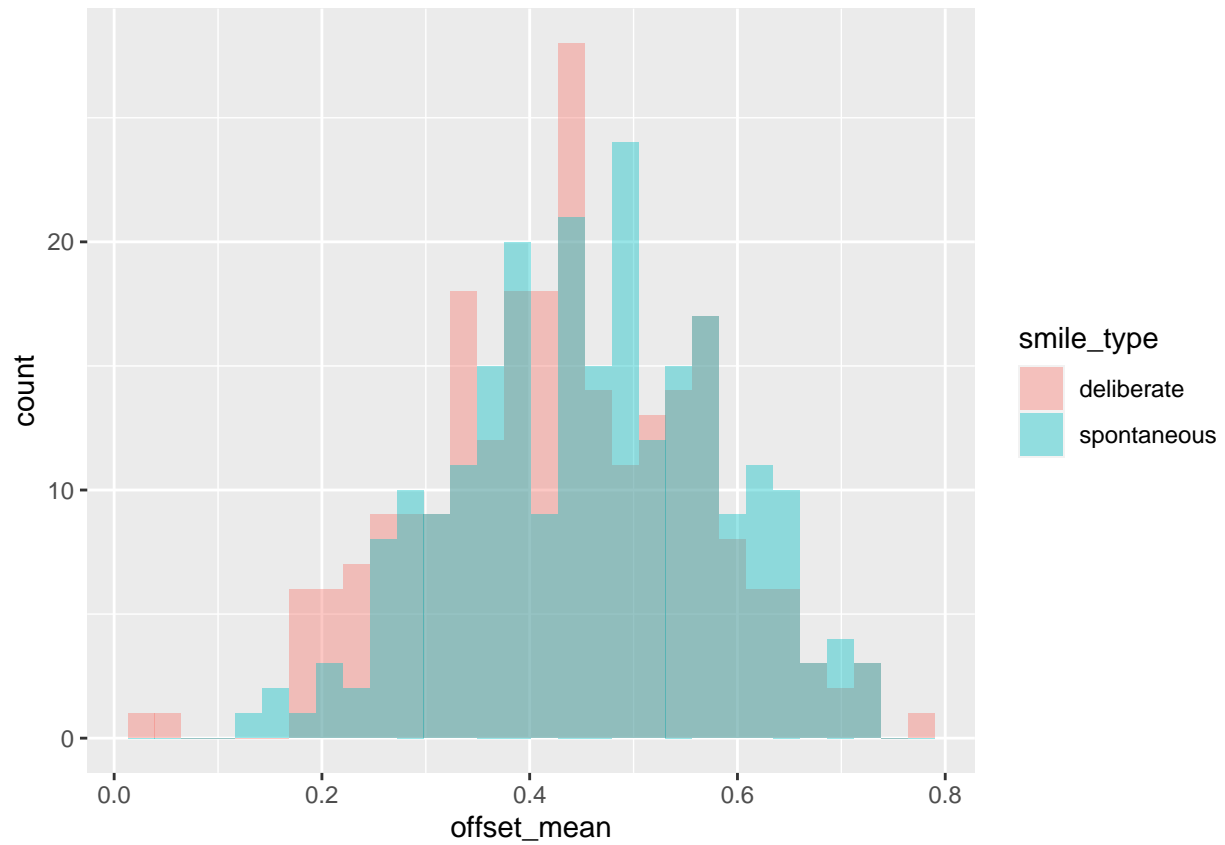
```
ggplot(UvA_sum, aes(x = offset_sd, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



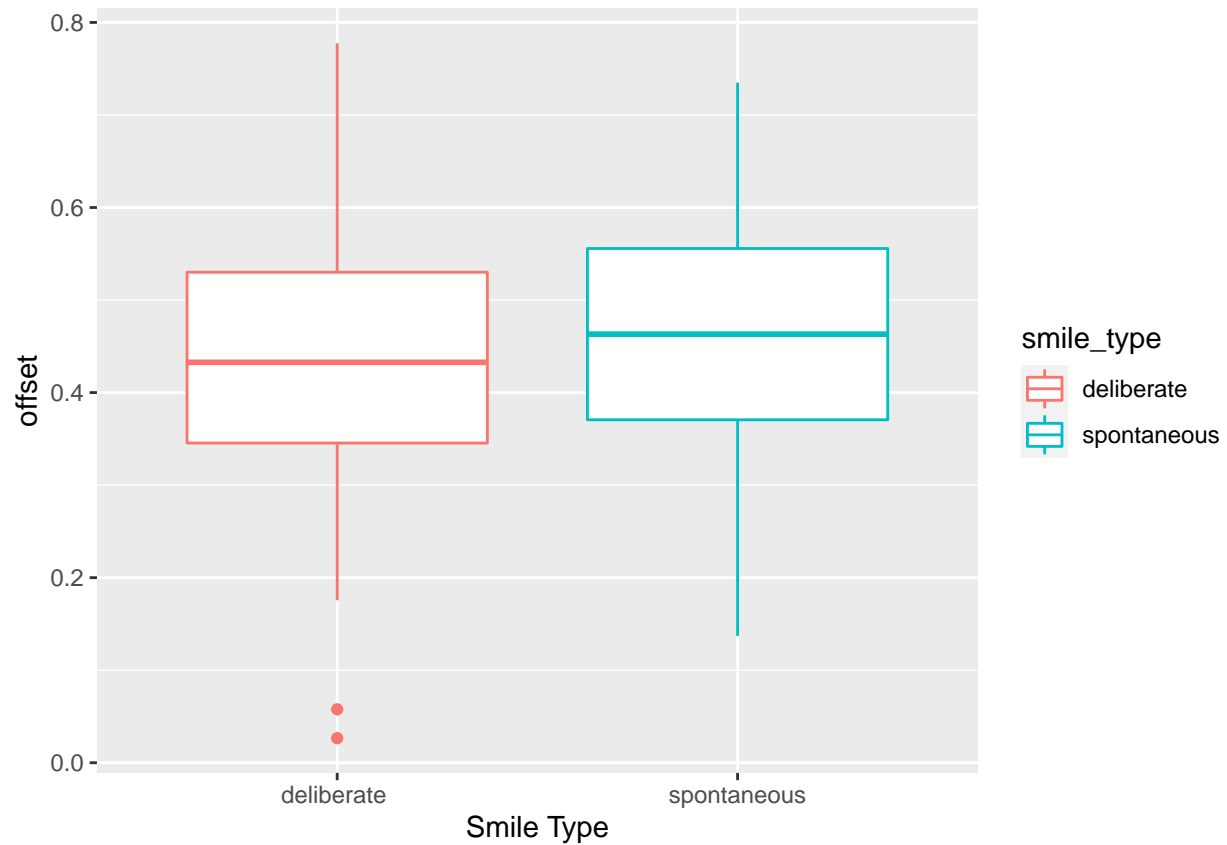
```
ggplot(UvA_sum, aes(x = offset_mean)) +  
  geom_histogram(fill = "white", colour = "black") +  
  facet_grid(smile_type ~ ., scales = "free")
```



```
ggplot(UvA_sum, aes(x = offset_mean, fill = smile_type)) +  
  geom_histogram(position = "identity", alpha = 0.4)
```



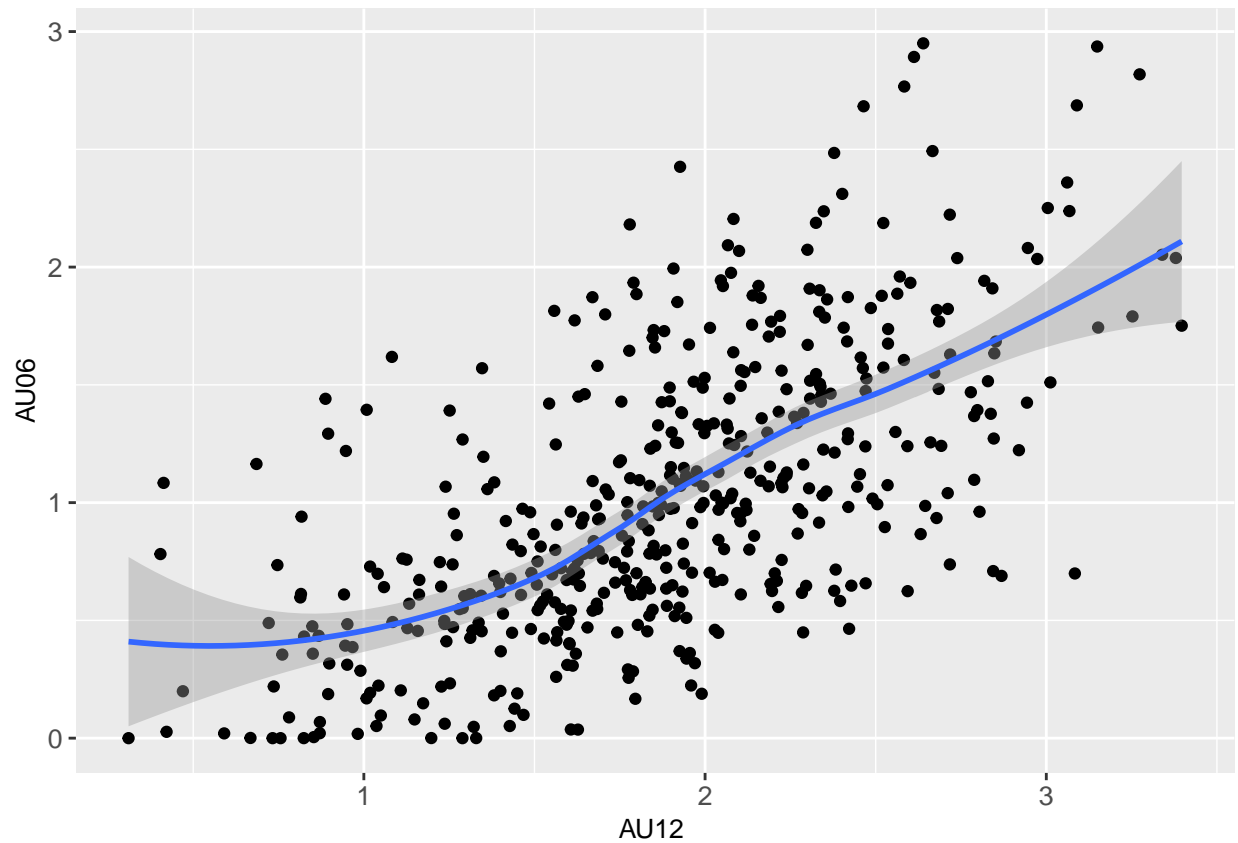
```
ggplot(UvA_sum, aes(x = smile_type, y = offset_mean, color = smile_type)) +  
  geom_boxplot() +  
  scale_y_continuous(name = "offset") +  
  scale_x_discrete(name = "Smile Type")
```



Some other check plot types to be maybe used later on

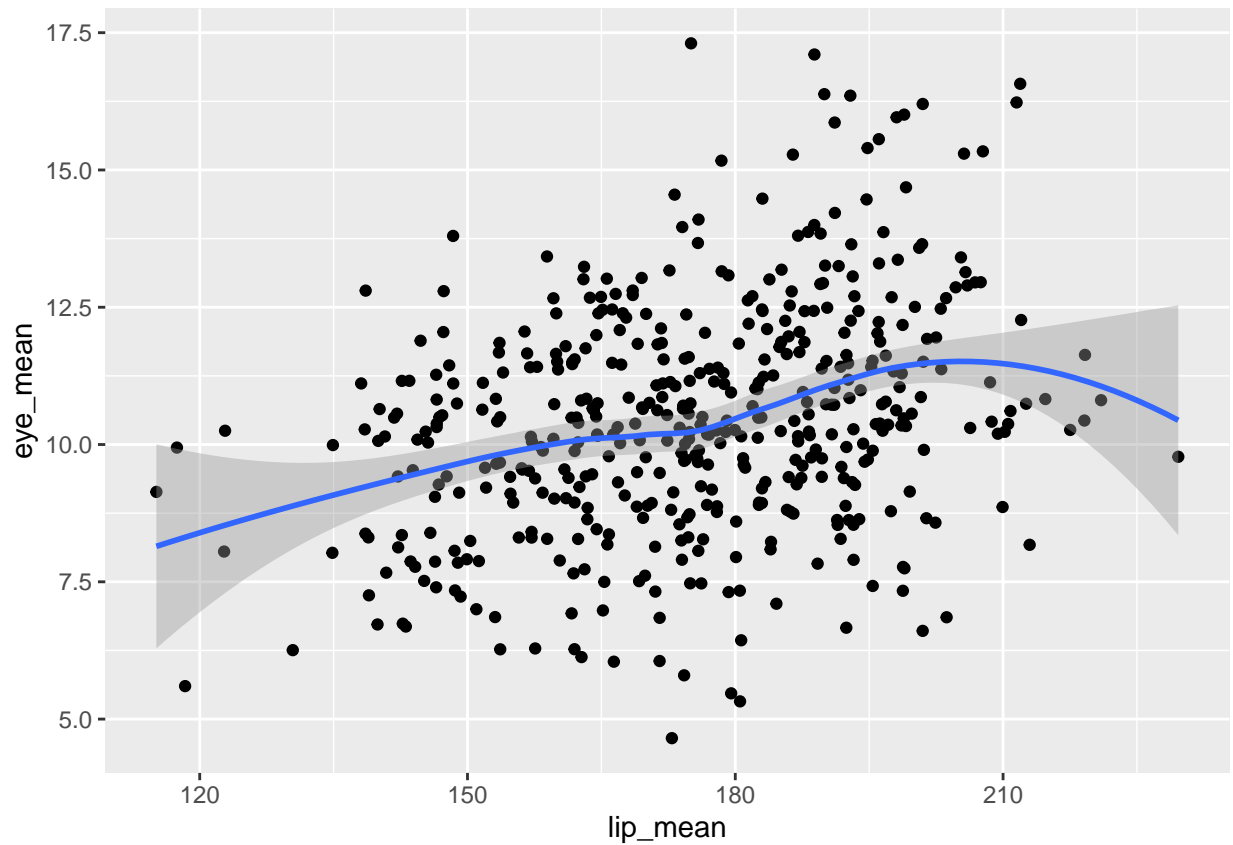
```
# apex vs AU's 6 and 12 for happiness
ggplot(data = UvA_sum, aes(x = AU12_r_mean, y = AU06_r_mean)) +
  geom_point() +
  geom_smooth() +
  scale_x_continuous(
    name = "AU12 ",
  ) +
  scale_y_continuous(name = "AU06") +
  labs() +
  theme(
    legend.position = "bottom", text = element_text(size = 10),
    axis.text = element_text(size = 10)
  )
```

```
## 'geom_smooth()' using method = 'loess' and formula 'y ~ x'
```



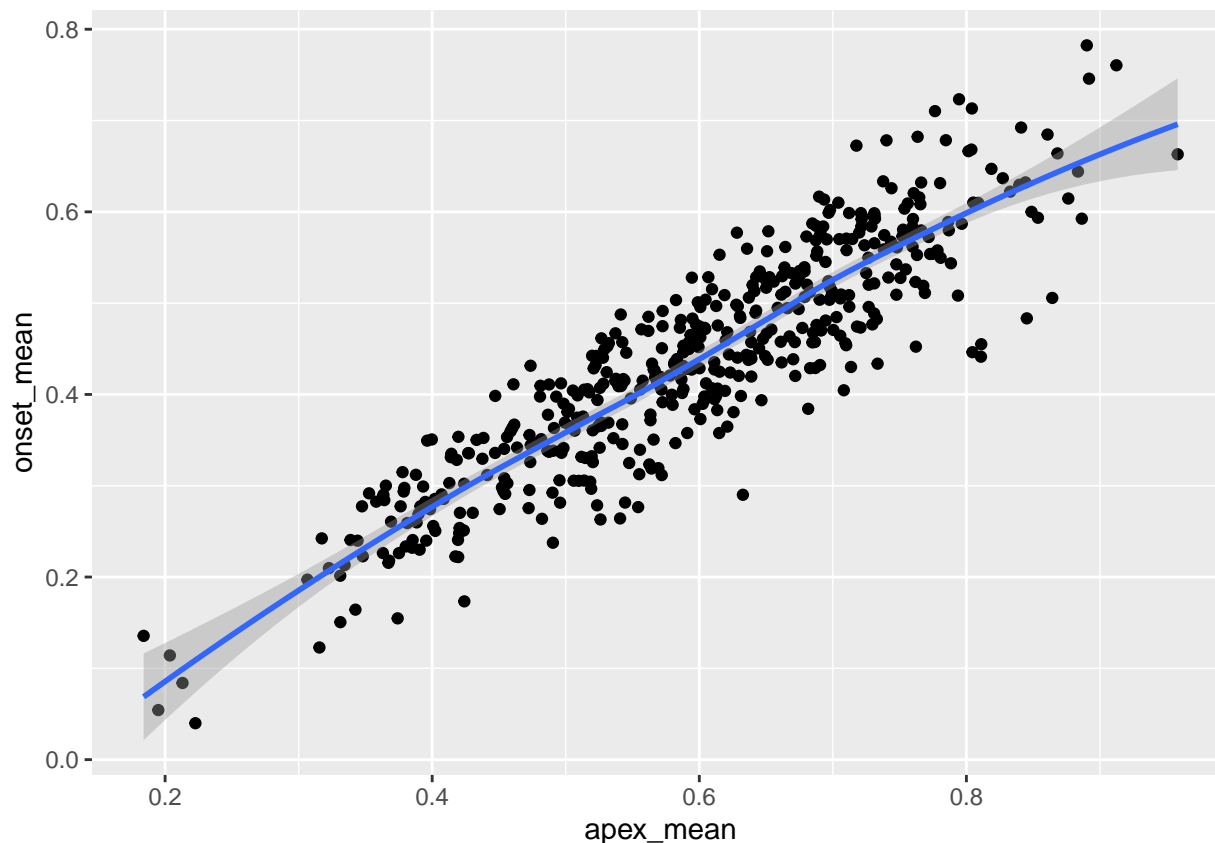
```
# correlation between eye and lip
ggplot(data = UvA_sum, aes(y = eye_mean, x = lip_mean)) +
  geom_point() +
  geom_smooth()

## 'geom_smooth()' using method = 'loess' and formula 'y ~ x'
```

```
# correlation between onset and apex  
ggplot(data = UvA_sum, aes(y = onset_mean, x = apex_mean)) +  
  geom_point() +  
  geom_smooth()
```

```
## 'geom_smooth()' using method = 'loess' and formula 'y ~ x'
```



Part 3: Train, predict and evaluation

The caret package is used to perform the training, testing and evaluation as well the splitting the data. Further explanation of the options and parameter settings of the caret package can be found in the thesis, via the citation link, or ? R help function.

Create data partitioning: Train and test set

```
# set.seed for modeling to 1973 for all models and predictions
set.seed(1973)

# loading packages
library(caret)
library(ggplot2)
library(dplyr)
library(tree)
library(rpart)
library(rpart.plot)
library(rattle)

# remove the filename (or ID) from the modelset to avoid overfilling
UvA_modelset$filename <- NULL
UvA_modelset$smile_type <- as.factor(UvA_modelset$smile_type)
```

```

UvA_modelset$gender <- as.factor(UvA_modelset$gender)

# releve to spontaneous smile
UvA_modelset$smile_type <- releve(UvA_modelset$smile_type, ref = "spontaneous")

# Split into training and test
set.seed(1973)
trn_index <- createDataPartition(UvA_modelset$smile_type, p = 0.7, list = FALSE)
trn_smile <- UvA_modelset[trn_index, ]
tst_smile <- UvA_modelset[-trn_index, ]

# Split the test set into boys and girls for detecting differences
set.seed(1973)
tst_smile_girls <- tst_smile %>%
  filter(gender == "female")
tst_smile_boys <- tst_smile %>%
  filter(gender == "male ")

# check the balance in the dataset for the independent variable
table(UvA_modelset$smile_type)

##
## spontaneous deliberate
##          235          240

```

```

# citation("caret")
# citation("tree")
# citation("rpart")
# citation("rpart.plot")
# citation("ggplot2")
# citation("rattle")

```

Tain, predict en evaluate models

Decision trees For the decision trees two packages are explored. For convenience of the project the choice has been made to work with the rpart package over the tree package. More information about these two packages can be found in the citation link or ? R help function. The trained models are divided into eight categories. Multiple models per category are explored. The explanation on the categories can be found in the thesis. To train the models the `train()` function is used. The models are stored as variable. The parameter settings are explained in the thesis. The models use 10 fold cross-validation. To check the density a visualization is added to the complete model. On this first complete model, also the pre-processing parameter is tested. This is done to see if scaling and centering the the dependent features improves the model. This is not the case for the complete decision tree including all features. The parameter is kept at default for that reason. To visualize the trained decision trees the rattle package is used. The package provides a nicer looking tree. The `predict()` function is used to create the predictions based on the test set, and stored as variable. For model evaluation the `confusionMatrix()` function is used and printed.

```

# check the balance for the baseline model
baseline_model <- table(trn_smile$smile_type)
baseline_model

```

```
##
```

```
## spontaneous deliberate
##           165           168
```

```
# model 0: complete model
```

```
# set the seed
```

```
set.seed(1973)
```

```
# train the model using train and rpart, store the model
```

```
smile__tree_model_0 <- train(smile_type ~ .,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
```

```
# check the outcome of the model
```

```
smile__tree_model_0$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5370544 0.07672893 0.07505544 0.1510397
## 2 0.05252525 0.5369652 0.07274720 0.07414327 0.1465495
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
# check and visualize the variable importance
```

```
varImp_0 <- varImp(smile__tree_model_0)
```

```
varImp_0
```

```
## rpart variable importance
```

```
##
```

```
## only 20 most important variables shown (out of 32)
```

```
##
```

```
## Overall
```

```
## AU45_r_mean 100.00
```

```
## AU01_r_mean 65.43
```

```
## AU25_r_mean 63.30
```

```
## apex_mean 59.99
```

```
## AU10_r_mean 54.54
```

```
## AU05_r_mean 52.28
```

```
## amplitude_mean 43.03
```

```
## lip_mean 43.03
```

```
## AU09_r_mean 40.62
```

```
## stage_mean 24.72
```

```
## AU14_r_mean 21.58
```

```
## AU20_r_mean 15.81
```

```
## AU15_r_mean 0.00
```

```
## age 0.00
```

```
## onset_mean 0.00
```

```
## AU23_r_mean 0.00
```

```
## AU12_r_mean 0.00
```

```
## pose_Ry_mean 0.00
```

```
## 'gendermale' 0.00
```

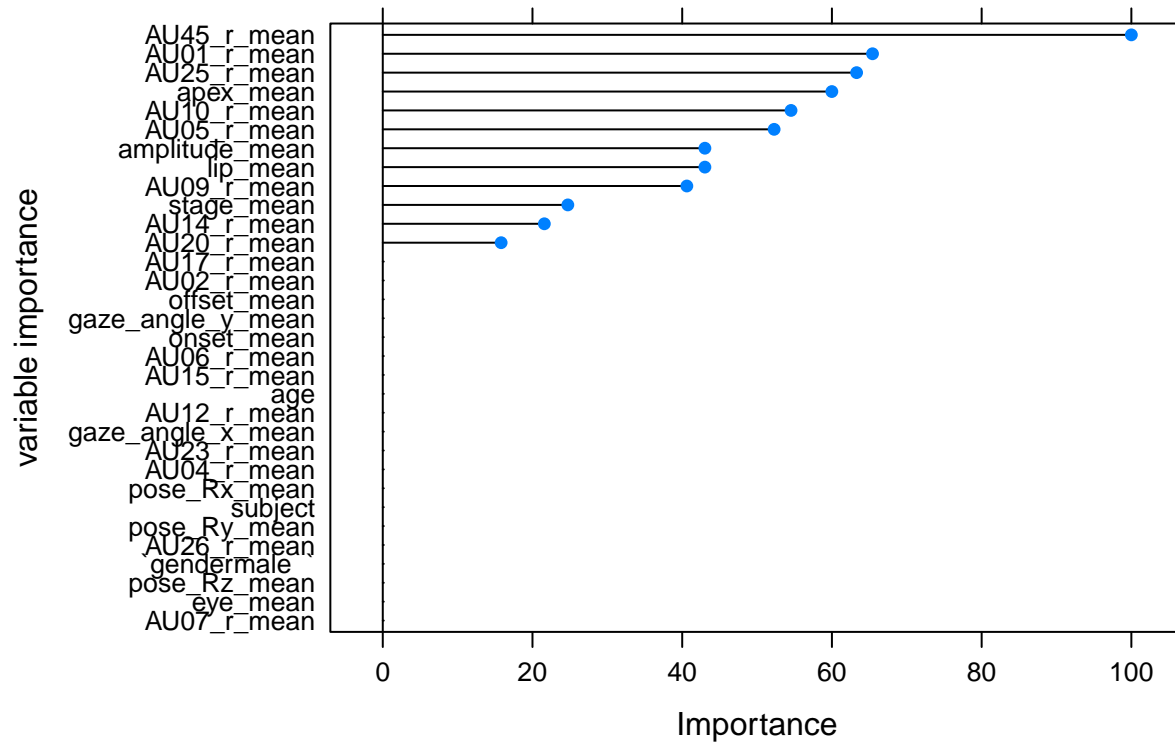
```
## AU04_r_mean 0.00
```

```

par(mfrow = c(1, 1))
par(mai = c(.8, .8, .2, .2))
plot(varImp_0,
     decreasing = TRUE,
     main = "Variable importance in complex model",
     ylab = "variable importance"
)

```

Variable importance in complex model

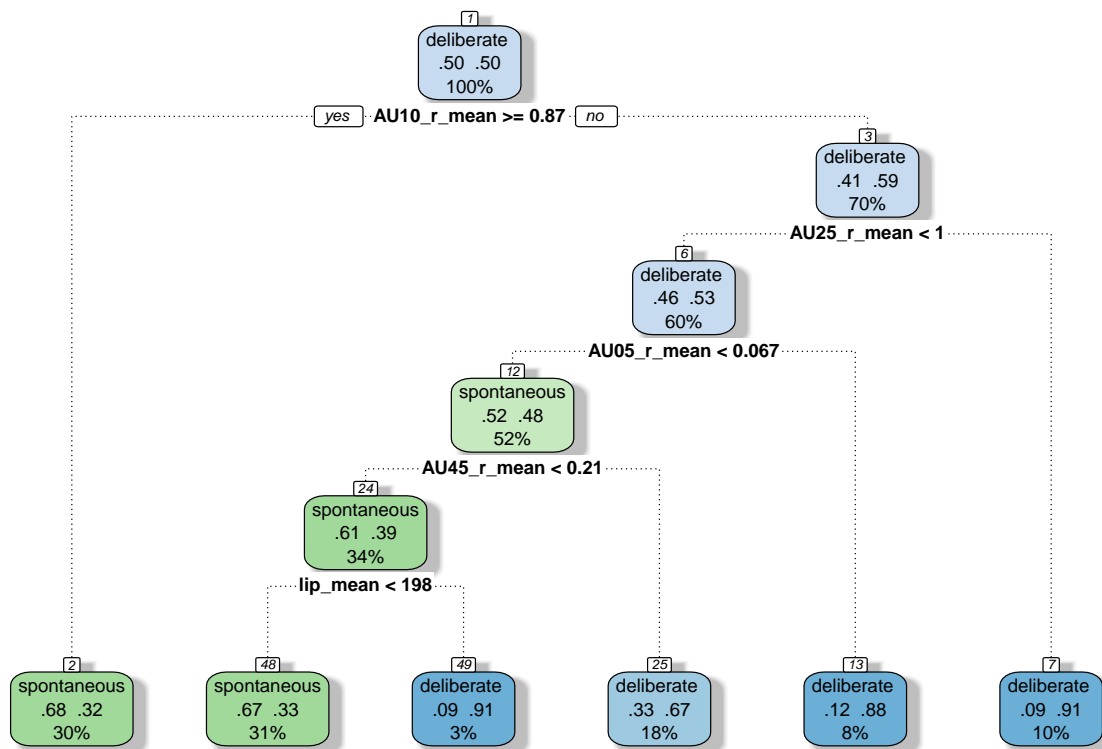


```

# summarize the model details - not printed
# summary(smile__tree_model_0$finalModel)

# visualize the tree using the rattle package
fancyRpartPlot(smile__tree_model_0$finalModel)

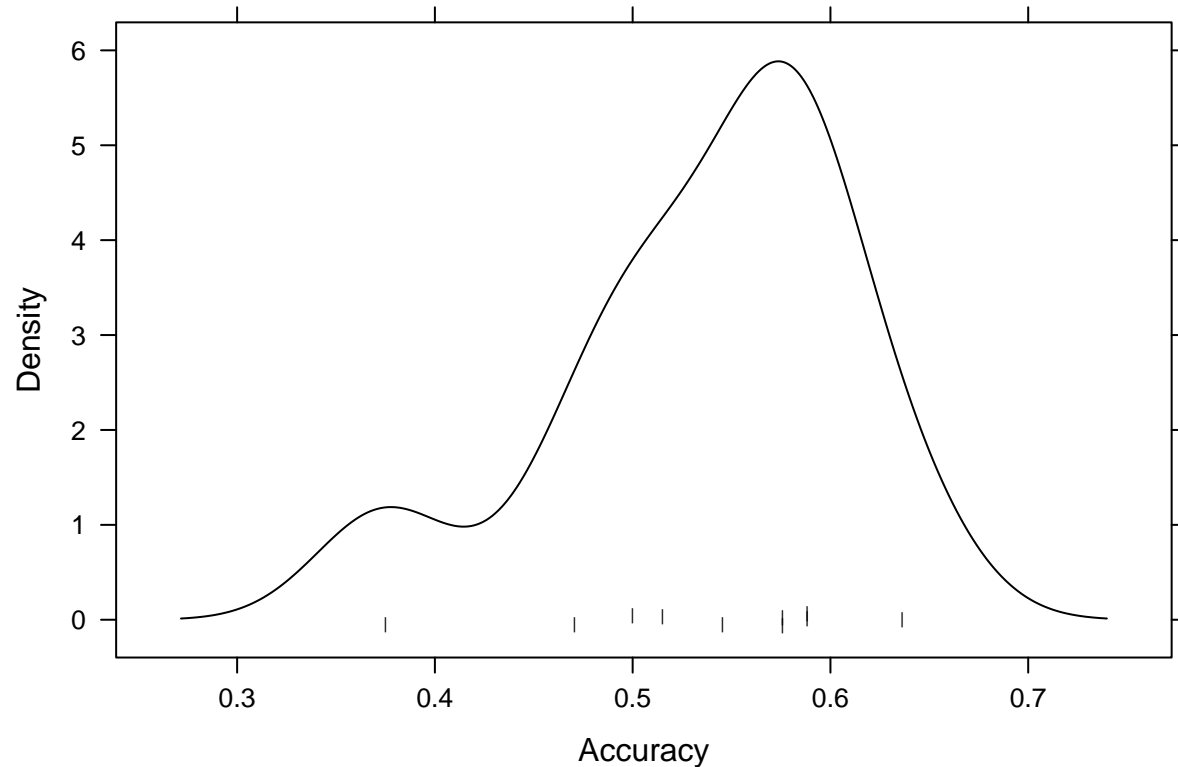
```



```

# density plot of accuracy measurements, check with the resample data
trellis.par.set(caretTheme())
densityplot(smile__tree_model_0, pch = "|")

```



```
smile__tree_model_0$resample
```

```
##      Accuracy      Kappa Resample
## 1  0.5151515  0.03649635  Fold02
## 2  0.6363636  0.27737226  Fold01
## 3  0.5757576  0.15693431  Fold03
## 4  0.5757576  0.15073529  Fold06
## 5  0.5882353  0.17647059  Fold05
## 6  0.5000000  0.00000000  Fold04
## 7  0.5454545  0.10163339  Fold07
## 8  0.5882353  0.17647059  Fold10
## 9  0.3750000 -0.25000000  Fold09
## 10 0.4705882 -0.05882353  Fold08
```

```
# model 0: complete model with centering and scaling - outcome does not change
set.seed(1973)
smile__tree_model_0.0.1 <- train(smile_type ~ .,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10),
  preProcess = c("center", "scale")
)
smile__tree_model_0.0.1$results
```

```
##      cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5370544 0.07672893 0.07505544 0.1510397
```

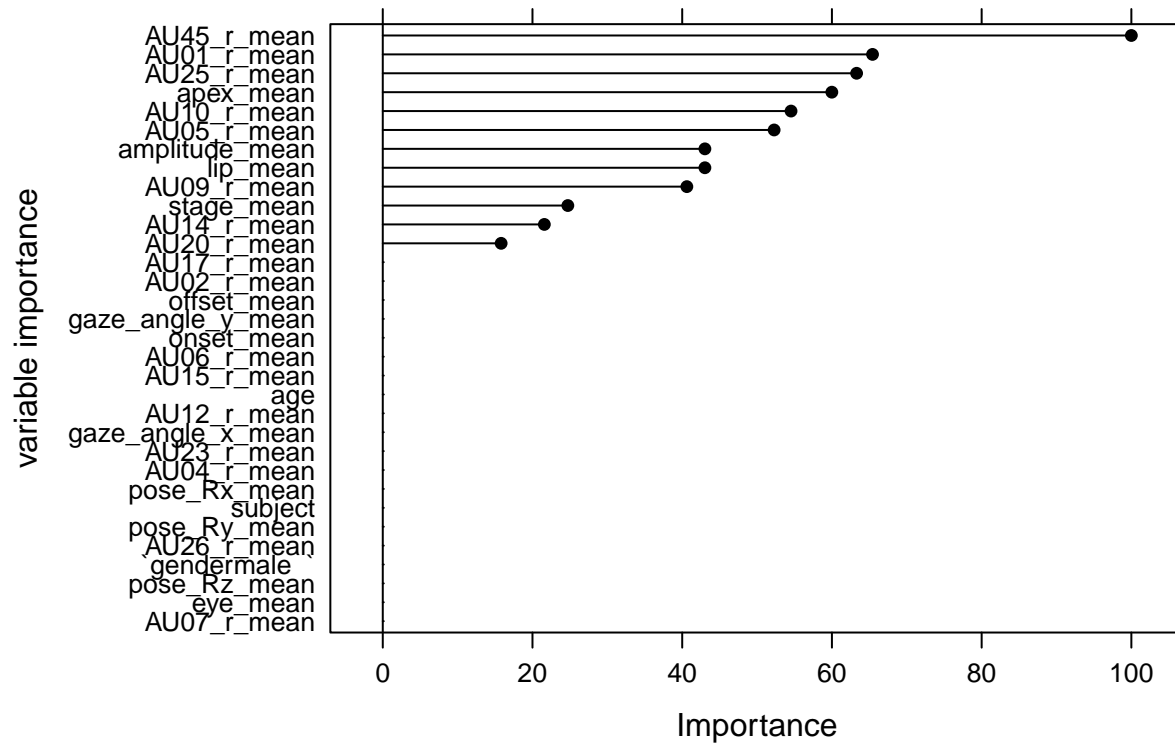
```
## 2 0.05252525 0.5369652 0.07274720 0.07414327 0.1465495
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
varImp_0.0.1 <- varImp(smile__tree_model_0.0.1)
varImp_0.0.1
```

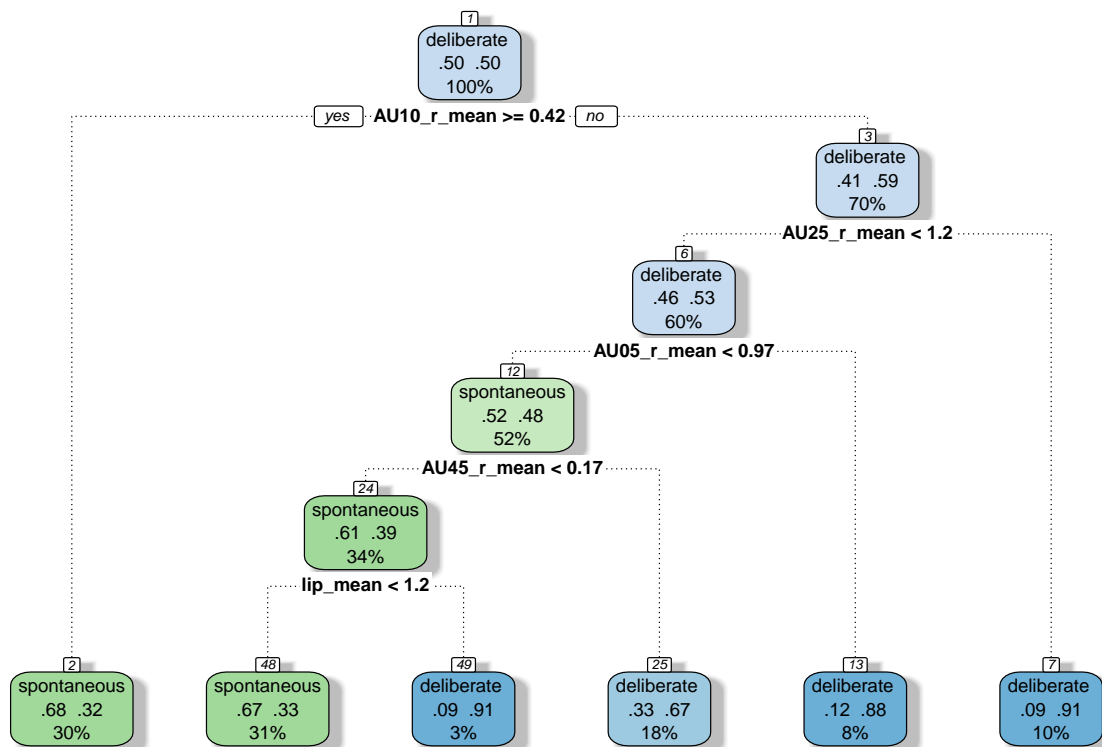
```
## rpart variable importance
##
##   only 20 most important variables shown (out of 32)
##
##           Overall
## AU45_r_mean    100.00
## AU01_r_mean     65.43
## AU25_r_mean     63.30
## apex_mean       59.99
## AU10_r_mean     54.54
## AU05_r_mean     52.28
## amplitude_mean  43.03
## lip_mean        43.03
## AU09_r_mean     40.62
## stage_mean      24.72
## AU14_r_mean     21.58
## AU20_r_mean     15.81
## AU15_r_mean      0.00
## age             0.00
## onset_mean      0.00
## AU23_r_mean      0.00
## AU12_r_mean      0.00
## pose_Ry_mean     0.00
## 'gendermale '    0.00
## AU04_r_mean      0.00
```

```
par(mfrow = c(1, 1))
par(mai = c(.8, .8, .2, .2))
plot(varImp_0,
     decreasing = TRUE,
     main = "Variable importance in complex model",
     ylab = "variable importance"
)
```


Variable importance in complex model



```
# summary(smile__tree_model_0$finalModel)
# visualize the tree using the rattle package
fancyRpartPlot(smile__tree_model_0.0.1$finalModel)
```



```

# predict based on the test set and the model, store the model
set.seed(1973)
smile__tree_model_0_pred <- predict(smile__tree_model_0, tst_smile)

# summary of the prediction
summary(smile__tree_model_0_pred)

```

```

## spontaneous deliberate
##           79           63

```

```

# create a confusion matrix to evaluate the model
smile__tree_model_0_confM <- confusionMatrix(
  smile__tree_model_0_pred,
  tst_smile$smile_type
)

# print the confusion matrix
smile__tree_model_0_confM

```

```

## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      42           37
## deliberate       28           35

```

```
##
##           Accuracy : 0.5423
##           95% CI : (0.4567, 0.6261)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.2251
##
##           Kappa : 0.086
##
##  McNemar's Test P-Value : 0.3211
##
##           Sensitivity : 0.6000
##           Specificity : 0.4861
##      Pos Pred Value : 0.5316
##      Neg Pred Value : 0.5556
##           Prevalence : 0.4930
##      Detection Rate : 0.2958
##      Detection Prevalence : 0.5563
##      Balanced Accuracy : 0.5431
##
##      'Positive' Class : spontaneous
##
```

same way working for predicting boys and girls

```
set.seed(1973)
smile__tree_model_0.1_pred <- predict(smile__tree_model_0, tst_smile_boys)
summary(smile__tree_model_0.1_pred)
```

```
## spontaneous deliberate
##           35           42
```

```
smile__tree_model_0.1_confM <- confusionMatrix(
  smile__tree_model_0.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_0.1_confM
```

Confusion Matrix and Statistics

```
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous           18           17
##  deliberate            19           23
##
##           Accuracy : 0.5325
##           95% CI : (0.4152, 0.6471)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.4552
##
##           Kappa : 0.0616
##
##  McNemar's Test P-Value : 0.8676
##
##           Sensitivity : 0.4865
```

```
##           Specificity : 0.5750
##           Pos Pred Value : 0.5143
##           Neg Pred Value : 0.5476
##           Prevalence : 0.4805
##           Detection Rate : 0.2338
##           Detection Prevalence : 0.4545
##           Balanced Accuracy : 0.5307
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_0.2_pred <- predict(smile__tree_model_0, tst_smile_girls)
summary(smile__tree_model_0.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__tree_model_0.2_confM <- confusionMatrix(
  smile__tree_model_0.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_0.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      24           20
## deliberate       9           12
##
##           Accuracy : 0.5538
##           95% CI : (0.4253, 0.6773)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.26784
##
##           Kappa : 0.1028
##
##           Mcnemar's Test P-Value : 0.06332
##
##           Sensitivity : 0.7273
##           Specificity : 0.3750
##           Pos Pred Value : 0.5455
##           Neg Pred Value : 0.5714
##           Prevalence : 0.5077
##           Detection Rate : 0.3692
##           Detection Prevalence : 0.6769
##           Balanced Accuracy : 0.5511
##
##           'Positive' Class : spontaneous
##
```

```
# model 1 onset-apex-offset
set.seed(1973)
smile__tree_model_1 <- train(smile_type ~ onset_mean + offset_mean + apex_mean,
  method = "rpart", data = trn_smile,
  trnControl = trainControl(method = "cv", number = 10)
)
smile__tree_model_1$results
```

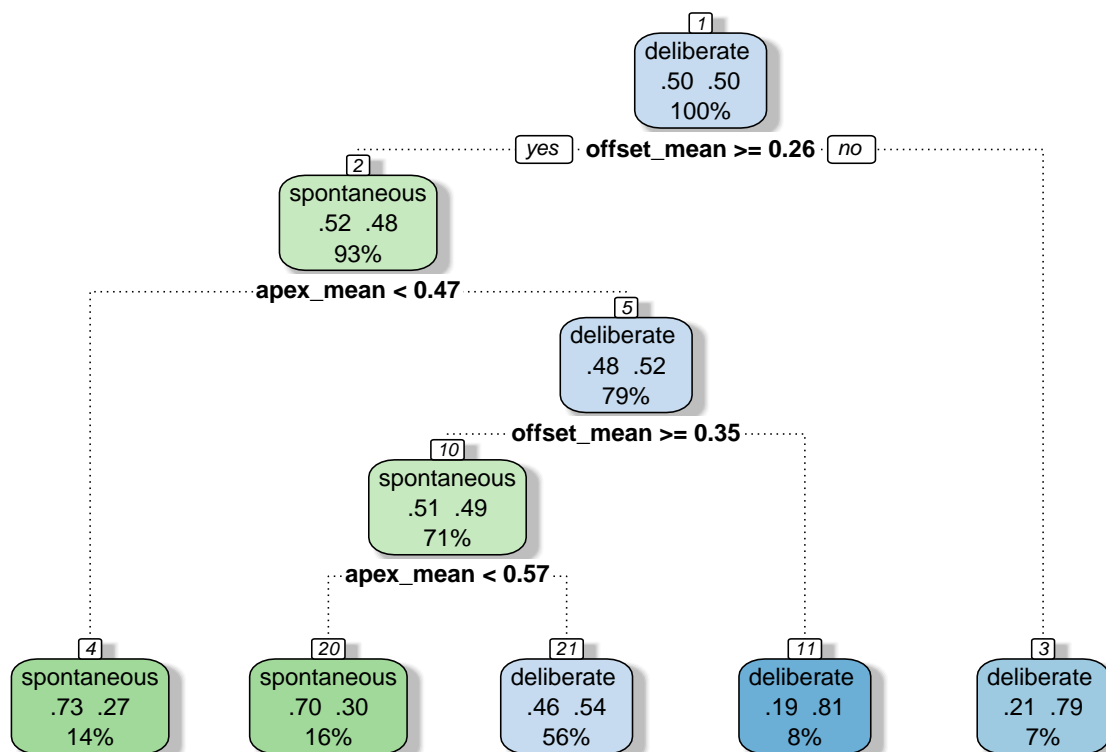
```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.05757576 0.5402184 0.08170716 0.07437569 0.1470887
## 2 0.06262626 0.5373663 0.07391236 0.07093887 0.1393274
## 3 0.06666667 0.5165107 0.03871962 0.06565946 0.1244773
```

```
varImp(smile__tree_model_1)
```

```
## rpart variable importance
##
##           Overall
## apex_mean      100.00
## offset_mean     51.79
## onset_mean       0.00
```

```
# summary(smile__tree_model_1$finalModel)
```

```
fancyRpartPlot(smile__tree_model_1$finalModel)
```



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```
smile__tree_model_1_pred <- predict(smile__tree_model_1, tst_smile)
summary(smile__tree_model_1_pred)
```

```
## spontaneous deliberate
##           28           114
```

```
smile__tree_model_1_confM <- confusionMatrix(
  smile__tree_model_1_pred,
  tst_smile$smile_type
)
smile__tree_model_1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           16           12
## deliberate           54           60
##
##              Accuracy : 0.5352
##              95% CI : (0.4497, 0.6193)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.2786
##
##              Kappa : 0.0624
##
##  Mcnemar's Test P-Value : 4.494e-07
##
##      Sensitivity : 0.2286
##      Specificity : 0.8333
##      Pos Pred Value : 0.5714
##      Neg Pred Value : 0.5263
##      Prevalence : 0.4930
##      Detection Rate : 0.1127
##      Detection Prevalence : 0.1972
##      Balanced Accuracy : 0.5310
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_1.1_pred <- predict(smile__tree_model_1, tst_smile_boys)
summary(smile__tree_model_1.1_pred)
```

```
## spontaneous deliberate
##           17           60
```

```
smile__tree_model_1.1_confM <- confusionMatrix(
  smile__tree_model_1.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_1.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      10           7
## deliberate       27          33
##
##               Accuracy : 0.5584
##               95% CI : (0.4407, 0.6716)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.28475
##
##               Kappa : 0.0972
##
## Mcnemar's Test P-Value : 0.00112
##
##       Sensitivity : 0.2703
##       Specificity : 0.8250
##       Pos Pred Value : 0.5882
##       Neg Pred Value : 0.5500
##       Prevalence : 0.4805
##       Detection Rate : 0.1299
##       Detection Prevalence : 0.2208
##       Balanced Accuracy : 0.5476
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_1.2_pred <- predict(smile__tree_model_1, tst_smile_girls)
summary(smile__tree_model_1.2_pred)
```

```
## spontaneous deliberate
##           11           54
```

```
smile__tree_model_1.2_confM <- confusionMatrix(
  smile__tree_model_1.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_1.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      6           5
## deliberate       27          27
##
##               Accuracy : 0.5077
##               95% CI : (0.3807, 0.634)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.5495482
##
```

```
##                Kappa : 0.0253
##
## Mcnemar's Test P-Value : 0.0002054
##
##          Sensitivity : 0.18182
##          Specificity : 0.84375
##          Pos Pred Value : 0.54545
##          Neg Pred Value : 0.50000
##          Prevalence : 0.50769
##          Detection Rate : 0.09231
##          Detection Prevalence : 0.16923
##          Balanced Accuracy : 0.51278
##
##          'Positive' Class : spontaneous
##
```

```
# model 1A onset
set.seed(1973)
smile__tree_model_1A <- train(smile_type ~ onset_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__tree_model_1A$results
```

```
##          cp Accuracy          Kappa AccuracySD      KappaSD
## 1 0.01515152 0.4710060 -0.055638375 0.08058915 0.15999168
## 2 0.02424242 0.4741254 -0.051455995 0.05907009 0.11360546
## 3 0.04242424 0.4986631 -0.005634066 0.04641479 0.08338809
```

```
# summary(smile__tree_model_1A$finalModel)

smile__tree_model_1A_pred <- predict(smile__tree_model_1A, tst_smile)
summary(smile__tree_model_1A_pred)
```

```
## spontaneous deliberate
##          0          142
```

```
smile__tree_model_1A_confM <- confusionMatrix(
  smile__tree_model_1A_pred,
  tst_smile$smile_type
)
smile__tree_model_1A_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
##  spontaneous          0          0
##  deliberate          70          72
##
##          Accuracy : 0.507
##          95% CI : (0.4219, 0.5919)
```



```
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.5336
##
##              Kappa : 0
##
##  Mcnemar's Test P-Value : <2e-16
##
##      Sensitivity : 0.000
##      Specificity : 1.000
##      Pos Pred Value :  NaN
##      Neg Pred Value : 0.507
##      Prevalence : 0.493
##      Detection Rate : 0.000
##      Detection Prevalence : 0.000
##      Balanced Accuracy : 0.500
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_1A.1_pred <- predict(smile__tree_model_1A, tst_smile_boys)
summary(smile__tree_model_1A.1_pred)
```

```
## spontaneous deliberate
##           0           77
```

```
smile__tree_model_1A.1_confM <- confusionMatrix(
  smile__tree_model_1A.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_1A.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           0           0
## deliberate          37          40
##
##      Accuracy : 0.5195
##      95% CI : (0.4026, 0.6348)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.5459
##
##              Kappa : 0
##
##  Mcnemar's Test P-Value : 3.252e-09
##
##      Sensitivity : 0.0000
##      Specificity : 1.0000
##      Pos Pred Value :  NaN
##      Neg Pred Value : 0.5195
```

```
##           Prevalence : 0.4805
##       Detection Rate : 0.0000
##   Detection Prevalence : 0.0000
##       Balanced Accuracy : 0.5000
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_1A.2_pred <- predict(smile__tree_model_1A, tst_smile_girls)
summary(smile__tree_model_1A.2_pred)
```

```
## spontaneous deliberate
##           0           65
```

```
smile__tree_model_1A.2_confM <- confusionMatrix(
  smile__tree_model_1A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_1A.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           0           0
## deliberate          33          32
##
##           Accuracy : 0.4923
##           95% CI : (0.366, 0.6193)
##   No Information Rate : 0.5077
##   P-Value [Acc > NIR] : 0.6452
##
##           Kappa : 0
##
## Mcnemar's Test P-Value : 2.54e-08
##
##           Sensitivity : 0.0000
##           Specificity : 1.0000
##   Pos Pred Value :      NaN
##   Neg Pred Value : 0.4923
##           Prevalence : 0.5077
##   Detection Rate : 0.0000
##   Detection Prevalence : 0.0000
##   Balanced Accuracy : 0.5000
##
##       'Positive' Class : spontaneous
##
```

```
# model 1B apex
set.seed(1973)
smile__tree_model_1B <- train(smile_type ~ apex_mean,
```

```

method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)
smile__tree_model_1B$results

```

```

##           cp Accuracy          Kappa AccuracySD   KappaSD
## 1 0.01818182 0.4931540 -0.01455893 0.06234358 0.1266862
## 2 0.02121212 0.4928866 -0.01707760 0.06605422 0.1333608
## 3 0.11515152 0.4866310 -0.03605245 0.03749912 0.0690707

```

```

# summary(smile__tree_model_1B$finalModel)

```

```

smile__tree_model_1B_pred <- predict(smile__tree_model_1B, tst_smile)
summary(smile__tree_model_1B_pred)

```

```

## spontaneous deliberate
##           23           119

```

```

smile__tree_model_1B_confM <- confusionMatrix(
  smile__tree_model_1B_pred,
  tst_smile$smile_type
)
smile__tree_model_1B_confM

```

```

## Confusion Matrix and Statistics

```

```

##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           13           10
## deliberate           57           62
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##   No Information Rate : 0.507
##   P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.0473
##
## Mcnemar's Test P-Value : 1.912e-08
##
##           Sensitivity : 0.18571
##           Specificity : 0.86111
##           Pos Pred Value : 0.56522
##           Neg Pred Value : 0.52101
##           Prevalence : 0.49296
##           Detection Rate : 0.09155
##   Detection Prevalence : 0.16197
##           Balanced Accuracy : 0.52341
##
##           'Positive' Class : spontaneous
##

```

```
set.seed(1973)
smile__tree_model_1B.1_pred <- predict(smile__tree_model_1B, tst_smile_boys)
summary(smile__tree_model_1B.1_pred)
```

```
## spontaneous deliberate
##           14           63
```

```
smile__tree_model_1B.1_confM <- confusionMatrix(
  smile__tree_model_1B.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_1B.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           9             5
## deliberate          28            35
##
##              Accuracy : 0.5714
##              95% CI : (0.4535, 0.6837)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.2125930
##
##              Kappa : 0.1211
##
##  Mcnemar's Test P-Value : 0.0001283
##
##      Sensitivity : 0.2432
##      Specificity : 0.8750
##      Pos Pred Value : 0.6429
##      Neg Pred Value : 0.5556
##      Prevalence : 0.4805
##      Detection Rate : 0.1169
##      Detection Prevalence : 0.1818
##      Balanced Accuracy : 0.5591
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_1B.2_pred <- predict(smile__tree_model_1B, tst_smile_girls)
summary(smile__tree_model_1B.2_pred)
```

```
## spontaneous deliberate
##           9           56
```

```
smile__tree_model_1B.2_confM <- confusionMatrix(
  smile__tree_model_1B.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_1B.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      4             5
## deliberate      29            27
##
##           Accuracy : 0.4769
##           95% CI : (0.3515, 0.6046)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.7324
##
##           Kappa : -0.0346
##
## Mcnemar's Test P-Value : 7.998e-05
##
##           Sensitivity : 0.12121
##           Specificity : 0.84375
##       Pos Pred Value : 0.44444
##       Neg Pred Value : 0.48214
##           Prevalence : 0.50769
##       Detection Rate : 0.06154
##       Detection Prevalence : 0.13846
##       Balanced Accuracy : 0.48248
##
##       'Positive' Class : spontaneous
##
```

```
# model 1C offset
set.seed(1973)
smile__tree_model_1C <- train(smile_type ~ offset_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__tree_model_1C$results
```

```
##           cp Accuracy           Kappa AccuracySD      KappaSD
## 1 0.01515152 0.4804924 -0.035544289 0.08003429 0.15971621
## 2 0.02424242 0.4951036 -0.005294115 0.07130717 0.14356728
## 3 0.06666667 0.5014316  0.016202110 0.03203681 0.05735123
```

```
# summary(smile__tree_model_1C$finalModel)

smile__tree_model_1C_pred <- predict(smile__tree_model_1C, tst_smile)
summary(smile__tree_model_1C_pred)
```

```
## spontaneous deliberate
##           0           142
```

```
smile__tree_model_1C_confM <- confusionMatrix(
  smile__tree_model_1C_pred,
  tst_smile$smile_type
```

```
)
smile__tree_model_1C_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           0           0
## deliberate           70           72
##
##               Accuracy : 0.507
##               95% CI : (0.4219, 0.5919)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.5336
##
##               Kappa : 0
##
## Mcnemar's Test P-Value : <2e-16
##
##       Sensitivity : 0.000
##       Specificity : 1.000
##       Pos Pred Value : NaN
##       Neg Pred Value : 0.507
##       Prevalence : 0.493
##       Detection Rate : 0.000
##       Detection Prevalence : 0.000
##       Balanced Accuracy : 0.500
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_1C.1_pred <- predict(smile__tree_model_1C, tst_smile_boys)
summary(smile__tree_model_1C.1_pred)
```

```
## spontaneous deliberate
##           0           77
```

```
smile__tree_model_1C.1_confM <- confusionMatrix(
  smile__tree_model_1C.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_1C.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           0           0
## deliberate           37           40
##
##               Accuracy : 0.5195
```

```
##          95% CI : (0.4026, 0.6348)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.5459
##
##          Kappa : 0
##
##    McNemar's Test P-Value : 3.252e-09
##
##          Sensitivity : 0.0000
##          Specificity : 1.0000
##    Pos Pred Value :    NaN
##    Neg Pred Value : 0.5195
##          Prevalence : 0.4805
##    Detection Rate : 0.0000
##    Detection Prevalence : 0.0000
##    Balanced Accuracy : 0.5000
##
##    'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_1C.2_pred <- predict(smile__tree_model_1C, tst_smile_girls)
summary(smile__tree_model_1C.2_pred)
```

```
## spontaneous deliberate
##           0           65
```

```
smile__tree_model_1C.2_confM <- confusionMatrix(
  smile__tree_model_1C.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_1C.2_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous           0           0
## deliberate          33          32
##
##          Accuracy : 0.4923
##          95% CI : (0.366, 0.6193)
##    No Information Rate : 0.5077
##    P-Value [Acc > NIR] : 0.6452
##
##          Kappa : 0
##
##    McNemar's Test P-Value : 2.54e-08
##
##          Sensitivity : 0.0000
##          Specificity : 1.0000
##    Pos Pred Value :    NaN
##    Neg Pred Value : 0.4923
```

```
##           Prevalence : 0.5077
##           Detection Rate : 0.0000
##           Detection Prevalence : 0.0000
##           Balanced Accuracy : 0.5000
##
##           'Positive' Class : spontaneous
##
```

```
# model 2 complete excluding subject and age info
set.seed(1973)
smile__tree_model_2 <- train(smile_type ~ . - subject - age,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

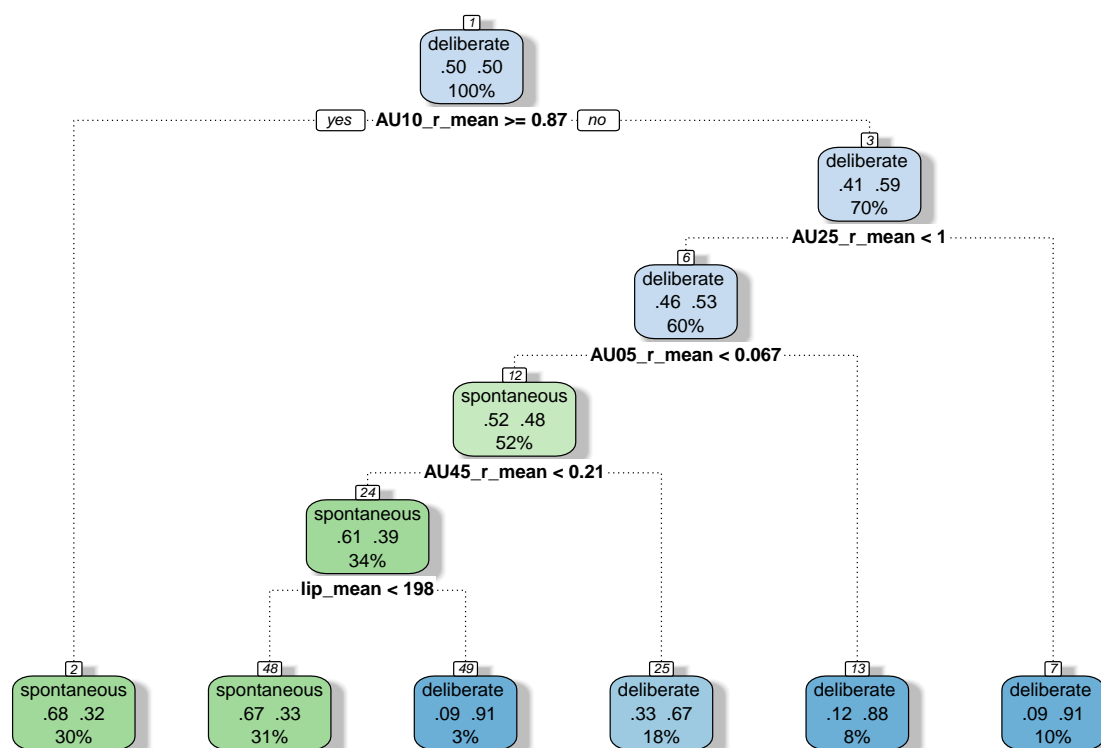
smile__tree_model_2$results
```

```
##           cp Accuracy      Kappa AccuracySD   KappaSD
## 1 0.03636364 0.5458779 0.09437598 0.07540099 0.1513876
## 2 0.05252525 0.5369652 0.07274720 0.07414327 0.1465495
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
varImp(smile__tree_model_2)
```

```
## rpart variable importance
##
##   only 20 most important variables shown (out of 30)
##
##           Overall
## AU45_r_mean      100.00
## AU01_r_mean       65.43
## AU25_r_mean       63.30
## apex_mean        59.99
## AU10_r_mean       54.54
## AU05_r_mean       52.28
## amplitude_mean    43.03
## lip_mean          43.03
## AU09_r_mean       40.62
## stage_mean        24.72
## AU14_r_mean       21.58
## AU20_r_mean       15.81
## AU23_r_mean        0.00
## gaze_angle_y_mean  0.00
## eye_mean          0.00
## AU17_r_mean       0.00
## AU02_r_mean       0.00
## gaze_angle_x_mean  0.00
## AU07_r_mean       0.00
## 'gendermale'      0.00
```

```
# summary(smile__tree_model_2$finalModel)
fancyRpartPlot(smile__tree_model_2$finalModel)
```

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```
smile__tree_model_2_pred <- predict(smile__tree_model_2, tst_smile)
summary(smile__tree_model_2_pred)
```

```
## spontaneous deliberate
##           79           63
```

```
smile__tree_model_2_confM <- confusionMatrix(
  smile__tree_model_2_pred,
  tst_smile$smile_type
)
smile__tree_model_2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      42           37
## deliberate       28           35
##
##           Accuracy : 0.5423
##           95% CI : (0.4567, 0.6261)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.2251
##
##           Kappa : 0.086
```

```
##
## McNemar's Test P-Value : 0.3211
##
##          Sensitivity : 0.6000
##          Specificity : 0.4861
##          Pos Pred Value : 0.5316
##          Neg Pred Value : 0.5556
##          Prevalence : 0.4930
##          Detection Rate : 0.2958
##          Detection Prevalence : 0.5563
##          Balanced Accuracy : 0.5431
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_2.1_pred <- predict(smile__tree_model_2, tst_smile_boys)
summary(smile__tree_model_2.1_pred)
```

```
## spontaneous deliberate
##          35          42
```

```
smile__tree_model_2.1_confM <- confusionMatrix(
  smile__tree_model_2.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_2.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          18          17
## deliberate           19          23
##
##          Accuracy : 0.5325
##          95% CI : (0.4152, 0.6471)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.4552
##
##          Kappa : 0.0616
##
## McNemar's Test P-Value : 0.8676
##
##          Sensitivity : 0.4865
##          Specificity : 0.5750
##          Pos Pred Value : 0.5143
##          Neg Pred Value : 0.5476
##          Prevalence : 0.4805
##          Detection Rate : 0.2338
##          Detection Prevalence : 0.4545
##          Balanced Accuracy : 0.5307
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_2.2_pred <- predict(smile__tree_model_2, tst_smile_girls)
summary(smile__tree_model_2.2_pred)

## spontaneous deliberate
##           44           21

smile__tree_model_2.2_confM <- confusionMatrix(
  smile__tree_model_2.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_2.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           24           20
## deliberate            9           12
##
##              Accuracy : 0.5538
##              95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.26784
##
##              Kappa : 0.1028
##
## Mcnemar's Test P-Value : 0.06332
##
##              Sensitivity : 0.7273
##              Specificity : 0.3750
##              Pos Pred Value : 0.5455
##              Neg Pred Value : 0.5714
##              Prevalence : 0.5077
##              Detection Rate : 0.3692
##      Detection Prevalence : 0.6769
##              Balanced Accuracy : 0.5511
##
##      'Positive' Class : spontaneous
##

# model 3 complete lip and eye features
set.seed(1973)
smile__tree_model_3 <- train(smile_type ~ lip_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

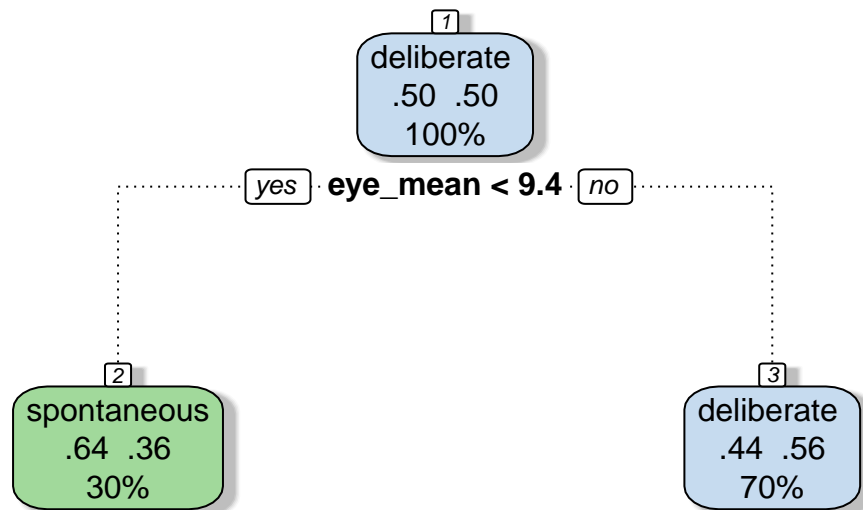
smile__tree_model_3$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.01515152 0.5526738 0.10440266 0.09180319 0.18217867
## 2 0.06666667 0.5892435 0.17469528 0.10479850 0.21101409
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

```
varImp(smile__tree_model_3)
```

```
## rpart variable importance
##
##           Overall
## eye_mean      100
## lip_mean        0
```

```
# summary(smile__tree_model_3$finalModel)
fancyRpartPlot(smile__tree_model_3$finalModel)
```



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```
smile__tree_model_3_pred <- predict(smile__tree_model_3, tst_smile)
summary(smile__tree_model_3_pred)
```

```
## spontaneous deliberate
##           41          101
```

```
smile__tree_model_3_confM <- confusionMatrix(
  smile__tree_model_3_pred,
  tst_smile$smile_type
)
smile__tree_model_3_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      25          16
## deliberate       45          56
##
##              Accuracy : 0.5704
##              95% CI : (0.4847, 0.6531)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.076642
##
##              Kappa : 0.1357
##
##  Mcnemar's Test P-Value : 0.000337
##
##      Sensitivity : 0.3571
##      Specificity : 0.7778
##      Pos Pred Value : 0.6098
##      Neg Pred Value : 0.5545
##      Prevalence : 0.4930
##      Detection Rate : 0.1761
##      Detection Prevalence : 0.2887
##      Balanced Accuracy : 0.5675
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_3.1_pred <- predict(smile__tree_model_3, tst_smile_boys)
summary(smile__tree_model_3.1_pred)
```

```
## spontaneous deliberate
##           22           55
```

```
smile__tree_model_3.1_confM <- confusionMatrix(
  smile__tree_model_3.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_3.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      13      9
##      deliberate      24     31
##
##              Accuracy : 0.5714
##              95% CI : (0.4535, 0.6837)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.21259
##
##              Kappa : 0.1283
##
##      McNemar's Test P-Value : 0.01481
##
##              Sensitivity : 0.3514
##              Specificity : 0.7750
##      Pos Pred Value : 0.5909
##      Neg Pred Value : 0.5636
##      Prevalence : 0.4805
##      Detection Rate : 0.1688
##      Detection Prevalence : 0.2857
##      Balanced Accuracy : 0.5632
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_3.2_pred <- predict(smile__tree_model_3, tst_smile_girls)
summary(smile__tree_model_3.2_pred)
```

```
## spontaneous deliberate
##           19          46
```

```
smile__tree_model_3.2_confM <- confusionMatrix(
  smile__tree_model_3.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_3.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      12      7
##      deliberate      21     25
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.19273
##
##              Kappa : 0.1439
##
##      McNemar's Test P-Value : 0.01402
##
```

```
##           Sensitivity : 0.3636
##           Specificity : 0.7812
##           Pos Pred Value : 0.6316
##           Neg Pred Value : 0.5435
##           Prevalence : 0.5077
##           Detection Rate : 0.1846
##           Detection Prevalence : 0.2923
##           Balanced Accuracy : 0.5724
##
##           'Positive' Class : spontaneous
##
```

```
# model 3A lip
set.seed(1973)
smile__tree_model_3A <- train(smile_type ~ lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_3A$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.02121212 0.4811943 -0.03738362 0.09195689 0.18310126
## 2 0.02424242 0.4667725 -0.06529158 0.09635085 0.19215722
## 3 0.09090909 0.4836898 -0.03924734 0.04451978 0.08362762
```

```
# summary(smile__tree_model_3A$finalModel)

smile__tree_model_3A_pred <- predict(smile__tree_model_3A, tst_smile)
summary(smile__tree_model_3A_pred)
```

```
## spontaneous deliberate
##           0           142
```

```
smile__tree_model_3A_confM <- confusionMatrix(
  smile__tree_model_3A_pred,
  tst_smile$smile_type
)
smile__tree_model_3A_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           0           0
## deliberate           70           72
##
##           Accuracy : 0.507
##           95% CI : (0.4219, 0.5919)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 0.5336
##
```

```
##                Kappa : 0
##
## Mcnemar's Test P-Value : <2e-16
##
##          Sensitivity : 0.000
##          Specificity : 1.000
##          Pos Pred Value :  NaN
##          Neg Pred Value : 0.507
##          Prevalence : 0.493
##          Detection Rate : 0.000
##          Detection Prevalence : 0.000
##          Balanced Accuracy : 0.500
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_3A.1_pred <- predict(smile__tree_model_3A, tst_smile_boys)
summary(smile__tree_model_3A.1_pred)
```

```
## spontaneous deliberate
##          0          77
```

```
smile__tree_model_3A.1_confM <- confusionMatrix(
  smile__tree_model_3A.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_3A.1_confM
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction    spontaneous deliberate
## spontaneous           0           0
## deliberate           37          40
##
##          Accuracy : 0.5195
##          95% CI : (0.4026, 0.6348)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.5459
##
##                Kappa : 0
##
## Mcnemar's Test P-Value : 3.252e-09
##
##          Sensitivity : 0.0000
##          Specificity : 1.0000
##          Pos Pred Value :  NaN
##          Neg Pred Value : 0.5195
##          Prevalence : 0.4805
##          Detection Rate : 0.0000
##          Detection Prevalence : 0.0000
```



```
##      Balanced Accuracy : 0.5000
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_3A.2_pred <- predict(smile__tree_model_3A, tst_smile_girls)
summary(smile__tree_model_3A.2_pred)
```

```
## spontaneous deliberate
##      0      65
```

```
smile__tree_model_3A.2_confM <- confusionMatrix(
  smile__tree_model_3A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_3A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      0      0
## deliberate      33      32
##
##              Accuracy : 0.4923
##              95% CI : (0.366, 0.6193)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.6452
##
##              Kappa : 0
##
##      Mcnemar's Test P-Value : 2.54e-08
##
##              Sensitivity : 0.0000
##              Specificity : 1.0000
##              Pos Pred Value :      NaN
##              Neg Pred Value : 0.4923
##              Prevalence : 0.5077
##              Detection Rate : 0.0000
##      Detection Prevalence : 0.0000
##              Balanced Accuracy : 0.5000
##
##      'Positive' Class : spontaneous
##
```

```
# model 3B eye
set.seed(1973)
smile__tree_model_3B <- train(smile_type ~ eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_3B$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5889706 0.17587312 0.07422087 0.14742791
## 2 0.06666667 0.5892435 0.17469528 0.10479850 0.21101409
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

```
# summary(smile__tree_model_3B$finalModel)
```

```
smile__tree_model_3B_pred <- predict(smile__tree_model_3B, tst_smile)
summary(smile__tree_model_3B_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__tree_model_3B_confM <- confusionMatrix(
  smile__tree_model_3B_pred,
  tst_smile$smile_type
)
smile__tree_model_3B_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           25           16
## deliberate           45           56
##
##           Accuracy : 0.5704
##           95% CI : (0.4847, 0.6531)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.076642
##
##           Kappa : 0.1357
##
## Mcnemar's Test P-Value : 0.000337
##
##           Sensitivity : 0.3571
##           Specificity : 0.7778
##           Pos Pred Value : 0.6098
##           Neg Pred Value : 0.5545
##           Prevalence : 0.4930
##           Detection Rate : 0.1761
##    Detection Prevalence : 0.2887
##           Balanced Accuracy : 0.5675
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_3B.1_pred <- predict(smile__tree_model_3B, tst_smile_boys)
summary(smile__tree_model_3B.1_pred)
```

```
## spontaneous deliberate
##           22           55
```

```
smile__tree_model_3B.1_confM <- confusionMatrix(
  smile__tree_model_3B.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_3B.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           13             9
## deliberate           24            31
##
##              Accuracy : 0.5714
##              95% CI : (0.4535, 0.6837)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.21259
##
##              Kappa : 0.1283
##
##  Mcnemar's Test P-Value : 0.01481
##
##      Sensitivity : 0.3514
##      Specificity : 0.7750
##      Pos Pred Value : 0.5909
##      Neg Pred Value : 0.5636
##      Prevalence : 0.4805
##      Detection Rate : 0.1688
##      Detection Prevalence : 0.2857
##      Balanced Accuracy : 0.5632
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_3B.2_pred <- predict(smile__tree_model_3B, tst_smile_girls)
summary(smile__tree_model_3B.2_pred)
```

```
## spontaneous deliberate
##           19           46
```

```
smile__tree_model_3B.2_confM <- confusionMatrix(
  smile__tree_model_3B.2_pred,
```

```

tst_smile_girls$smile_type
)
smile__tree_model_3B.2_confM

```

```

## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      12             7
## deliberate       21            25
##
##               Accuracy : 0.5692
##               95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.19273
##
##               Kappa : 0.1439
##
##  Mcnemar's Test P-Value : 0.01402
##
##      Sensitivity : 0.3636
##      Specificity : 0.7812
##      Pos Pred Value : 0.6316
##      Neg Pred Value : 0.5435
##      Prevalence : 0.5077
##      Detection Rate : 0.1846
##      Detection Prevalence : 0.2923
##      Balanced Accuracy : 0.5724
##
##      'Positive' Class : spontaneous
##

```

```

# model 3C complete lip, amplitude, and eye features
set.seed(1973)
smile__tree_model_3C <- train(smile_type ~ lip_mean + eye_mean + amplitude_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_3C$results

```

```

##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.01515152 0.5526738 0.10440266 0.09180319 0.18217867
## 2 0.06666667 0.5892435 0.17469528 0.10479850 0.21101409
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332

```

```

varImp(smile__tree_model_3C)

```

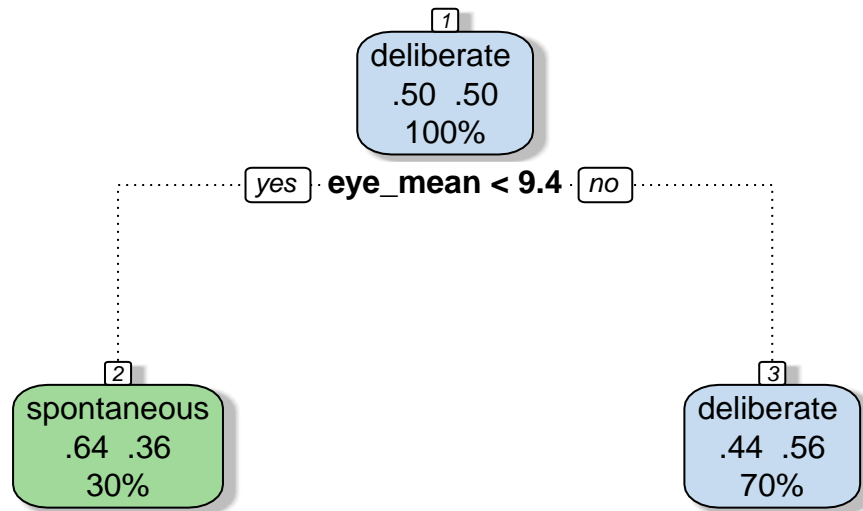
```

## rpart variable importance
##
##               Overall
## eye_mean          100

```

```
## amplitude_mean      0
## lip_mean            0

# summary(smile__tree_model_3C$finalModel)
fancyRpartPlot(smile__tree_model_3C$finalModel)
```



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```
smile__tree_model_3C_pred <- predict(smile__tree_model_3C, tst_smile)
summary(smile__tree_model_3C_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__tree_model_3C_confM <- confusionMatrix(
  smile__tree_model_3C_pred,
  tst_smile$smile_type
)
smile__tree_model_3C_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      25           16
## deliberate       45           56
```

```
##
##           Accuracy : 0.5704
##           95% CI : (0.4847, 0.6531)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.076642
##
##           Kappa : 0.1357
##
##    McNemar's Test P-Value : 0.000337
##
##           Sensitivity : 0.3571
##           Specificity : 0.7778
##    Pos Pred Value : 0.6098
##    Neg Pred Value : 0.5545
##    Prevalence : 0.4930
##    Detection Rate : 0.1761
##    Detection Prevalence : 0.2887
##    Balanced Accuracy : 0.5675
##
##    'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_3C.1_pred <- predict(smile__tree_model_3C, tst_smile_boys)
summary(smile__tree_model_3C.1_pred)
```

```
## spontaneous deliberate
##           22           55
```

```
smile__tree_model_3C.1_confM <- confusionMatrix(
  smile__tree_model_3C.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_3C.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##    spontaneous           13           9
##    deliberate           24           31
##
##           Accuracy : 0.5714
##           95% CI : (0.4535, 0.6837)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.21259
##
##           Kappa : 0.1283
##
##    McNemar's Test P-Value : 0.01481
##
##           Sensitivity : 0.3514
```

```
##           Specificity : 0.7750
##           Pos Pred Value : 0.5909
##           Neg Pred Value : 0.5636
##           Prevalence : 0.4805
##           Detection Rate : 0.1688
##           Detection Prevalence : 0.2857
##           Balanced Accuracy : 0.5632
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_3C.2_pred <- predict(smile__tree_model_3C, tst_smile_girls)
summary(smile__tree_model_3C.2_pred)
```

```
## spontaneous deliberate
##           19           46
```

```
smile__tree_model_3C.2_confM <- confusionMatrix(
  smile__tree_model_3C.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_3C.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           12             7
## deliberate           21            25
##
##           Accuracy : 0.5692
##           95% CI : (0.4404, 0.6915)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.19273
##
##           Kappa : 0.1439
##
## Mcnemar's Test P-Value : 0.01402
##
##           Sensitivity : 0.3636
##           Specificity : 0.7812
##           Pos Pred Value : 0.6316
##           Neg Pred Value : 0.5435
##           Prevalence : 0.5077
##           Detection Rate : 0.1846
##           Detection Prevalence : 0.2923
##           Balanced Accuracy : 0.5724
##
##           'Positive' Class : spontaneous
##
```

```
# model 4 AU features complete model
set.seed(1973)
smile__tree_model_4 <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5636141 0.12907456 0.08437636 0.1685849
## 2 0.05252525 0.5308155 0.05932530 0.07759515 0.1551832
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

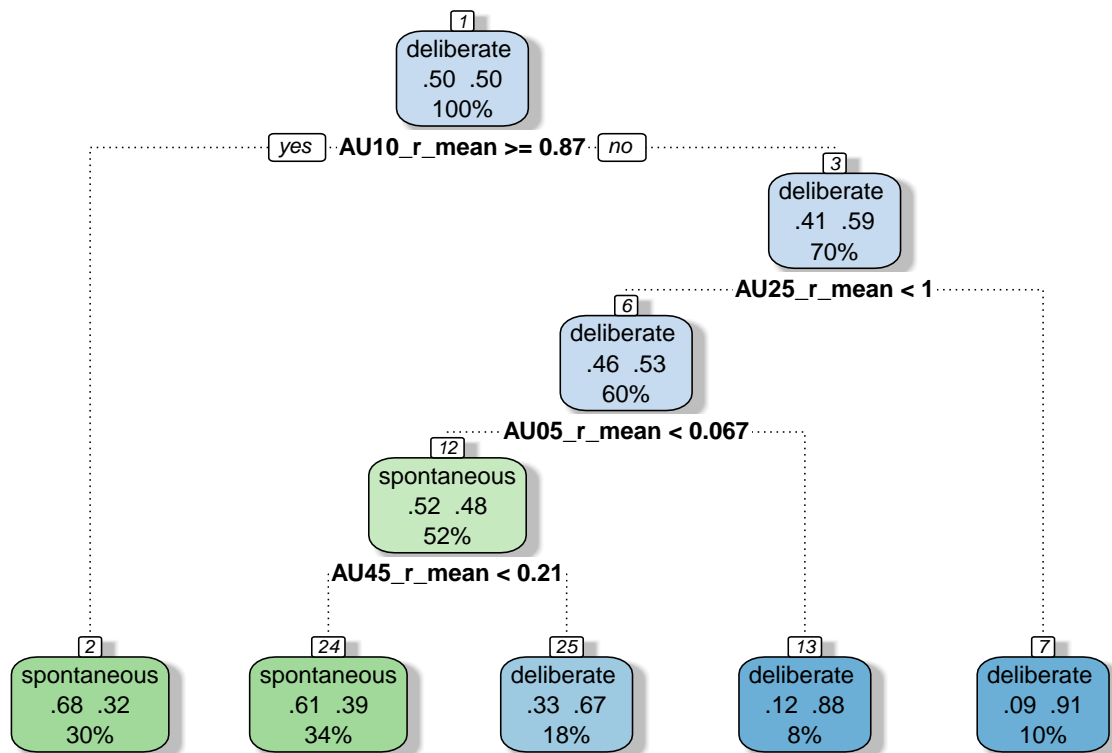
```
smile__tree_model_4$coefnames
```

```
## [1] "AU01_r_mean" "AU02_r_mean" "AU04_r_mean" "AU05_r_mean" "AU06_r_mean"
## [6] "AU07_r_mean" "AU09_r_mean" "AU10_r_mean" "AU12_r_mean" "AU14_r_mean"
## [11] "AU15_r_mean" "AU17_r_mean" "AU20_r_mean" "AU23_r_mean" "AU25_r_mean"
## [16] "AU26_r_mean" "AU45_r_mean"
```

```
varImp(smile__tree_model_4)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## AU01_r_mean  81.66
## AU25_r_mean  77.78
## AU09_r_mean  73.78
## AU10_r_mean  54.54
## AU05_r_mean  52.28
## AU14_r_mean  21.58
## AU12_r_mean   0.00
## AU23_r_mean   0.00
## AU07_r_mean   0.00
## AU02_r_mean   0.00
## AU04_r_mean   0.00
## AU06_r_mean   0.00
## AU17_r_mean   0.00
## AU20_r_mean   0.00
## AU26_r_mean   0.00
## AU15_r_mean   0.00
```

```
# summary(smile__tree_model_4$finalModel)
fancyRpartPlot(smile__tree_model_4$finalModel)
```

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```
smile__tree_model_4_pred <- predict(smile__tree_model_4, tst_smile)
summary(smile__tree_model_4_pred)
```

```
## spontaneous deliberate
##           84           58
```

```
smile__tree_model_4_confM <- confusionMatrix(
  smile__tree_model_4_pred,
  tst_smile$smile_type
)
smile__tree_model_4_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      44           40
## deliberate       26           32
##
##              Accuracy : 0.5352
##              95% CI : (0.4497, 0.6193)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.2786
##
##              Kappa : 0.0728
```

```
##
## McNemar's Test P-Value : 0.1096
##
##          Sensitivity : 0.6286
##          Specificity : 0.4444
##          Pos Pred Value : 0.5238
##          Neg Pred Value : 0.5517
##          Prevalence : 0.4930
##          Detection Rate : 0.3099
##          Detection Prevalence : 0.5915
##          Balanced Accuracy : 0.5365
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4.1_pred <- predict(smile__tree_model_4, tst_smile_boys)
summary(smile__tree_model_4.1_pred)
```

```
## spontaneous deliberate
##          40          37
```

```
smile__tree_model_4.1_confM <- confusionMatrix(
  smile__tree_model_4.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          20          20
## deliberate           17          20
##
##          Accuracy : 0.5195
##          95% CI : (0.4026, 0.6348)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.5459
##
##          Kappa : 0.0404
##
## McNemar's Test P-Value : 0.7423
##
##          Sensitivity : 0.5405
##          Specificity : 0.5000
##          Pos Pred Value : 0.5000
##          Neg Pred Value : 0.5405
##          Prevalence : 0.4805
##          Detection Rate : 0.2597
##          Detection Prevalence : 0.5195
##          Balanced Accuracy : 0.5203
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4.2_pred <- predict(smile__tree_model_4, tst_smile_girls)
summary(smile__tree_model_4.2_pred)
```

```
## spontaneous deliberate
##      44      21
```

```
smile__tree_model_4.2_confM <- confusionMatrix(
  smile__tree_model_4.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      24      20
## deliberate       9      12
##
##              Accuracy : 0.5538
##              95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.26784
##
##              Kappa : 0.1028
##
## Mcnemar's Test P-Value : 0.06332
##
##      Sensitivity : 0.7273
##      Specificity : 0.3750
##      Pos Pred Value : 0.5455
##      Neg Pred Value : 0.5714
##      Prevalence : 0.5077
##      Detection Rate : 0.3692
##      Detection Prevalence : 0.6769
##      Balanced Accuracy : 0.5511
##
##      'Positive' Class : spontaneous
##
```

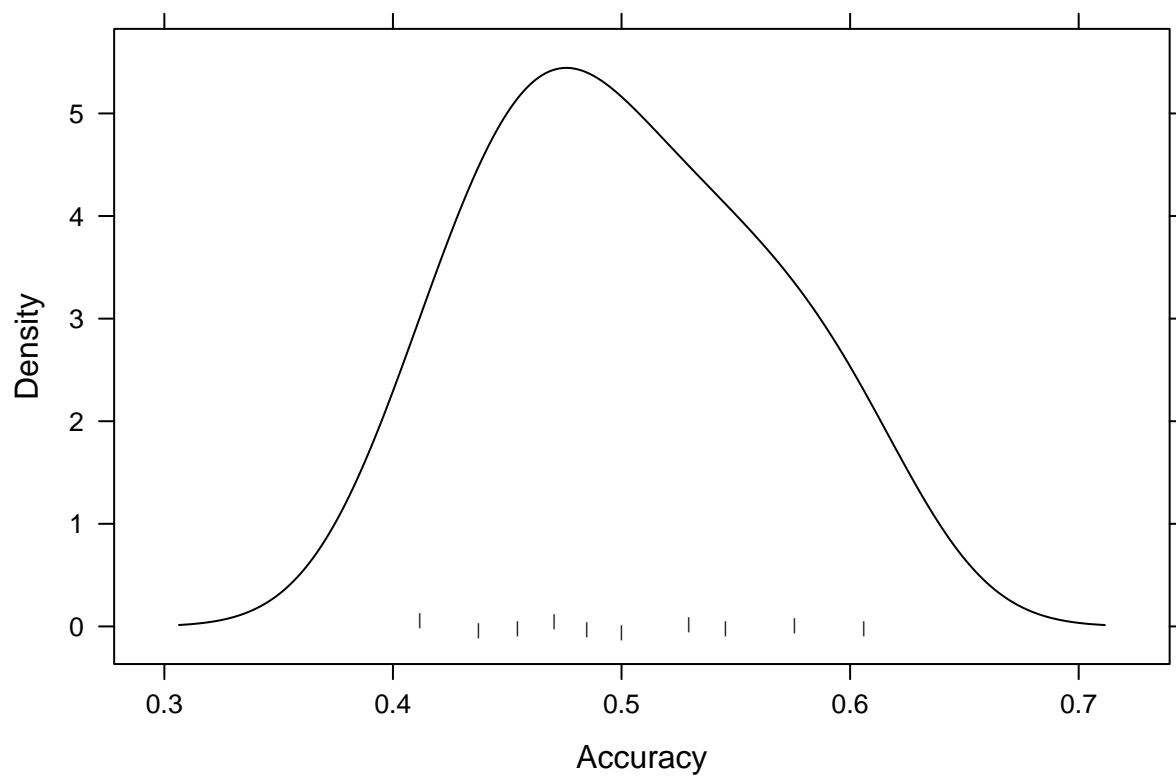
```
# model 4A AU features happiness model
set.seed(1973)
smile__tree_model_4A <- train(smile_type ~ AU06_r_mean + AU12_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(
    method = "cv",
```

```

    number = 10
  )
)

# density plot of accuracy measurements
trellis.par.set(caretTheme())
densityplot(smile__tree_model_4A, pch = "|")

```



```
smile__tree_model_4A$resample
```

##	Accuracy	Kappa	Resample
## 1	0.4545455	-0.09191176	Fold02
## 2	0.5454545	0.09506399	Fold01
## 3	0.6060606	0.22702703	Fold03
## 4	0.4848485	-0.02935780	Fold06
## 5	0.5000000	0.00000000	Fold05
## 6	0.4117647	-0.17647059	Fold04
## 7	0.5757576	0.14126394	Fold07
## 8	0.5294118	0.05882353	Fold10
## 9	0.4375000	-0.12500000	Fold09
## 10	0.4705882	-0.05882353	Fold08

```
smile__tree_model_4A$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.01969697 0.5015931 0.00406148 0.06213453 0.12621231
## 2 0.02828283 0.4866199 -0.02825439 0.04520997 0.08863008
## 3 0.10909091 0.4985684 -0.01151477 0.02486434 0.04647333
```

```
smile__tree_model_4A$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean"
```

```
varImp(smile__tree_model_4A)
```

```
## rpart variable importance
```

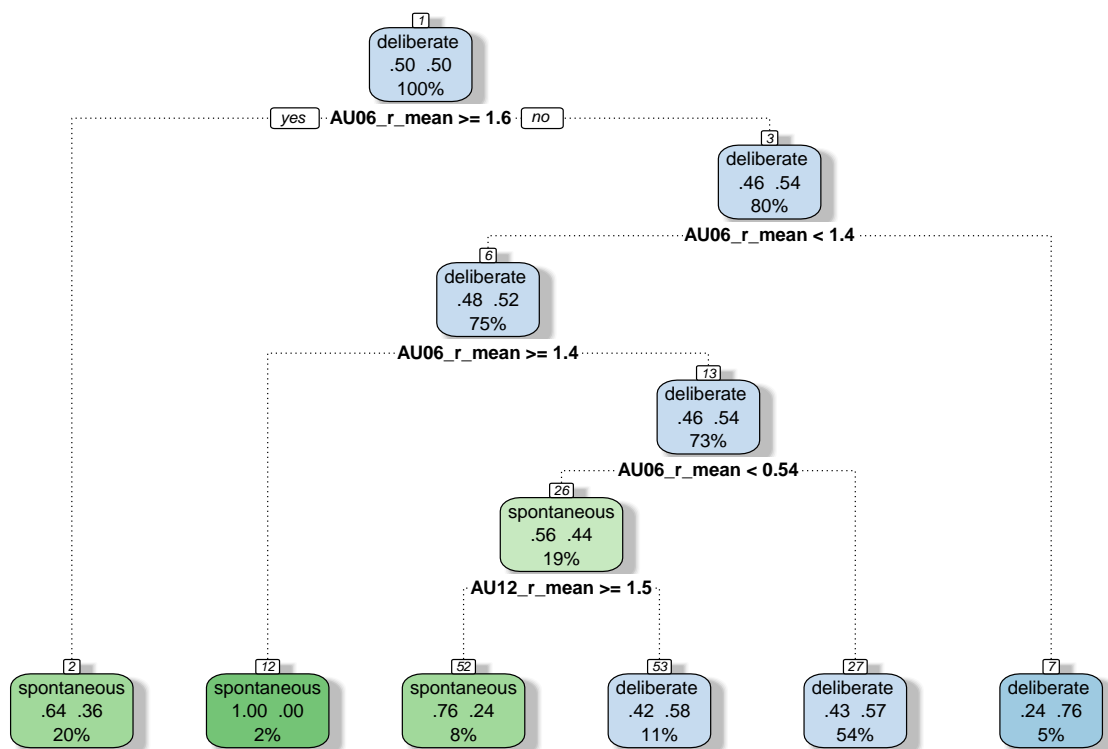
```
##
```

```
##           Overall
```

```
## AU06_r_mean      100
```

```
## AU12_r_mean       0
```

```
# summary(smile__tree_model_4A$finalModel)
fancyRpartPlot(smile__tree_model_4A$finalModel,
  caption = "Model 4A: AU06 + AU12"
)
```



Model 4A: AU06 + AU12

```
smile__tree_model_4A_pred <- predict(smile__tree_model_4A, tst_smile)
summary(smile__tree_model_4A_pred)
```

```
## spontaneous deliberate
##           38           104
```

```
smile__tree_model_4A_confM <- confusionMatrix(
  smile__tree_model_4A_pred,
  tst_smile$smile_type
)
smile__tree_model_4A_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           20           18
## deliberate           50           54
##
##              Accuracy : 0.5211
##              95% CI : (0.4358, 0.6056)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.4008030
##
##              Kappa : 0.0359
##
## Mcnemar's Test P-Value : 0.0001704
##
##      Sensitivity : 0.2857
##      Specificity : 0.7500
##      Pos Pred Value : 0.5263
##      Neg Pred Value : 0.5192
##      Prevalence : 0.4930
##      Detection Rate : 0.1408
##      Detection Prevalence : 0.2676
##      Balanced Accuracy : 0.5179
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4A.1_pred <- predict(smile__tree_model_4A, tst_smile_boys)
summary(smile__tree_model_4A.1_pred)
```

```
## spontaneous deliberate
##           23           54
```

```
smile__tree_model_4A.1_confM <- confusionMatrix(
  smile__tree_model_4A.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4A.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      13           10
## deliberate       24           30
##
##               Accuracy : 0.5584
##               95% CI : (0.4407, 0.6716)
##               No Information Rate : 0.5195
##               P-Value [Acc > NIR] : 0.28475
##
##               Kappa : 0.1028
##
## Mcnemar's Test P-Value : 0.02578
##
##               Sensitivity : 0.3514
##               Specificity : 0.7500
##               Pos Pred Value : 0.5652
##               Neg Pred Value : 0.5556
##               Prevalence : 0.4805
##               Detection Rate : 0.1688
##               Detection Prevalence : 0.2987
##               Balanced Accuracy : 0.5507
##
##               'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4A.2_pred <- predict(smile__tree_model_4A, tst_smile_girls)
summary(smile__tree_model_4A.2_pred)
```

```
## spontaneous deliberate
##           15           50
```

```
smile__tree_model_4A.2_confM <- confusionMatrix(
  smile__tree_model_4A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4A.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      7           8
## deliberate       26          24
##
##               Accuracy : 0.4769
##               95% CI : (0.3515, 0.6046)
##               No Information Rate : 0.5077
##               P-Value [Acc > NIR] : 0.732416
##
```

```
##                Kappa : -0.0376
##
## Mcnemar's Test P-Value : 0.003551
##
##          Sensitivity : 0.2121
##          Specificity : 0.7500
##          Pos Pred Value : 0.4667
##          Neg Pred Value : 0.4800
##          Prevalence : 0.5077
##          Detection Rate : 0.1077
##          Detection Prevalence : 0.2308
##          Balanced Accuracy : 0.4811
##
##          'Positive' Class : spontaneous
##
```

```
# model 4B AU best model
set.seed(1973)
smile__tree_model_4B <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean,
method = "rpart",
data = trn_smile,
trControl = trainControl(
  method = "cv",
  number = 10
)
)

smile__tree_model_4B$results
```

```
##          cp Accuracy      Kappa AccuracySD  KappaSD
## 1 0.03030303 0.5547126 0.11324964 0.07576006 0.1500753
## 2 0.04545455 0.5364305 0.07335263 0.07508962 0.1507522
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
smile__tree_model_4B$coefnames
```

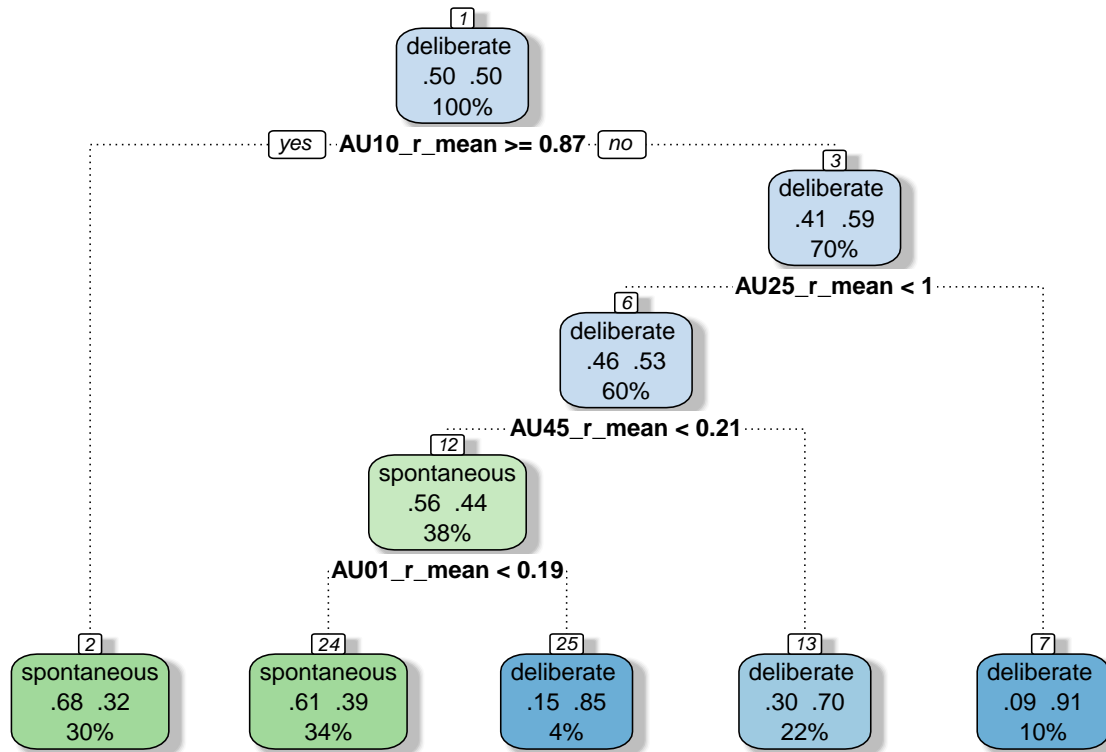
```
## [1] "AU01_r_mean" "AU09_r_mean" "AU10_r_mean" "AU25_r_mean" "AU45_r_mean"
```

```
varImp(smile__tree_model_4B)
```

```
## rpart variable importance
##
##          Overall
## AU25_r_mean 100.00
## AU45_r_mean  65.35
## AU01_r_mean  47.05
## AU10_r_mean  15.19
## AU09_r_mean   0.00
```



```
# summary(smile__tree_model_4$finalModel)
fancyRpartPlot(smile__tree_model_4B$finalModel)
```



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```
smile__tree_model_4B_pred <- predict(smile__tree_model_4B, tst_smile)
summary(smile__tree_model_4B_pred)
```

```
## spontaneous deliberate
##           89           53
```

```
smile__tree_model_4B_confM <- confusionMatrix(
  smile__tree_model_4B_pred,
  tst_smile$smile_type
)
smile__tree_model_4B_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
##  spontaneous         49          40
##  deliberate          21          32
##
##              Accuracy : 0.5704
##              95% CI : (0.4847, 0.6531)
```

```
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.07664
##
##              Kappa : 0.1439
##
##      McNemar's Test P-Value : 0.02119
##
##              Sensitivity : 0.7000
##              Specificity : 0.4444
##              Pos Pred Value : 0.5506
##              Neg Pred Value : 0.6038
##              Prevalence : 0.4930
##              Detection Rate : 0.3451
##      Detection Prevalence : 0.6268
##      Balanced Accuracy : 0.5722
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4B.1_pred <- predict(smile__tree_model_4B, tst_smile_boys)
summary(smile__tree_model_4B.1_pred)
```

```
## spontaneous deliberate
##           41           36
```

```
smile__tree_model_4B.1_confM <- confusionMatrix(
  smile__tree_model_4B.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4B.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           23           18
## deliberate           14           22
##
##              Accuracy : 0.5844
##              95% CI : (0.4664, 0.6957)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1523
##
##              Kappa : 0.1709
##
##      McNemar's Test P-Value : 0.5959
##
##              Sensitivity : 0.6216
##              Specificity : 0.5500
##              Pos Pred Value : 0.5610
##              Neg Pred Value : 0.6111
```

```
##           Prevalence : 0.4805
##           Detection Rate : 0.2987
##           Detection Prevalence : 0.5325
##           Balanced Accuracy : 0.5858
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4B.2_pred <- predict(smile__tree_model_4B, tst_smile_girls)
summary(smile__tree_model_4B.2_pred)
```

```
## spontaneous deliberate
##           48           17
```

```
smile__tree_model_4B.2_confM <- confusionMatrix(
  smile__tree_model_4B.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4B.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      26           22
## deliberate        7           10
##
##           Accuracy : 0.5538
##           95% CI : (0.4253, 0.6773)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.26784
##
##           Kappa : 0.1011
##
##           Mcnemar's Test P-Value : 0.00933
##
##           Sensitivity : 0.7879
##           Specificity : 0.3125
##           Pos Pred Value : 0.5417
##           Neg Pred Value : 0.5882
##           Prevalence : 0.5077
##           Detection Rate : 0.4000
##           Detection Prevalence : 0.7385
##           Balanced Accuracy : 0.5502
##
##           'Positive' Class : spontaneous
##
```

```
# model 4C AU happiness + blink
set.seed(1973)
smile__tree_model_4C <- train(smile_type ~ AU45_r_mean + AU06_r_mean +
```

```

AU12_r_mean,
method = "rpart",
data = trn_smile,
trControl = trainControl(
  method = "cv",
  number = 10
)
)

smile__tree_model_4C$results

```

```

##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.02424242 0.5797850 0.16016594 0.05522519 0.11234354
## 2 0.06060606 0.5464516 0.09717643 0.04388348 0.08896946
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091

```

```

smile__tree_model_4C$coefnames

```

```

## [1] "AU45_r_mean" "AU06_r_mean" "AU12_r_mean"

```

```

varImp(smile__tree_model_4C)

```

```

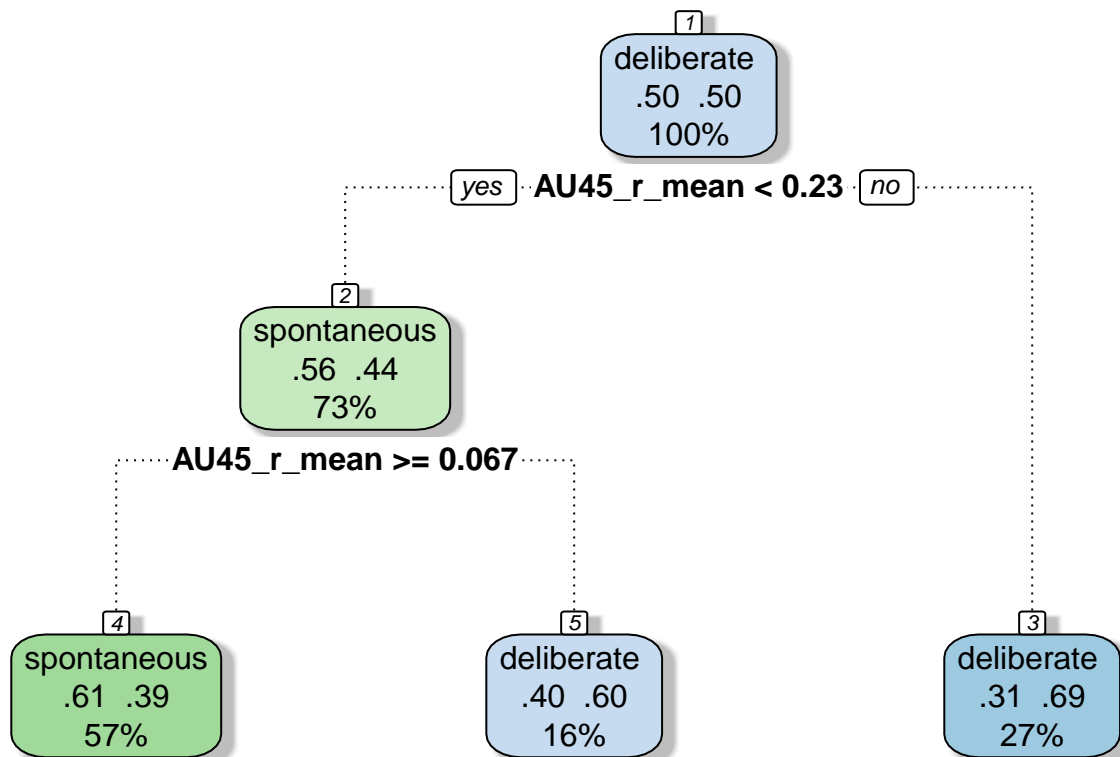
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## AU06_r_mean  31.92
## AU12_r_mean   0.00

```

```

# summary(smile__tree_model_4C$finalModel)
fancyRpartPlot(smile__tree_model_4C$finalModel)

```



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```
smile__tree_model_4C_pred <- predict(smile__tree_model_4C, tst_smile)
summary(smile__tree_model_4C_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_4C_confM <- confusionMatrix(
  smile__tree_model_4C_pred,
  tst_smile$smile_type
)
smile__tree_model_4C_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      44           41
## deliberate       26           31
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.059
```

```
##
## McNemar's Test P-Value : 0.0872
##
##           Sensitivity : 0.6286
##           Specificity : 0.4306
##           Pos Pred Value : 0.5176
##           Neg Pred Value : 0.5439
##           Prevalence : 0.4930
##           Detection Rate : 0.3099
##           Detection Prevalence : 0.5986
##           Balanced Accuracy : 0.5296
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4C.1_pred <- predict(smile__tree_model_4C, tst_smile_boys)
summary(smile__tree_model_4C.1_pred)
```

```
## spontaneous deliberate
##           45           32
```

```
smile__tree_model_4C.1_confM <- confusionMatrix(
  smile__tree_model_4C.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4C.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           23           22
## deliberate           14           18
##
##           Accuracy : 0.5325
##           95% CI : (0.4152, 0.6471)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.4552
##
##           Kappa : 0.071
##
## McNemar's Test P-Value : 0.2433
##
##           Sensitivity : 0.6216
##           Specificity : 0.4500
##           Pos Pred Value : 0.5111
##           Neg Pred Value : 0.5625
##           Prevalence : 0.4805
##           Detection Rate : 0.2987
##           Detection Prevalence : 0.5844
##           Balanced Accuracy : 0.5358
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_4C.2_pred <- predict(smile__tree_model_4C, tst_smile_girls)
summary(smile__tree_model_4C.2_pred)

## spontaneous deliberate
##      40      25

smile__tree_model_4C.2_confM <- confusionMatrix(
  smile__tree_model_4C.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4C.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21          19
## deliberate      12          13
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.6364
##              Specificity : 0.4062
##              Pos Pred Value : 0.5250
##              Neg Pred Value : 0.5200
##              Prevalence : 0.5077
##              Detection Rate : 0.3231
##      Detection Prevalence : 0.6154
##              Balanced Accuracy : 0.5213
##
##      'Positive' Class : spontaneous
##

# model 4D AU45
set.seed(1973)
smile__tree_model_4D <- train(smile_type ~ AU45_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_4D$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.02121212 0.5617814 0.12519241 0.03886699 0.08002424
## 2 0.06060606 0.5464516 0.09717643 0.04388348 0.08896946
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091
```

```
smile__tree_model_4D$coefnames
```

```
## [1] "AU45_r_mean"
```

```
# summary(smile__tree_model_4D$finalModel)
```

```
smile__tree_model_4D_pred <- predict(smile__tree_model_4D, tst_smile)
summary(smile__tree_model_4D_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_4D_confM <- confusionMatrix(
  smile__tree_model_4D_pred,
  tst_smile$smile_type
)
smile__tree_model_4D_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous          44           41
## deliberate          26           31
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.059
##
## Mcnemar's Test P-Value : 0.0872
##
##           Sensitivity : 0.6286
##           Specificity : 0.4306
##           Pos Pred Value : 0.5176
##           Neg Pred Value : 0.5439
##           Prevalence : 0.4930
##           Detection Rate : 0.3099
##           Detection Prevalence : 0.5986
##           Balanced Accuracy : 0.5296
##
##           'Positive' Class : spontaneous
##
```



```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4D.1_pred <- predict(smile__tree_model_4D, tst_smile_boys)
summary(smile__tree_model_4D.1_pred)
```

```
## spontaneous deliberate
##           45           32
```

```
smile__tree_model_4D.1_confM <- confusionMatrix(
  smile__tree_model_4D.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4D.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           23           22
## deliberate           14           18
##
##              Accuracy : 0.5325
##              95% CI : (0.4152, 0.6471)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.4552
##
##              Kappa : 0.071
##
##  Mcnemar's Test P-Value : 0.2433
##
##      Sensitivity : 0.6216
##      Specificity : 0.4500
##      Pos Pred Value : 0.5111
##      Neg Pred Value : 0.5625
##      Prevalence : 0.4805
##      Detection Rate : 0.2987
##      Detection Prevalence : 0.5844
##      Balanced Accuracy : 0.5358
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4D.2_pred <- predict(smile__tree_model_4D, tst_smile_girls)
summary(smile__tree_model_4D.2_pred)
```

```
## spontaneous deliberate
##           40           25
```

```
smile__tree_model_4D.2_confM <- confusionMatrix(
  smile__tree_model_4D.2_pred,
```

```
tst_smile_girls$smile_type
)
smile__tree_model_4D.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      21             19
## deliberate       12             13
##
##               Accuracy : 0.5231
##               95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##               Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##      Sensitivity : 0.6364
##      Specificity : 0.4062
##      Pos Pred Value : 0.5250
##      Neg Pred Value : 0.5200
##      Prevalence : 0.5077
##      Detection Rate : 0.3231
##      Detection Prevalence : 0.6154
##      Balanced Accuracy : 0.5213
##
##      'Positive' Class : spontaneous
##
```

```
# model 4E AU12
set.seed(1973)
smile__tree_model_4E <- train(smile_type ~ AU12_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4E$results
```

```
##           cp Accuracy           Kappa AccuracySD      KappaSD
## 1 0.01818182 0.5102496 0.020310865 0.08191055 0.16558148
## 2 0.03636364 0.5100713 0.019546074 0.05974664 0.11914570
## 3 0.06666667 0.4951872 -0.004623925 0.05086760 0.09953796
```

```
smile__tree_model_4E$coefnames
```

```
## [1] "AU12_r_mean"
```

```
# summary(smile__tree_model_4E$finalModel)
```

```
smile__tree_model_4E_pred <- predict(smile__tree_model_4E, tst_smile)
summary(smile__tree_model_4E_pred)
```

```
## spontaneous deliberate
##           58           84
```

```
smile__tree_model_4E_confM <- confusionMatrix(
  smile__tree_model_4E_pred,
  tst_smile$smile_type
)
smile__tree_model_4E_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           29           29
## deliberate           41           43
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.5336
##
##              Kappa : 0.0115
##
##  McNemar's Test P-Value : 0.1886
##
##      Sensitivity : 0.4143
##      Specificity : 0.5972
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5119
##      Prevalence : 0.4930
##      Detection Rate : 0.2042
##      Detection Prevalence : 0.4085
##      Balanced Accuracy : 0.5058
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
```

```
set.seed(1973)
smile__tree_model_4E.1_pred <- predict(smile__tree_model_4E, tst_smile_boys)
summary(smile__tree_model_4E.1_pred)
```

```
## spontaneous deliberate
##           21           56
```

```
smile__tree_model_4E.1_confM <- confusionMatrix(
  smile__tree_model_4E.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4E.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           13             8
## deliberate           24            32
##
##              Accuracy : 0.5844
##              95% CI : (0.4664, 0.6957)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.15232
##
##              Kappa : 0.1538
##
## Mcnemar's Test P-Value : 0.00801
##
##      Sensitivity : 0.3514
##      Specificity : 0.8000
##      Pos Pred Value : 0.6190
##      Neg Pred Value : 0.5714
##      Prevalence : 0.4805
##      Detection Rate : 0.1688
##      Detection Prevalence : 0.2727
##      Balanced Accuracy : 0.5757
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4E.2_pred <- predict(smile__tree_model_4E, tst_smile_girls)
summary(smile__tree_model_4E.2_pred)
```

```
## spontaneous deliberate
##              37              28
```

```
smile__tree_model_4E.2_confM <- confusionMatrix(
  smile__tree_model_4E.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4E.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           16            21
```

```
## deliberate          17          11
##
##           Accuracy : 0.4154
##           95% CI : (0.2944, 0.5444)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.9468
##
##           Kappa : -0.1717
##
## Mcnemar's Test P-Value : 0.6265
##
##           Sensitivity : 0.4848
##           Specificity : 0.3438
##       Pos Pred Value : 0.4324
##       Neg Pred Value : 0.3929
##           Prevalence : 0.5077
##       Detection Rate : 0.2462
##       Detection Prevalence : 0.5692
##       Balanced Accuracy : 0.4143
##
##       'Positive' Class : spontaneous
##
```

```
# model 4F AU06
set.seed(1973)
smile__tree_model_4F <- train(smile_type ~ AU06_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4F$results
```

```
##           cp Accuracy          Kappa AccuracySD      KappaSD
## 1 0.02020202 0.5135361 0.02820820 0.06572235 0.13344946
## 2 0.02828283 0.4896502 -0.02109638 0.05230700 0.10518620
## 3 0.10909091 0.4985684 -0.01151477 0.02486434 0.04647333
```

```
smile__tree_model_4F$coefnames
```

```
## [1] "AU06_r_mean"
```

```
# summary(smile__tree_model_4F$finalModel)

smile__tree_model_4F_pred <- predict(smile__tree_model_4F, tst_smile)
summary(smile__tree_model_4F_pred)
```

```
## spontaneous deliberate
##           47           95
```

```
smile__tree_model_4F_confM <- confusionMatrix(
  smile__tree_model_4F_pred,
  tst_smile$smile_type
)
smile__tree_model_4F_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      22          25
## deliberate      48          47
##
##              Accuracy : 0.4859
##              95% CI : (0.4013, 0.5712)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.72157
##
##              Kappa : -0.0331
##
## Mcnemar's Test P-Value : 0.01003
##
##      Sensitivity : 0.3143
##      Specificity : 0.6528
##      Pos Pred Value : 0.4681
##      Neg Pred Value : 0.4947
##      Prevalence : 0.4930
##      Detection Rate : 0.1549
##      Detection Prevalence : 0.3310
##      Balanced Accuracy : 0.4835
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4F.1_pred <- predict(smile__tree_model_4F, tst_smile_boys)
summary(smile__tree_model_4F.1_pred)
```

```
## spontaneous deliberate
##          26          51
```

```
smile__tree_model_4F.1_confM <- confusionMatrix(
  smile__tree_model_4F.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4F.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      13      13
##      deliberate      24      27
##
##              Accuracy : 0.5195
##              95% CI : (0.4026, 0.6348)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.5459
##
##              Kappa : 0.0266
##
##      McNemar's Test P-Value : 0.1002
##
##              Sensitivity : 0.3514
##              Specificity : 0.6750
##              Pos Pred Value : 0.5000
##              Neg Pred Value : 0.5294
##              Prevalence : 0.4805
##              Detection Rate : 0.1688
##      Detection Prevalence : 0.3377
##              Balanced Accuracy : 0.5132
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4F.2_pred <- predict(smile__tree_model_4F, tst_smile_girls)
summary(smile__tree_model_4F.2_pred)
```

```
## spontaneous deliberate
##           21          44
```

```
smile__tree_model_4F.2_confM <- confusionMatrix(
  smile__tree_model_4F.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4F.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      9          12
##      deliberate      24          20
##
##              Accuracy : 0.4462
##              95% CI : (0.3227, 0.5747)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.86792
##
##              Kappa : -0.1017
##
##      McNemar's Test P-Value : 0.06675
##
```

```
##           Sensitivity : 0.2727
##           Specificity : 0.6250
##           Pos Pred Value : 0.4286
##           Neg Pred Value : 0.4545
##           Prevalence : 0.5077
##           Detection Rate : 0.1385
##           Detection Prevalence : 0.3231
##           Balanced Accuracy : 0.4489
##
##           'Positive' Class : spontaneous
##
```

```
# model 4G AU10
set.seed(1973)
smile__tree_model_4G <- train(smile_type ~ AU10_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4G$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.01212121 0.5520611 0.10499803 0.06372484 0.12732122
## 2 0.01414141 0.5253175 0.05036962 0.03849244 0.07670847
## 3 0.22424242 0.5437667 0.08478626 0.04730443 0.09468424
```

```
smile__tree_model_4G$coefnames
```

```
## [1] "AU10_r_mean"
```

```
# summary(smile__tree_model_4G$finalModel)

smile__tree_model_4G_pred <- predict(smile__tree_model_4G, tst_smile)
summary(smile__tree_model_4G_pred)
```

```
## spontaneous deliberate
##           76           66
```

```
smile__tree_model_4G_confM <- confusionMatrix(
  smile__tree_model_4G_pred,
  tst_smile$smile_type
)
smile__tree_model_4G_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      38          38
## deliberate       32          34
```



```
##
##           Accuracy : 0.507
##           95% CI : (0.4219, 0.5919)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.5336
##
##           Kappa : 0.0151
##
##    McNemar's Test P-Value : 0.5501
##
##           Sensitivity : 0.5429
##           Specificity : 0.4722
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5152
##           Prevalence : 0.4930
##           Detection Rate : 0.2676
##           Detection Prevalence : 0.5352
##           Balanced Accuracy : 0.5075
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4G.1_pred <- predict(smile__tree_model_4G, tst_smile_boys)
summary(smile__tree_model_4G.1_pred)
```

```
## spontaneous deliberate
##           32           45
```

```
smile__tree_model_4G.1_confM <- confusionMatrix(
  smile__tree_model_4G.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4G.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous           16           16
##  deliberate            21           24
##
##           Accuracy : 0.5195
##           95% CI : (0.4026, 0.6348)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.5459
##
##           Kappa : 0.0326
##
##    McNemar's Test P-Value : 0.5108
##
##           Sensitivity : 0.4324
```

```
##           Specificity : 0.6000
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5333
##           Prevalence : 0.4805
##           Detection Rate : 0.2078
##           Detection Prevalence : 0.4156
##           Balanced Accuracy : 0.5162
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4G.2_pred <- predict(smile__tree_model_4G, tst_smile_girls)
summary(smile__tree_model_4G.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__tree_model_4G.2_confM <- confusionMatrix(
  smile__tree_model_4G.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4G.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           22           22
## deliberate           11           10
##
##           Accuracy : 0.4923
##           95% CI : (0.366, 0.6193)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.64516
##
##           Kappa : -0.0209
##
## Mcnemar's Test P-Value : 0.08172
##
##           Sensitivity : 0.6667
##           Specificity : 0.3125
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.4762
##           Prevalence : 0.5077
##           Detection Rate : 0.3385
##           Detection Prevalence : 0.6769
##           Balanced Accuracy : 0.4896
##
##           'Positive' Class : spontaneous
##
```

```
# model 4H AU01
set.seed(1973)
smile__tree_model_4H <- train(smile_type ~ AU01_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4H$results
```

```
##           cp Accuracy      Kappa AccuracySD  KappaSD
## 1 0.01818182 0.5226437 0.04911567 0.09722360 0.1916064
## 2 0.03030303 0.5528743 0.10890407 0.09706592 0.1908838
## 3 0.14545455 0.5290775 0.06682929 0.09259357 0.1810430
```

```
smile__tree_model_4H$coefnames
```

```
## [1] "AU01_r_mean"
```

```
# summary(smile__tree_model_4H$finalModel)
```

```
smile__tree_model_4H_pred <- predict(smile__tree_model_4H, tst_smile)
summary(smile__tree_model_4H_pred)
```

```
## spontaneous deliberate
##           107           35
```

```
smile__tree_model_4H_confM <- confusionMatrix(
  smile__tree_model_4H_pred,
  tst_smile$smile_type
)
smile__tree_model_4H_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           56           51
## deliberate           14           21
##
##           Accuracy : 0.5423
##           95% CI : (0.4567, 0.6261)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 0.2251
##
##           Kappa : 0.091
##
## Mcnemar's Test P-Value : 7.998e-06
##
##           Sensitivity : 0.8000
##           Specificity : 0.2917
```

```
##          Pos Pred Value : 0.5234
##          Neg Pred Value : 0.6000
##          Prevalence : 0.4930
##          Detection Rate : 0.3944
##          Detection Prevalence : 0.7535
##          Balanced Accuracy : 0.5458
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4H.1_pred <- predict(smile__tree_model_4H, tst_smile_boys)
summary(smile__tree_model_4H.1_pred)
```

```
## spontaneous deliberate
##          61          16
```

```
smile__tree_model_4H.1_confM <- confusionMatrix(
  smile__tree_model_4H.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4H.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction    spontaneous deliberate
## spontaneous      32          29
## deliberate       5          11
##
##          Accuracy : 0.5584
##          95% CI : (0.4407, 0.6716)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.2847
##
##          Kappa : 0.1365
##
##          Mcnemar's Test P-Value : 7.998e-05
##
##          Sensitivity : 0.8649
##          Specificity : 0.2750
##          Pos Pred Value : 0.5246
##          Neg Pred Value : 0.6875
##          Prevalence : 0.4805
##          Detection Rate : 0.4156
##          Detection Prevalence : 0.7922
##          Balanced Accuracy : 0.5699
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4H.2_pred <- predict(smile__tree_model_4H, tst_smile_girls)
summary(smile__tree_model_4H.2_pred)
```

```
## spontaneous deliberate
##           46           19
```

```
smile__tree_model_4H.2_confM <- confusionMatrix(
  smile__tree_model_4H.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4H.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      24           22
## deliberate       9           10
##
##               Accuracy : 0.5231
##               95% CI : (0.3954, 0.6485)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.45095
##
##               Kappa : 0.04
##
##  Mcnemar's Test P-Value : 0.03114
##
##       Sensitivity : 0.7273
##       Specificity : 0.3125
##       Pos Pred Value : 0.5217
##       Neg Pred Value : 0.5263
##       Prevalence : 0.5077
##       Detection Rate : 0.3692
##       Detection Prevalence : 0.7077
##       Balanced Accuracy : 0.5199
##
##       'Positive' Class : spontaneous
##
```

```
# model 4I AU25
set.seed(1973)
smile__tree_model_4I <- train(smile_type ~ AU25_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4I$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
```

```
## 1 0.03333333 0.5639149 0.13205234 0.06160107 0.12264971
## 2 0.06666667 0.5612411 0.12788597 0.03840889 0.06994947
## 3 0.14545455 0.5076705 0.02165391 0.01935801 0.04079529
```

```
smile__tree_model_4I$coefnames
```

```
## [1] "AU25_r_mean"
```

```
# summary(smile__tree_model_4I$finalModel)
```

```
smile__tree_model_4I_pred <- predict(smile__tree_model_4I, tst_smile)
summary(smile__tree_model_4I_pred)
```

```
## spontaneous deliberate
##          122          20
```

```
smile__tree_model_4I_confM <- confusionMatrix(
  smile__tree_model_4I_pred,
  tst_smile$smile_type
)
smile__tree_model_4I_confM
```

```
## Confusion Matrix and Statistics
```

```
##
```

```
##              Reference
## Prediction      spontaneous deliberate
## spontaneous      65          57
## deliberate       5          15
```

```
##
```

```
##              Accuracy : 0.5634
##              95% CI : (0.4777, 0.6464)
##              No Information Rate : 0.507
##              P-Value [Acc > NIR] : 0.1039
```

```
##
```

```
##              Kappa : 0.1355
```

```
##
```

```
## McNemar's Test P-Value : 9.356e-11
```

```
##
```

```
##              Sensitivity : 0.9286
```

```
##              Specificity : 0.2083
```

```
##              Pos Pred Value : 0.5328
```

```
##              Neg Pred Value : 0.7500
```

```
##              Prevalence : 0.4930
```

```
##              Detection Rate : 0.4577
```

```
##              Detection Prevalence : 0.8592
```

```
##              Balanced Accuracy : 0.5685
```

```
##
```

```
##              'Positive' Class : spontaneous
```

```
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_4I.1_pred <- predict(smile__tree_model_4I, tst_smile_boys)
summary(smile__tree_model_4I.1_pred)
```

```
## spontaneous deliberate
##           68           9
```

```
smile__tree_model_4I.1_confM <- confusionMatrix(
  smile__tree_model_4I.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4I.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      35           33
## deliberate        2           7
##
##              Accuracy : 0.5455
##              95% CI : (0.4279, 0.6594)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.3667
##
##              Kappa : 0.1173
##
##  Mcnemar's Test P-Value : 3.959e-07
##
##      Sensitivity : 0.9459
##      Specificity : 0.1750
##      Pos Pred Value : 0.5147
##      Neg Pred Value : 0.7778
##      Prevalence : 0.4805
##      Detection Rate : 0.4545
##      Detection Prevalence : 0.8831
##      Balanced Accuracy : 0.5605
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4I.2_pred <- predict(smile__tree_model_4I, tst_smile_girls)
summary(smile__tree_model_4I.2_pred)
```

```
## spontaneous deliberate
##           54           11
```

```
smile__tree_model_4I.2_confM <- confusionMatrix(
  smile__tree_model_4I.2_pred,
```

```
tst_smile_girls$smile_type
)
smile__tree_model_4I.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      30             24
## deliberate       3              8
##
##               Accuracy : 0.5846
##               95% CI : (0.4556, 0.7056)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.1320123
##
##               Kappa : 0.1607
##
##  Mcnemar's Test P-Value : 0.0001186
##
##      Sensitivity : 0.9091
##      Specificity : 0.2500
##      Pos Pred Value : 0.5556
##      Neg Pred Value : 0.7273
##      Prevalence : 0.5077
##      Detection Rate : 0.4615
##      Detection Prevalence : 0.8308
##      Balanced Accuracy : 0.5795
##
##      'Positive' Class : spontaneous
##
```

```
# model 4J AU09
set.seed(1973)
smile__tree_model_4J <- train(smile_type ~ AU09_r_mean,
  method = "rpart",
  data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_4J$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.01818182 0.5195131 0.04226591 0.06740442 0.13251259
## 2 0.02222222 0.5195131 0.04226591 0.06740442 0.13251259
## 3 0.16363636 0.5073028 0.01055068 0.02369084 0.04615194
```

```
smile__tree_model_4J$coefnames
```

```
## [1] "AU09_r_mean"
```



```
# summary(smile__tree_model_4J$finalModel)
```

```
smile__tree_model_4J_pred <- predict(smile__tree_model_4J, tst_smile)
summary(smile__tree_model_4J_pred)
```

```
## spontaneous deliberate
##           109           33
```

```
smile__tree_model_4J_confM <- confusionMatrix(
  smile__tree_model_4J_pred,
  tst_smile$smile_type
)
smile__tree_model_4J_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           54           55
## deliberate            16           17
##
##              Accuracy : 0.5
##              95% CI : (0.415, 0.585)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.5995
##
##              Kappa : 0.0075
##
##  McNemar's Test P-Value : 6.49e-06
##
##      Sensitivity : 0.7714
##      Specificity : 0.2361
##      Pos Pred Value : 0.4954
##      Neg Pred Value : 0.5152
##      Prevalence : 0.4930
##      Detection Rate : 0.3803
##      Detection Prevalence : 0.7676
##      Balanced Accuracy : 0.5038
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
```

```
set.seed(1973)
smile__tree_model_4J.1_pred <- predict(smile__tree_model_4J, tst_smile_boys)
summary(smile__tree_model_4J.1_pred)
```

```
## spontaneous deliberate
##           57           20
```

```
smile__tree_model_4J.1_confM <- confusionMatrix(
  smile__tree_model_4J.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_4J.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           27           30
## deliberate           10           10
##
##              Accuracy : 0.4805
##              95% CI : (0.3652, 0.5974)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.787723
##
##              Kappa : -0.0199
##
##  Mcnemar's Test P-Value : 0.002663
##
##              Sensitivity : 0.7297
##              Specificity : 0.2500
##              Pos Pred Value : 0.4737
##              Neg Pred Value : 0.5000
##              Prevalence : 0.4805
##              Detection Rate : 0.3506
##      Detection Prevalence : 0.7403
##              Balanced Accuracy : 0.4899
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_4J.2_pred <- predict(smile__tree_model_4J, tst_smile_girls)
summary(smile__tree_model_4J.2_pred)
```

```
## spontaneous deliberate
##              52              13
```

```
smile__tree_model_4J.2_confM <- confusionMatrix(
  smile__tree_model_4J.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_4J.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           27           25
```

```
## deliberate          6          7
##
##           Accuracy : 0.5231
##           95% CI : (0.3954, 0.6485)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.450951
##
##           Kappa : 0.0373
##
## Mcnemar's Test P-Value : 0.001225
##
##           Sensitivity : 0.8182
##           Specificity : 0.2188
##       Pos Pred Value : 0.5192
##       Neg Pred Value : 0.5385
##           Prevalence : 0.5077
##       Detection Rate : 0.4154
##       Detection Prevalence : 0.8000
##       Balanced Accuracy : 0.5185
##
##       'Positive' Class : spontaneous
##
```

```
# model 5 head pose features
```

```
set.seed(1973)
smile__tree_model_5 <-
  train(smile_type ~ pose_Rx_mean + pose_Ry_mean + pose_Rz_mean,
        method = "rpart", data = trn_smile,
        trControl = trainControl(method = "cv", number = 10)
  )

smile__tree_model_5$results
```

```
##           cp Accuracy          Kappa AccuracySD      KappaSD
## 1 0.02575758 0.4929590 -0.018628892 0.06773807 0.13394796
## 2 0.02727273 0.5048964  0.005640949 0.07089130 0.14078111
## 3 0.10909091 0.5015096 -0.002110352 0.02310174 0.03990447
```

```
smile__tree_model_5$coefnames
```

```
## [1] "pose_Rx_mean" "pose_Ry_mean" "pose_Rz_mean"
```

```
varImp(smile__tree_model_5)
```

```
## rpart variable importance
##
##           Overall
## pose_Rz_mean 100.00
## pose_Ry_mean  19.25
## pose_Rx_mean   0.00
```

```
# summary(smile__tree_model_5$finalModel)
```

```
smile__tree_model_5_pred <- predict(smile__tree_model_5, tst_smile)
summary(smile__tree_model_5_pred)
```

```
## spontaneous deliberate
##           42           100
```

```
smile__tree_model_5_confM <- confusionMatrix(
  smile__tree_model_5_pred,
  tst_smile$smile_type
)
smile__tree_model_5_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           20           22
## deliberate           50           50
##
##              Accuracy : 0.493
##              95% CI : (0.4081, 0.5781)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.662667
##
##              Kappa : -0.02
##
## Mcnemar's Test P-Value : 0.001463
##
##              Sensitivity : 0.2857
##              Specificity : 0.6944
##              Pos Pred Value : 0.4762
##              Neg Pred Value : 0.5000
##              Prevalence : 0.4930
##              Detection Rate : 0.1408
##      Detection Prevalence : 0.2958
##              Balanced Accuracy : 0.4901
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
```

```
set.seed(1973)
smile__tree_model_5.1_pred <- predict(smile__tree_model_5, tst_smile_boys)
summary(smile__tree_model_5.1_pred)
```

```
## spontaneous deliberate
##           19           58
```

```
smile__tree_model_5.1_confM <- confusionMatrix(
  smile__tree_model_5.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_5.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           8           11
## deliberate          29           29
##
##              Accuracy : 0.4805
##              95% CI : (0.3652, 0.5974)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.78772
##
##              Kappa : -0.0599
##
## Mcnemar's Test P-Value : 0.00719
##
##      Sensitivity : 0.2162
##      Specificity : 0.7250
##      Pos Pred Value : 0.4211
##      Neg Pred Value : 0.5000
##      Prevalence : 0.4805
##      Detection Rate : 0.1039
##      Detection Prevalence : 0.2468
##      Balanced Accuracy : 0.4706
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_5.2_pred <- predict(smile__tree_model_5, tst_smile_girls)
summary(smile__tree_model_5.2_pred)
```

```
## spontaneous deliberate
##           23           42
```

```
smile__tree_model_5.2_confM <- confusionMatrix(
  smile__tree_model_5.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_5.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           12           11
```

```
## deliberate          21          21
##
##           Accuracy : 0.5077
##           95% CI : (0.3807, 0.634)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.5495
##
##           Kappa : 0.0198
##
## Mcnemar's Test P-Value : 0.1116
##
##           Sensitivity : 0.3636
##           Specificity : 0.6562
##       Pos Pred Value : 0.5217
##       Neg Pred Value : 0.5000
##           Prevalence : 0.5077
##       Detection Rate : 0.1846
##       Detection Prevalence : 0.3538
##       Balanced Accuracy : 0.5099
##
##       'Positive' Class : spontaneous
##
```

```
# model 5A gaze features
set.seed(1973)
smile__tree_model_5A <-
  train(smile_type ~ gaze_angle_x_mean + gaze_angle_y_mean,
    method = "rpart", data = trn_smile,
    trControl = trainControl(method = "cv", number = 10)
  )

smile__tree_model_5A$results
```

```
##           cp Accuracy          Kappa AccuracySD   KappaSD
## 1 0.03939394 0.4440062 -0.10718904 0.08008631 0.1553984
## 2 0.04242424 0.4590686 -0.08001649 0.08664907 0.1694805
## 3 0.09090909 0.4810160 -0.04705882 0.05472730 0.1030112
```

```
smile__tree_model_5A$coefnames
```

```
## [1] "gaze_angle_x_mean" "gaze_angle_y_mean"
```

```
varImp(smile__tree_model_5A)
```

```
## rpart variable importance
##
##           Overall
## gaze_angle_x_mean    NaN
## gaze_angle_y_mean    NaN
```

```
# summary(smile__tree_model_5A$finalModel)
```

```
smile__tree_model_5A_pred <- predict(smile__tree_model_5A, tst_smile)
summary(smile__tree_model_5A_pred)
```

```
## spontaneous deliberate
##           0           142
```

```
smile__tree_model_5A_confM <- confusionMatrix(
  smile__tree_model_5A_pred,
  tst_smile$smile_type
)
smile__tree_model_5A_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           0             0
## deliberate          70             72
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.5336
##
##              Kappa : 0
##
##  Mcnemar's Test P-Value : <2e-16
##
##      Sensitivity : 0.000
##      Specificity : 1.000
##      Pos Pred Value :  NaN
##      Neg Pred Value : 0.507
##      Prevalence : 0.493
##      Detection Rate : 0.000
##      Detection Prevalence : 0.000
##      Balanced Accuracy : 0.500
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
```

```
smile__tree_model_5A.1_pred <- predict(smile__tree_model_5A, tst_smile_boys)
summary(smile__tree_model_5A.1_pred)
```

```
## spontaneous deliberate
##           0           77
```

```
smile__tree_model_5A.1_confM <- confusionMatrix(
  smile__tree_model_5A.1_pred,
```

```

    tst_smile_boys$smile_type
)
smile__tree_model_5A.1_confM

```

```

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
##  spontaneous           0           0
##  deliberate           37           40
##
##              Accuracy : 0.5195
##              95% CI : (0.4026, 0.6348)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.5459
##
##              Kappa : 0
##
##  McNemar's Test P-Value : 3.252e-09
##
##              Sensitivity : 0.0000
##              Specificity : 1.0000
##    Pos Pred Value :      NaN
##    Neg Pred Value : 0.5195
##    Prevalence : 0.4805
##    Detection Rate : 0.0000
##    Detection Prevalence : 0.0000
##    Balanced Accuracy : 0.5000
##
##    'Positive' Class : spontaneous
##

```

```

set.seed(1973)
smile__tree_model_5A.2_pred <- predict(smile__tree_model_5A, tst_smile_girls)
summary(smile__tree_model_5A.2_pred)

```

```

## spontaneous deliberate
##              0           65

```

```

smile__tree_model_5A.2_confM <- confusionMatrix(
  smile__tree_model_5A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_5A.2_confM

```

```

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
##  spontaneous           0           0
##  deliberate           33           32
##

```



```
##               Accuracy : 0.4923
##               95% CI : (0.366, 0.6193)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.6452
##
##               Kappa : 0
##
##  McNemar's Test P-Value : 2.54e-08
##
##      Sensitivity : 0.0000
##      Specificity : 1.0000
##      Pos Pred Value :      NaN
##      Neg Pred Value : 0.4923
##      Prevalence : 0.5077
##      Detection Rate : 0.0000
##      Detection Prevalence : 0.0000
##      Balanced Accuracy : 0.5000
##
##      'Positive' Class : spontaneous
##
```

```
# model 5B headpose + gaze features
set.seed(1973)
smile__tree_model_5B <-
  train(smile_type ~ pose_Rx_mean + pose_Ry_mean + pose_Rz_mean +
    gaze_angle_x_mean + gaze_angle_y_mean,
    method = "rpart", data = trn_smile,
    trControl = trainControl(method = "cv", number = 10)
  )

smile__tree_model_5B$results
```

```
##           cp Accuracy           Kappa AccuracySD      KappaSD
## 1 0.01969697 0.4623719 -0.073073994 0.07260347 0.14825324
## 2 0.02575758 0.4686999 -0.064517461 0.07874648 0.16003545
## 3 0.10909091 0.5015096 -0.002110352 0.02310174 0.03990447
```

```
smile__tree_model_5B$coefnames
```

```
## [1] "pose_Rx_mean"      "pose_Ry_mean"      "pose_Rz_mean"
## [4] "gaze_angle_x_mean" "gaze_angle_y_mean"
```

```
varImp(smile__tree_model_5B)
```

```
## rpart variable importance
##
##               Overall
## gaze_angle_y_mean      NaN
## gaze_angle_x_mean      NaN
## pose_Rx_mean           NaN
## pose_Ry_mean           NaN
## pose_Rz_mean           NaN
```

```
# summary(smile__tree_model_5B$finalModel)
```

```
smile__tree_model_5B_pred <- predict(smile__tree_model_5B, tst_smile)
summary(smile__tree_model_5B_pred)
```

```
## spontaneous deliberate
##           0           142
```

```
smile__tree_model_5B_confM <- confusionMatrix(
  smile__tree_model_5B_pred,
  tst_smile$smile_type
)
smile__tree_model_5B_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           0             0
## deliberate           70             72
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.5336
##
##              Kappa : 0
##
##  Mcnemar's Test P-Value : <2e-16
##
##      Sensitivity : 0.000
##      Specificity : 1.000
##      Pos Pred Value :  NaN
##      Neg Pred Value : 0.507
##      Prevalence : 0.493
##      Detection Rate : 0.000
##      Detection Prevalence : 0.000
##      Balanced Accuracy : 0.500
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
```

```
smile__tree_model_5B.1_pred <- predict(smile__tree_model_5B, tst_smile_boys)
summary(smile__tree_model_5B.1_pred)
```

```
## spontaneous deliberate
##           0           77
```

```
smile__tree_model_5B.1_confM <- confusionMatrix(
  smile__tree_model_5B.1_pred,
```

```

    tst_smile_boys$smile_type
)
smile__tree_model_5B.1_confM

```

```

## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous           0           0
##  deliberate          37          40
##
##               Accuracy : 0.5195
##               95% CI : (0.4026, 0.6348)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.5459
##
##               Kappa : 0
##
##  McNemar's Test P-Value : 3.252e-09
##
##               Sensitivity : 0.0000
##               Specificity : 1.0000
##    Pos Pred Value :      NaN
##    Neg Pred Value : 0.5195
##    Prevalence : 0.4805
##    Detection Rate : 0.0000
##    Detection Prevalence : 0.0000
##    Balanced Accuracy : 0.5000
##
##    'Positive' Class : spontaneous
##

```

```

set.seed(1973)
smile__tree_model_5B.2_pred <- predict(smile__tree_model_5B, tst_smile_girls)
summary(smile__tree_model_5B.2_pred)

```

```

## spontaneous deliberate
##           0           65

```

```

smile__tree_model_5B.2_confM <- confusionMatrix(
  smile__tree_model_5B.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_5B.2_confM

```

```

## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous           0           0
##  deliberate          33          32
##

```

```
##               Accuracy : 0.4923
##               95% CI : (0.366, 0.6193)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.6452
##
##               Kappa : 0
##
##  McNemar's Test P-Value : 2.54e-08
##
##      Sensitivity : 0.0000
##      Specificity : 1.0000
##      Pos Pred Value :      NaN
##      Neg Pred Value : 0.4923
##      Prevalence : 0.5077
##      Detection Rate : 0.0000
##      Detection Prevalence : 0.0000
##      Balanced Accuracy : 0.5000
##
##      'Positive' Class : spontaneous
##
```

```
# model 6 dynamics and movement
```

```
set.seed(1973)
smile__tree_model_6 <-
  train(smile_type ~ onset_mean + apex_mean + offset_mean + eye_mean + lip_mean,
        method = "rpart", data = trn_smile,
        trControl = trainControl(method = "cv", number = 10)
  )
smile__tree_model_6$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5492090 0.09642256 0.09355662 0.18550882
## 2 0.06666667 0.5314728 0.06480625 0.09078317 0.17739898
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

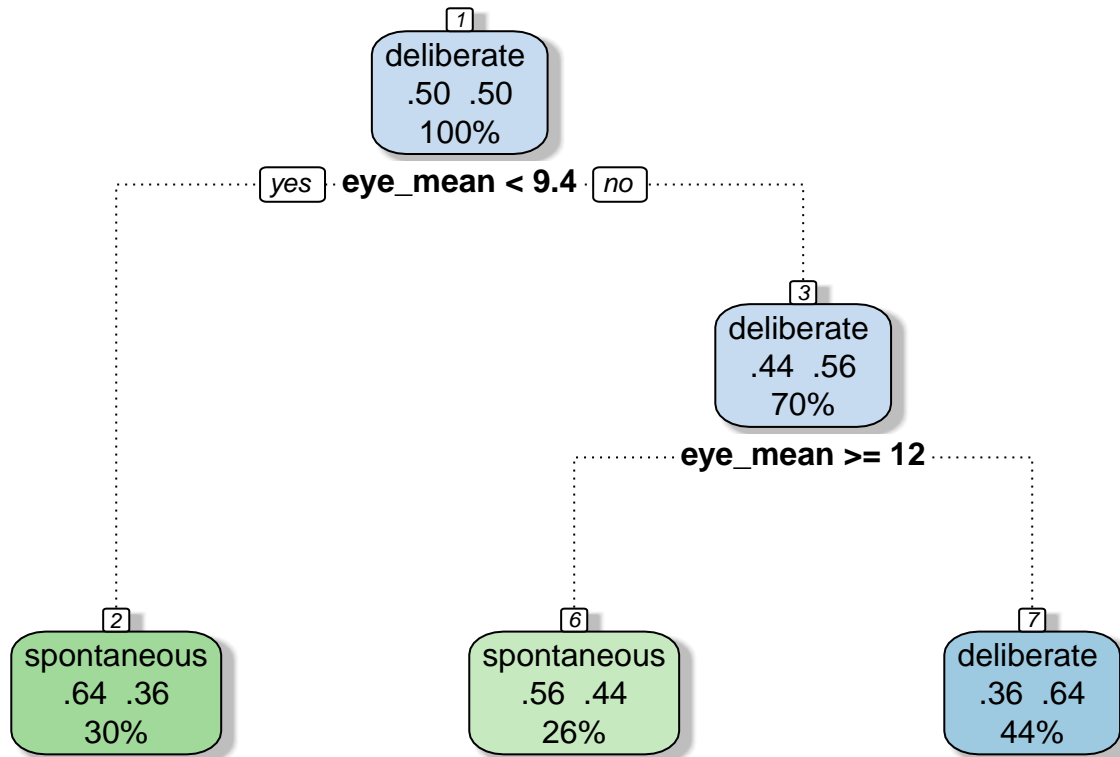
```
smile__tree_model_6$coefnames
```

```
## [1] "onset_mean" "apex_mean" "offset_mean" "eye_mean" "lip_mean"
```

```
varImp(smile__tree_model_6)
```

```
## rpart variable importance
##
##           Overall
## eye_mean      100.00
## offset_mean    77.33
## onset_mean     43.18
## apex_mean      19.36
## lip_mean        0.00
```

```
# summary(smile__tree_model_6$finalModel)
fancyRpartPlot(smile__tree_model_6$finalModel)
```



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```
smile__tree_model_6_pred <- predict(smile__tree_model_6, tst_smile)
summary(smile__tree_model_6_pred)
```

```
## spontaneous deliberate
##           88           54
```

```
smile__tree_model_6_confM <- confusionMatrix(
  smile__tree_model_6_pred,
  tst_smile$smile_type
)
smile__tree_model_6_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction   spontaneous deliberate
## spontaneous      45           43
## deliberate       25           29
##
##              Accuracy : 0.5211
##              95% CI : (0.4358, 0.6056)
```

```
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.40080
##
##              Kappa : 0.0455
##
##  Mcnemar's Test P-Value : 0.03925
##
##      Sensitivity : 0.6429
##      Specificity : 0.4028
##      Pos Pred Value : 0.5114
##      Neg Pred Value : 0.5370
##      Prevalence : 0.4930
##      Detection Rate : 0.3169
##      Detection Prevalence : 0.6197
##      Balanced Accuracy : 0.5228
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6.1_pred <- predict(smile__tree_model_6, tst_smile_boys)
summary(smile__tree_model_6.1_pred)
```

```
## spontaneous deliberate
##           52           25
```

```
smile__tree_model_6.1_confM <- confusionMatrix(
  smile__tree_model_6.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           26           26
## deliberate           11           14
##
##              Accuracy : 0.5195
##              95% CI : (0.4026, 0.6348)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.54593
##
##              Kappa : 0.0519
##
##  Mcnemar's Test P-Value : 0.02136
##
##      Sensitivity : 0.7027
##      Specificity : 0.3500
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5600
```

```
##           Prevalence : 0.4805
##           Detection Rate : 0.3377
##           Detection Prevalence : 0.6753
##           Balanced Accuracy : 0.5264
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6.2_pred <- predict(smile__tree_model_6, tst_smile_girls)
summary(smile__tree_model_6.2_pred)
```

```
## spontaneous deliberate
##           36           29
```

```
smile__tree_model_6.2_confM <- confusionMatrix(
  smile__tree_model_6.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           19           17
## deliberate           14           15
##
##           Accuracy : 0.5231
##           95% CI : (0.3954, 0.6485)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.4510
##
##           Kappa : 0.0446
##
##           Mcnemar's Test P-Value : 0.7194
##
##           Sensitivity : 0.5758
##           Specificity : 0.4688
##           Pos Pred Value : 0.5278
##           Neg Pred Value : 0.5172
##           Prevalence : 0.5077
##           Detection Rate : 0.2923
##           Detection Prevalence : 0.5538
##           Balanced Accuracy : 0.5223
##
##           'Positive' Class : spontaneous
##
```

```
# model 6A dynamics and eye movement
set.seed(1973)
smile__tree_model_6A <-
```

```
train(smile_type ~ onset_mean + apex_mean + offset_mean + eye_mean,
      method = "rpart", data = trn_smile,
      trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_6A$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5522393 0.10505764 0.08946029 0.17418506
## 2 0.06666667 0.5314728 0.06480625 0.09078317 0.17739898
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

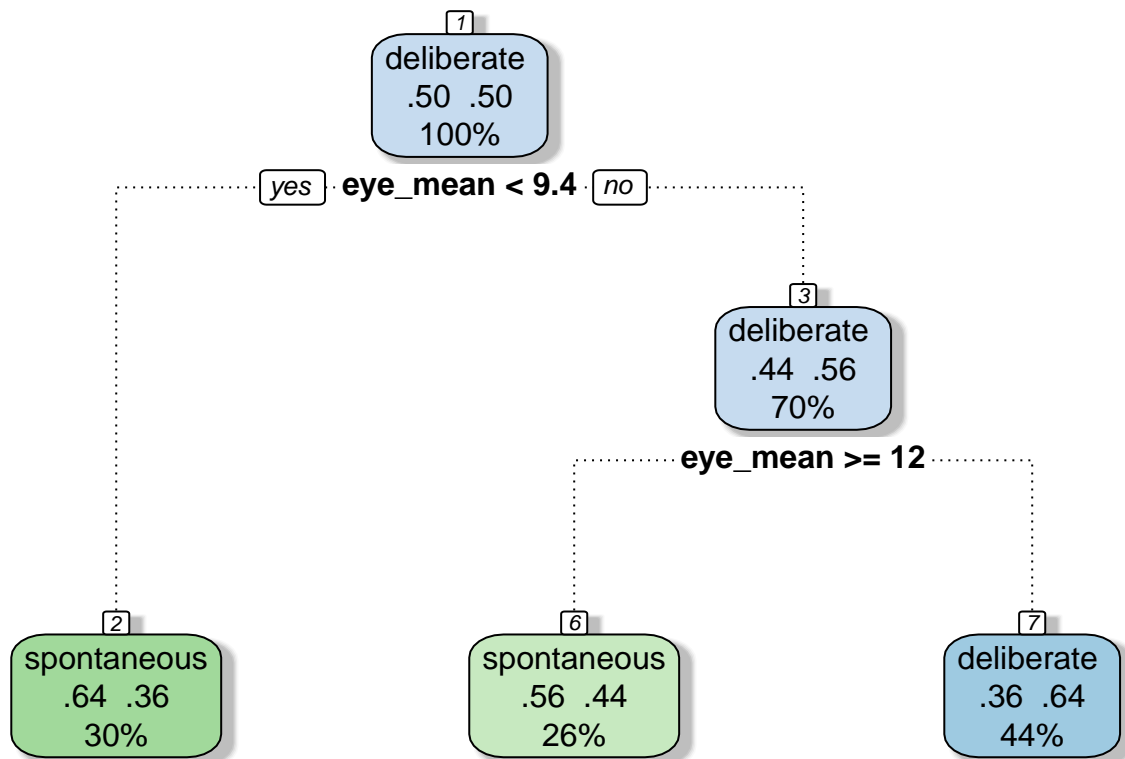
```
smile__tree_model_6A$coefnames
```

```
## [1] "onset_mean" "apex_mean" "offset_mean" "eye_mean"
```

```
varImp(smile__tree_model_6A)
```

```
## rpart variable importance
##
##           Overall
## eye_mean      100.00
## offset_mean    71.88
## onset_mean     29.55
## apex_mean       0.00
```

```
# summary(smile__tree_model_6A$finalModel)
fancyRpartPlot(smile__tree_model_6A$finalModel)
```

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```
smile__tree_model_6A_pred <- predict(smile__tree_model_6A, tst_smile)
summary(smile__tree_model_6A_pred)
```

```
## spontaneous deliberate
##           88           54
```

```
smile__tree_model_6A_confM <- confusionMatrix(
  smile__tree_model_6A_pred,
  tst_smile$smile_type
)
smile__tree_model_6A_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      45           43
## deliberate       25           29
##
##              Accuracy : 0.5211
##              95% CI : (0.4358, 0.6056)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.40080
##
##              Kappa : 0.0455
```

```
##
## McNemar's Test P-Value : 0.03925
##
##           Sensitivity : 0.6429
##           Specificity : 0.4028
##           Pos Pred Value : 0.5114
##           Neg Pred Value : 0.5370
##           Prevalence : 0.4930
##           Detection Rate : 0.3169
##           Detection Prevalence : 0.6197
##           Balanced Accuracy : 0.5228
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6A.1_pred <- predict(smile__tree_model_6A, tst_smile_boys)
summary(smile__tree_model_6A.1_pred)
```

```
## spontaneous deliberate
##           52           25
```

```
smile__tree_model_6A.1_confM <- confusionMatrix(
  smile__tree_model_6A.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6A.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           26           26
## deliberate           11           14
##
##           Accuracy : 0.5195
##           95% CI : (0.4026, 0.6348)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.54593
##
##           Kappa : 0.0519
##
## McNemar's Test P-Value : 0.02136
##
##           Sensitivity : 0.7027
##           Specificity : 0.3500
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5600
##           Prevalence : 0.4805
##           Detection Rate : 0.3377
##           Detection Prevalence : 0.6753
##           Balanced Accuracy : 0.5264
```

```

##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_6A.2_pred <- predict(smile__tree_model_6A, tst_smile_girls)
summary(smile__tree_model_6A.2_pred)

## spontaneous deliberate
##      36      29

smile__tree_model_6A.2_confM <- confusionMatrix(
  smile__tree_model_6A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6A.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      19          17
## deliberate       14          15
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0446
##
##  Mcnemar's Test P-Value : 0.7194
##
##              Sensitivity : 0.5758
##              Specificity : 0.4688
##              Pos Pred Value : 0.5278
##              Neg Pred Value : 0.5172
##              Prevalence : 0.5077
##              Detection Rate : 0.2923
##      Detection Prevalence : 0.5538
##              Balanced Accuracy : 0.5223
##
##      'Positive' Class : spontaneous
##

# model 6B dynamics and lip movement
set.seed(1973)
smile__tree_model_6B <-
  train(smile_type ~ onset_mean + apex_mean + offset_mean + lip_mean,
    method = "rpart", data = trn_smile,
    trControl = trainControl(method = "cv", number = 10)
  )

```

```
smile__tree_model_6B$results
```

```
##           cp Accuracy      Kappa AccuracySD  KappaSD
## 1 0.04242424 0.5341466 0.06676405 0.08133394 0.1623784
## 2 0.06666667 0.5102718 0.02342038 0.08905266 0.1730390
## 3 0.07878788 0.5106283 0.02562619 0.06235534 0.1200097
```

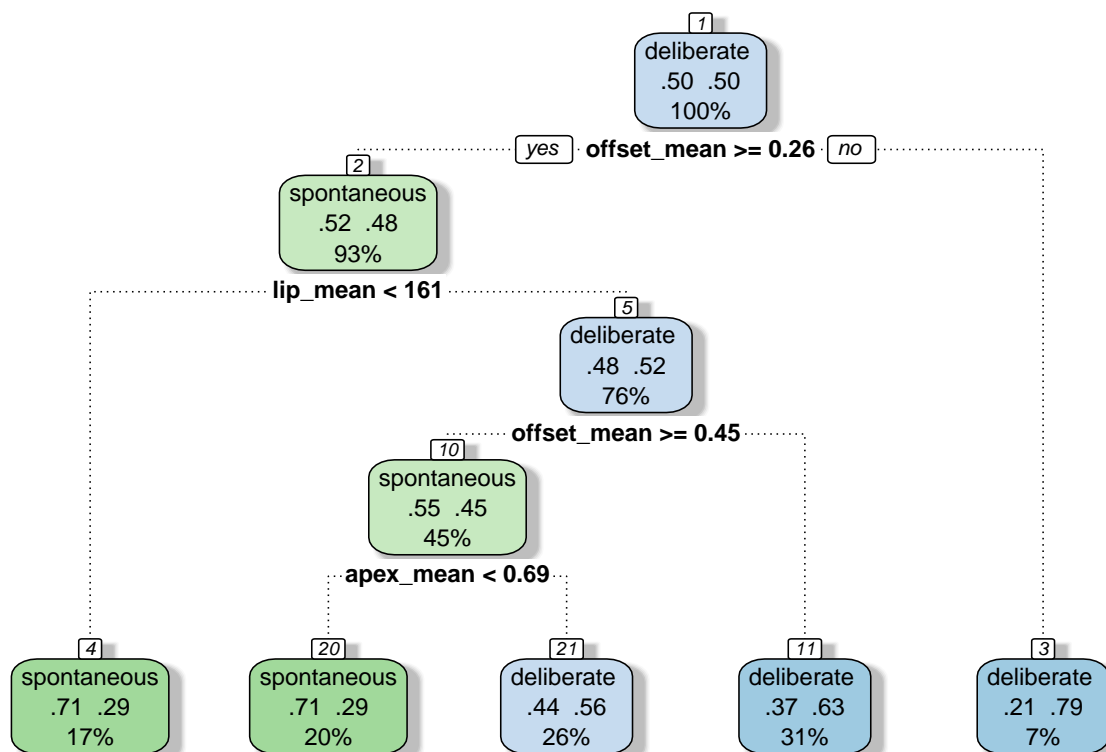
```
smile__tree_model_6B$coefnames
```

```
## [1] "onset_mean" "apex_mean" "offset_mean" "lip_mean"
```

```
varImp(smile__tree_model_6B)
```

```
## rpart variable importance
##
##           Overall
## apex_mean    100.00
## offset_mean   67.01
## lip_mean      64.83
## onset_mean     0.00
```

```
# summary(smile__tree_model_6B$finalModel)
fancyRpartPlot(smile__tree_model_6B$finalModel)
```



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```
smile__tree_model_6B_pred <- predict(smile__tree_model_6B, tst_smile)
summary(smile__tree_model_6B_pred)
```

```
## spontaneous deliberate
##           51           91
```

```
smile__tree_model_6B_confM <- confusionMatrix(
  smile__tree_model_6B_pred,
  tst_smile$smile_type
)
smile__tree_model_6B_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction      spontaneous deliberate
## spontaneous           36           15
## deliberate           34           57
##
##              Accuracy : 0.6549
##              95% CI : (0.5706, 0.7326)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0002621
##
##              Kappa : 0.3071
##
## Mcnemar's Test P-Value : 0.0101280
##
##      Sensitivity : 0.5143
##      Specificity : 0.7917
##      Pos Pred Value : 0.7059
##      Neg Pred Value : 0.6264
##      Prevalence : 0.4930
##      Detection Rate : 0.2535
##      Detection Prevalence : 0.3592
##      Balanced Accuracy : 0.6530
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6B.1_pred <- predict(smile__tree_model_6B, tst_smile_boys)
# summary(smile__tree_model_6B.1_pred)
smile__tree_model_6B.1_confM <- confusionMatrix(
  smile__tree_model_6B.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6B.1_confM
```

```
## Confusion Matrix and Statistics
##
```

```
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      20           10
## deliberate       17           30
##
##               Accuracy : 0.6494
##               95% CI : (0.5322, 0.7547)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.01457
##
##               Kappa : 0.2926
##
## Mcnemar's Test P-Value : 0.24821
##
##       Sensitivity : 0.5405
##       Specificity : 0.7500
##       Pos Pred Value : 0.6667
##       Neg Pred Value : 0.6383
##       Prevalence : 0.4805
##       Detection Rate : 0.2597
##       Detection Prevalence : 0.3896
##       Balanced Accuracy : 0.6453
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6B.2_pred <- predict(smile__tree_model_6B, tst_smile_girls)
summary(smile__tree_model_6B.2_pred)
```

```
## spontaneous deliberate
##           21           44
```

```
smile__tree_model_6B.2_confM <- confusionMatrix(
  smile__tree_model_6B.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6B.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      16           5
## deliberate       17           27
##
##               Accuracy : 0.6615
##               95% CI : (0.5335, 0.7743)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.008794
##
##               Kappa : 0.3267
##
```

```
## McNemar's Test P-Value : 0.019016
##
##      Sensitivity : 0.4848
##      Specificity : 0.8438
##      Pos Pred Value : 0.7619
##      Neg Pred Value : 0.6136
##      Prevalence : 0.5077
##      Detection Rate : 0.2462
##      Detection Prevalence : 0.3231
##      Balanced Accuracy : 0.6643
##
##      'Positive' Class : spontaneous
##
```

```
# model 6C onset and movement
set.seed(1973)
smile__tree_model_6C <- train(smile_type ~ onset_mean + eye_mean + lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6C$results
```

```
##      cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.02424242 0.5678420 0.13387329 0.07670856 0.15409631
## 2 0.06666667 0.5863024 0.16881293 0.10339900 0.20811509
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

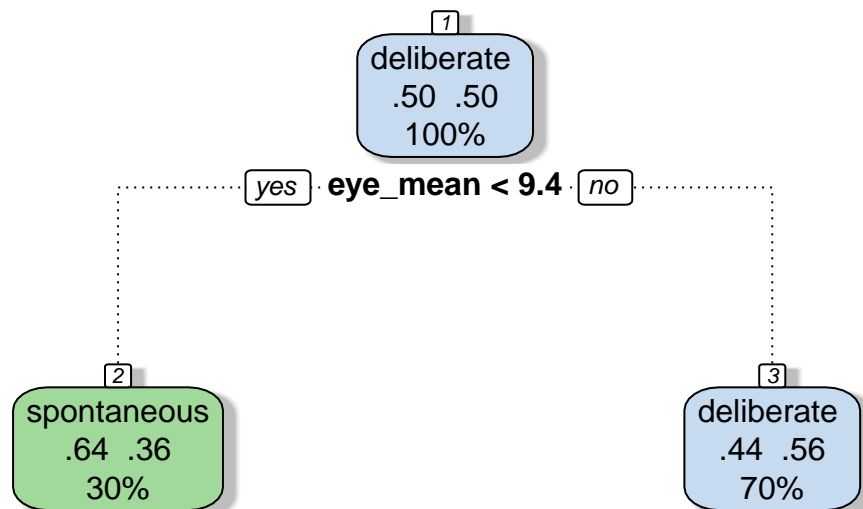
```
smile__tree_model_6C$coefnames
```

```
## [1] "onset_mean" "eye_mean" "lip_mean"
```

```
varImp(smile__tree_model_6C)
```

```
## rpart variable importance
##
##      Overall
## eye_mean    100.0
## onset_mean   18.8
## lip_mean      0.0
```

```
# summary(smile__tree_model_6C$finalModel)
fancyRpartPlot(smile__tree_model_6C$finalModel)
```



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```
smile__tree_model_6C_pred <- predict(smile__tree_model_6C, tst_smile)
summary(smile__tree_model_6C_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__tree_model_6C_confM <- confusionMatrix(
  smile__tree_model_6C_pred,
  tst_smile$smile_type
)
smile__tree_model_6C_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      25           16
##  deliberate       45           56
##
##           Accuracy : 0.5704
##           95% CI : (0.4847, 0.6531)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.076642
##
##           Kappa : 0.1357
```



```
##
## McNemar's Test P-Value : 0.000337
##
##          Sensitivity : 0.3571
##          Specificity : 0.7778
##          Pos Pred Value : 0.6098
##          Neg Pred Value : 0.5545
##          Prevalence : 0.4930
##          Detection Rate : 0.1761
##          Detection Prevalence : 0.2887
##          Balanced Accuracy : 0.5675
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6C.1_pred <- predict(smile__tree_model_6C, tst_smile_boys)
summary(smile__tree_model_6C.1_pred)
```

```
## spontaneous deliberate
##          22          55
```

```
smile__tree_model_6C.1_confM <- confusionMatrix(
  smile__tree_model_6C.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6C.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          13           9
## deliberate          24          31
##
##          Accuracy : 0.5714
##          95% CI : (0.4535, 0.6837)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.21259
##
##          Kappa : 0.1283
##
## McNemar's Test P-Value : 0.01481
##
##          Sensitivity : 0.3514
##          Specificity : 0.7750
##          Pos Pred Value : 0.5909
##          Neg Pred Value : 0.5636
##          Prevalence : 0.4805
##          Detection Rate : 0.1688
##          Detection Prevalence : 0.2857
##          Balanced Accuracy : 0.5632
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_6C.2_pred <- predict(smile__tree_model_6C, tst_smile_girls)
summary(smile__tree_model_6C.2_pred)

## spontaneous deliberate
##           19           46

smile__tree_model_6C.2_confM <- confusionMatrix(
  smile__tree_model_6C.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6C.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           12             7
## deliberate            21            25
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.19273
##
##              Kappa : 0.1439
##
##  Mcnemar's Test P-Value : 0.01402
##
##              Sensitivity : 0.3636
##              Specificity : 0.7812
##              Pos Pred Value : 0.6316
##              Neg Pred Value : 0.5435
##              Prevalence : 0.5077
##              Detection Rate : 0.1846
##      Detection Prevalence : 0.2923
##              Balanced Accuracy : 0.5724
##
##      'Positive' Class : spontaneous
##

# model 6D onset + eye
set.seed(1973)
smile__tree_model_6D <- train(smile_type ~ onset_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6D$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5830882 0.16410842 0.07002286 0.13877600
## 2 0.06666667 0.5863024 0.16881293 0.10339900 0.20811509
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

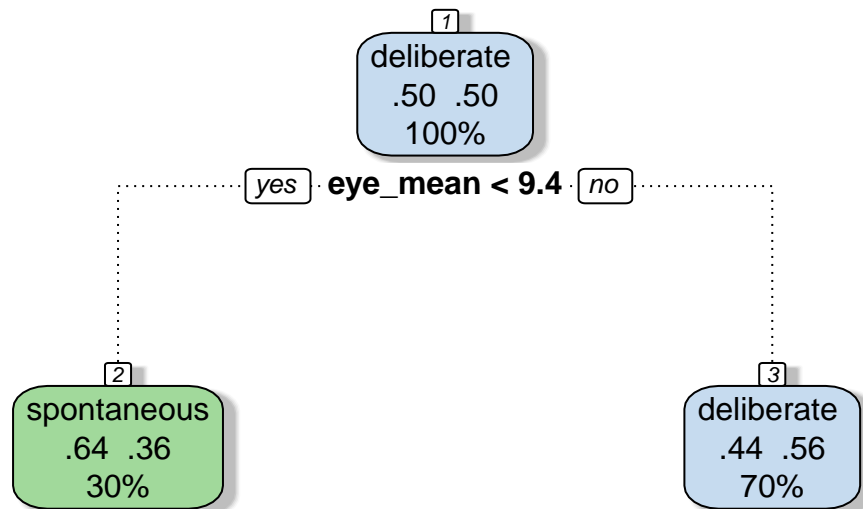
```
smile__tree_model_6D$coefnames
```

```
## [1] "onset_mean" "eye_mean"
```

```
varImp(smile__tree_model_6D)
```

```
## rpart variable importance
##
##           Overall
## eye_mean      100
## onset_mean      0
```

```
# summary(smile__tree_model_6D$finalModel)
fancyRpartPlot(smile__tree_model_6D$finalModel)
```



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```
smile__tree_model_6D_pred <- predict(smile__tree_model_6D, tst_smile)
summary(smile__tree_model_6D_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__tree_model_6D_confM <- confusionMatrix(
  smile__tree_model_6D_pred,
  tst_smile$smile_type
)
smile__tree_model_6D_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      25           16
## deliberate       45           56
##
##              Accuracy : 0.5704
##              95% CI : (0.4847, 0.6531)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.076642
##
##              Kappa : 0.1357
##
##  Mcnemar's Test P-Value : 0.000337
##
##      Sensitivity : 0.3571
##      Specificity : 0.7778
##      Pos Pred Value : 0.6098
##      Neg Pred Value : 0.5545
##      Prevalence : 0.4930
##      Detection Rate : 0.1761
##      Detection Prevalence : 0.2887
##      Balanced Accuracy : 0.5675
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6D.1_pred <- predict(smile__tree_model_6D, tst_smile_boys)
summary(smile__tree_model_6D.1_pred)
```

```
## spontaneous deliberate
##           22           55
```

```
smile__tree_model_6D.1_confM <- confusionMatrix(
  smile__tree_model_6D.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6D.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      13           9
## deliberate       24          31
##
##           Accuracy : 0.5714
##           95% CI : (0.4535, 0.6837)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.21259
##
##           Kappa : 0.1283
##
## Mcnemar's Test P-Value : 0.01481
##
##           Sensitivity : 0.3514
##           Specificity : 0.7750
##       Pos Pred Value : 0.5909
##       Neg Pred Value : 0.5636
##           Prevalence : 0.4805
##       Detection Rate : 0.1688
##       Detection Prevalence : 0.2857
##       Balanced Accuracy : 0.5632
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6D.2_pred <- predict(smile__tree_model_6D, tst_smile_girls)
summary(smile__tree_model_6D.2_pred)
```

```
## spontaneous deliberate
##           19           46
```

```
smile__tree_model_6D.2_confM <- confusionMatrix(
  smile__tree_model_6D.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6D.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      12           7
## deliberate       21          25
##
##           Accuracy : 0.5692
##           95% CI : (0.4404, 0.6915)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.19273
##
##           Kappa : 0.1439
```

```
##
## McNemar's Test P-Value : 0.01402
##
##          Sensitivity : 0.3636
##          Specificity : 0.7812
##          Pos Pred Value : 0.6316
##          Neg Pred Value : 0.5435
##          Prevalence : 0.5077
##          Detection Rate : 0.1846
##          Detection Prevalence : 0.2923
##          Balanced Accuracy : 0.5724
##
##          'Positive' Class : spontaneous
##
```

```
# model 6E onset + lip
set.seed(1973)
smile__tree_model_6E <- train(smile_type ~ onset_mean + lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6E$results
```

```
##          cp Accuracy          Kappa AccuracySD      KappaSD
## 1 0.02121212 0.5669285 0.13279284 0.05096836 0.1021507
## 2 0.02424242 0.5670232 0.13415123 0.04546484 0.0904795
## 3 0.05909091 0.4897504 -0.02427537 0.05640185 0.1111774
```

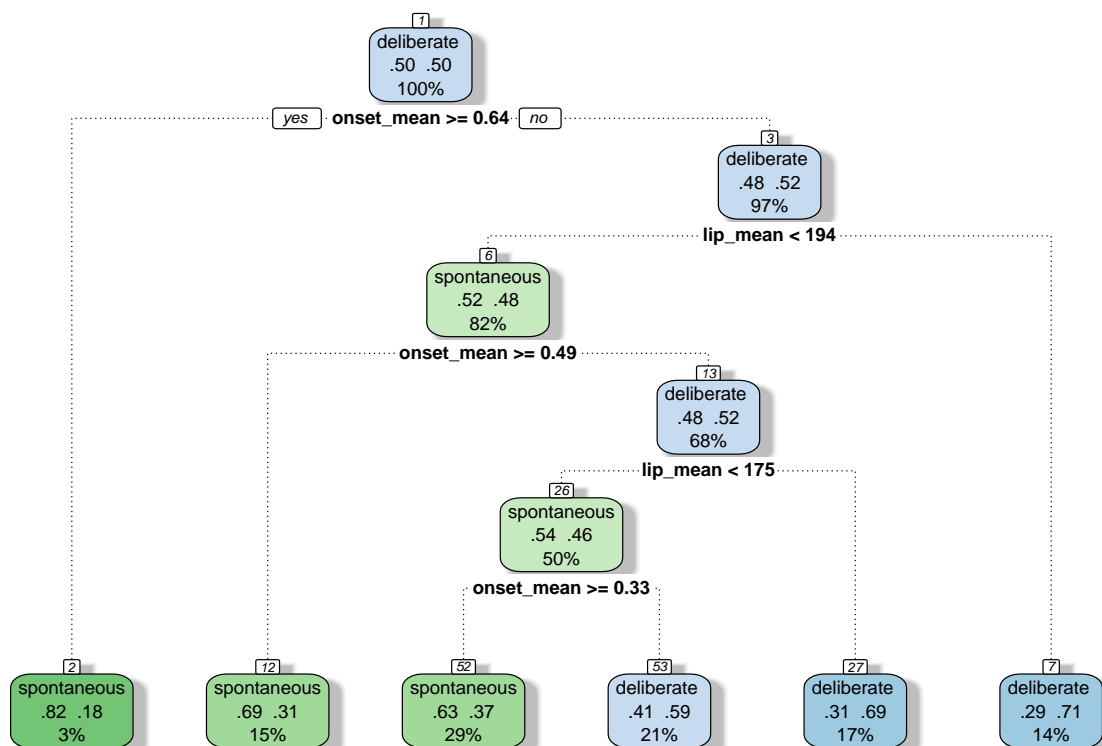
```
smile__tree_model_6E$coefnames
```

```
## [1] "onset_mean" "lip_mean"
```

```
varImp(smile__tree_model_6E)
```

```
## rpart variable importance
##
##          Overall
## lip_mean      100
## onset_mean      0
```

```
# summary(smile__tree_model_6E$finalModel)
fancyRpartPlot(smile__tree_model_6E$finalModel)
```



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```
smile__tree_model_6E_pred <- predict(smile__tree_model_6E, tst_smile)
summary(smile__tree_model_6E_pred)
```

```
## spontaneous deliberate
##           68           74
```

```
smile__tree_model_6E_confM <- confusionMatrix(
  smile__tree_model_6E_pred,
  tst_smile$smile_type
)
smile__tree_model_6E_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           35           33
## deliberate            35           39
##
##           Accuracy : 0.5211
##           95% CI : (0.4358, 0.6056)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.4008
##
##           Kappa : 0.0417
```

```
##
## McNemar's Test P-Value : 0.9035
##
##           Sensitivity : 0.5000
##           Specificity : 0.5417
##           Pos Pred Value : 0.5147
##           Neg Pred Value : 0.5270
##           Prevalence : 0.4930
##           Detection Rate : 0.2465
##           Detection Prevalence : 0.4789
##           Balanced Accuracy : 0.5208
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6E.1_pred <- predict(smile__tree_model_6E, tst_smile_boys)
summary(smile__tree_model_6E.1_pred)
```

```
## spontaneous deliberate
##           34           43
```

```
smile__tree_model_6E.1_confM <- confusionMatrix(
  smile__tree_model_6E.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6E.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           15           19
## deliberate            22           21
##
##           Accuracy : 0.4675
##           95% CI : (0.3529, 0.5848)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.8476
##
##           Kappa : -0.0698
##
## McNemar's Test P-Value : 0.7548
##
##           Sensitivity : 0.4054
##           Specificity : 0.5250
##           Pos Pred Value : 0.4412
##           Neg Pred Value : 0.4884
##           Prevalence : 0.4805
##           Detection Rate : 0.1948
##           Detection Prevalence : 0.4416
##           Balanced Accuracy : 0.4652
```



```

##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_6E.2_pred <- predict(smile__tree_model_6E, tst_smile_girls)
summary(smile__tree_model_6E.2_pred)

## spontaneous deliberate
##           34           31

smile__tree_model_6E.2_confM <- confusionMatrix(
  smile__tree_model_6E.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6E.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           20           14
## deliberate            13           18
##
##              Accuracy : 0.5846
##              95% CI : (0.4556, 0.7056)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.132
##
##              Kappa : 0.1686
##
## Mcnemar's Test P-Value : 1.000
##
##      Sensitivity : 0.6061
##      Specificity : 0.5625
##      Pos Pred Value : 0.5882
##      Neg Pred Value : 0.5806
##      Prevalence : 0.5077
##      Detection Rate : 0.3077
##      Detection Prevalence : 0.5231
##      Balanced Accuracy : 0.5843
##
##      'Positive' Class : spontaneous
##

# model 6F apex and movement
set.seed(1973)
smile__tree_model_6F <- train(smile_type ~ apex_mean + eye_mean + lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6F$results

```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5920065 0.18186252 0.09150065 0.18186377
## 2 0.06666667 0.5892435 0.17469528 0.10479850 0.21101409
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

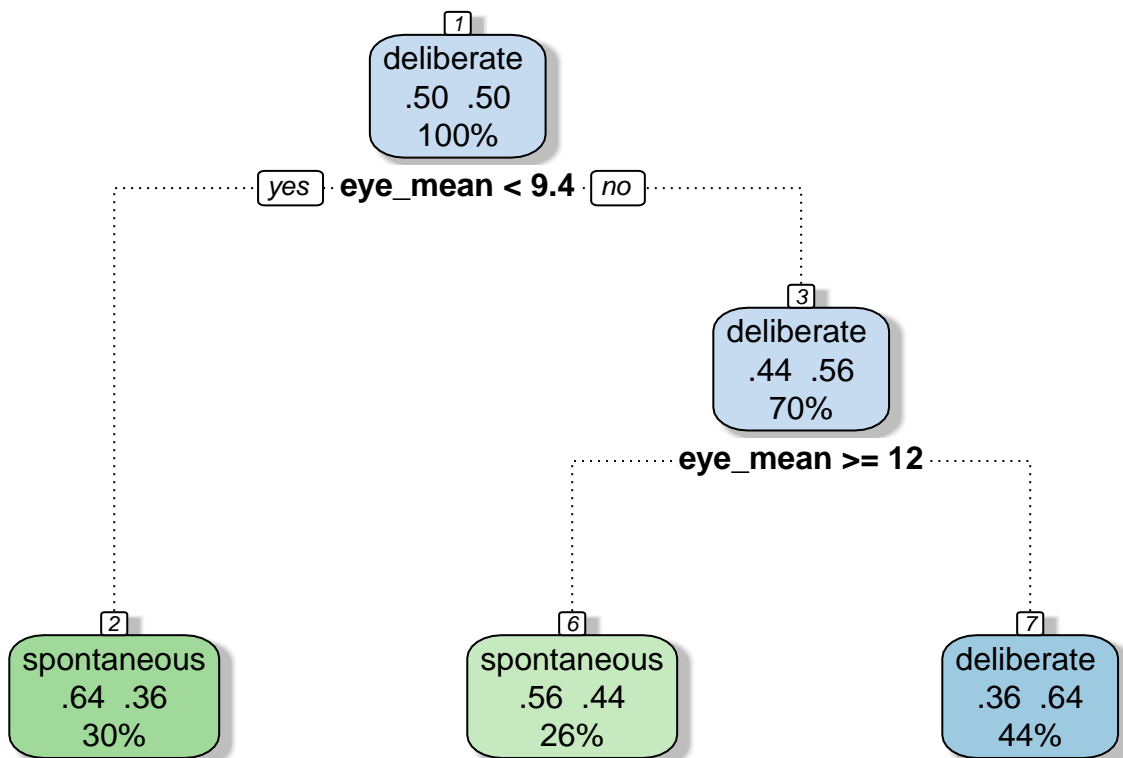
```
smile__tree_model_6F$coefnames
```

```
## [1] "apex_mean" "eye_mean" "lip_mean"
```

```
varImp(smile__tree_model_6F)
```

```
## rpart variable importance
##
##           Overall
## eye_mean    100.00
## apex_mean    19.36
## lip_mean      0.00
```

```
# summary(smile__tree_model_6F$finalModel)
fancyRpartPlot(smile__tree_model_6F$finalModel,
  caption = "model 6F: Decision Tree - apex, eye, lip"
)
```



model 6F: Decision Tree – apex, eye, lip

```
smile__tree_model_6F_pred <- predict(smile__tree_model_6F, tst_smile)
summary(smile__tree_model_6F_pred)
```

```
## spontaneous deliberate
##           88           54
```

```
smile__tree_model_6F_confM <- confusionMatrix(
  smile__tree_model_6F_pred,
  tst_smile$smile_type
)
smile__tree_model_6F_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           45           43
## deliberate           25           29
##
##              Accuracy : 0.5211
##              95% CI : (0.4358, 0.6056)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.40080
##
##              Kappa : 0.0455
##
##  Mcnemar's Test P-Value : 0.03925
##
##              Sensitivity : 0.6429
##              Specificity : 0.4028
##              Pos Pred Value : 0.5114
##              Neg Pred Value : 0.5370
##              Prevalence : 0.4930
##              Detection Rate : 0.3169
##      Detection Prevalence : 0.6197
##              Balanced Accuracy : 0.5228
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6F.1_pred <- predict(smile__tree_model_6F, tst_smile_boys)
summary(smile__tree_model_6F.1_pred)
```

```
## spontaneous deliberate
##           52           25
```

```
smile__tree_model_6F.1_confM <- confusionMatrix(
  smile__tree_model_6F.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6F.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      26             26
## deliberate       11             14
##
##               Accuracy : 0.5195
##               95% CI : (0.4026, 0.6348)
##               No Information Rate : 0.5195
##               P-Value [Acc > NIR] : 0.54593
##
##               Kappa : 0.0519
##
## Mcnemar's Test P-Value : 0.02136
##
##               Sensitivity : 0.7027
##               Specificity : 0.3500
##               Pos Pred Value : 0.5000
##               Neg Pred Value : 0.5600
##               Prevalence : 0.4805
##               Detection Rate : 0.3377
##               Detection Prevalence : 0.6753
##               Balanced Accuracy : 0.5264
##
##               'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6F.2_pred <- predict(smile__tree_model_6F, tst_smile_girls)
summary(smile__tree_model_6F.2_pred)
```

```
## spontaneous deliberate
##           36           29
```

```
smile__tree_model_6F.2_confM <- confusionMatrix(
  smile__tree_model_6F.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6F.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      19             17
## deliberate       14             15
##
##               Accuracy : 0.5231
##               95% CI : (0.3954, 0.6485)
##               No Information Rate : 0.5077
##               P-Value [Acc > NIR] : 0.4510
##
```

```
##                Kappa : 0.0446
##
## Mcnemar's Test P-Value : 0.7194
##
##          Sensitivity : 0.5758
##          Specificity : 0.4688
##          Pos Pred Value : 0.5278
##          Neg Pred Value : 0.5172
##          Prevalence : 0.5077
##          Detection Rate : 0.2923
##          Detection Prevalence : 0.5538
##          Balanced Accuracy : 0.5223
##
##          'Positive' Class : spontaneous
##
```

```
# model 6G apex + eye
set.seed(1973)
smile__tree_model_6G <- train(smile_type ~ apex_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6G$results
```

```
##          cp Accuracy          Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5920065 0.18186252 0.09150065 0.18186377
## 2 0.06666667 0.5892435 0.17469528 0.10479850 0.21101409
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

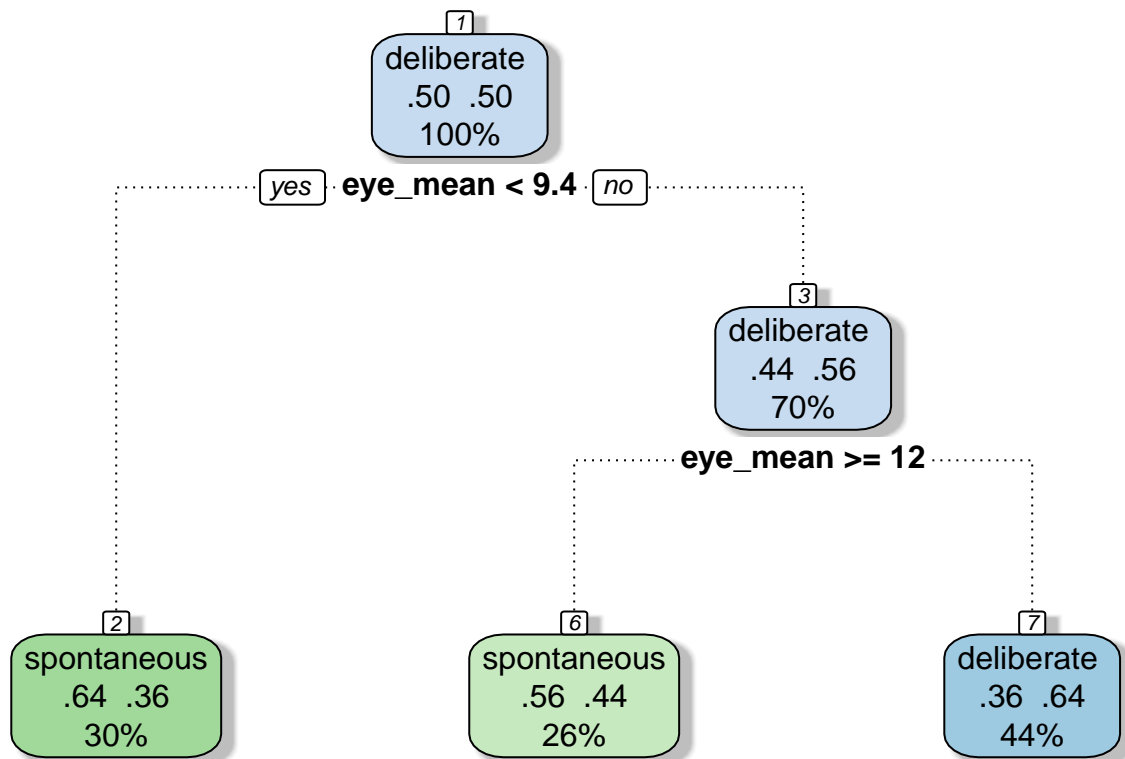
```
smile__tree_model_6G$coefnames
```

```
## [1] "apex_mean" "eye_mean"
```

```
varImp(smile__tree_model_6G)
```

```
## rpart variable importance
##
##          Overall
## eye_mean      100
## apex_mean       0
```

```
# summary(smile__tree_model_6G$finalModel)
fancyRpartPlot(smile__tree_model_6G$finalModel)
```



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```
smile__tree_model_6G_pred <- predict(smile__tree_model_6G, tst_smile)
summary(smile__tree_model_6G_pred)
```

```
## spontaneous deliberate
##           88           54
```

```
smile__tree_model_6G_confM <- confusionMatrix(
  smile__tree_model_6G_pred,
  tst_smile$smile_type
)
smile__tree_model_6G_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      45           43
##  deliberate       25           29
##
##           Accuracy : 0.5211
##           95% CI : (0.4358, 0.6056)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.40080
##
##           Kappa : 0.0455
```

```
##
## McNemar's Test P-Value : 0.03925
##
##           Sensitivity : 0.6429
##           Specificity : 0.4028
##           Pos Pred Value : 0.5114
##           Neg Pred Value : 0.5370
##           Prevalence : 0.4930
##           Detection Rate : 0.3169
##           Detection Prevalence : 0.6197
##           Balanced Accuracy : 0.5228
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6G.1_pred <- predict(smile__tree_model_6G, tst_smile_boys)
summary(smile__tree_model_6G.1_pred)
```

```
## spontaneous deliberate
##           52           25
```

```
smile__tree_model_6G.1_confM <- confusionMatrix(
  smile__tree_model_6G.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6G.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           26           26
## deliberate           11           14
##
##           Accuracy : 0.5195
##           95% CI : (0.4026, 0.6348)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.54593
##
##           Kappa : 0.0519
##
## McNemar's Test P-Value : 0.02136
##
##           Sensitivity : 0.7027
##           Specificity : 0.3500
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5600
##           Prevalence : 0.4805
##           Detection Rate : 0.3377
##           Detection Prevalence : 0.6753
##           Balanced Accuracy : 0.5264
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_6G.2_pred <- predict(smile__tree_model_6G, tst_smile_girls)
summary(smile__tree_model_6G.2_pred)

## spontaneous deliberate
##           36           29

smile__tree_model_6G.2_confM <- confusionMatrix(
  smile__tree_model_6G.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6G.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           19           17
## deliberate            14           15
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0446
##
## Mcnemar's Test P-Value : 0.7194
##
##              Sensitivity : 0.5758
##              Specificity : 0.4688
##              Pos Pred Value : 0.5278
##              Neg Pred Value : 0.5172
##              Prevalence : 0.5077
##              Detection Rate : 0.2923
##      Detection Prevalence : 0.5538
##              Balanced Accuracy : 0.5223
##
##      'Positive' Class : spontaneous
##

# model 6H apex + lip
set.seed(1973)
smile__tree_model_6H <- train(smile_type ~ apex_mean + lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6H$results
```



```
##          cp Accuracy      Kappa AccuracySD   KappaSD
## 1 0.02272727 0.4543895 -0.09300652 0.09708536 0.1932817
## 2 0.03333333 0.4632074 -0.07541557 0.09095422 0.1816019
## 3 0.11515152 0.4866310 -0.03605245 0.03749912 0.0690707
```

```
smile__tree_model_6H$coefnames
```

```
## [1] "apex_mean" "lip_mean"
```

```
varImp(smile__tree_model_6H)
```

```
## rpart variable importance
##
##          Overall
## apex_mean      NaN
## lip_mean       NaN
```

```
# summary(smile__tree_model_6H$finalModel)
```

```
smile__tree_model_6H_pred <- predict(smile__tree_model_6H, tst_smile)
summary(smile__tree_model_6H_pred)
```

```
## spontaneous deliberate
##          0          142
```

```
smile__tree_model_6H_confM <- confusionMatrix(
  smile__tree_model_6H_pred,
  tst_smile$smile_type
)
smile__tree_model_6H_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          0           0
## deliberate          70          72
##
##          Accuracy : 0.507
##          95% CI : (0.4219, 0.5919)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.5336
##
##          Kappa : 0
##
## Mcnemar's Test P-Value : <2e-16
##
##          Sensitivity : 0.000
##          Specificity : 1.000
##    Pos Pred Value :   NaN
##    Neg Pred Value : 0.507
```

```
##           Prevalence : 0.493
##           Detection Rate : 0.000
##           Detection Prevalence : 0.000
##           Balanced Accuracy : 0.500
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6H.1_pred <- predict(smile__tree_model_6H, tst_smile_boys)
summary(smile__tree_model_6H.1_pred)
```

```
## spontaneous deliberate
##           0           77
```

```
smile__tree_model_6H.1_confM <- confusionMatrix(
  smile__tree_model_6H.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6H.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           0           0
## deliberate           37           40
##
##           Accuracy : 0.5195
##           95% CI : (0.4026, 0.6348)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.5459
##
##           Kappa : 0
##
## Mcnemar's Test P-Value : 3.252e-09
##
##           Sensitivity : 0.0000
##           Specificity : 1.0000
##           Pos Pred Value :      NaN
##           Neg Pred Value : 0.5195
##           Prevalence : 0.4805
##           Detection Rate : 0.0000
##           Detection Prevalence : 0.0000
##           Balanced Accuracy : 0.5000
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6H.2_pred <- predict(smile__tree_model_6H, tst_smile_girls)
summary(smile__tree_model_6H.2_pred)
```

```
## spontaneous deliberate
##           0           65
```

```
smile__tree_model_6H.2_confM <- confusionMatrix(
  smile__tree_model_6H.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6H.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           0           0
## deliberate          33           32
##
##              Accuracy : 0.4923
##              95% CI : (0.366, 0.6193)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.6452
##
##              Kappa : 0
##
##  McNemar's Test P-Value : 2.54e-08
##
##      Sensitivity : 0.0000
##      Specificity : 1.0000
##      Pos Pred Value :      NaN
##      Neg Pred Value : 0.4923
##      Prevalence : 0.5077
##      Detection Rate : 0.0000
##      Detection Prevalence : 0.0000
##      Balanced Accuracy : 0.5000
##
##      'Positive' Class : spontaneous
##
```

```
# model 6I offset and movement
set.seed(1973)
smile__tree_model_6I <- train(smile_type ~ offset_mean + eye_mean + lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__tree_model_6I$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.02272727 0.5322081 0.06456196 0.09174672 0.18428052
## 2 0.06666667 0.5407587 0.08370581 0.10511016 0.20533476
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

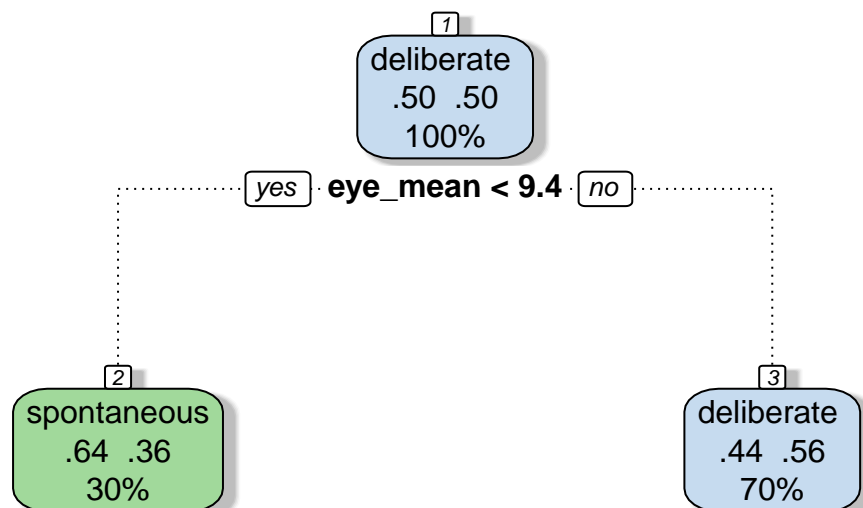
```
smile__tree_model_6I$coefnames
```

```
## [1] "offset_mean" "eye_mean"    "lip_mean"
```

```
varImp(smile__tree_model_6I)
```

```
## rpart variable importance
##
##           Overall
## eye_mean    100.00
## offset_mean  66.59
## lip_mean      0.00
```

```
# summary(smile__tree_model_6I$finalModel)
fancyRpartPlot(smile__tree_model_6I$finalModel)
```



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```
smile__tree_model_6I_pred <- predict(smile__tree_model_6I, tst_smile)
summary(smile__tree_model_6I_pred)
```

```
## spontaneous deliberate
##           41          101
```

```
smile__tree_model_6I_confM <- confusionMatrix(
  smile__tree_model_6I_pred,
  tst_smile$smile_type
)
smile__tree_model_6I_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      25          16
## deliberate      45          56
##
##              Accuracy : 0.5704
##              95% CI : (0.4847, 0.6531)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.076642
##
##              Kappa : 0.1357
##
## Mcnemar's Test P-Value : 0.000337
##
##      Sensitivity : 0.3571
##      Specificity : 0.7778
##      Pos Pred Value : 0.6098
##      Neg Pred Value : 0.5545
##      Prevalence : 0.4930
##      Detection Rate : 0.1761
##      Detection Prevalence : 0.2887
##      Balanced Accuracy : 0.5675
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6I.1_pred <- predict(smile__tree_model_6I, tst_smile_boys)
summary(smile__tree_model_6I.1_pred)
```

```
## spontaneous deliberate
##              22          55
```

```
smile__tree_model_6I.1_confM <- confusionMatrix(
  smile__tree_model_6I.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6I.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      13      9
##      deliberate      24     31
##
##              Accuracy : 0.5714
##              95% CI : (0.4535, 0.6837)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.21259
##
##              Kappa : 0.1283
##
##      McNemar's Test P-Value : 0.01481
##
##              Sensitivity : 0.3514
##              Specificity : 0.7750
##              Pos Pred Value : 0.5909
##              Neg Pred Value : 0.5636
##              Prevalence : 0.4805
##              Detection Rate : 0.1688
##      Detection Prevalence : 0.2857
##              Balanced Accuracy : 0.5632
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6I.2_pred <- predict(smile__tree_model_6I, tst_smile_girls)
summary(smile__tree_model_6I.2_pred)
```

```
## spontaneous deliberate
##           19           46
```

```
smile__tree_model_6I.2_confM <- confusionMatrix(
  smile__tree_model_6I.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6I.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      12      7
##      deliberate      21     25
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.19273
##
##              Kappa : 0.1439
##
##      McNemar's Test P-Value : 0.01402
##
```

```
##           Sensitivity : 0.3636
##           Specificity : 0.7812
##           Pos Pred Value : 0.6316
##           Neg Pred Value : 0.5435
##           Prevalence : 0.5077
##           Detection Rate : 0.1846
##           Detection Prevalence : 0.2923
##           Balanced Accuracy : 0.5724
##
##           'Positive' Class : spontaneous
##
```

```
# model 6J offset + eye
set.seed(1973)
smile__tree_model_6J <- train(smile_type ~ offset_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6J$results
```

```
##           cp Accuracy          Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5642547 0.12621182 0.07907261 0.15669999
## 2 0.06666667 0.5862132 0.16762689 0.10072271 0.20239814
## 3 0.16363636 0.4868093 -0.03388104 0.03960046 0.07404332
```

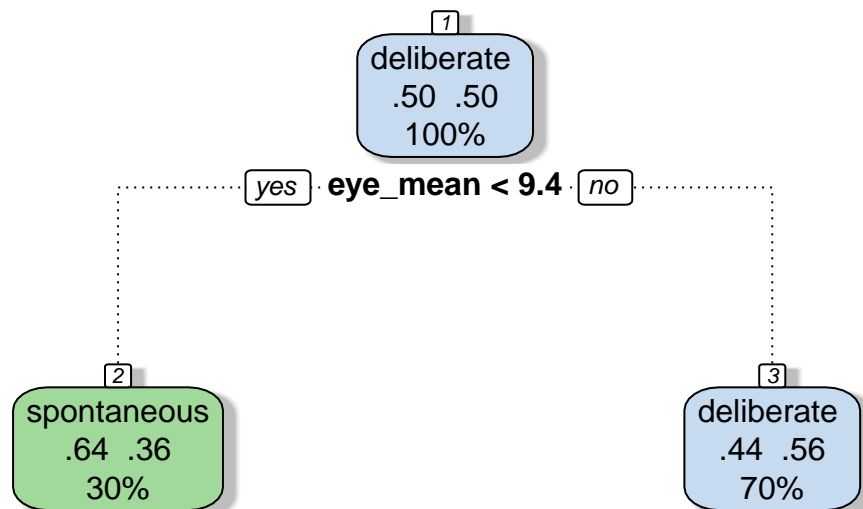
```
smile__tree_model_6J$coefnames
```

```
## [1] "offset_mean" "eye_mean"
```

```
varImp(smile__tree_model_6J)
```

```
## rpart variable importance
##
##           Overall
## eye_mean      100
## offset_mean     0
```

```
# summary(smile__tree_model_6J$finalModel)
fancyRpartPlot(smile__tree_model_6J$finalModel)
```



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```
smile__tree_model_6J_pred <- predict(smile__tree_model_6J, tst_smile)
summary(smile__tree_model_6J_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__tree_model_6J_confM <- confusionMatrix(
  smile__tree_model_6J_pred,
  tst_smile$smile_type
)
smile__tree_model_6J_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      25           16
##  deliberate      45           56
##
##           Accuracy : 0.5704
##           95% CI : (0.4847, 0.6531)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.076642
##
##           Kappa : 0.1357
```



```
##
## McNemar's Test P-Value : 0.000337
##
##          Sensitivity : 0.3571
##          Specificity : 0.7778
##          Pos Pred Value : 0.6098
##          Neg Pred Value : 0.5545
##          Prevalence : 0.4930
##          Detection Rate : 0.1761
##          Detection Prevalence : 0.2887
##          Balanced Accuracy : 0.5675
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6J.1_pred <- predict(smile__tree_model_6J, tst_smile_boys)
summary(smile__tree_model_6J.1_pred)
```

```
## spontaneous deliberate
##          22          55
```

```
smile__tree_model_6J.1_confM <- confusionMatrix(
  smile__tree_model_6J.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6J.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          13           9
## deliberate           24          31
##
##          Accuracy : 0.5714
##          95% CI : (0.4535, 0.6837)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.21259
##
##          Kappa : 0.1283
##
## McNemar's Test P-Value : 0.01481
##
##          Sensitivity : 0.3514
##          Specificity : 0.7750
##          Pos Pred Value : 0.5909
##          Neg Pred Value : 0.5636
##          Prevalence : 0.4805
##          Detection Rate : 0.1688
##          Detection Prevalence : 0.2857
##          Balanced Accuracy : 0.5632
```

```

##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_6J.2_pred <- predict(smile__tree_model_6J, tst_smile_girls)
summary(smile__tree_model_6J.2_pred)

## spontaneous deliberate
##           19           46

smile__tree_model_6J.2_confM <- confusionMatrix(
  smile__tree_model_6J.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6J.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           12             7
## deliberate            21            25
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.19273
##
##              Kappa : 0.1439
##
##  Mcnemar's Test P-Value : 0.01402
##
##              Sensitivity : 0.3636
##              Specificity : 0.7812
##              Pos Pred Value : 0.6316
##              Neg Pred Value : 0.5435
##              Prevalence : 0.5077
##              Detection Rate : 0.1846
##      Detection Prevalence : 0.2923
##              Balanced Accuracy : 0.5724
##
##      'Positive' Class : spontaneous
##

# model 6K offset + lip
set.seed(1973)
smile__tree_model_6K <- train(smile_type ~ offset_mean + lip_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_6K$results

```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.02424242 0.5676693 0.13426752 0.07837002 0.1574382
## 2 0.03434343 0.5552640 0.11098029 0.08076035 0.1634492
## 3 0.07878788 0.5075869 0.02036637 0.08687993 0.1683719
```

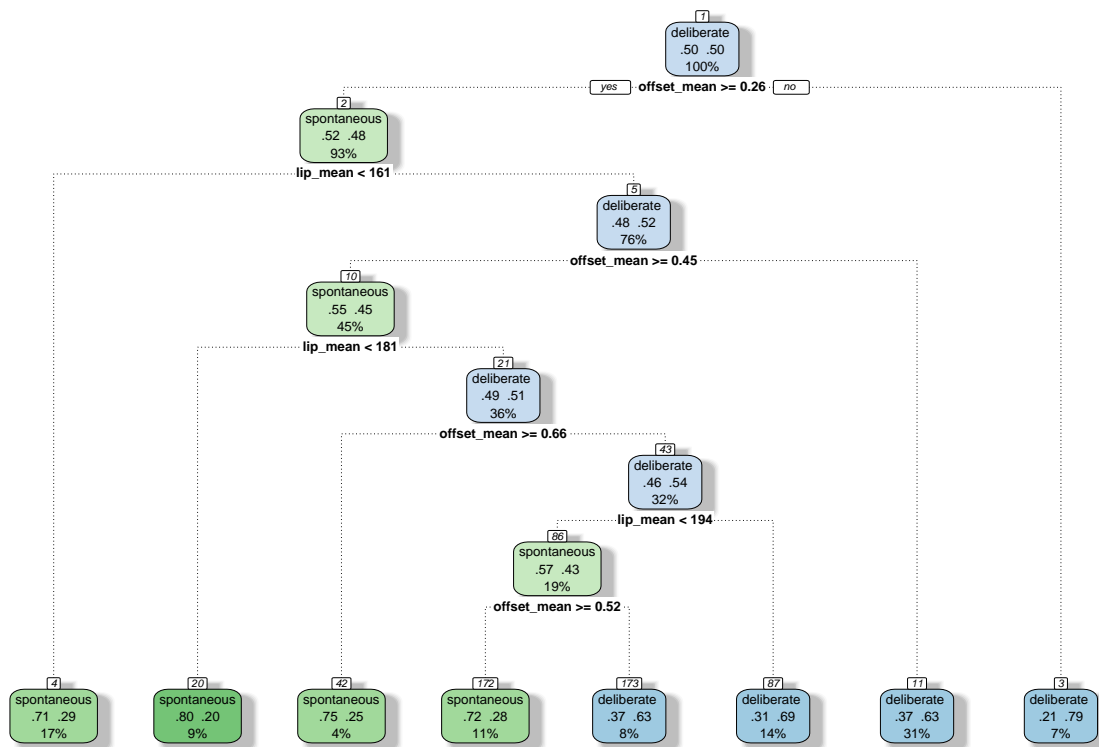
```
smile__tree_model_6K$coefnames
```

```
## [1] "offset_mean" "lip_mean"
```

```
varImp(smile__tree_model_6K)
```

```
## rpart variable importance
##
##           Overall
## lip_mean      100
## offset_mean     0
```

```
# summary(smile__tree_model_6K$finalModel)
fancyRpartPlot(smile__tree_model_6K$finalModel)
```



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```
smile__tree_model_6K_pred <- predict(smile__tree_model_6K, tst_smile)
summary(smile__tree_model_6K_pred)
```

```
## spontaneous deliberate
##           60           82
```

```
smile__tree_model_6K_confM <- confusionMatrix(
  smile__tree_model_6K_pred,
  tst_smile$smile_type
)
smile__tree_model_6K_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           37           23
## deliberate           33           49
##
##           Accuracy : 0.6056
##           95% CI : (0.5202, 0.6865)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.01151
##
##           Kappa : 0.2095
##
##  Mcnemar's Test P-Value : 0.22910
##
##           Sensitivity : 0.5286
##           Specificity : 0.6806
##           Pos Pred Value : 0.6167
##           Neg Pred Value : 0.5976
##           Prevalence : 0.4930
##           Detection Rate : 0.2606
##       Detection Prevalence : 0.4225
##           Balanced Accuracy : 0.6046
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_6K.1_pred <- predict(smile__tree_model_6K, tst_smile_boys)
summary(smile__tree_model_6K.1_pred)
```

```
## spontaneous deliberate
##           35           42
```

```
smile__tree_model_6K.1_confM <- confusionMatrix(
  smile__tree_model_6K.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_6K.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      20          15
## deliberate       17          25
##
##           Accuracy : 0.5844
##           95% CI : (0.4664, 0.6957)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.1523
##
##           Kappa : 0.1659
##
## Mcnemar's Test P-Value : 0.8597
##
##           Sensitivity : 0.5405
##           Specificity : 0.6250
##       Pos Pred Value : 0.5714
##       Neg Pred Value : 0.5952
##           Prevalence : 0.4805
##       Detection Rate : 0.2597
##       Detection Prevalence : 0.4545
##       Balanced Accuracy : 0.5828
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_6K.2_pred <- predict(smile__tree_model_6K, tst_smile_girls)
summary(smile__tree_model_6K.2_pred)
```

```
## spontaneous deliberate
##           25          40
```

```
smile__tree_model_6K.2_confM <- confusionMatrix(
  smile__tree_model_6K.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_6K.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      17          8
## deliberate       16          24
##
##           Accuracy : 0.6308
##           95% CI : (0.502, 0.7472)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.03086
##
##           Kappa : 0.2642
```

```
##
## McNemar's Test P-Value : 0.15304
##
##          Sensitivity : 0.5152
##          Specificity : 0.7500
##          Pos Pred Value : 0.6800
##          Neg Pred Value : 0.6000
##          Prevalence : 0.5077
##          Detection Rate : 0.2615
##          Detection Prevalence : 0.3846
##          Balanced Accuracy : 0.6326
##
##          'Positive' Class : spontaneous
##
```

```
# Model 7: dynamics and AU's
```

```
set.seed(1973)
smile__tree_model_7 <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7$results
```

```
##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04848485 0.5368761 0.07420769 0.07460008 0.1488441
## 2 0.05252525 0.5308155 0.05932530 0.07759515 0.1551832
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
smile__tree_model_7$coefnames
```

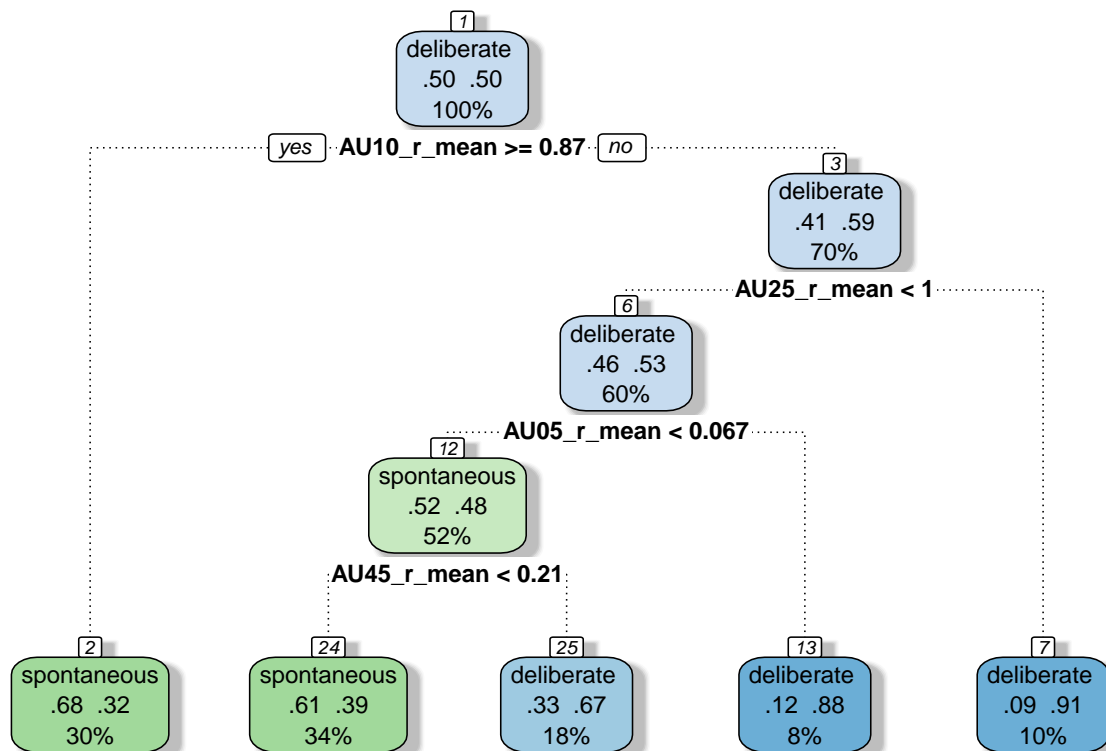
```
## [1] "AU01_r_mean" "AU02_r_mean" "AU04_r_mean" "AU05_r_mean" "AU06_r_mean"
## [6] "AU07_r_mean" "AU09_r_mean" "AU10_r_mean" "AU12_r_mean" "AU14_r_mean"
## [11] "AU15_r_mean" "AU17_r_mean" "AU20_r_mean" "AU23_r_mean" "AU25_r_mean"
## [16] "AU26_r_mean" "AU45_r_mean" "onset_mean" "apex_mean" "offset_mean"
```

```
varImp(smile__tree_model_7)
```

```
## rpart variable importance
##
##          Overall
## AU45_r_mean 100.00
## AU01_r_mean  81.66
## AU25_r_mean  63.30
## AU09_r_mean  56.35
## AU10_r_mean  54.54
```

```
## AU05_r_mean 52.28
## apex_mean 38.50
## AU14_r_mean 21.58
## AU12_r_mean 0.00
## AU23_r_mean 0.00
## AU07_r_mean 0.00
## AU02_r_mean 0.00
## AU04_r_mean 0.00
## offset_mean 0.00
## AU06_r_mean 0.00
## onset_mean 0.00
## AU17_r_mean 0.00
## AU20_r_mean 0.00
## AU26_r_mean 0.00
## AU15_r_mean 0.00
```

```
# summary(smile__tree_model_7$finalModel)
fancyRpartPlot(smile__tree_model_7$finalModel)
```



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```
smile__tree_model_7_pred <- predict(smile__tree_model_7, tst_smile)
summary(smile__tree_model_7_pred)
```

```
## spontaneous deliberate
##           84           58
```

```
smile__tree_model_7_confM <- confusionMatrix(
  smile__tree_model_7_pred,
  tst_smile$smile_type
)
smile__tree_model_7_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      44             40
## deliberate       26             32
##
##               Accuracy : 0.5352
##               95% CI : (0.4497, 0.6193)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.2786
##
##               Kappa : 0.0728
##
##  Mcnemar's Test P-Value : 0.1096
##
##               Sensitivity : 0.6286
##               Specificity : 0.4444
##               Pos Pred Value : 0.5238
##               Neg Pred Value : 0.5517
##               Prevalence : 0.4930
##               Detection Rate : 0.3099
##       Detection Prevalence : 0.5915
##       Balanced Accuracy : 0.5365
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7.1_pred <- predict(smile__tree_model_7, tst_smile_boys)
summary(smile__tree_model_7.1_pred)
```

```
## spontaneous deliberate
##           40           37
```

```
smile__tree_model_7.1_confM <- confusionMatrix(
  smile__tree_model_7.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
```



```
##      spontaneous      20      20
##      deliberate      17      20
##
##              Accuracy : 0.5195
##              95% CI : (0.4026, 0.6348)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.5459
##
##              Kappa : 0.0404
##
##      McNemar's Test P-Value : 0.7423
##
##              Sensitivity : 0.5405
##              Specificity : 0.5000
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5405
##      Prevalence : 0.4805
##      Detection Rate : 0.2597
##      Detection Prevalence : 0.5195
##      Balanced Accuracy : 0.5203
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7.2_pred <- predict(smile__tree_model_7, tst_smile_girls)
summary(smile__tree_model_7.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__tree_model_7.2_confM <- confusionMatrix(
  smile__tree_model_7.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
##      spontaneous      24      20
##      deliberate       9      12
##
##              Accuracy : 0.5538
##              95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.26784
##
##              Kappa : 0.1028
##
##      McNemar's Test P-Value : 0.06332
##
```

```
##           Sensitivity : 0.7273
##           Specificity : 0.3750
##           Pos Pred Value : 0.5455
##           Neg Pred Value : 0.5714
##           Prevalence : 0.5077
##           Detection Rate : 0.3692
##           Detection Prevalence : 0.6769
##           Balanced Accuracy : 0.5511
##
##           'Positive' Class : spontaneous
##
```

```
# 7A AU's + onset
```

```
set.seed(1973)
smile__tree_model_7A <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  onset_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_7A$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5636141 0.12907456 0.08437636 0.1685849
## 2 0.05252525 0.5308155 0.05932530 0.07759515 0.1551832
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
smile__tree_model_7A$coefnames
```

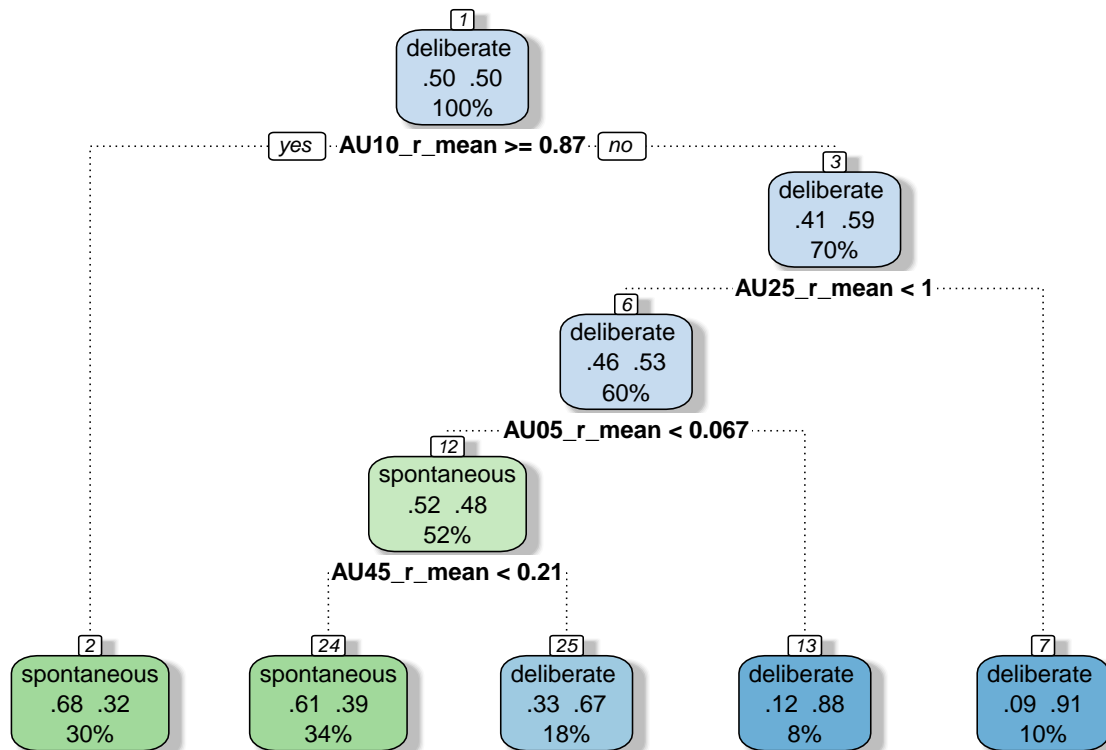
```
## [1] "AU01_r_mean" "AU02_r_mean" "AU04_r_mean" "AU05_r_mean" "AU06_r_mean"
## [6] "AU07_r_mean" "AU09_r_mean" "AU10_r_mean" "AU12_r_mean" "AU14_r_mean"
## [11] "AU15_r_mean" "AU17_r_mean" "AU20_r_mean" "AU23_r_mean" "AU25_r_mean"
## [16] "AU26_r_mean" "AU45_r_mean" "onset_mean"
```

```
varImp(smile__tree_model_7A)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## AU01_r_mean  81.66
## AU25_r_mean  77.78
## AU09_r_mean  73.78
## AU10_r_mean  54.54
## AU05_r_mean  52.28
## AU14_r_mean  21.58
```

```
## AU12_r_mean 0.00
## AU23_r_mean 0.00
## AU07_r_mean 0.00
## AU02_r_mean 0.00
## AU04_r_mean 0.00
## AU06_r_mean 0.00
## onset_mean 0.00
## AU17_r_mean 0.00
## AU20_r_mean 0.00
## AU26_r_mean 0.00
## AU15_r_mean 0.00
```

```
# summary(smile__tree_model_7A$finalModel)
fancyRpartPlot(smile__tree_model_7A$finalModel)
```



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```
smile__tree_model_7A_pred <- predict(smile__tree_model_7A, tst_smile)
summary(smile__tree_model_7A_pred)
```

```
## spontaneous deliberate
##           84           58
```

```
smile__tree_model_7A_confM <- confusionMatrix(
  smile__tree_model_7A_pred,
  tst_smile$smile_type)
```

```
)
smile__tree_model_7A_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           44           40
## deliberate           26           32
##
##               Accuracy : 0.5352
##               95% CI : (0.4497, 0.6193)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.2786
##
##               Kappa : 0.0728
##
## Mcnemar's Test P-Value : 0.1096
##
##       Sensitivity : 0.6286
##       Specificity : 0.4444
##       Pos Pred Value : 0.5238
##       Neg Pred Value : 0.5517
##       Prevalence : 0.4930
##       Detection Rate : 0.3099
##       Detection Prevalence : 0.5915
##       Balanced Accuracy : 0.5365
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7A.1_pred <- predict(smile__tree_model_7A, tst_smile_boys)
summary(smile__tree_model_7A.1_pred)
```

```
## spontaneous deliberate
##           40           37
```

```
smile__tree_model_7A.1_confM <- confusionMatrix(
  smile__tree_model_7A.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7A.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           20           20
## deliberate           17           20
##
```

```
##               Accuracy : 0.5195
##               95% CI : (0.4026, 0.6348)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.5459
##
##               Kappa : 0.0404
##
##  McNemar's Test P-Value : 0.7423
##
##               Sensitivity : 0.5405
##               Specificity : 0.5000
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5405
##      Prevalence : 0.4805
##      Detection Rate : 0.2597
##      Detection Prevalence : 0.5195
##      Balanced Accuracy : 0.5203
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7A.2_pred <- predict(smile__tree_model_7A, tst_smile_girls)
summary(smile__tree_model_7A.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__tree_model_7A.2_confM <- confusionMatrix(
  smile__tree_model_7A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7A.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      24             20
## deliberate       9              12
##
##               Accuracy : 0.5538
##               95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.26784
##
##               Kappa : 0.1028
##
##  McNemar's Test P-Value : 0.06332
##
##               Sensitivity : 0.7273
##               Specificity : 0.3750
##      Pos Pred Value : 0.5455
```

```
##          Neg Pred Value : 0.5714
##          Prevalence : 0.5077
##          Detection Rate : 0.3692
##          Detection Prevalence : 0.6769
##          Balanced Accuracy : 0.5511
##
##          'Positive' Class : spontaneous
##
```

```
# 7B AU's + apex
```

```
set.seed(1973)
smile__tree_model_7B <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  apex_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7B$results
```

```
##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04848485 0.5368761 0.07420769 0.07460008 0.1488441
## 2 0.05252525 0.5308155 0.05932530 0.07759515 0.1551832
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
smile__tree_model_7B$coefnames
```

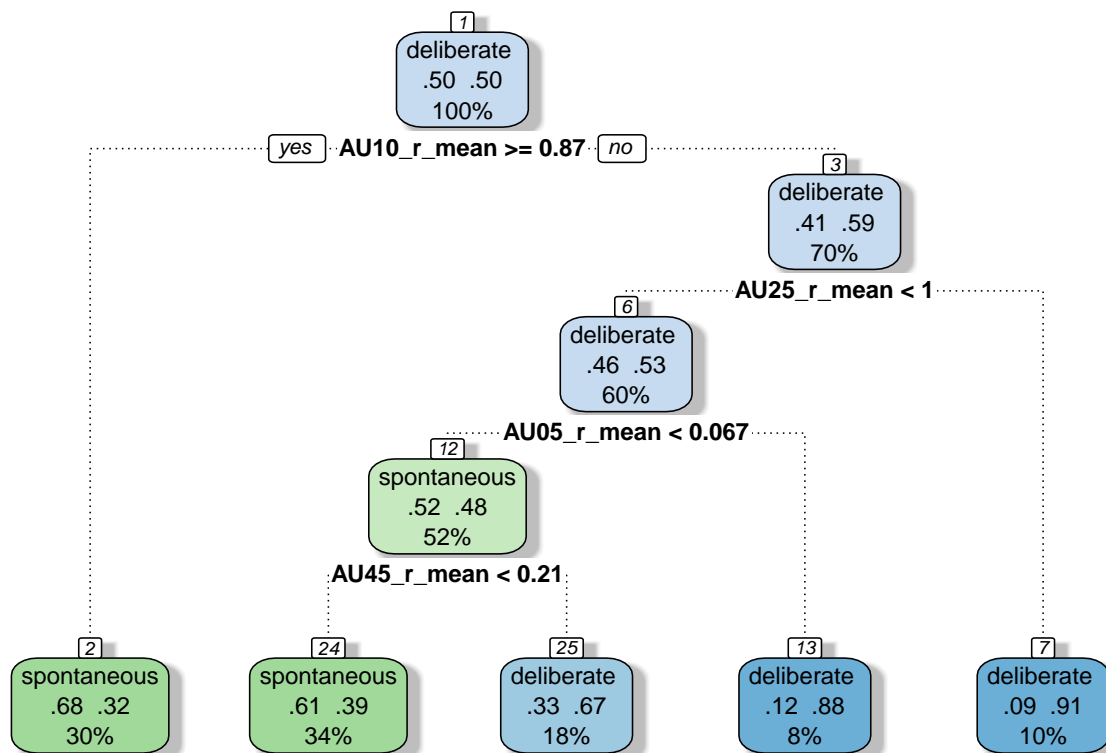
```
## [1] "AU01_r_mean" "AU02_r_mean" "AU04_r_mean" "AU05_r_mean" "AU06_r_mean"
## [6] "AU07_r_mean" "AU09_r_mean" "AU10_r_mean" "AU12_r_mean" "AU14_r_mean"
## [11] "AU15_r_mean" "AU17_r_mean" "AU20_r_mean" "AU23_r_mean" "AU25_r_mean"
## [16] "AU26_r_mean" "AU45_r_mean" "apex_mean"
```

```
varImp(smile__tree_model_7B)
```

```
## rpart variable importance
##
##          Overall
## AU45_r_mean 100.00
## AU01_r_mean  81.66
## AU25_r_mean  63.30
## AU09_r_mean  56.35
## AU10_r_mean  54.54
## AU05_r_mean  52.28
## apex_mean   38.50
## AU14_r_mean  21.58
## AU12_r_mean   0.00
## AU23_r_mean   0.00
```

```
## AU07_r_mean    0.00
## AU02_r_mean    0.00
## AU04_r_mean    0.00
## AU06_r_mean    0.00
## AU17_r_mean    0.00
## AU20_r_mean    0.00
## AU26_r_mean    0.00
## AU15_r_mean    0.00
```

```
# summary(smile__tree_model_7B$finalModel)
fancyRpartPlot(smile__tree_model_7B$finalModel)
```



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```
smile__tree_model_7B_pred <- predict(smile__tree_model_7B, tst_smile)
summary(smile__tree_model_7B_pred)
```

```
## spontaneous deliberate
##           84           58
```

```
smile__tree_model_7B_confM <- confusionMatrix(
  smile__tree_model_7B_pred,
  tst_smile$smile_type
)
smile__tree_model_7B_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      44             40
## deliberate       26             32
##
##               Accuracy : 0.5352
##               95% CI : (0.4497, 0.6193)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.2786
##
##               Kappa : 0.0728
##
## Mcnemar's Test P-Value : 0.1096
##
##       Sensitivity : 0.6286
##       Specificity : 0.4444
##       Pos Pred Value : 0.5238
##       Neg Pred Value : 0.5517
##       Prevalence : 0.4930
##       Detection Rate : 0.3099
##       Detection Prevalence : 0.5915
##       Balanced Accuracy : 0.5365
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7B.1_pred <- predict(smile__tree_model_7B, tst_smile_boys)
summary(smile__tree_model_7B.1_pred)
```

```
## spontaneous deliberate
##           40           37
```

```
smile__tree_model_7B.1_confM <- confusionMatrix(
  smile__tree_model_7B.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7B.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      20             20
## deliberate       17             20
##
##               Accuracy : 0.5195
##               95% CI : (0.4026, 0.6348)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.5459
```



```
##
##           Kappa : 0.0404
##
## Mcnemar's Test P-Value : 0.7423
##
##           Sensitivity : 0.5405
##           Specificity : 0.5000
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5405
##           Prevalence : 0.4805
##           Detection Rate : 0.2597
##           Detection Prevalence : 0.5195
##           Balanced Accuracy : 0.5203
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7B.2_pred <- predict(smile__tree_model_7B, tst_smile_girls)
summary(smile__tree_model_7B.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__tree_model_7B.2_confM <- confusionMatrix(
  smile__tree_model_7B.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7B.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      24             20
## deliberate       9              12
##
##           Accuracy : 0.5538
##           95% CI : (0.4253, 0.6773)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.26784
##
##           Kappa : 0.1028
##
## Mcnemar's Test P-Value : 0.06332
##
##           Sensitivity : 0.7273
##           Specificity : 0.3750
##           Pos Pred Value : 0.5455
##           Neg Pred Value : 0.5714
##           Prevalence : 0.5077
##           Detection Rate : 0.3692
##           Detection Prevalence : 0.6769
```

```
##          Balanced Accuracy : 0.5511
##
##          'Positive' Class : spontaneous
##
```

```
# 7C AU's + offset
```

```
set.seed(1973)
smile__tree_model_7C <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  offset_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7C$results
```

```
##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5666444 0.13557324 0.08539890 0.1707513
## 2 0.05252525 0.5308155 0.05932530 0.07759515 0.1551832
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

```
smile__tree_model_7C$coefnames
```

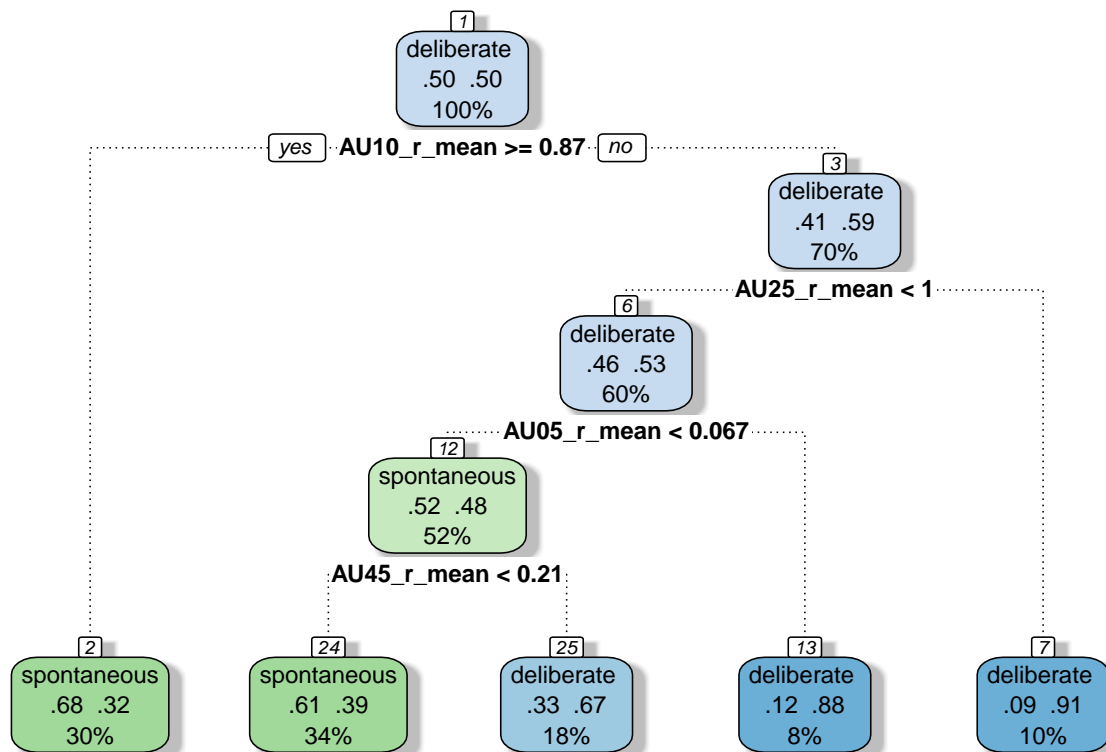
```
## [1] "AU01_r_mean" "AU02_r_mean" "AU04_r_mean" "AU05_r_mean" "AU06_r_mean"
## [6] "AU07_r_mean" "AU09_r_mean" "AU10_r_mean" "AU12_r_mean" "AU14_r_mean"
## [11] "AU15_r_mean" "AU17_r_mean" "AU20_r_mean" "AU23_r_mean" "AU25_r_mean"
## [16] "AU26_r_mean" "AU45_r_mean" "offset_mean"
```

```
varImp(smile__tree_model_7C)
```

```
## rpart variable importance
##
##          Overall
## AU45_r_mean 100.00
## AU01_r_mean  81.66
## AU25_r_mean  77.78
## AU09_r_mean  73.78
## AU10_r_mean  54.54
## AU05_r_mean  52.28
## AU14_r_mean  21.58
## AU12_r_mean   0.00
## AU23_r_mean   0.00
## AU07_r_mean   0.00
## AU02_r_mean   0.00
## AU04_r_mean   0.00
## AU06_r_mean   0.00
## offset_mean   0.00
```

```
## AU17_r_mean    0.00
## AU20_r_mean    0.00
## AU26_r_mean    0.00
## AU15_r_mean    0.00
```

```
# summary(smile__tree_model_7C$finalModel)
fancyRpartPlot(smile__tree_model_7C$finalModel)
```



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```
smile__tree_model_7C_pred <- predict(smile__tree_model_7C, tst_smile)
summary(smile__tree_model_7C_pred)
```

```
## spontaneous deliberate
##           84           58
```

```
smile__tree_model_7C_confM <- confusionMatrix(
  smile__tree_model_7C_pred,
  tst_smile$smile_type
)
smile__tree_model_7C_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      44      40
##      deliberate      26      32
##
##              Accuracy : 0.5352
##              95% CI : (0.4497, 0.6193)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.2786
##
##              Kappa : 0.0728
##
##      McNemar's Test P-Value : 0.1096
##
##              Sensitivity : 0.6286
##              Specificity : 0.4444
##      Pos Pred Value : 0.5238
##      Neg Pred Value : 0.5517
##      Prevalence : 0.4930
##      Detection Rate : 0.3099
##      Detection Prevalence : 0.5915
##      Balanced Accuracy : 0.5365
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7C.1_pred <- predict(smile__tree_model_7C, tst_smile_boys)
summary(smile__tree_model_7C.1_pred)
```

```
## spontaneous deliberate
##           40           37
```

```
smile__tree_model_7C.1_confM <- confusionMatrix(
  smile__tree_model_7C.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7C.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      20      20
##      deliberate      17      20
##
##              Accuracy : 0.5195
##              95% CI : (0.4026, 0.6348)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.5459
##
##              Kappa : 0.0404
##
##      McNemar's Test P-Value : 0.7423
```

```
##
##           Sensitivity : 0.5405
##           Specificity : 0.5000
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5405
##           Prevalence : 0.4805
##           Detection Rate : 0.2597
##           Detection Prevalence : 0.5195
##           Balanced Accuracy : 0.5203
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7C.2_pred <- predict(smile__tree_model_7C, tst_smile_girls)
summary(smile__tree_model_7C.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__tree_model_7C.2_confM <- confusionMatrix(
  smile__tree_model_7C.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7C.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           24           20
## deliberate           9           12
##
##           Accuracy : 0.5538
##           95% CI : (0.4253, 0.6773)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.26784
##
##           Kappa : 0.1028
##
## Mcnemar's Test P-Value : 0.06332
##
##           Sensitivity : 0.7273
##           Specificity : 0.3750
##           Pos Pred Value : 0.5455
##           Neg Pred Value : 0.5714
##           Prevalence : 0.5077
##           Detection Rate : 0.3692
##           Detection Prevalence : 0.6769
##           Balanced Accuracy : 0.5511
##
##           'Positive' Class : spontaneous
##
```

```
# 7D
set.seed(1973)
smile__tree_model_7D <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean,
method = "rpart", data = trn_smile,
trnControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7D$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5584837 0.11790741 0.03491922 0.06900019
## 2 0.05454545 0.5493928 0.09982095 0.04575070 0.09183336
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091
```

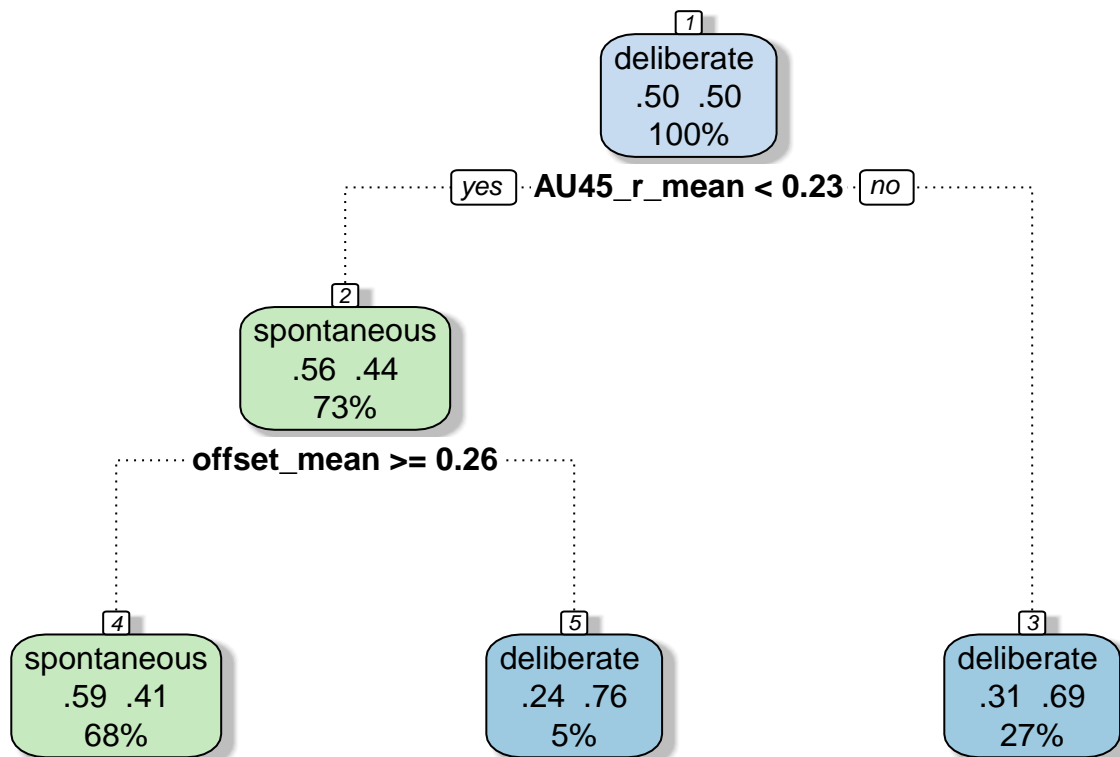
```
smile__tree_model_7D$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean" "apex_mean"
## [6] "offset_mean"
```

```
varImp(smile__tree_model_7D)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## offset_mean  69.75
## AU06_r_mean  48.99
## onset_mean   46.87
## apex_mean    39.60
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_7D$finalModel)
fancyRpartPlot(smile__tree_model_7D$finalModel)
```



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```
smile__tree_model_7D_pred <- predict(smile__tree_model_7D, tst_smile)
summary(smile__tree_model_7D_pred)
```

```
## spontaneous deliberate
##           92           50
```

```
smile__tree_model_7D_confM <- confusionMatrix(
  smile__tree_model_7D_pred,
  tst_smile$smile_type
)
smile__tree_model_7D_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      46           46
##  deliberate       24           26
##
##           Accuracy : 0.507
##           95% CI : (0.4219, 0.5919)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.53358
##
##           Kappa : 0.0182
```

```
##
## McNemar's Test P-Value : 0.01207
##
##           Sensitivity : 0.6571
##           Specificity : 0.3611
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5200
##           Prevalence : 0.4930
##           Detection Rate : 0.3239
##           Detection Prevalence : 0.6479
##           Balanced Accuracy : 0.5091
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7D.1_pred <- predict(smile__tree_model_7D, tst_smile_boys)
summary(smile__tree_model_7D.1_pred)
```

```
## spontaneous deliberate
##           49           28
```

```
smile__tree_model_7D.1_confM <- confusionMatrix(
  smile__tree_model_7D.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7D.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           24           25
## deliberate           13           15
##
##           Accuracy : 0.5065
##           95% CI : (0.39, 0.6224)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.63425
##
##           Kappa : 0.0234
##
## McNemar's Test P-Value : 0.07435
##
##           Sensitivity : 0.6486
##           Specificity : 0.3750
##           Pos Pred Value : 0.4898
##           Neg Pred Value : 0.5357
##           Prevalence : 0.4805
##           Detection Rate : 0.3117
##           Detection Prevalence : 0.6364
##           Balanced Accuracy : 0.5118
```



```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7D.2_pred <- predict(smile__tree_model_7D, tst_smile_girls)
summary(smile__tree_model_7D.2_pred)
```

```
## spontaneous deliberate
##      43      22
```

```
smile__tree_model_7D.2_confM <- confusionMatrix(
  smile__tree_model_7D.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7D.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      22      21
## deliberate      11      11
##
##              Accuracy : 0.5077
##              95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
##              Kappa : 0.0105
##
## Mcnemar's Test P-Value : 0.1116
##
##              Sensitivity : 0.6667
##              Specificity : 0.3438
##              Pos Pred Value : 0.5116
##              Neg Pred Value : 0.5000
##              Prevalence : 0.5077
##              Detection Rate : 0.3385
##      Detection Prevalence : 0.6615
##              Balanced Accuracy : 0.5052
##
##      'Positive' Class : spontaneous
##
```

```
# 7E
```

```
set.seed(1973)
smile__tree_model_7E <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
```

```
)
```

```
smile__tree_model_7E$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5707832 0.14319007 0.03027685 0.06296834
## 2 0.06060606 0.5464516 0.09717643 0.04388348 0.08896946
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091
```

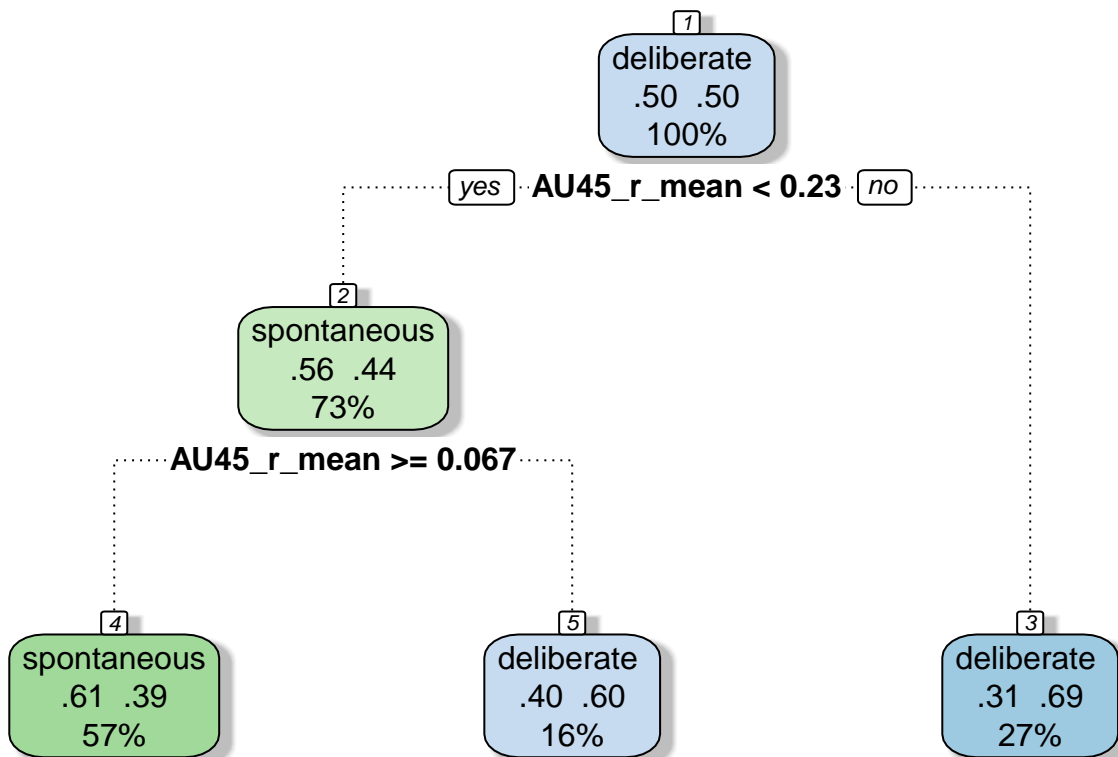
```
smile__tree_model_7E$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean"
```

```
varImp(smile__tree_model_7E)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## AU06_r_mean  31.92
## onset_mean   29.09
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_7E$finalModel)
fancyRpartPlot(smile__tree_model_7E$finalModel)
```



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```
smile__tree_model_7E_pred <- predict(smile__tree_model_7E, tst_smile)
summary(smile__tree_model_7E_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_7E_confM <- confusionMatrix(
  smile__tree_model_7E_pred,
  tst_smile$smile_type
)
smile__tree_model_7E_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           44           41
## deliberate           26           31
##
##              Accuracy : 0.5282
##              95% CI : (0.4427, 0.6124)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.3376
##
##              Kappa : 0.059
##
##  Mcnemar's Test P-Value : 0.0872
##
##              Sensitivity : 0.6286
##              Specificity : 0.4306
##              Pos Pred Value : 0.5176
##              Neg Pred Value : 0.5439
##              Prevalence : 0.4930
##              Detection Rate : 0.3099
##      Detection Prevalence : 0.5986
##              Balanced Accuracy : 0.5296
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7E.1_pred <- predict(smile__tree_model_7E, tst_smile_boys)
summary(smile__tree_model_7E.1_pred)
```

```
## spontaneous deliberate
##           45           32
```

```
smile__tree_model_7E.1_confM <- confusionMatrix(
  smile__tree_model_7E.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7E.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      23           22
## deliberate       14           18
##
##               Accuracy : 0.5325
##               95% CI : (0.4152, 0.6471)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.4552
##
##               Kappa : 0.071
##
## Mcnemar's Test P-Value : 0.2433
##
##       Sensitivity : 0.6216
##       Specificity : 0.4500
##       Pos Pred Value : 0.5111
##       Neg Pred Value : 0.5625
##       Prevalence : 0.4805
##       Detection Rate : 0.2987
##       Detection Prevalence : 0.5844
##       Balanced Accuracy : 0.5358
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7E.2_pred <- predict(smile__tree_model_7E, tst_smile_girls)
summary(smile__tree_model_7E.2_pred)
```

```
## spontaneous deliberate
##           40           25
```

```
smile__tree_model_7E.2_confM <- confusionMatrix(
  smile__tree_model_7E.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7E.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      21           19
## deliberate       12           13
##
##               Accuracy : 0.5231
##               95% CI : (0.3954, 0.6485)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.4510
##
```

```
##                Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##          Sensitivity : 0.6364
##          Specificity : 0.4062
##          Pos Pred Value : 0.5250
##          Neg Pred Value : 0.5200
##          Prevalence : 0.5077
##          Detection Rate : 0.3231
##          Detection Prevalence : 0.6154
##          Balanced Accuracy : 0.5213
##
##          'Positive' Class : spontaneous
##
```

```
# 7F
```

```
set.seed(1973)
smile__tree_model_7F <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + apex_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7F$results
```

```
##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5706941 0.14076293 0.03491488 0.07078494
## 2 0.06060606 0.5464516 0.09717643 0.04388348 0.08896946
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091
```

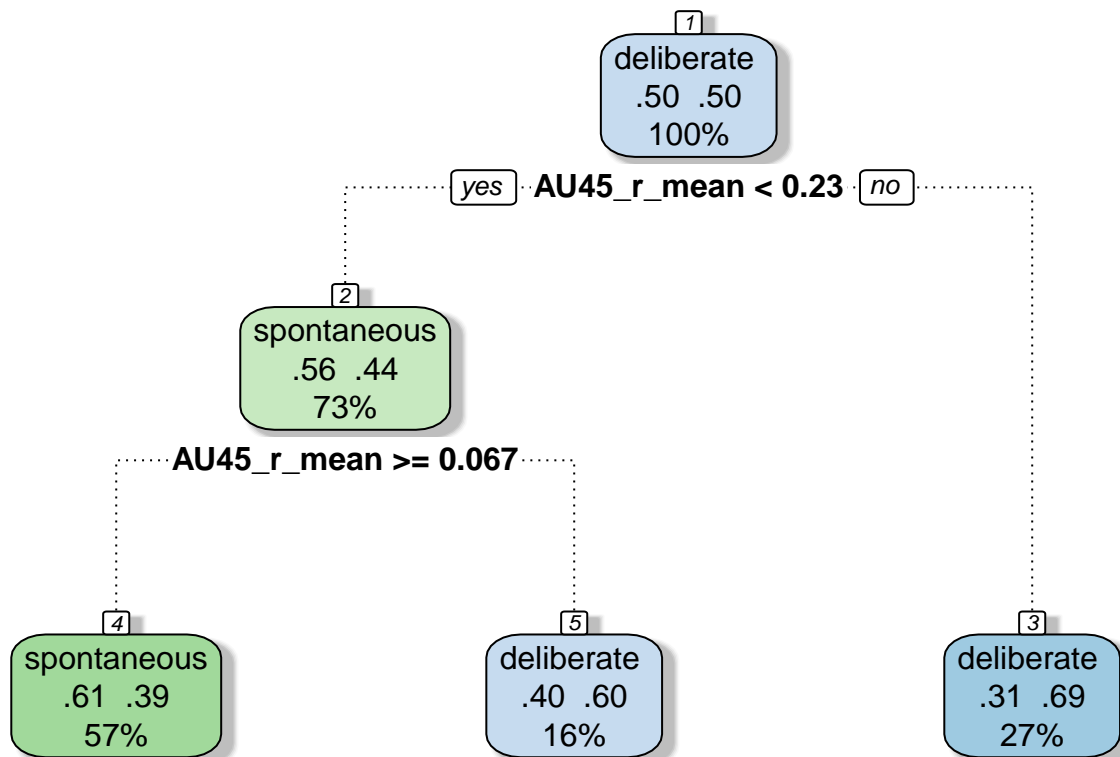
```
smile__tree_model_7F$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "apex_mean"
```

```
varImp(smile__tree_model_7F)
```

```
## rpart variable importance
##
##          Overall
## AU45_r_mean 100.00
## AU06_r_mean  31.92
## apex_mean    19.39
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_7F$finalModel)
fancyRpartPlot(smile__tree_model_7F$finalModel)
```



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```
smile__tree_model_7F_pred <- predict(smile__tree_model_7F, tst_smile)
summary(smile__tree_model_7F_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_7F_confM <- confusionMatrix(
  smile__tree_model_7F_pred,
  tst_smile$smile_type
)
smile__tree_model_7F_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      44           41
## deliberate       26           31
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.059
```

```
##
## McNemar's Test P-Value : 0.0872
##
##          Sensitivity : 0.6286
##          Specificity : 0.4306
##          Pos Pred Value : 0.5176
##          Neg Pred Value : 0.5439
##          Prevalence : 0.4930
##          Detection Rate : 0.3099
##          Detection Prevalence : 0.5986
##          Balanced Accuracy : 0.5296
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7F.1_pred <- predict(smile__tree_model_7F, tst_smile_boys)
summary(smile__tree_model_7F.1_pred)
```

```
## spontaneous deliberate
##          45          32
```

```
smile__tree_model_7F.1_confM <- confusionMatrix(
  smile__tree_model_7F.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7F.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          23          22
## deliberate           14          18
##
##          Accuracy : 0.5325
##          95% CI : (0.4152, 0.6471)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.4552
##
##          Kappa : 0.071
##
## McNemar's Test P-Value : 0.2433
##
##          Sensitivity : 0.6216
##          Specificity : 0.4500
##          Pos Pred Value : 0.5111
##          Neg Pred Value : 0.5625
##          Prevalence : 0.4805
##          Detection Rate : 0.2987
##          Detection Prevalence : 0.5844
##          Balanced Accuracy : 0.5358
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7F.2_pred <- predict(smile__tree_model_7F, tst_smile_girls)
summary(smile__tree_model_7F.2_pred)
```

```
## spontaneous deliberate
##      40      25
```

```
smile__tree_model_7F.2_confM <- confusionMatrix(
  smile__tree_model_7F.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7F.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21      19
## deliberate       12      13
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.6364
##              Specificity : 0.4062
##              Pos Pred Value : 0.5250
##              Neg Pred Value : 0.5200
##              Prevalence : 0.5077
##              Detection Rate : 0.3231
##      Detection Prevalence : 0.6154
##              Balanced Accuracy : 0.5213
##
##      'Positive' Class : spontaneous
##
```

```
# 7G
```

```
set.seed(1973)
smile__tree_model_7G <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + offset_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
```



```
)
```

```
smile__tree_model_7G$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04848485 0.5524231 0.10692105 0.04645894 0.09414045
## 2 0.05454545 0.5493928 0.10144561 0.04575070 0.09188355
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091
```

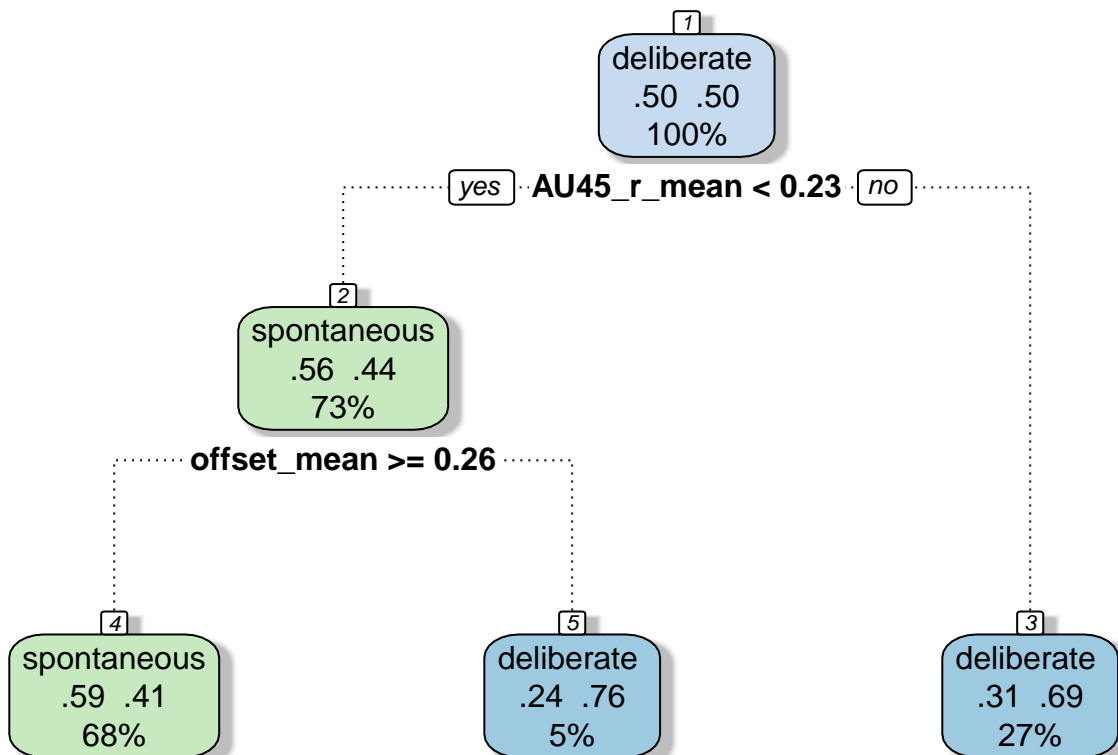
```
smile__tree_model_7G$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "offset_mean"
```

```
varImp(smile__tree_model_7G)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## offset_mean  59.63
## AU06_r_mean  31.92
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_7G$finalModel)
fancyRpartPlot(smile__tree_model_7G$finalModel)
```



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```
smile__tree_model_7G_pred <- predict(smile__tree_model_7G, tst_smile)
summary(smile__tree_model_7G_pred)
```

```
## spontaneous deliberate
##           92           50
```

```
smile__tree_model_7G_confM <- confusionMatrix(
  smile__tree_model_7G_pred,
  tst_smile$smile_type
)
smile__tree_model_7G_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           46           46
## deliberate           24           26
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.53358
##
##              Kappa : 0.0182
##
##  Mcnemar's Test P-Value : 0.01207
##
##      Sensitivity : 0.6571
##      Specificity : 0.3611
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5200
##      Prevalence : 0.4930
##      Detection Rate : 0.3239
##      Detection Prevalence : 0.6479
##      Balanced Accuracy : 0.5091
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7G.1_pred <- predict(smile__tree_model_7G, tst_smile_boys)
summary(smile__tree_model_7G.1_pred)
```

```
## spontaneous deliberate
##           49           28
```

```
smile__tree_model_7G.1_confM <- confusionMatrix(
  smile__tree_model_7G.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7G.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      24             25
## deliberate       13             15
##
##               Accuracy : 0.5065
##               95% CI : (0.39, 0.6224)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.63425
##
##               Kappa : 0.0234
##
## Mcnemar's Test P-Value : 0.07435
##
##       Sensitivity : 0.6486
##       Specificity : 0.3750
##       Pos Pred Value : 0.4898
##       Neg Pred Value : 0.5357
##       Prevalence : 0.4805
##       Detection Rate : 0.3117
##       Detection Prevalence : 0.6364
##       Balanced Accuracy : 0.5118
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7G.2_pred <- predict(smile__tree_model_7G, tst_smile_girls)
summary(smile__tree_model_7G.2_pred)
```

```
## spontaneous deliberate
##           43           22
```

```
smile__tree_model_7G.2_confM <- confusionMatrix(
  smile__tree_model_7G.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7G.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      22             21
## deliberate       11             11
##
##               Accuracy : 0.5077
##               95% CI : (0.3807, 0.634)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.5495
##
```

```
##                Kappa : 0.0105
##
## Mcnemar's Test P-Value : 0.1116
##
##          Sensitivity : 0.6667
##          Specificity : 0.3438
##          Pos Pred Value : 0.5116
##          Neg Pred Value : 0.5000
##          Prevalence : 0.5077
##          Detection Rate : 0.3385
##          Detection Prevalence : 0.6615
##          Balanced Accuracy : 0.5052
##
##          'Positive' Class : spontaneous
##
```

```
# 7H dynamics and AU's selection
set.seed(1973)
smile__tree_model_7H <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7H$results
```

```
##          cp Accuracy      Kappa AccuracySD  KappaSD
## 1 0.04242424 0.5425802 0.08849963 0.07231989 0.1450692
## 2 0.04545455 0.5424020 0.08399104 0.07351021 0.1485909
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

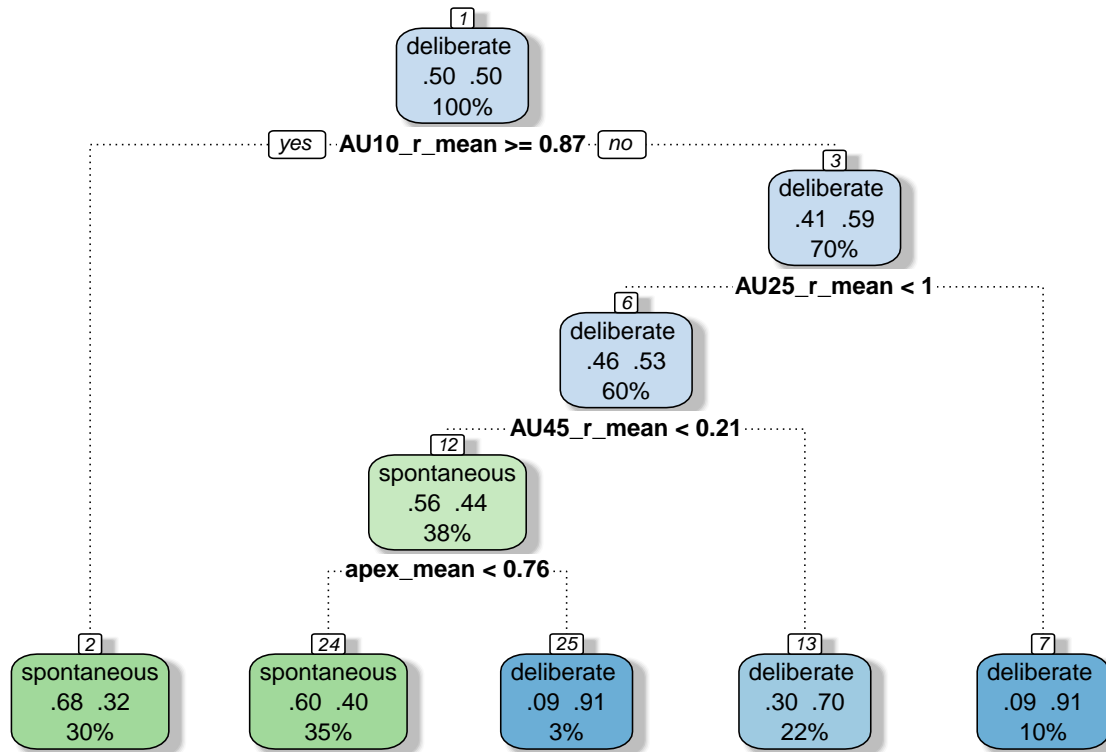
```
smile__tree_model_7H$coefnames
```

```
## [1] "AU01_r_mean" "AU09_r_mean" "AU10_r_mean" "AU25_r_mean" "AU45_r_mean"
## [6] "onset_mean"  "apex_mean"   "offset_mean"
```

```
varImp(smile__tree_model_7H)
```

```
## rpart variable importance
##
##          Overall
## AU25_r_mean 100.00
## AU45_r_mean  90.39
## AU01_r_mean  85.32
## AU09_r_mean  72.27
## apex_mean    55.42
## AU10_r_mean  38.91
## onset_mean    0.00
## offset_mean    0.00
```

```
# summary(smile__tree_model_7H$finalModel)
fancyRpartPlot(smile__tree_model_7H$finalModel)
```



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```
smile__tree_model_7H_pred <- predict(smile__tree_model_7H, tst_smile)
summary(smile__tree_model_7H_pred)
```

```
## spontaneous deliberate
##           88           54
```

```
smile__tree_model_7H_confM <- confusionMatrix(
  smile__tree_model_7H_pred,
  tst_smile$smile_type
)
smile__tree_model_7H_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      49           39
##  deliberate       21           33
##
##           Accuracy : 0.5775
##           95% CI : (0.4918, 0.6598)
```

```
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.05517
##
##              Kappa : 0.1578
##
##  McNemar's Test P-Value : 0.02819
##
##      Sensitivity : 0.7000
##      Specificity : 0.4583
##      Pos Pred Value : 0.5568
##      Neg Pred Value : 0.6111
##      Prevalence : 0.4930
##      Detection Rate : 0.3451
##      Detection Prevalence : 0.6197
##      Balanced Accuracy : 0.5792
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7H.1_pred <- predict(smile__tree_model_7H, tst_smile_boys)
summary(smile__tree_model_7H.1_pred)
```

```
## spontaneous deliberate
##           39           38
```

```
smile__tree_model_7H.1_confM <- confusionMatrix(
  smile__tree_model_7H.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7H.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           22           17
## deliberate            15           23
##
##      Accuracy : 0.5844
##      95% CI : (0.4664, 0.6957)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1523
##
##              Kappa : 0.1693
##
##  McNemar's Test P-Value : 0.8597
##
##      Sensitivity : 0.5946
##      Specificity : 0.5750
##      Pos Pred Value : 0.5641
##      Neg Pred Value : 0.6053
```

```
##           Prevalence : 0.4805
##           Detection Rate : 0.2857
##           Detection Prevalence : 0.5065
##           Balanced Accuracy : 0.5848
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_7H.2_pred <- predict(smile__tree_model_7H, tst_smile_girls)
summary(smile__tree_model_7H.2_pred)
```

```
## spontaneous deliberate
##           49           16
```

```
smile__tree_model_7H.2_confM <- confusionMatrix(
  smile__tree_model_7H.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7H.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      27           22
## deliberate       6           10
##
##           Accuracy : 0.5692
##           95% CI : (0.4404, 0.6915)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.192728
##
##           Kappa : 0.1317
##
##           Mcnemar's Test P-Value : 0.004586
##
##           Sensitivity : 0.8182
##           Specificity : 0.3125
##           Pos Pred Value : 0.5510
##           Neg Pred Value : 0.6250
##           Prevalence : 0.5077
##           Detection Rate : 0.4154
##           Detection Prevalence : 0.7538
##           Balanced Accuracy : 0.5653
##
##           'Positive' Class : spontaneous
##
```

```
# 7I
```

```
set.seed(1973)
```

```
smile__tree_model_7I <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean,
method = "rpart", data = trn_smile,
trnControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_7I$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03030303 0.5458890 0.09560258 0.06427069 0.1274249
## 2 0.04545455 0.5364305 0.07335263 0.07508962 0.1507522
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

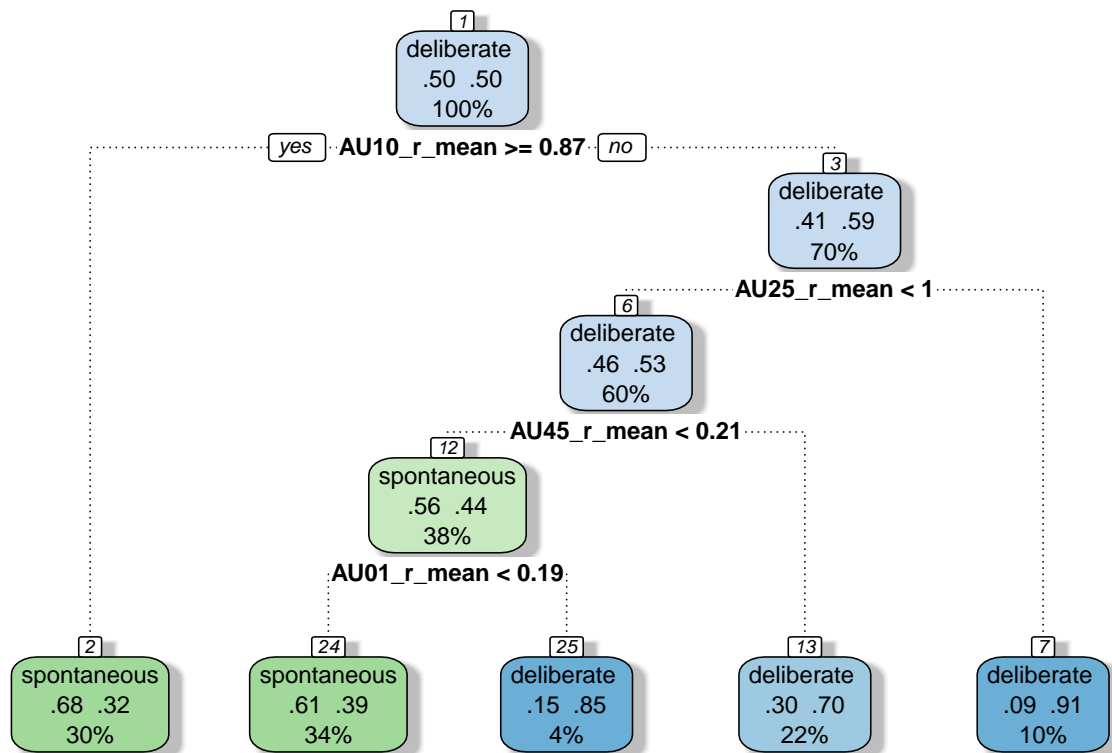
```
smile__tree_model_7I$coefnames
```

```
## [1] "AU01_r_mean" "AU09_r_mean" "AU10_r_mean" "AU25_r_mean" "AU45_r_mean"
## [6] "onset_mean"
```

```
varImp(smile__tree_model_7I)
```

```
## rpart variable importance
##
##           Overall
## AU25_r_mean 100.00
## AU45_r_mean  90.39
## AU01_r_mean  85.32
## AU10_r_mean  76.48
## AU09_r_mean  72.27
## onset_mean   0.00
```

```
# summary(smile__tree_model_7I$finalModel)
fancyRpartPlot(smile__tree_model_7I$finalModel)
```

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```
smile__tree_model_7I_pred <- predict(smile__tree_model_7I, tst_smile)
summary(smile__tree_model_7I_pred)
```

```
## spontaneous deliberate
##           89           53
```

```
smile__tree_model_7I_confM <- confusionMatrix(
  smile__tree_model_7I_pred,
  tst_smile$smile_type
)
smile__tree_model_7I_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      49           40
## deliberate       21           32
##
##              Accuracy : 0.5704
##              95% CI : (0.4847, 0.6531)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.07664
##
##              Kappa : 0.1439
```

```
##
## McNemar's Test P-Value : 0.02119
##
##          Sensitivity : 0.7000
##          Specificity : 0.4444
##          Pos Pred Value : 0.5506
##          Neg Pred Value : 0.6038
##          Prevalence : 0.4930
##          Detection Rate : 0.3451
##          Detection Prevalence : 0.6268
##          Balanced Accuracy : 0.5722
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7I.1_pred <- predict(smile__tree_model_7I, tst_smile_boys)
summary(smile__tree_model_7I.1_pred)
```

```
## spontaneous deliberate
##          41          36
```

```
smile__tree_model_7I.1_confM <- confusionMatrix(
  smile__tree_model_7I.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7I.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          23          18
## deliberate           14          22
##
##          Accuracy : 0.5844
##          95% CI : (0.4664, 0.6957)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.1523
##
##          Kappa : 0.1709
##
## McNemar's Test P-Value : 0.5959
##
##          Sensitivity : 0.6216
##          Specificity : 0.5500
##          Pos Pred Value : 0.5610
##          Neg Pred Value : 0.6111
##          Prevalence : 0.4805
##          Detection Rate : 0.2987
##          Detection Prevalence : 0.5325
##          Balanced Accuracy : 0.5858
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_7I.2_pred <- predict(smile__tree_model_7I, tst_smile_girls)
summary(smile__tree_model_7I.2_pred)

## spontaneous deliberate
##      48      17

smile__tree_model_7I.2_confM <- confusionMatrix(
  smile__tree_model_7I.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7I.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      26          22
## deliberate       7          10
##
##              Accuracy : 0.5538
##              95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.26784
##
##              Kappa : 0.1011
##
##  Mcnemar's Test P-Value : 0.00933
##
##              Sensitivity : 0.7879
##              Specificity : 0.3125
##              Pos Pred Value : 0.5417
##              Neg Pred Value : 0.5882
##              Prevalence : 0.5077
##              Detection Rate : 0.4000
##      Detection Prevalence : 0.7385
##              Balanced Accuracy : 0.5502
##
##      'Positive' Class : spontaneous
##

# 7J apex

set.seed(1973)
smile__tree_model_7J <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  apex_mean,
method = "rpart", data = trn_smile,
```

```
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_7J$results
```

```
##           cp  Accuracy      Kappa AccuracySD  KappaSD
## 1 0.04242424 0.5454323 0.09550827 0.07304606 0.1452256
## 2 0.04545455 0.5393717 0.07923498 0.07276411 0.1460974
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

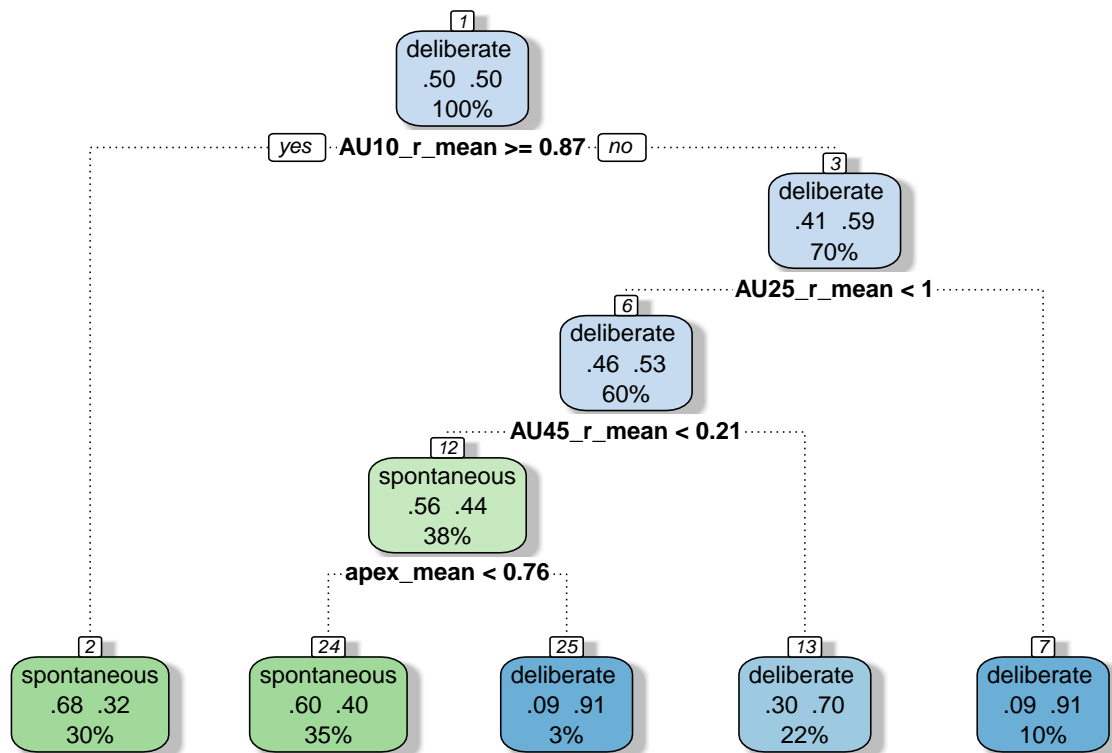
```
smile__tree_model_7J$coefnames
```

```
## [1] "AU01_r_mean" "AU09_r_mean" "AU10_r_mean" "AU25_r_mean" "AU45_r_mean"
## [6] "apex_mean"
```

```
varImp(smile__tree_model_7J)
```

```
## rpart variable importance
##
##           Overall
## AU25_r_mean 100.00
## AU45_r_mean  84.27
## AU01_r_mean  75.97
## AU09_r_mean  54.61
## apex_mean   27.02
## AU10_r_mean   0.00
```

```
# summary(smile__tree_model_7J$finalModel)
fancyRpartPlot(smile__tree_model_7J$finalModel)
```



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```
smile__tree_model_7J_pred <- predict(smile__tree_model_7J, tst_smile)
summary(smile__tree_model_7J_pred)
```

```
## spontaneous deliberate
##           88           54
```

```
smile__tree_model_7J_confM <- confusionMatrix(
  smile__tree_model_7J_pred,
  tst_smile$smile_type
)
smile__tree_model_7J_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      49           39
## deliberate       21           33
##
##           Accuracy : 0.5775
##           95% CI : (0.4918, 0.6598)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.05517
##
##           Kappa : 0.1578
```

```
##
## McNemar's Test P-Value : 0.02819
##
##          Sensitivity : 0.7000
##          Specificity : 0.4583
##          Pos Pred Value : 0.5568
##          Neg Pred Value : 0.6111
##          Prevalence : 0.4930
##          Detection Rate : 0.3451
##          Detection Prevalence : 0.6197
##          Balanced Accuracy : 0.5792
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7J.1_pred <- predict(smile__tree_model_7J, tst_smile_boys)
summary(smile__tree_model_7J.1_pred)
```

```
## spontaneous deliberate
##          39          38
```

```
smile__tree_model_7J.1_confM <- confusionMatrix(
  smile__tree_model_7J.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7J.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          22          17
## deliberate           15          23
##
##          Accuracy : 0.5844
##          95% CI : (0.4664, 0.6957)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.1523
##
##          Kappa : 0.1693
##
## McNemar's Test P-Value : 0.8597
##
##          Sensitivity : 0.5946
##          Specificity : 0.5750
##          Pos Pred Value : 0.5641
##          Neg Pred Value : 0.6053
##          Prevalence : 0.4805
##          Detection Rate : 0.2857
##          Detection Prevalence : 0.5065
##          Balanced Accuracy : 0.5848
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_7J.2_pred <- predict(smile__tree_model_7J, tst_smile_girls)
summary(smile__tree_model_7J.2_pred)

## spontaneous deliberate
##      49      16

smile__tree_model_7J.2_confM <- confusionMatrix(
  smile__tree_model_7J.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7J.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      27      22
## deliberate       6      10
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.192728
##
##              Kappa : 0.1317
##
## Mcnemar's Test P-Value : 0.004586
##
##              Sensitivity : 0.8182
##              Specificity : 0.3125
##              Pos Pred Value : 0.5510
##              Neg Pred Value : 0.6250
##              Prevalence : 0.5077
##              Detection Rate : 0.4154
##      Detection Prevalence : 0.7538
##              Balanced Accuracy : 0.5653
##
##      'Positive' Class : spontaneous
##

# 7K

set.seed(1973)
smile__tree_model_7K <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  offset_mean,
method = "rpart", data = trn_smile,
```

```
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_7K$results
```

```
##           cp  Accuracy      Kappa AccuracySD  KappaSD
## 1 0.03030303 0.5548017 0.11382011 0.08030484 0.1597152
## 2 0.04545455 0.5334893 0.06747028 0.07339185 0.1473916
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

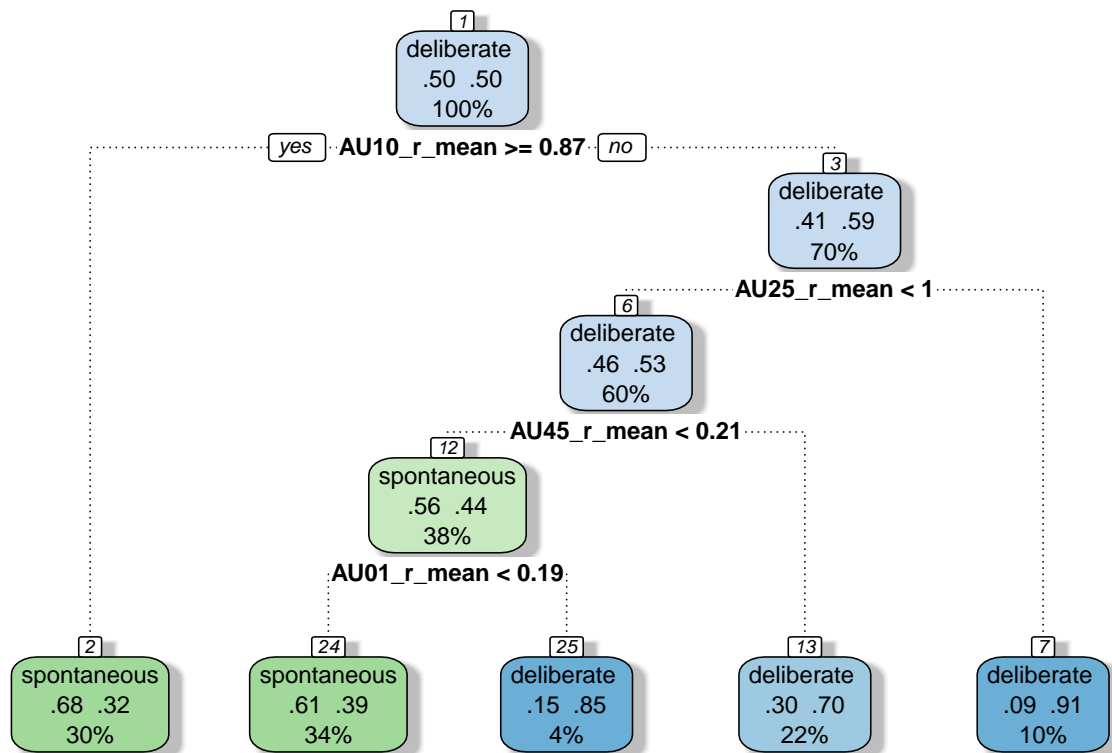
```
smile__tree_model_7K$coefnames
```

```
## [1] "AU01_r_mean" "AU09_r_mean" "AU10_r_mean" "AU25_r_mean" "AU45_r_mean"
## [6] "offset_mean"
```

```
varImp(smile__tree_model_7K)
```

```
## rpart variable importance
##
##           Overall
## AU25_r_mean 100.00
## AU45_r_mean  90.39
## AU01_r_mean  85.32
## AU10_r_mean  76.48
## AU09_r_mean  72.27
## offset_mean   0.00
```

```
# summary(smile__tree_model_7K$finalModel)
fancyRpartPlot(smile__tree_model_7K$finalModel)
```

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```
smile__tree_model_7K_pred <- predict(smile__tree_model_7K, tst_smile)
summary(smile__tree_model_7K_pred)
```

```
## spontaneous deliberate
##           89           53
```

```
smile__tree_model_7K_confM <- confusionMatrix(
  smile__tree_model_7K_pred,
  tst_smile$smile_type
)
smile__tree_model_7K_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      49           40
## deliberate       21           32
##
##           Accuracy : 0.5704
##           95% CI : (0.4847, 0.6531)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.07664
##
##           Kappa : 0.1439
```

```
##
## McNemar's Test P-Value : 0.02119
##
##           Sensitivity : 0.7000
##           Specificity : 0.4444
##           Pos Pred Value : 0.5506
##           Neg Pred Value : 0.6038
##           Prevalence : 0.4930
##           Detection Rate : 0.3451
##           Detection Prevalence : 0.6268
##           Balanced Accuracy : 0.5722
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_7K.1_pred <- predict(smile__tree_model_7K, tst_smile_boys)
summary(smile__tree_model_7K.1_pred)
```

```
## spontaneous deliberate
##           41           36
```

```
smile__tree_model_7K.1_confM <- confusionMatrix(
  smile__tree_model_7K.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_7K.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           23           18
## deliberate           14           22
##
##           Accuracy : 0.5844
##           95% CI : (0.4664, 0.6957)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.1523
##
##           Kappa : 0.1709
##
## McNemar's Test P-Value : 0.5959
##
##           Sensitivity : 0.6216
##           Specificity : 0.5500
##           Pos Pred Value : 0.5610
##           Neg Pred Value : 0.6111
##           Prevalence : 0.4805
##           Detection Rate : 0.2987
##           Detection Prevalence : 0.5325
##           Balanced Accuracy : 0.5858
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__tree_model_7K.2_pred <- predict(smile__tree_model_7K, tst_smile_girls)
summary(smile__tree_model_7K.2_pred)

## spontaneous deliberate
##      48      17

smile__tree_model_7K.2_confM <- confusionMatrix(
  smile__tree_model_7K.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_7K.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      26      22
## deliberate       7      10
##
##              Accuracy : 0.5538
##              95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.26784
##
##              Kappa : 0.1011
##
##  Mcnemar's Test P-Value : 0.00933
##
##      Sensitivity : 0.7879
##      Specificity : 0.3125
##      Pos Pred Value : 0.5417
##      Neg Pred Value : 0.5882
##      Prevalence : 0.5077
##      Detection Rate : 0.4000
##      Detection Prevalence : 0.7385
##      Balanced Accuracy : 0.5502
##
##      'Positive' Class : spontaneous
##

# 8 strongest feature combination

# 8A
set.seed(1973)
smile__tree_model_8A <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean + lip_mean + eye_mean,
```

```
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_8A$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5645443 0.13035315 0.04265332 0.08444669
## 2 0.05454545 0.5464516 0.09393859 0.04163563 0.08371676
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

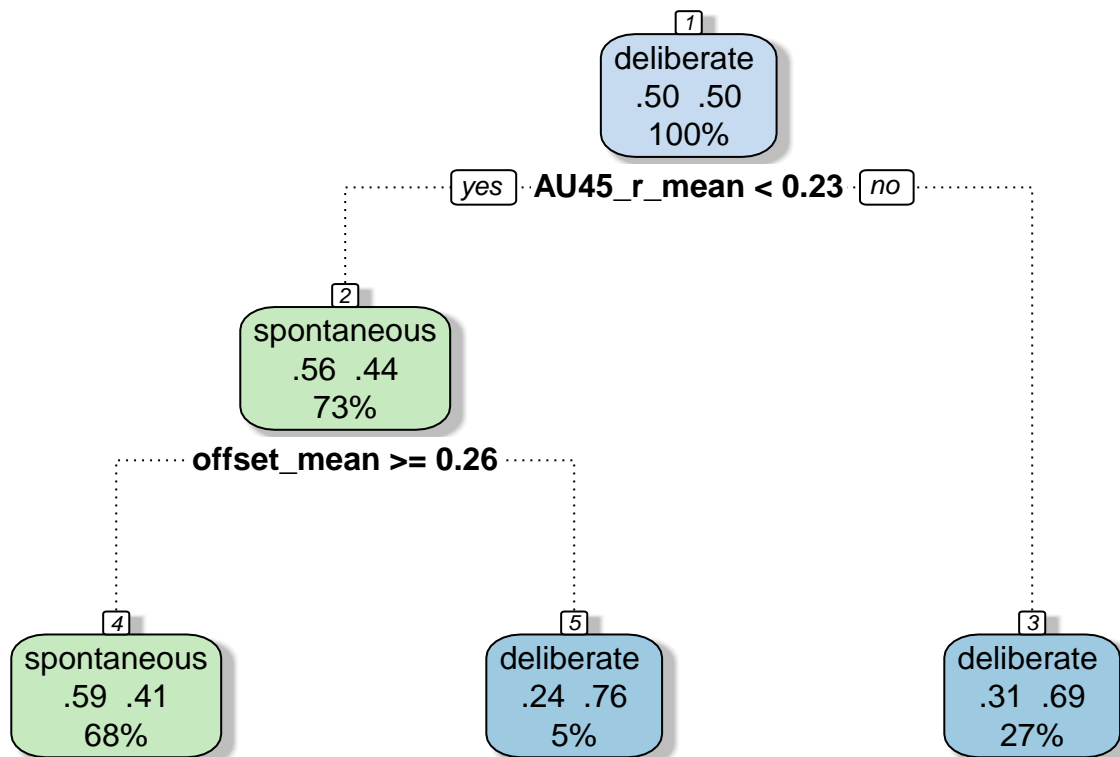
```
smile__tree_model_8A$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean" "apex_mean"
## [6] "offset_mean" "lip_mean"      "eye_mean"
```

```
varImp(smile__tree_model_8A)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## offset_mean  69.75
## eye_mean     69.12
## AU06_r_mean  48.99
## onset_mean   26.75
## apex_mean    21.60
## AU12_r_mean   0.00
## lip_mean      0.00
```

```
# summary(smile__tree_model_8A$finalModel)
fancyRpartPlot(smile__tree_model_8A$finalModel)
```



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```
smile__tree_model_8A_pred <- predict(smile__tree_model_8A, tst_smile)
summary(smile__tree_model_8A_pred)
```

```
## spontaneous deliberate
##           92           50
```

```
smile__tree_model_8A_confM <- confusionMatrix(
  smile__tree_model_8A_pred,
  tst_smile$smile_type
)
smile__tree_model_8A_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      46           46
##  deliberate       24           26
##
##           Accuracy : 0.507
##           95% CI : (0.4219, 0.5919)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.53358
##
##           Kappa : 0.0182
```

```
##
## McNemar's Test P-Value : 0.01207
##
##          Sensitivity : 0.6571
##          Specificity : 0.3611
##          Pos Pred Value : 0.5000
##          Neg Pred Value : 0.5200
##          Prevalence : 0.4930
##          Detection Rate : 0.3239
##          Detection Prevalence : 0.6479
##          Balanced Accuracy : 0.5091
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8A.1_pred <- predict(smile__tree_model_8A, tst_smile_boys)
summary(smile__tree_model_8A.1_pred)
```

```
## spontaneous deliberate
##          49          28
```

```
smile__tree_model_8A.1_confM <- confusionMatrix(
  smile__tree_model_8A.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8A.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          24          25
## deliberate           13          15
##
##          Accuracy : 0.5065
##          95% CI : (0.39, 0.6224)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.63425
##
##          Kappa : 0.0234
##
## McNemar's Test P-Value : 0.07435
##
##          Sensitivity : 0.6486
##          Specificity : 0.3750
##          Pos Pred Value : 0.4898
##          Neg Pred Value : 0.5357
##          Prevalence : 0.4805
##          Detection Rate : 0.3117
##          Detection Prevalence : 0.6364
##          Balanced Accuracy : 0.5118
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8A.2_pred <- predict(smile__tree_model_8A, tst_smile_girls)
summary(smile__tree_model_8A.2_pred)
```

```
## spontaneous deliberate
##      43      22
```

```
smile__tree_model_8A.2_confM <- confusionMatrix(
  smile__tree_model_8A.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      22      21
## deliberate       11      11
##
##              Accuracy : 0.5077
##              95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
##              Kappa : 0.0105
##
## Mcnemar's Test P-Value : 0.1116
##
##      Sensitivity : 0.6667
##      Specificity : 0.3438
##      Pos Pred Value : 0.5116
##      Neg Pred Value : 0.5000
##      Prevalence : 0.5077
##      Detection Rate : 0.3385
##      Detection Prevalence : 0.6615
##      Balanced Accuracy : 0.5052
##
##      'Positive' Class : spontaneous
##
```

```
# 8B
set.seed(1973)
smile__tree_model_8B <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + lip_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_8B$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5707832 0.14212731 0.03047154 0.06075247
## 2 0.06060606 0.5435105 0.09129408 0.03933110 0.08035001
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

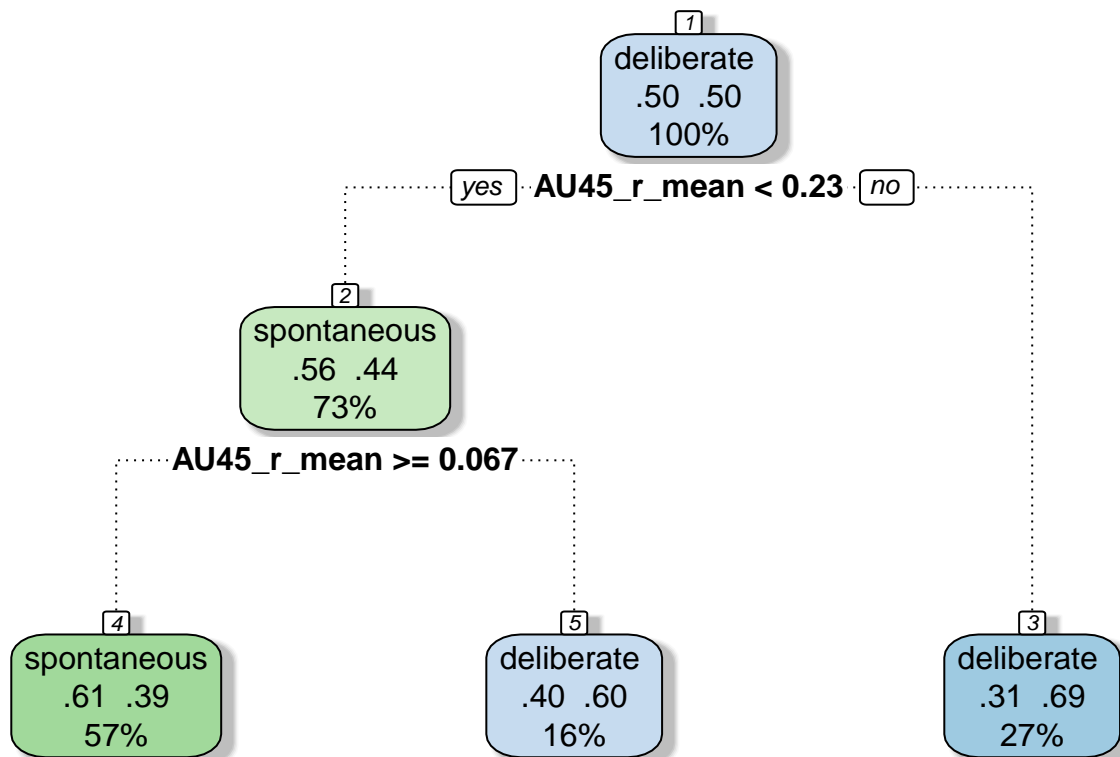
```
smile__tree_model_8B$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean" "lip_mean"
## [6] "eye_mean"
```

```
varImp(smile__tree_model_8B)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## eye_mean    69.12
## AU06_r_mean  48.99
## onset_mean  46.87
## lip_mean     27.55
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_8B$finalModel)
fancyRpartPlot(smile__tree_model_8B$finalModel)
```

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```
smile__tree_model_8B_pred <- predict(smile__tree_model_8B, tst_smile)
summary(smile__tree_model_8B_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_8B_confM <- confusionMatrix(
  smile__tree_model_8B_pred,
  tst_smile$smile_type
)
smile__tree_model_8B_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      44           41
##  deliberate       26           31
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.059
```

```
##
## McNemar's Test P-Value : 0.0872
##
##          Sensitivity : 0.6286
##          Specificity : 0.4306
##          Pos Pred Value : 0.5176
##          Neg Pred Value : 0.5439
##          Prevalence : 0.4930
##          Detection Rate : 0.3099
##          Detection Prevalence : 0.5986
##          Balanced Accuracy : 0.5296
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8B.1_pred <- predict(smile__tree_model_8B, tst_smile_boys)
summary(smile__tree_model_8B.1_pred)
```

```
## spontaneous deliberate
##          45          32
```

```
smile__tree_model_8B.1_confM <- confusionMatrix(
  smile__tree_model_8B.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8B.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          23          22
## deliberate           14          18
##
##          Accuracy : 0.5325
##          95% CI : (0.4152, 0.6471)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.4552
##
##          Kappa : 0.071
##
## McNemar's Test P-Value : 0.2433
##
##          Sensitivity : 0.6216
##          Specificity : 0.4500
##          Pos Pred Value : 0.5111
##          Neg Pred Value : 0.5625
##          Prevalence : 0.4805
##          Detection Rate : 0.2987
##          Detection Prevalence : 0.5844
##          Balanced Accuracy : 0.5358
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8B.2_pred <- predict(smile__tree_model_8B, tst_smile_girls)
summary(smile__tree_model_8B.2_pred)
```

```
## spontaneous deliberate
##      40      25
```

```
smile__tree_model_8B.2_confM <- confusionMatrix(
  smile__tree_model_8B.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8B.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21      19
## deliberate       12      13
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.6364
##              Specificity : 0.4062
##              Pos Pred Value : 0.5250
##              Neg Pred Value : 0.5200
##              Prevalence : 0.5077
##              Detection Rate : 0.3231
##      Detection Prevalence : 0.6154
##              Balanced Accuracy : 0.5213
##
##      'Positive' Class : spontaneous
##
```

```
# 8C
set.seed(1973)
smile__tree_model_8C <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + apex_mean + lip_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_8C$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5646335 0.13053791 0.02257622 0.04670496
## 2 0.06060606 0.5435105 0.09129408 0.03933110 0.08035001
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

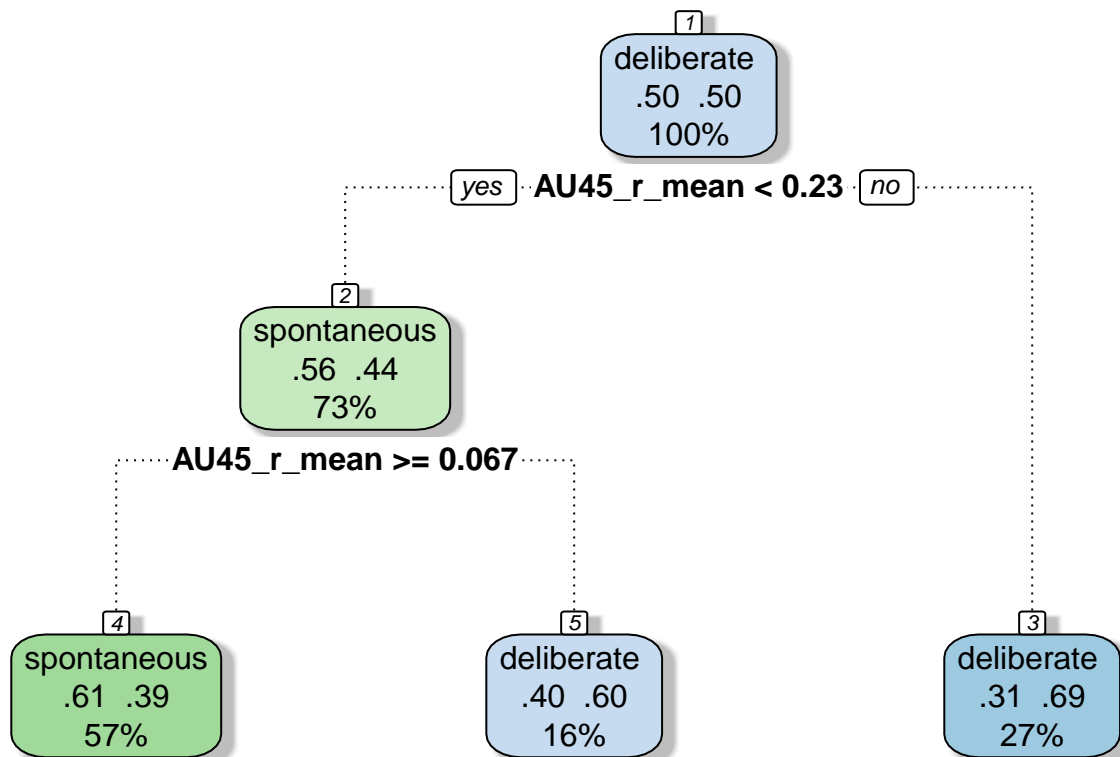
```
smile__tree_model_8C$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "apex_mean"  "lip_mean"
## [6] "eye_mean"
```

```
varImp(smile__tree_model_8C)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## eye_mean    69.12
## AU06_r_mean 48.99
## apex_mean   39.60
## lip_mean    27.55
## AU12_r_mean  0.00
```

```
# summary(smile__tree_model_8C$finalModel)
fancyRpartPlot(smile__tree_model_8C$finalModel)
```



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```
smile__tree_model_8C_pred <- predict(smile__tree_model_8C, tst_smile)
summary(smile__tree_model_8C_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_8C_confM <- confusionMatrix(
  smile__tree_model_8C_pred,
  tst_smile$smile_type
)
smile__tree_model_8C_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      44           41
## deliberate       26           31
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.059
```

```
##
## McNemar's Test P-Value : 0.0872
##
##           Sensitivity : 0.6286
##           Specificity : 0.4306
##           Pos Pred Value : 0.5176
##           Neg Pred Value : 0.5439
##           Prevalence : 0.4930
##           Detection Rate : 0.3099
##           Detection Prevalence : 0.5986
##           Balanced Accuracy : 0.5296
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8C.1_pred <- predict(smile__tree_model_8C, tst_smile_boys)
summary(smile__tree_model_8C.1_pred)
```

```
## spontaneous deliberate
##           45           32
```

```
smile__tree_model_8C.1_confM <- confusionMatrix(
  smile__tree_model_8C.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8C.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           23           22
## deliberate           14           18
##
##           Accuracy : 0.5325
##           95% CI : (0.4152, 0.6471)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.4552
##
##           Kappa : 0.071
##
## McNemar's Test P-Value : 0.2433
##
##           Sensitivity : 0.6216
##           Specificity : 0.4500
##           Pos Pred Value : 0.5111
##           Neg Pred Value : 0.5625
##           Prevalence : 0.4805
##           Detection Rate : 0.2987
##           Detection Prevalence : 0.5844
##           Balanced Accuracy : 0.5358
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8C.2_pred <- predict(smile__tree_model_8C, tst_smile_girls)
summary(smile__tree_model_8C.2_pred)
```

```
## spontaneous deliberate
##      40      25
```

```
smile__tree_model_8C.2_confM <- confusionMatrix(
  smile__tree_model_8C.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8C.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21      19
## deliberate       12      13
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.6364
##              Specificity : 0.4062
##              Pos Pred Value : 0.5250
##              Neg Pred Value : 0.5200
##              Prevalence : 0.5077
##              Detection Rate : 0.3231
##      Detection Prevalence : 0.6154
##              Balanced Accuracy : 0.5213
##
##      'Positive' Class : spontaneous
##
```

```
# 8D
set.seed(1973)
smile__tree_model_8D <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + offset_mean + lip_mean +
  eye_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
```

```
)
```

```
smile__tree_model_8D$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04848485 0.5525123 0.1060044 0.04568814 0.09216566
## 2 0.05454545 0.5525123 0.1060044 0.04568814 0.09216566
## 3 0.18787879 0.5076649 0.0196029 0.05893775 0.12183508
```

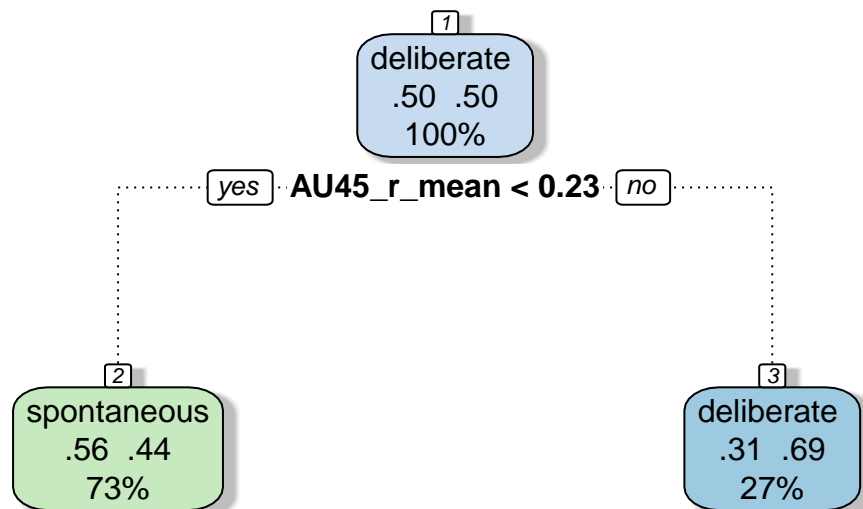
```
smile__tree_model_8D$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "offset_mean" "lip_mean"
## [6] "eye_mean"
```

```
varImp(smile__tree_model_8D)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## eye_mean    66.67
## offset_mean 50.87
## AU06_r_mean 38.96
## lip_mean    19.35
## AU12_r_mean  0.00
```

```
# summary(smile__tree_model_8D$finalModel)
fancyRpartPlot(smile__tree_model_8D$finalModel)
```

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```
smile__tree_model_8D_pred <- predict(smile__tree_model_8D, tst_smile)
summary(smile__tree_model_8D_pred)
```

```
## spontaneous deliberate
##           102           40
```

```
smile__tree_model_8D_confM <- confusionMatrix(
  smile__tree_model_8D_pred,
  tst_smile$smile_type
)
smile__tree_model_8D_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous          52          50
##  deliberate           18          22
##
##           Accuracy : 0.5211
##           95% CI : (0.4358, 0.6056)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.4008030
##
##           Kappa : 0.0481
```

```
##
## McNemar's Test P-Value : 0.0001704
##
##          Sensitivity : 0.7429
##          Specificity : 0.3056
##          Pos Pred Value : 0.5098
##          Neg Pred Value : 0.5500
##          Prevalence : 0.4930
##          Detection Rate : 0.3662
##          Detection Prevalence : 0.7183
##          Balanced Accuracy : 0.5242
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8D.1_pred <- predict(smile__tree_model_8D, tst_smile_boys)
summary(smile__tree_model_8D.1_pred)
```

```
## spontaneous deliberate
##          54          23
```

```
smile__tree_model_8D.1_confM <- confusionMatrix(
  smile__tree_model_8D.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8D.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          27          27
## deliberate          10          13
##
##          Accuracy : 0.5195
##          95% CI : (0.4026, 0.6348)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.545933
##
##          Kappa : 0.0538
##
## McNemar's Test P-Value : 0.008529
##
##          Sensitivity : 0.7297
##          Specificity : 0.3250
##          Pos Pred Value : 0.5000
##          Neg Pred Value : 0.5652
##          Prevalence : 0.4805
##          Detection Rate : 0.3506
##          Detection Prevalence : 0.7013
##          Balanced Accuracy : 0.5274
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8D.2_pred <- predict(smile__tree_model_8D, tst_smile_girls)
summary(smile__tree_model_8D.2_pred)
```

```
## spontaneous deliberate
##      48      17
```

```
smile__tree_model_8D.2_confM <- confusionMatrix(
  smile__tree_model_8D.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8D.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      25      23
## deliberate       8       9
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.45095
##
##              Kappa : 0.0391
##
## Mcnemar's Test P-Value : 0.01192
##
##      Sensitivity : 0.7576
##      Specificity : 0.2812
##      Pos Pred Value : 0.5208
##      Neg Pred Value : 0.5294
##      Prevalence : 0.5077
##      Detection Rate : 0.3846
##      Detection Prevalence : 0.7385
##      Balanced Accuracy : 0.5194
##
##      'Positive' Class : spontaneous
##
```

```
# 8E
set.seed(1973)
smile__tree_model_8E <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean + lip_mean +
  eye_mean,
method = "rpart", data = trn_smile,
```

```
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_8E$results
```

```
##           cp  Accuracy      Kappa AccuracySD   KappaSD
## 1 0.04242424 0.5335784 0.06951700 0.06719129 0.1351431
## 2 0.04545455 0.5394608 0.08128171 0.06932694 0.1391696
## 3 0.22424242 0.5255849 0.04429576 0.04913641 0.0997257
```

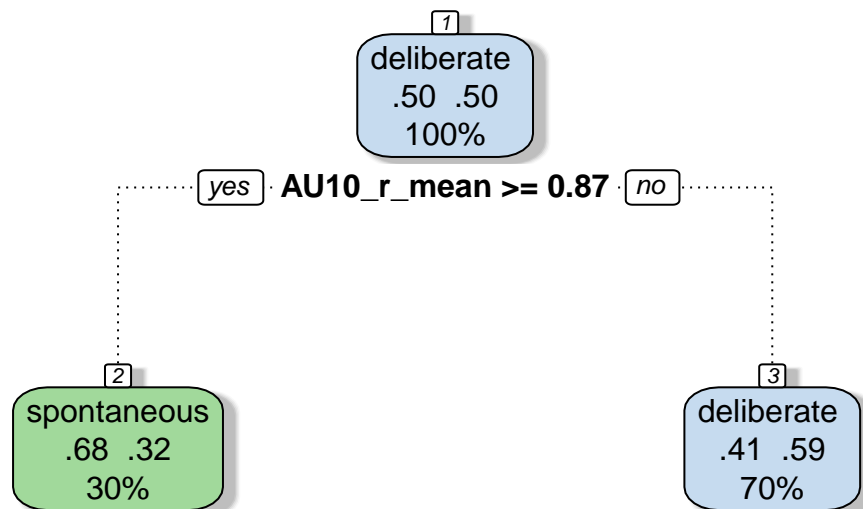
```
smile__tree_model_8E$coefnames
```

```
## [1] "AU01_r_mean" "AU09_r_mean" "AU10_r_mean" "AU25_r_mean" "AU45_r_mean"
## [6] "onset_mean"  "apex_mean"   "offset_mean" "lip_mean"    "eye_mean"
```

```
varImp(smile__tree_model_8E)
```

```
## rpart variable importance
##
##           Overall
## AU10_r_mean 100.00
## AU25_r_mean  92.60
## AU45_r_mean  82.12
## AU09_r_mean  62.58
## AU01_r_mean  60.90
## eye_mean      0.00
## lip_mean      0.00
## onset_mean    0.00
## apex_mean     0.00
## offset_mean   0.00
```

```
# summary(smile__tree_model_8E$finalModel)
fancyRpartPlot(smile__tree_model_8E$finalModel)
```



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```
smile__tree_model_8E_pred <- predict(smile__tree_model_8E, tst_smile)
summary(smile__tree_model_8E_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__tree_model_8E_confM <- confusionMatrix(
  smile__tree_model_8E_pred,
  tst_smile$smile_type
)
smile__tree_model_8E_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      22           19
## deliberate       48           53
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.3375712
##
##           Kappa : 0.0507
```

```
##
## McNemar's Test P-Value : 0.0006245
##
##          Sensitivity : 0.3143
##          Specificity : 0.7361
##          Pos Pred Value : 0.5366
##          Neg Pred Value : 0.5248
##          Prevalence : 0.4930
##          Detection Rate : 0.1549
##          Detection Prevalence : 0.2887
##          Balanced Accuracy : 0.5252
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8E.1_pred <- predict(smile__tree_model_8E, tst_smile_boys)
summary(smile__tree_model_8E.1_pred)
```

```
## spontaneous deliberate
##          13          64
```

```
smile__tree_model_8E.1_confM <- confusionMatrix(
  smile__tree_model_8E.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8E.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          9           4
## deliberate         28          36
##
##          Accuracy : 0.5844
##          95% CI : (0.4664, 0.6957)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.1523
##
##          Kappa : 0.1468
##
## McNemar's Test P-Value : 4.785e-05
##
##          Sensitivity : 0.2432
##          Specificity : 0.9000
##          Pos Pred Value : 0.6923
##          Neg Pred Value : 0.5625
##          Prevalence : 0.4805
##          Detection Rate : 0.1169
##          Detection Prevalence : 0.1688
##          Balanced Accuracy : 0.5716
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8E.2_pred <- predict(smile__tree_model_8E, tst_smile_girls)
summary(smile__tree_model_8E.2_pred)
```

```
## spontaneous deliberate
##      28      37
```

```
smile__tree_model_8E.2_confM <- confusionMatrix(
  smile__tree_model_8E.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8E.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      13      15
## deliberate      20      17
##
##              Accuracy : 0.4615
##              95% CI : (0.337, 0.5897)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.8074
##
##              Kappa : -0.0746
##
## Mcnemar's Test P-Value : 0.4990
##
##              Sensitivity : 0.3939
##              Specificity : 0.5312
##              Pos Pred Value : 0.4643
##              Neg Pred Value : 0.4595
##              Prevalence : 0.5077
##              Detection Rate : 0.2000
##      Detection Prevalence : 0.4308
##              Balanced Accuracy : 0.4626
##
##      'Positive' Class : spontaneous
##
```

```
# 8F
set.seed(1973)
smile__tree_model_8F <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean + eye_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
```

```
)
```

```
smile__tree_model_8F$results
```

```
##           cp  Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5584837 0.11790741 0.03491922 0.06900019
## 2 0.05454545 0.5464516 0.09393859 0.04163563 0.08371676
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

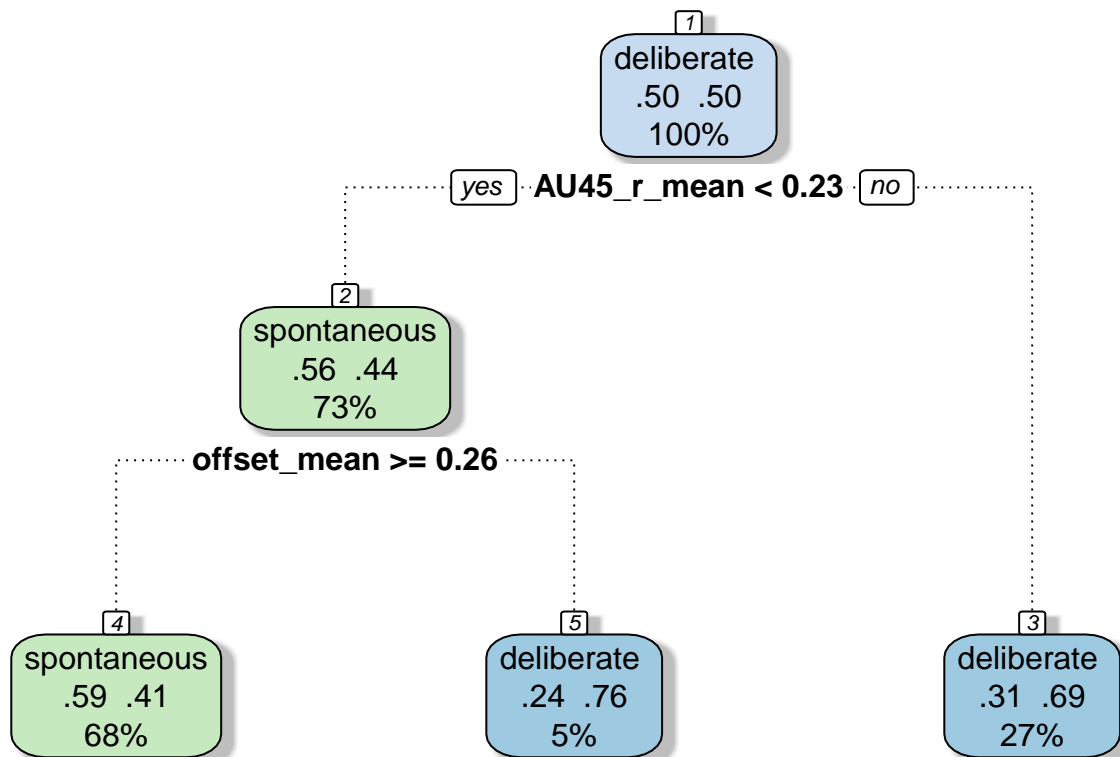
```
smile__tree_model_8F$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean"  "apex_mean"
## [6] "offset_mean" "eye_mean"
```

```
varImp(smile__tree_model_8F)
```

```
## rpart variable importance
##
##           Overall
## AU45_r_mean 100.00
## offset_mean  69.75
## eye_mean     69.12
## AU06_r_mean  48.99
## onset_mean   26.75
## apex_mean    21.60
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_8F$finalModel)
fancyRpartPlot(smile__tree_model_8F$finalModel)
```

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```
smile__tree_model_8F_pred <- predict(smile__tree_model_8F, tst_smile)
summary(smile__tree_model_8F_pred)
```

```
## spontaneous deliberate
##           92           50
```

```
smile__tree_model_8F_confM <- confusionMatrix(
  smile__tree_model_8F_pred,
  tst_smile$smile_type
)
smile__tree_model_8F_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      46           46
## deliberate       24           26
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.53358
##
##              Kappa : 0.0182
```

```
##
## McNemar's Test P-Value : 0.01207
##
##           Sensitivity : 0.6571
##           Specificity : 0.3611
##           Pos Pred Value : 0.5000
##           Neg Pred Value : 0.5200
##           Prevalence : 0.4930
##           Detection Rate : 0.3239
##           Detection Prevalence : 0.6479
##           Balanced Accuracy : 0.5091
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8F.1_pred <- predict(smile__tree_model_8F, tst_smile_boys)
summary(smile__tree_model_8F.1_pred)
```

```
## spontaneous deliberate
##           49           28
```

```
smile__tree_model_8F.1_confM <- confusionMatrix(
  smile__tree_model_8F.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8F.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           24           25
## deliberate           13           15
##
##           Accuracy : 0.5065
##           95% CI : (0.39, 0.6224)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.63425
##
##           Kappa : 0.0234
##
## McNemar's Test P-Value : 0.07435
##
##           Sensitivity : 0.6486
##           Specificity : 0.3750
##           Pos Pred Value : 0.4898
##           Neg Pred Value : 0.5357
##           Prevalence : 0.4805
##           Detection Rate : 0.3117
##           Detection Prevalence : 0.6364
##           Balanced Accuracy : 0.5118
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8F.2_pred <- predict(smile__tree_model_8F, tst_smile_girls)
summary(smile__tree_model_8F.2_pred)
```

```
## spontaneous deliberate
##      43      22
```

```
smile__tree_model_8F.2_confM <- confusionMatrix(
  smile__tree_model_8F.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8F.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      22      21
## deliberate       11      11
##
##              Accuracy : 0.5077
##              95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
##              Kappa : 0.0105
##
## Mcnemar's Test P-Value : 0.1116
##
##      Sensitivity : 0.6667
##      Specificity : 0.3438
##      Pos Pred Value : 0.5116
##      Neg Pred Value : 0.5000
##      Prevalence : 0.5077
##      Detection Rate : 0.3385
##      Detection Prevalence : 0.6615
##      Balanced Accuracy : 0.5052
##
##      'Positive' Class : spontaneous
##
```

```
# 8G
set.seed(1973)
smile__tree_model_8G <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + eye_mean,
  method = "rpart", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_8G$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5617814 0.12318742 0.03094505 0.06127823
## 2 0.06060606 0.5435105 0.09129408 0.03933110 0.08035001
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

```
smile__tree_model_8G$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean" "eye_mean"
```

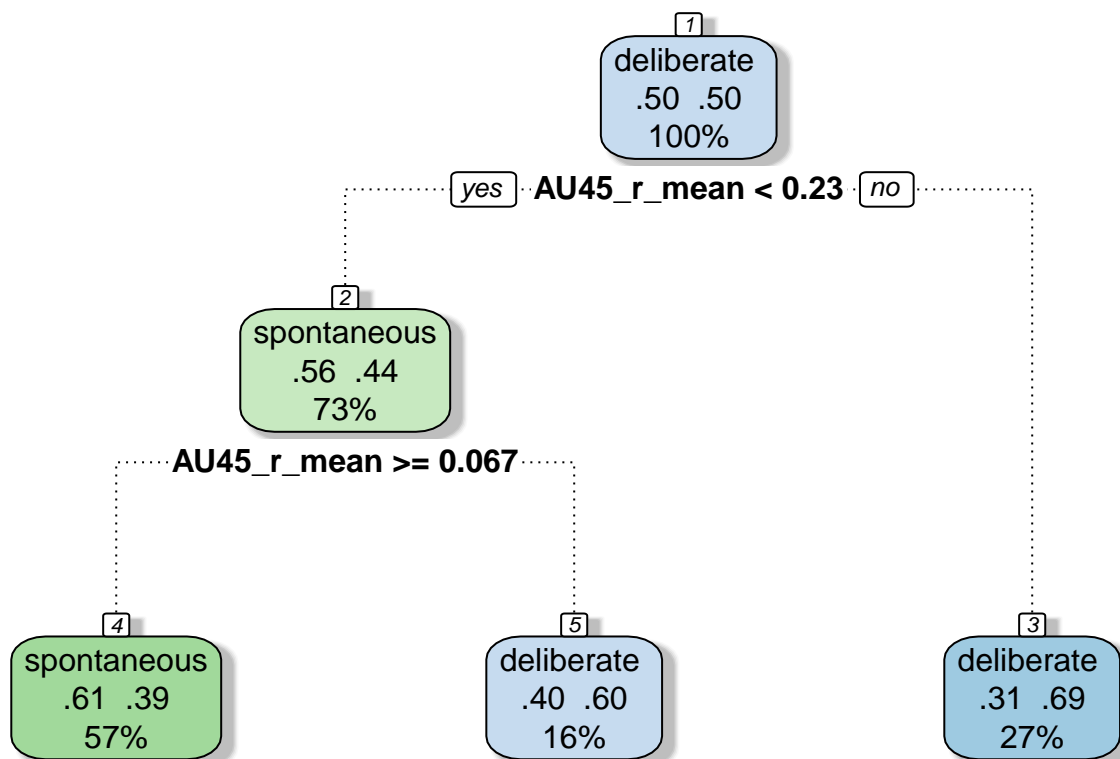
```
varImp(smile__tree_model_8G)
```

```
## rpart variable importance
```

```
##
##           Overall
## AU45_r_mean 100.00
## eye_mean    58.79
## AU06_r_mean 31.92
## onset_mean  29.09
## AU12_r_mean  0.00
```

```
# summary(smile__tree_model_8G$finalModel)
```

```
fancyRpartPlot(smile__tree_model_8G$finalModel)
```



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```
smile__tree_model_8G_pred <- predict(smile__tree_model_8G, tst_smile)
summary(smile__tree_model_8G_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_8G_confM <- confusionMatrix(
  smile__tree_model_8G_pred,
  tst_smile$smile_type
)
smile__tree_model_8G_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           44           41
## deliberate           26           31
##
##              Accuracy : 0.5282
##              95% CI : (0.4427, 0.6124)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.3376
##
##              Kappa : 0.059
##
##  Mcnemar's Test P-Value : 0.0872
##
##              Sensitivity : 0.6286
##              Specificity : 0.4306
##              Pos Pred Value : 0.5176
##              Neg Pred Value : 0.5439
##              Prevalence : 0.4930
##              Detection Rate : 0.3099
##      Detection Prevalence : 0.5986
##              Balanced Accuracy : 0.5296
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8G.1_pred <- predict(smile__tree_model_8G, tst_smile_boys)
summary(smile__tree_model_8G.1_pred)
```

```
## spontaneous deliberate
##           45           32
```

```
smile__tree_model_8G.1_confM <- confusionMatrix(
  smile__tree_model_8G.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8G.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      23           22
## deliberate       14           18
##
##               Accuracy : 0.5325
##               95% CI : (0.4152, 0.6471)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.4552
##
##               Kappa : 0.071
##
## Mcnemar's Test P-Value : 0.2433
##
##       Sensitivity : 0.6216
##       Specificity : 0.4500
##       Pos Pred Value : 0.5111
##       Neg Pred Value : 0.5625
##       Prevalence : 0.4805
##       Detection Rate : 0.2987
##       Detection Prevalence : 0.5844
##       Balanced Accuracy : 0.5358
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8G.2_pred <- predict(smile__tree_model_8G, tst_smile_girls)
summary(smile__tree_model_8G.2_pred)
```

```
## spontaneous deliberate
##           40           25
```

```
smile__tree_model_8G.2_confM <- confusionMatrix(
  smile__tree_model_8G.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8G.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      21           19
## deliberate       12           13
##
##               Accuracy : 0.5231
##               95% CI : (0.3954, 0.6485)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.4510
##
```

```
##                Kappa : 0.0428
##
## Mcnemar's Test P-Value : 0.2812
##
##          Sensitivity : 0.6364
##          Specificity : 0.4062
##          Pos Pred Value : 0.5250
##          Neg Pred Value : 0.5200
##          Prevalence : 0.5077
##          Detection Rate : 0.3231
##          Detection Prevalence : 0.6154
##          Balanced Accuracy : 0.5213
##
##          'Positive' Class : spontaneous
##
```

```
# 8H apex
set.seed(1973)
smile__tree_model_8H <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + apex_mean + eye_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_8H$results
```

```
##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04242424 0.5647226 0.12902381 0.03522295 0.07058369
## 2 0.06060606 0.5435105 0.09129408 0.03933110 0.08035001
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

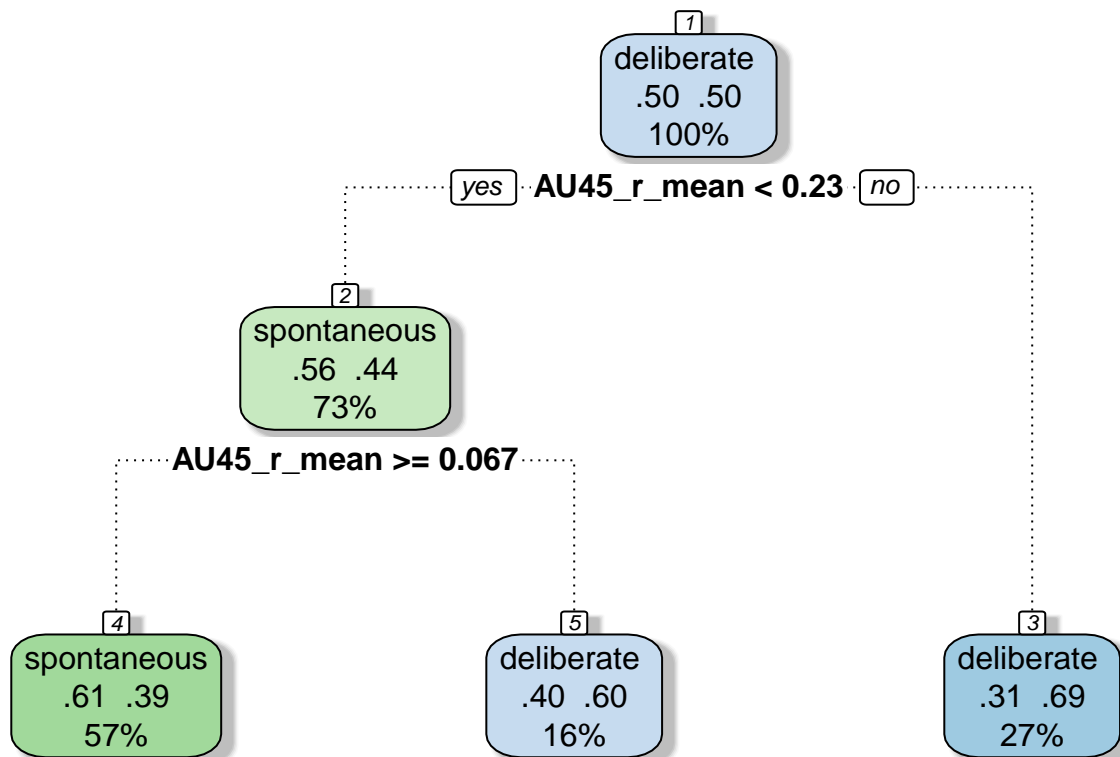
```
smile__tree_model_8H$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "apex_mean" "eye_mean"
```

```
varImp(smile__tree_model_8H)
```

```
## rpart variable importance
##
##          Overall
## AU45_r_mean 100.00
## eye_mean    58.79
## AU06_r_mean 31.92
## apex_mean   19.39
## AU12_r_mean  0.00
```

```
# summary(smile__tree_model_8H$finalModel)
fancyRpartPlot(smile__tree_model_8H$finalModel)
```



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```
smile__tree_model_8H_pred <- predict(smile__tree_model_8H, tst_smile)
summary(smile__tree_model_8H_pred)
```

```
## spontaneous deliberate
##           85           57
```

```
smile__tree_model_8H_confM <- confusionMatrix(
  smile__tree_model_8H_pred,
  tst_smile$smile_type
)
smile__tree_model_8H_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      44           41
##  deliberate       26           31
##
##           Accuracy : 0.5282
##           95% CI : (0.4427, 0.6124)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.3376
##
##           Kappa : 0.059
```



```
##
## McNemar's Test P-Value : 0.0872
##
##           Sensitivity : 0.6286
##           Specificity : 0.4306
##           Pos Pred Value : 0.5176
##           Neg Pred Value : 0.5439
##           Prevalence : 0.4930
##           Detection Rate : 0.3099
##           Detection Prevalence : 0.5986
##           Balanced Accuracy : 0.5296
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8H.1_pred <- predict(smile__tree_model_8H, tst_smile_boys)
summary(smile__tree_model_8H.1_pred)
```

```
## spontaneous deliberate
##           45           32
```

```
smile__tree_model_8H.1_confM <- confusionMatrix(
  smile__tree_model_8H.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8H.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           23           22
## deliberate           14           18
##
##           Accuracy : 0.5325
##           95% CI : (0.4152, 0.6471)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.4552
##
##           Kappa : 0.071
##
## McNemar's Test P-Value : 0.2433
##
##           Sensitivity : 0.6216
##           Specificity : 0.4500
##           Pos Pred Value : 0.5111
##           Neg Pred Value : 0.5625
##           Prevalence : 0.4805
##           Detection Rate : 0.2987
##           Detection Prevalence : 0.5844
##           Balanced Accuracy : 0.5358
```

```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8H.2_pred <- predict(smile__tree_model_8H, tst_smile_girls)
summary(smile__tree_model_8H.2_pred)
```

```
## spontaneous deliberate
##      40      25
```

```
smile__tree_model_8H.2_confM <- confusionMatrix(
  smile__tree_model_8H.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8H.2_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21      19
## deliberate      12      13
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0428
##
##      McNemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.6364
##              Specificity : 0.4062
##              Pos Pred Value : 0.5250
##              Neg Pred Value : 0.5200
##              Prevalence : 0.5077
##              Detection Rate : 0.3231
##      Detection Prevalence : 0.6154
##              Balanced Accuracy : 0.5213
##
##      'Positive' Class : spontaneous
##
```

```
# 8I offset
set.seed(1973)
smile__tree_model_8I <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + offset_mean + eye_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__tree_model_8I$results
```

```
##           cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.04848485 0.5494820 0.10103869 0.04264550 0.08677768
## 2 0.05454545 0.5464516 0.09556325 0.04163563 0.08389847
## 3 0.18787879 0.5076649 0.01960290 0.05893775 0.12183508
```

```
smile__tree_model_8I$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "offset_mean" "eye_mean"
```

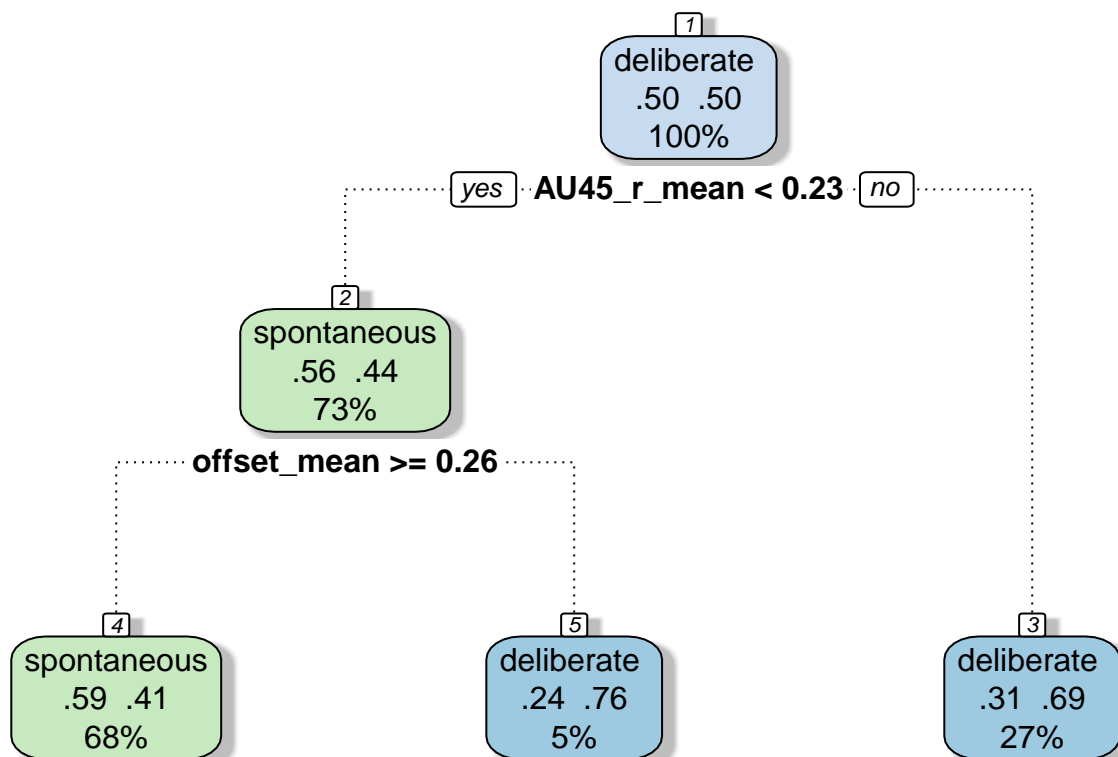
```
varImp(smile__tree_model_8I)
```

```
## rpart variable importance
```

```
##
##           Overall
## AU45_r_mean 100.00
## offset_mean  59.63
## eye_mean     58.79
## AU06_r_mean  31.92
## AU12_r_mean   0.00
```

```
# summary(smile__tree_model_8I$finalModel)
```

```
fancyRpartPlot(smile__tree_model_8I$finalModel)
```



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```
smile__tree_model_8I_pred <- predict(smile__tree_model_8I, tst_smile)
summary(smile__tree_model_8I_pred)
```

```
## spontaneous deliberate
##           92           50
```

```
smile__tree_model_8I_confM <- confusionMatrix(
  smile__tree_model_8I_pred,
  tst_smile$smile_type
)
smile__tree_model_8I_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           46           46
## deliberate           24           26
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.53358
##
##              Kappa : 0.0182
##
##  Mcnemar's Test P-Value : 0.01207
##
##      Sensitivity : 0.6571
##      Specificity : 0.3611
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5200
##      Prevalence : 0.4930
##      Detection Rate : 0.3239
##      Detection Prevalence : 0.6479
##      Balanced Accuracy : 0.5091
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8I.1_pred <- predict(smile__tree_model_8I, tst_smile_boys)
summary(smile__tree_model_8I.1_pred)
```

```
## spontaneous deliberate
##           49           28
```

```
smile__tree_model_8I.1_confM <- confusionMatrix(
  smile__tree_model_8I.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8I.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous      24          25
##  deliberate       13          15
##
##               Accuracy : 0.5065
##               95% CI : (0.39, 0.6224)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.63425
##
##               Kappa : 0.0234
##
##  McNemar's Test P-Value : 0.07435
##
##      Sensitivity : 0.6486
##      Specificity : 0.3750
##      Pos Pred Value : 0.4898
##      Neg Pred Value : 0.5357
##      Prevalence : 0.4805
##      Detection Rate : 0.3117
##      Detection Prevalence : 0.6364
##      Balanced Accuracy : 0.5118
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8I.2_pred <- predict(smile__tree_model_8I, tst_smile_girls)
summary(smile__tree_model_8I.2_pred)
```

```
## spontaneous deliberate
##           43           22
```

```
smile__tree_model_8I.2_confM <- confusionMatrix(
  smile__tree_model_8I.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8I.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous      22          21
##  deliberate       11          11
##
##               Accuracy : 0.5077
##               95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
```

```
##                Kappa : 0.0105
##
## Mcnemar's Test P-Value : 0.1116
##
##          Sensitivity : 0.6667
##          Specificity : 0.3438
##          Pos Pred Value : 0.5116
##          Neg Pred Value : 0.5000
##          Prevalence : 0.5077
##          Detection Rate : 0.3385
##          Detection Prevalence : 0.6615
##          Balanced Accuracy : 0.5052
##
##          'Positive' Class : spontaneous
##
```

```
# 8J
set.seed(1973)
smile__tree_model_8J <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean + lip_mean,
method = "rpart", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__tree_model_8J$results
```

```
##          cp Accuracy      Kappa AccuracySD      KappaSD
## 1 0.03636364 0.5704267 0.14211785 0.04974950 0.09859519
## 2 0.05454545 0.5493928 0.09982095 0.04575070 0.09183336
## 3 0.18787879 0.5223708 0.04901466 0.03672728 0.07788091
```

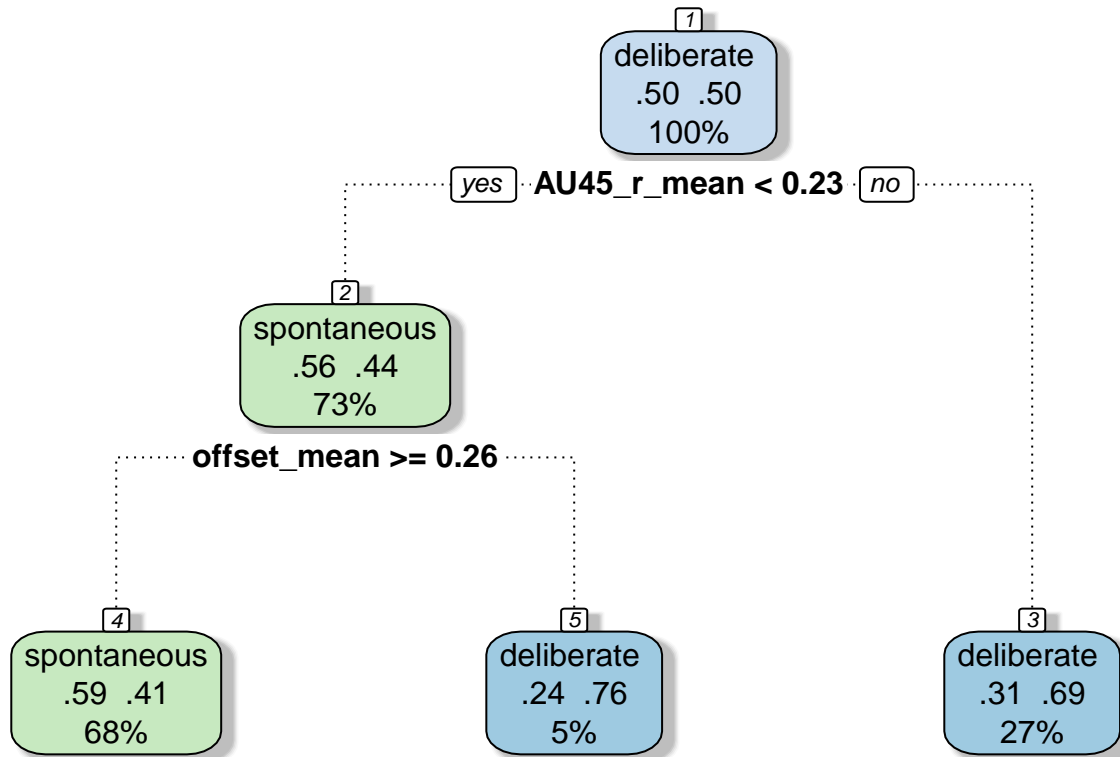
```
smile__tree_model_8J$coefnames
```

```
## [1] "AU06_r_mean" "AU12_r_mean" "AU45_r_mean" "onset_mean" "apex_mean"
## [6] "offset_mean" "lip_mean"
```

```
varImp(smile__tree_model_8J)
```

```
## rpart variable importance
##
##          Overall
## AU45_r_mean 100.00
## offset_mean  69.75
## AU06_r_mean  48.99
## onset_mean   46.87
## apex_mean    39.60
## AU12_r_mean   0.00
## lip_mean      0.00
```

```
# summary(smile__tree_model_8J$finalModel)
fancyRpartPlot(smile__tree_model_8J$finalModel)
```



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```
smile__tree_model_8J_pred <- predict(smile__tree_model_8J, tst_smile)
summary(smile__tree_model_8J_pred)
```

```
## spontaneous deliberate
##           92           50
```

```
smile__tree_model_8J_confM <- confusionMatrix(
  smile__tree_model_8J_pred,
  tst_smile$smile_type
)
smile__tree_model_8J_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction  spontaneous deliberate
##  spontaneous      46           46
##  deliberate       24           26
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
```

```
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.53358
##
##              Kappa : 0.0182
##
##  McNemar's Test P-Value : 0.01207
##
##      Sensitivity : 0.6571
##      Specificity : 0.3611
##      Pos Pred Value : 0.5000
##      Neg Pred Value : 0.5200
##      Prevalence : 0.4930
##      Detection Rate : 0.3239
##      Detection Prevalence : 0.6479
##      Balanced Accuracy : 0.5091
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__tree_model_8J.1_pred <- predict(smile__tree_model_8J, tst_smile_boys)
summary(smile__tree_model_8J.1_pred)
```

```
## spontaneous deliberate
##           49           28
```

```
smile__tree_model_8J.1_confM <- confusionMatrix(
  smile__tree_model_8J.1_pred,
  tst_smile_boys$smile_type
)
smile__tree_model_8J.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           24           25
## deliberate           13           15
##
##              Accuracy : 0.5065
##              95% CI : (0.39, 0.6224)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.63425
##
##              Kappa : 0.0234
##
##  McNemar's Test P-Value : 0.07435
##
##      Sensitivity : 0.6486
##      Specificity : 0.3750
##      Pos Pred Value : 0.4898
##      Neg Pred Value : 0.5357
```



```
##           Prevalence : 0.4805
##           Detection Rate : 0.3117
##           Detection Prevalence : 0.6364
##           Balanced Accuracy : 0.5118
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__tree_model_8J.2_pred <- predict(smile__tree_model_8J, tst_smile_girls)
summary(smile__tree_model_8J.2_pred)
```

```
## spontaneous deliberate
##           43           22
```

```
smile__tree_model_8J.2_confM <- confusionMatrix(
  smile__tree_model_8J.2_pred,
  tst_smile_girls$smile_type
)
smile__tree_model_8J.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      22           21
## deliberate       11           11
##
##           Accuracy : 0.5077
##           95% CI : (0.3807, 0.634)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.5495
##
##           Kappa : 0.0105
##
##           Mcnemar's Test P-Value : 0.1116
##
##           Sensitivity : 0.6667
##           Specificity : 0.3438
##           Pos Pred Value : 0.5116
##           Neg Pred Value : 0.5000
##           Prevalence : 0.5077
##           Detection Rate : 0.3385
##           Detection Prevalence : 0.6615
##           Balanced Accuracy : 0.5052
##
##           'Positive' Class : spontaneous
##
```

SVM complete model For SVM the kernlab package is used. The method used in the caret package is `svmlinear`. More information about the ksvm packages can be found in the citation link or ? R help function. The trained models are divided into the same eight categories as decision trees. Two additional

strong models were build for SVM. Again, multiple models per category are explored. The explanation on the categories can be found in the thesis. To train the models the `train()` function is used. The models are stored as variable. The parameter settings are explained in the thesis. The models use 10 fold cross-validation. The same pre-processing check is added to the complete model. On this first complete model, a ROC example has been visualized. As this is not an evaluation parameter in the thesis, it is not used any further. The cost function (C) is set to 1 which is the default in for this model. To visualize the trained SVM based on two features the kernlab plot is used. Some examples are displayed in the code. The `predict()` function is used to create the predictions based on the test set, and stored as variable. For model evaluation the `confusionMatrix()` function is used and printed.

```
# load packages
library(kernlab)

# set seed
set.seed(1973)

# complete model 0 with cost function set to 1 (default)
smile__svm_model_0 <- train(smile_type ~ .,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

# check different parameters of the model results
smile__svm_model_0
```

```
## Support Vector Machines with Linear Kernel
##
## 333 samples
## 32 predictor
## 2 classes: 'spontaneous', 'deliberate '
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 300, 300, 300, 299, 299, 300, ...
## Resampling results:
##
## Accuracy Kappa
## 0.7050914 0.4098127
##
## Tuning parameter 'C' was held constant at a value of 1
```

```
smile__svm_model_0$results
```

```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.7050914 0.4098127 0.1064684 0.2126184
```

```
smile__svm_model_0$resample
```

```
## Accuracy Kappa Resample
## 1 0.8181818 0.63602941 Fold01
## 2 0.7878788 0.57458564 Fold02
## 3 0.6666667 0.33394495 Fold03
```

```
## 4  0.7941176 0.58823529  Fold04
## 5  0.5294118 0.05882353  Fold05
## 6  0.7272727 0.45101664  Fold06
## 7  0.6060606 0.21284404  Fold07
## 8  0.7941176 0.58823529  Fold08
## 9  0.5625000 0.12500000  Fold09
## 10 0.7647059 0.52941176  Fold10
```

```
smile__svm_model_0$bestTune
```

```
##    C
## 1 1
```

```
# summary(smile__svm_model_0$finalModel) - not printed

# prediction on the test set and the model
smile__svm_model_0_pred <- predict(smile__svm_model_0, newdata = tst_smile)

# print prediction
summary(smile__svm_model_0_pred)
```

```
## spontaneous deliberate
##           67           75
```

```
# Evaluation of the accuracy based on the confusion matrix
smile__svm_model_0_confM <- confusionMatrix(
  smile__svm_model_0_pred,
  tst_smile$smile_type
)

# print the confusion matrix
smile__svm_model_0_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           50           17
## deliberate           20           55
##
##              Accuracy : 0.7394
##              95% CI : (0.6592, 0.8094)
##              No Information Rate : 0.507
##              P-Value [Acc > NIR] : 1.288e-08
##
##              Kappa : 0.4785
##
## Mcnemar's Test P-Value : 0.7423
##
##              Sensitivity : 0.7143
##              Specificity : 0.7639
##              Pos Pred Value : 0.7463
```

```
##          Neg Pred Value : 0.7333
##          Prevalence : 0.4930
##          Detection Rate : 0.3521
##    Detection Prevalence : 0.4718
##          Balanced Accuracy : 0.7391
##
##          'Positive' Class : spontaneous
##
```

```
# set seed
set.seed(1973)

# complete model 0 + pre-processing - outcome does not improve!
smile__svm_model_0.0.1 <- train(smile_type ~ .,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10),
  preProcess = c("center", "scale")
)
smile__svm_model_0.0.1
```

```
## Support Vector Machines with Linear Kernel
##
## 333 samples
## 32 predictor
## 2 classes: 'spontaneous', 'deliberate '
##
## Pre-processing: centered (32), scaled (32)
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 300, 300, 300, 299, 299, 300, ...
## Resampling results:
##
## Accuracy   Kappa
## 0.7050914  0.4098127
##
## Tuning parameter 'C' was held constant at a value of 1
```

```
smile__svm_model_0.0.1$results
```

```
## C Accuracy   Kappa AccuracySD   KappaSD
## 1 1 0.7050914 0.4098127 0.1064684 0.2126184
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_0.1_pred <- predict(smile__svm_model_0, tst_smile_boys)
summary(smile__svm_model_0.1_pred)
```

```
## spontaneous deliberate
##          33          44
```

```
smile__svm_model_0.1_confM <- confusionMatrix(
  smile__svm_model_0.1_pred,
  tst_smile_boys$smile_type
```

```
)
smile__svm_model_0.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      26             7
## deliberate       11            33
##
##               Accuracy : 0.7662
##               95% CI : (0.6559, 0.8552)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 7.359e-06
##
##               Kappa : 0.5299
##
## Mcnemar's Test P-Value : 0.4795
##
##       Sensitivity : 0.7027
##       Specificity : 0.8250
##       Pos Pred Value : 0.7879
##       Neg Pred Value : 0.7500
##       Prevalence : 0.4805
##       Detection Rate : 0.3377
##       Detection Prevalence : 0.4286
##       Balanced Accuracy : 0.7639
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_0.2_pred <- predict(smile__svm_model_0, tst_smile_girls)
summary(smile__svm_model_0.2_pred)
```

```
## spontaneous deliberate
##           34           31
```

```
smile__svm_model_0.2_confM <- confusionMatrix(
  smile__svm_model_0.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_0.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      24             10
## deliberate        9             22
##
##               Accuracy : 0.7077
```

```
##          95% CI : (0.5817, 0.814)
##    No Information Rate : 0.5077
##    P-Value [Acc > NIR] : 0.0008348
##
##          Kappa : 0.415
##
##    Mcnemar's Test P-Value : 1.0000000
##
##          Sensitivity : 0.7273
##          Specificity : 0.6875
##          Pos Pred Value : 0.7059
##          Neg Pred Value : 0.7097
##          Prevalence : 0.5077
##          Detection Rate : 0.3692
##    Detection Prevalence : 0.5231
##          Balanced Accuracy : 0.7074
##
##          'Positive' Class : spontaneous
##
```

```
# example ROC
```

```
# load packages
```

```
library(pROC)
```

```
# citation("pROC")
```

```
# ROC model 0
```

```
roc_0 <- roc(
  as.numeric(tst_smile$smile_type),
  as.numeric(as.factor(smile__svm_model_0_pred))
)
roc_0
```

```
##
```

```
## Call:
```

```
## roc.default(response = as.numeric(tst_smile$smile_type), predictor = as.numeric(as.factor(smile__svm_model_0_pred))
```

```
##
```

```
## Data: as.numeric(as.factor(smile__svm_model_0_pred)) in 70 controls (as.numeric(tst_smile$smile_type))
```

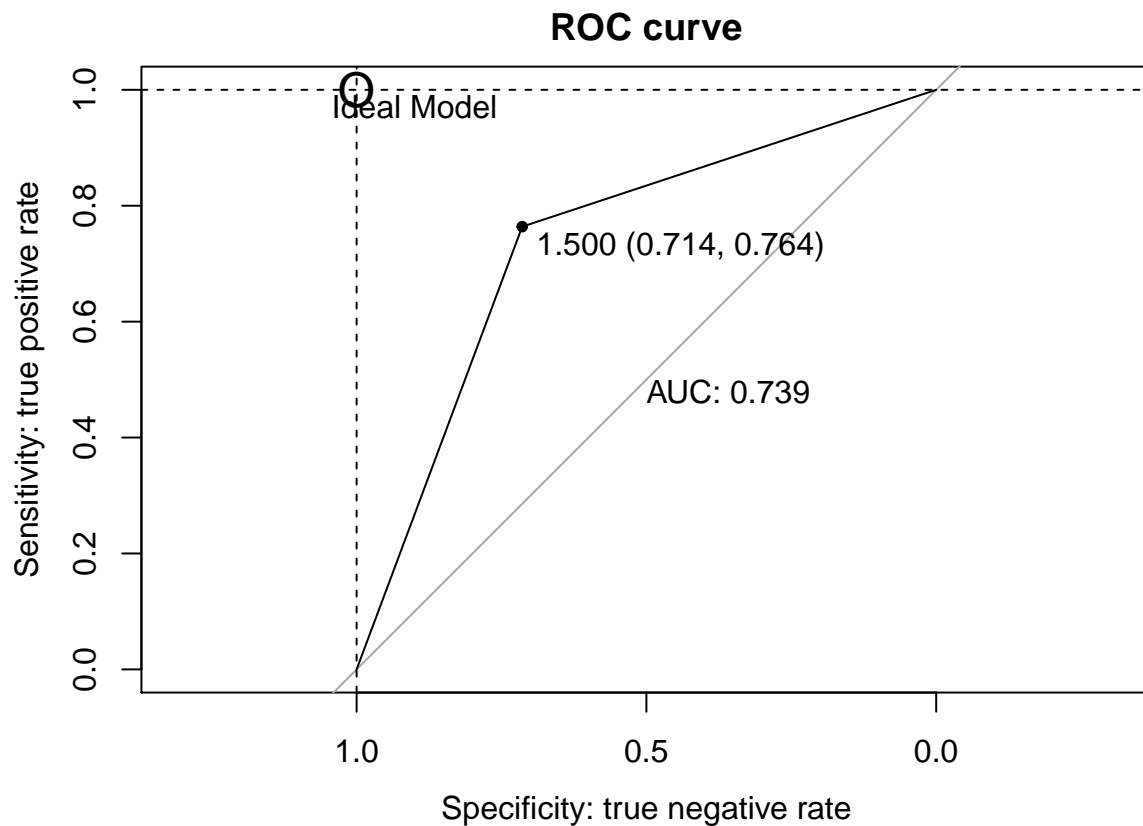
```
## Area under the curve: 0.7391
```

```
# Visualize the ROC model
```

```
par(mfrow = c(1, 1))
```

```
par(mai = c(.9, .8, .2, .2))
```

```
plot.roc(roc_0,
  print.auc = TRUE, col = "black", lwd = 1,
  main = "ROC curve", xlab = "Specificity: true negative rate",
  ylab = "Sensitivity: true positive rate",
  xlim = c(1, 0), ylim = c(0, 1), print.thres = "best"
)
abline(v = 1, lty = 2)
abline(h = 1, lty = 2)
text(.90, .97, labels = "Ideal Model")
points(1, 1, pch = "0", cex = 1.5)
```



```
# citation("kernlab")
```

```
# model 1 onset-apex-offset
set.seed(1973)
smile__svm_model_1 <- train(smile_type ~ onset_mean + offset_mean + apex_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_1$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6448362 0.2904029 0.1026657 0.2039863
```

```
smile__svm_model_1_pred <- predict(smile__svm_model_1, newdata = tst_smile)
summary(smile__svm_model_1_pred)
```

```
## spontaneous deliberate
##           76           66
```

```
smile__svm_model_1_confM <- confusionMatrix(
  smile__svm_model_1_pred,
  tst_smile$smile_type
)
smile__svm_model_1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      47             29
## deliberate       23             43
##
##               Accuracy : 0.6338
##               95% CI : (0.5489, 0.713)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.001568
##
##               Kappa : 0.2683
##
## Mcnemar's Test P-Value : 0.488074
##
##       Sensitivity : 0.6714
##       Specificity : 0.5972
##       Pos Pred Value : 0.6184
##       Neg Pred Value : 0.6515
##       Prevalence : 0.4930
##       Detection Rate : 0.3310
##       Detection Prevalence : 0.5352
##       Balanced Accuracy : 0.6343
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_1.1_pred <- predict(smile__svm_model_1, tst_smile_boys)
summary(smile__svm_model_1.1_pred)
```

```
## spontaneous deliberate
##           38           39
```

```
smile__svm_model_1.1_confM <- confusionMatrix(
  smile__svm_model_1.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_1.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      23             15
## deliberate       14             25
##
##               Accuracy : 0.6234
##               95% CI : (0.5056, 0.7313)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.04297
```



```
##
##           Kappa : 0.2464
##
## Mcnemar's Test P-Value : 1.00000
##
##           Sensitivity : 0.6216
##           Specificity : 0.6250
##           Pos Pred Value : 0.6053
##           Neg Pred Value : 0.6410
##           Prevalence : 0.4805
##           Detection Rate : 0.2987
##           Detection Prevalence : 0.4935
##           Balanced Accuracy : 0.6233
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_1.2_pred <- predict(smile__svm_model_1, tst_smile_girls)
summary(smile__svm_model_1.2_pred)
```

```
## spontaneous deliberate
##           38           27
```

```
smile__svm_model_1.2_confM <- confusionMatrix(
  smile__svm_model_1.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_1.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           24           14
## deliberate            9           18
##
##           Accuracy : 0.6462
##           95% CI : (0.5177, 0.7608)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.01698
##
##           Kappa : 0.2905
##
## Mcnemar's Test P-Value : 0.40425
##
##           Sensitivity : 0.7273
##           Specificity : 0.5625
##           Pos Pred Value : 0.6316
##           Neg Pred Value : 0.6667
##           Prevalence : 0.5077
##           Detection Rate : 0.3692
##           Detection Prevalence : 0.5846
```

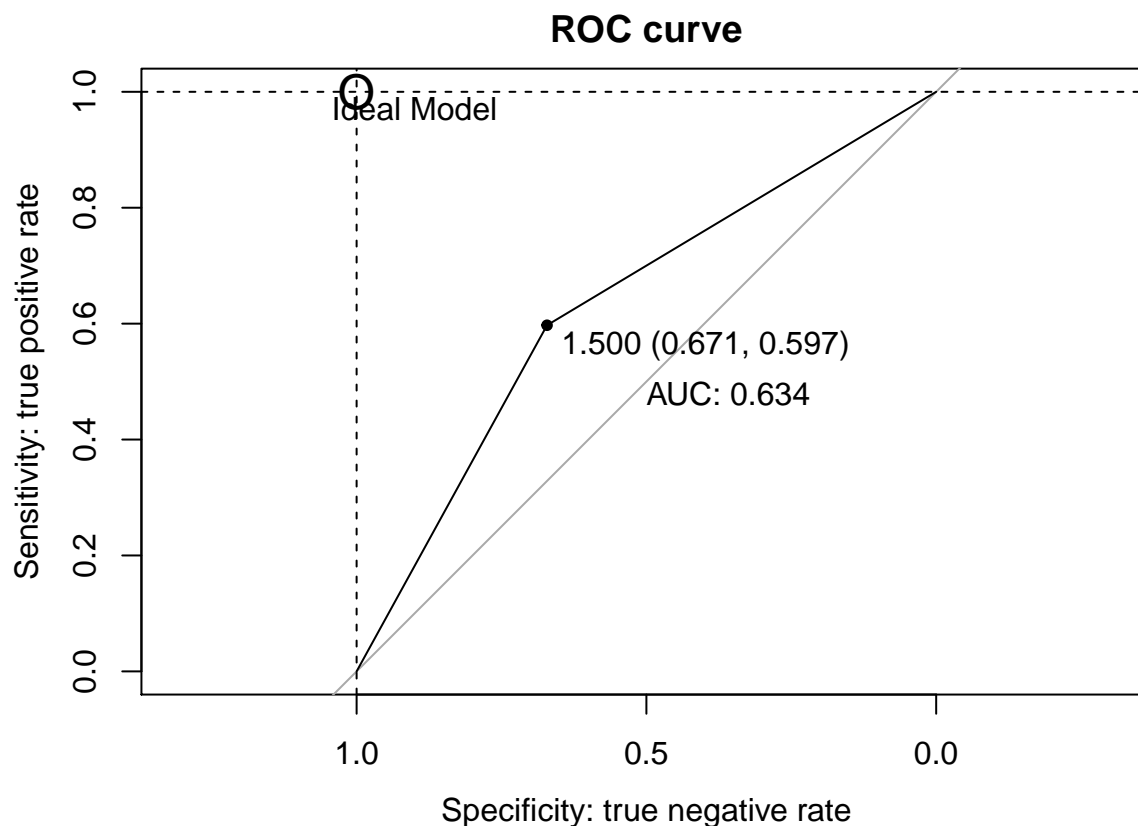
```
##      Balanced Accuracy : 0.6449
##
##      'Positive' Class : spontaneous
##
```

```
# Roc model 1
```

```
roc_1 <- roc(
  as.numeric(tst_smile$smile_type),
  as.numeric(as.factor(smile__svm_model_1_pred))
)
roc_1
```

```
##
## Call:
## roc.default(response = as.numeric(tst_smile$smile_type), predictor = as.numeric(as.factor(smile__svm_model_1_pred)),
## Data: as.numeric(as.factor(smile__svm_model_1_pred)) in 70 controls (as.numeric(tst_smile$smile_type))
## Area under the curve: 0.6343
```

```
par(mfrow = c(1, 1))
par(mai = c(.9, .8, .2, .2))
plot.roc(roc_1,
  print.auc = TRUE, col = "black", lwd = 1,
  main = "ROC curve", xlab = "Specificity: true negative rate",
  ylab = "Sensitivity: true positive rate",
  xlim = c(1, 0), ylim = c(0, 1), print.thres = "best"
)
abline(v = 1, lty = 2)
abline(h = 1, lty = 2)
text(.90, .97, labels = "Ideal Model")
points(1, 1, pch = "0", cex = 1.5)
```



```
# model 1A onset
set.seed(1973)
smile__svm_model_1A <- train(smile_type ~ onset_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_1A$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.4977607 -0.0005964829 0.07121788 0.1409985
```

```
smile__svm_model_1A_pred <- predict(smile__svm_model_1A, newdata = tst_smile)
summary(smile__svm_model_1A_pred)
```

```
## spontaneous deliberate
##           72           70
```

```
smile__svm_model_1A_confM <- confusionMatrix(
  smile__svm_model_1A_pred,
  tst_smile$smile_type
)
smile__svm_model_1A_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      42           30
## deliberate       28           42
##
##           Accuracy : 0.5915
##           95% CI : (0.506, 0.6732)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 0.02653
##
##           Kappa : 0.1833
##
## Mcnemar's Test P-Value : 0.89553
##
##           Sensitivity : 0.6000
##           Specificity : 0.5833
##           Pos Pred Value : 0.5833
##           Neg Pred Value : 0.6000
##           Prevalence : 0.4930
##           Detection Rate : 0.2958
##           Detection Prevalence : 0.5070
##           Balanced Accuracy : 0.5917
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_1A.1_pred <- predict(smile__svm_model_1A, tst_smile_boys)
summary(smile__svm_model_1A.1_pred)
```

```
## spontaneous deliberate
##           37           40
```

```
smile__svm_model_1A.1_confM <- confusionMatrix(
  smile__svm_model_1A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_1A.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      21           16
## deliberate       16           24
##
##           Accuracy : 0.5844
##           95% CI : (0.4664, 0.6957)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.1523
##
```

```
##                Kappa : 0.1676
##
## Mcnemar's Test P-Value : 1.0000
##
##          Sensitivity : 0.5676
##          Specificity : 0.6000
##          Pos Pred Value : 0.5676
##          Neg Pred Value : 0.6000
##          Prevalence : 0.4805
##          Detection Rate : 0.2727
##          Detection Prevalence : 0.4805
##          Balanced Accuracy : 0.5838
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_1A.2_pred <- predict(smile__svm_model_1A, tst_smile_girls)
summary(smile__svm_model_1A.2_pred)
```

```
## spontaneous deliberate
##          35          30
```

```
smile__svm_model_1A.2_confM <- confusionMatrix(
  smile__svm_model_1A.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_1A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          21          14
## deliberate          12          18
##
##          Accuracy : 0.6
##          95% CI : (0.471, 0.7196)
##          No Information Rate : 0.5077
##          P-Value [Acc > NIR] : 0.08588
##
##          Kappa : 0.1991
##
## Mcnemar's Test P-Value : 0.84452
##
##          Sensitivity : 0.6364
##          Specificity : 0.5625
##          Pos Pred Value : 0.6000
##          Neg Pred Value : 0.6000
##          Prevalence : 0.5077
##          Detection Rate : 0.3231
##          Detection Prevalence : 0.5385
##          Balanced Accuracy : 0.5994
```

```
##
##      'Positive' Class : spontaneous
##
```

```
# model 1B apex
set.seed(1973)
smile__svm_model_1B <- train(smile_type ~ apex_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_1B$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5408422 0.0803652 0.07503868 0.1492659
```

```
smile__svm_model_1B_pred <- predict(smile__svm_model_1B, newdata = tst_smile)
summary(smile__svm_model_1B_pred)
```

```
## spontaneous deliberate
##           57           85
```

```
smile__svm_model_1B_confM <- confusionMatrix(
  smile__svm_model_1B_pred,
  tst_smile$smile_type
)
smile__svm_model_1B_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      26           31
## deliberate      44           41
##
##              Accuracy : 0.4718
##              95% CI : (0.3876, 0.5573)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.8220
##
##              Kappa : -0.0593
##
## Mcnemar's Test P-Value : 0.1659
##
##              Sensitivity : 0.3714
##              Specificity : 0.5694
##      Pos Pred Value : 0.4561
##      Neg Pred Value : 0.4824
##      Prevalence : 0.4930
##      Detection Rate : 0.1831
##      Detection Prevalence : 0.4014
##      Balanced Accuracy : 0.4704
##
```

```
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_1B.1_pred <- predict(smile__svm_model_1B, tst_smile_boys)
summary(smile__svm_model_1B.1_pred)
```

```
## spontaneous deliberate
##          31          46
```

```
smile__svm_model_1B.1_confM <- confusionMatrix(
  smile__svm_model_1B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_1B.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          15          16
## deliberate          22          24
##
##              Accuracy : 0.5065
##              95% CI : (0.39, 0.6224)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.6342
##
##              Kappa : 0.0054
##
## Mcnemar's Test P-Value : 0.4173
##
##              Sensitivity : 0.4054
##              Specificity : 0.6000
##              Pos Pred Value : 0.4839
##              Neg Pred Value : 0.5217
##              Prevalence : 0.4805
##              Detection Rate : 0.1948
##      Detection Prevalence : 0.4026
##              Balanced Accuracy : 0.5027
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_1B.2_pred <- predict(smile__svm_model_1B, tst_smile_girls)
summary(smile__svm_model_1B.2_pred)
```

```
## spontaneous deliberate
##          26          39
```

```
smile__svm_model_1B.2_confM <- confusionMatrix(
  smile__svm_model_1B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_1B.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      11             15
## deliberate       22             17
##
##              Accuracy : 0.4308
##              95% CI : (0.3085, 0.5596)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.9139
##
##              Kappa : -0.135
##
##  Mcnemar's Test P-Value : 0.3239
##
##      Sensitivity : 0.3333
##      Specificity : 0.5312
##      Pos Pred Value : 0.4231
##      Neg Pred Value : 0.4359
##      Prevalence : 0.5077
##      Detection Rate : 0.1692
##      Detection Prevalence : 0.4000
##      Balanced Accuracy : 0.4323
##
##      'Positive' Class : spontaneous
##
```

```
# model 1C offset
set.seed(1973)
smile__svm_model_1C <- train(smile_type ~ offset_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_1C$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5464294 0.09219777 0.05082367 0.1022998
```

```
smile__svm_model_1C_pred <- predict(smile__svm_model_1C, newdata = tst_smile)
summary(smile__svm_model_1C_pred)
```

```
## spontaneous deliberate
##              76              66
```



```
smile__svm_model_1C_confM <- confusionMatrix(
  smile__svm_model_1C_pred,
  tst_smile$smile_type
)
smile__svm_model_1C_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      45          31
## deliberate       25          41
##
##              Accuracy : 0.6056
##              95% CI : (0.5202, 0.6865)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.01151
##
##              Kappa : 0.212
##
##  Mcnemar's Test P-Value : 0.50404
##
##              Sensitivity : 0.6429
##              Specificity : 0.5694
##              Pos Pred Value : 0.5921
##              Neg Pred Value : 0.6212
##              Prevalence : 0.4930
##              Detection Rate : 0.3169
##      Detection Prevalence : 0.5352
##              Balanced Accuracy : 0.6062
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_1C.1_pred <- predict(smile__svm_model_1C, tst_smile_boys)
summary(smile__svm_model_1C.1_pred)
```

```
## spontaneous deliberate
##              40          37
```

```
smile__svm_model_1C.1_confM <- confusionMatrix(
  smile__svm_model_1C.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_1C.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      22      18
##      deliberate      15      22
##
##              Accuracy : 0.5714
##              95% CI : (0.4535, 0.6837)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.2126
##
##              Kappa : 0.1442
##
##      McNemar's Test P-Value : 0.7277
##
##              Sensitivity : 0.5946
##              Specificity : 0.5500
##              Pos Pred Value : 0.5500
##              Neg Pred Value : 0.5946
##              Prevalence : 0.4805
##              Detection Rate : 0.2857
##      Detection Prevalence : 0.5195
##              Balanced Accuracy : 0.5723
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_1C.2_pred <- predict(smile__svm_model_1C, tst_smile_girls)
summary(smile__svm_model_1C.2_pred)
```

```
## spontaneous deliberate
##           36           29
```

```
smile__svm_model_1C.2_confM <- confusionMatrix(
  smile__svm_model_1C.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_1C.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      23      13
##      deliberate      10      19
##
##              Accuracy : 0.6462
##              95% CI : (0.5177, 0.7608)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.01698
##
##              Kappa : 0.2911
##
##      McNemar's Test P-Value : 0.67666
##
```

```
##           Sensitivity : 0.6970
##           Specificity : 0.5938
##           Pos Pred Value : 0.6389
##           Neg Pred Value : 0.6552
##           Prevalence : 0.5077
##           Detection Rate : 0.3538
##           Detection Prevalence : 0.5538
##           Balanced Accuracy : 0.6454
##
##           'Positive' Class : spontaneous
##
```

```
# model 2 complete excluding subject info
set.seed(1973)
smile__svm_model_2 <- train(smile_type ~ . - subject - age,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10),
)

smile__svm_model_2$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.728799 0.4571015 0.1104272 0.2212161
```

```
smile__svm_model_2_pred <- predict(smile__svm_model_2, tst_smile)
summary(smile__svm_model_2_pred)
```

```
## spontaneous deliberate
##           61           81
```

```
smile__tree_svm_2_confM <- confusionMatrix(
  smile__svm_model_2_pred,
  tst_smile$smile_type
)
smile__tree_svm_2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous          44          17
##  deliberate           26          55
##
##           Accuracy : 0.6972
##           95% CI : (0.6145, 0.7714)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 3.274e-06
##
##           Kappa : 0.3932
##
##  Mcnemar's Test P-Value : 0.2225
##
```

```
##           Sensitivity : 0.6286
##           Specificity : 0.7639
##           Pos Pred Value : 0.7213
##           Neg Pred Value : 0.6790
##           Prevalence : 0.4930
##           Detection Rate : 0.3099
##           Detection Prevalence : 0.4296
##           Balanced Accuracy : 0.6962
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_2.1_pred <- predict(smile__svm_model_2, tst_smile_boys)
summary(smile__svm_model_2.1_pred)
```

```
## spontaneous deliberate
##           28           49
```

```
smile__svm_model_2.1_confM <- confusionMatrix(
  smile__svm_model_2.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_2.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           22           6
## deliberate           15           34
##
##           Accuracy : 0.7273
##           95% CI : (0.6138, 0.8226)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.0001583
##
##           Kappa : 0.4487
##
## Mcnemar's Test P-Value : 0.0808556
##
##           Sensitivity : 0.5946
##           Specificity : 0.8500
##           Pos Pred Value : 0.7857
##           Neg Pred Value : 0.6939
##           Prevalence : 0.4805
##           Detection Rate : 0.2857
##           Detection Prevalence : 0.3636
##           Balanced Accuracy : 0.7223
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_2.2_pred <- predict(smile__svm_model_2, tst_smile_girls)
summary(smile__svm_model_2.2_pred)
```

```
## spontaneous deliberate
##           33           32
```

```
smile__svm_model_2.2_confM <- confusionMatrix(
  smile__svm_model_2.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_2.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      22           11
## deliberate       11           21
##
##              Accuracy : 0.6615
##              95% CI : (0.5335, 0.7743)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.008794
##
##              Kappa : 0.3229
##
##  Mcnemar's Test P-Value : 1.000000
##
##      Sensitivity : 0.6667
##      Specificity : 0.6562
##      Pos Pred Value : 0.6667
##      Neg Pred Value : 0.6562
##      Prevalence : 0.5077
##      Detection Rate : 0.3385
##      Detection Prevalence : 0.5077
##      Balanced Accuracy : 0.6615
##
##      'Positive' Class : spontaneous
##
```

```
# model 3 complete lip and eye features
set.seed(1973)
smile__svm_model_3 <- train(smile_type ~ lip_mean + eye_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

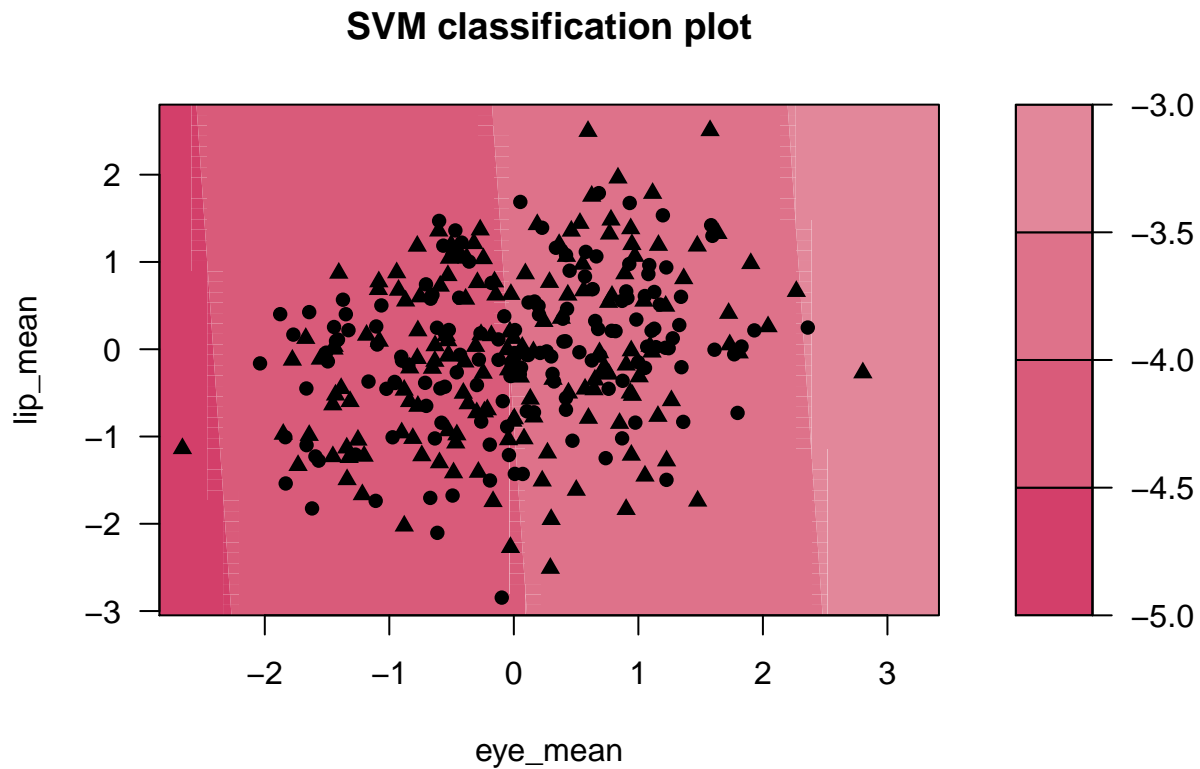
smile__svm_model_3$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5143661 0.02580907 0.08044698 0.1609386
```

```
summary(smile__svm_model_3$finalModel)
```

```
## Length Class Mode  
##      1   ksvm   S4
```

```
kernlab::plot(smile__svm_model_3$finalModel)
```



```
smile__svm_model_3_pred <- predict(smile__svm_model_3, tst_smile)  
summary(smile__svm_model_3_pred)
```

```
## spontaneous deliberate  
##           55           87
```

```
smile__svm_model_3_confM <- confusionMatrix(  
  smile__svm_model_3_pred,  
  tst_smile$smile_type  
)  
smile__svm_model_3_confM
```

```
## Confusion Matrix and Statistics  
##  
##           Reference  
## Prediction   spontaneous deliberate
```

```
##      spontaneous      31      24
##      deliberate      39      48
##
##              Accuracy : 0.5563
##              95% CI : (0.4707, 0.6396)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.13758
##
##              Kappa : 0.1099
##
##      McNemar's Test P-Value : 0.07776
##
##              Sensitivity : 0.4429
##              Specificity : 0.6667
##      Pos Pred Value : 0.5636
##      Neg Pred Value : 0.5517
##      Prevalence : 0.4930
##      Detection Rate : 0.2183
##      Detection Prevalence : 0.3873
##      Balanced Accuracy : 0.5548
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_3.1_pred <- predict(smile__svm_model_3, tst_smile_boys)
summary(smile__svm_model_3.1_pred)
```

```
## spontaneous deliberate
##           28           49
```

```
smile__svm_model_3.1_confM <- confusionMatrix(
  smile__svm_model_3.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_3.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      17      11
##      deliberate      20      29
##
##              Accuracy : 0.5974
##              95% CI : (0.4794, 0.7077)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1045
##
##              Kappa : 0.1862
##
##      McNemar's Test P-Value : 0.1508
```

```
##
##          Sensitivity : 0.4595
##          Specificity : 0.7250
##          Pos Pred Value : 0.6071
##          Neg Pred Value : 0.5918
##          Prevalence : 0.4805
##          Detection Rate : 0.2208
##          Detection Prevalence : 0.3636
##          Balanced Accuracy : 0.5922
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_3.2_pred <- predict(smile__svm_model_3, tst_smile_girls)
summary(smile__svm_model_3.2_pred)
```

```
## spontaneous deliberate
##          27          38
```

```
smile__svm_model_3.2_confM <- confusionMatrix(
  smile__svm_model_3.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_3.2_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
##  spontaneous          14          13
##  deliberate           19          19
##
##          Accuracy : 0.5077
##          95% CI : (0.3807, 0.634)
##          No Information Rate : 0.5077
##          P-Value [Acc > NIR] : 0.5495
##
##          Kappa : 0.0179
##
##  McNemar's Test P-Value : 0.3768
##
##          Sensitivity : 0.4242
##          Specificity : 0.5938
##          Pos Pred Value : 0.5185
##          Neg Pred Value : 0.5000
##          Prevalence : 0.5077
##          Detection Rate : 0.2154
##          Detection Prevalence : 0.4154
##          Balanced Accuracy : 0.5090
##
##          'Positive' Class : spontaneous
##
```



```
# model 3A complete lip and eye features
set.seed(1973)
smile__svm_model_3A <- train(smile_type ~ lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_3A$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5262255 0.05020194 0.08590419 0.1693449
```

```
summary(smile__svm_model_3A$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_3A_pred <- predict(smile__svm_model_3A, tst_smile)
summary(smile__svm_model_3A_pred)
```

```
## spontaneous deliberate
##           46           96
```

```
smile__svm_model_3A_confM <- confusionMatrix(
  smile__svm_model_3A_pred,
  tst_smile$smile_type
)
smile__svm_model_3A_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          23           23
## deliberate          47           49
##
##              Accuracy : 0.507
##              95% CI : (0.4219, 0.5919)
##              No Information Rate : 0.507
##              P-Value [Acc > NIR] : 0.533579
##
##              Kappa : 0.0092
##
## Mcnemar's Test P-Value : 0.005977
##
##              Sensitivity : 0.3286
##              Specificity : 0.6806
##              Pos Pred Value : 0.5000
##              Neg Pred Value : 0.5104
##              Prevalence : 0.4930
##              Detection Rate : 0.1620
```

```
## Detection Prevalence : 0.3239
## Balanced Accuracy : 0.5046
##
## 'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_3A.1_pred <- predict(smile__svm_model_3A, tst_smile_boys)
summary(smile__svm_model_3A.1_pred)
```

```
## spontaneous deliberate
## 24 53
```

```
smile__svm_model_3A.1_confM <- confusionMatrix(
  smile__svm_model_3A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_3A.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      13          11
## deliberate       24          29
##
##              Accuracy : 0.5455
##              95% CI : (0.4279, 0.6594)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.36674
##
##              Kappa : 0.0774
##
## Mcnemar's Test P-Value : 0.04252
##
##      Sensitivity : 0.3514
##      Specificity : 0.7250
##      Pos Pred Value : 0.5417
##      Neg Pred Value : 0.5472
##      Prevalence : 0.4805
##      Detection Rate : 0.1688
##      Detection Prevalence : 0.3117
##      Balanced Accuracy : 0.5382
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_3A.2_pred <- predict(smile__svm_model_3A, tst_smile_girls)
summary(smile__svm_model_3A.2_pred)
```

```
## spontaneous deliberate
##           22           43
```

```
smile__svm_model_3A.2_confM <- confusionMatrix(
  smile__svm_model_3A.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_3A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction      spontaneous deliberate
## spontaneous           10           12
## deliberate           23           20
##
##              Accuracy : 0.4615
##              95% CI : (0.337, 0.5897)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.80736
##
##              Kappa : -0.0716
##
##  Mcnemar's Test P-Value : 0.09097
##
##      Sensitivity : 0.3030
##      Specificity : 0.6250
##      Pos Pred Value : 0.4545
##      Neg Pred Value : 0.4651
##      Prevalence : 0.5077
##      Detection Rate : 0.1538
##      Detection Prevalence : 0.3385
##      Balanced Accuracy : 0.4640
##
##      'Positive' Class : spontaneous
##
```

```
# model 3B eye
set.seed(1973)
smile__svm_model_3B <- train(smile_type ~ eye_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_3B$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5529523 0.1030544 0.09511338 0.1911904
```

```
summary(smile__svm_model_3B$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_3B_pred <- predict(smile__svm_model_3B, tst_smile)
summary(smile__svm_model_3B_pred)
```

```
## spontaneous deliberate
##           50           92
```

```
smile__svm_model_3B_confM <- confusionMatrix(
  smile__svm_model_3B_pred,
  tst_smile$smile_type
)
smile__svm_model_3B_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           30           20
## deliberate           40           52
##
##              Accuracy : 0.5775
##              95% CI : (0.4918, 0.6598)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.05517
##
##              Kappa : 0.1514
##
##  Mcnemar's Test P-Value : 0.01417
##
##      Sensitivity : 0.4286
##      Specificity : 0.7222
##      Pos Pred Value : 0.6000
##      Neg Pred Value : 0.5652
##      Prevalence : 0.4930
##      Detection Rate : 0.2113
##      Detection Prevalence : 0.3521
##      Balanced Accuracy : 0.5754
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_3B.1_pred <- predict(smile__svm_model_3B, tst_smile_boys)
summary(smile__svm_model_3B.1_pred)
```

```
## spontaneous deliberate
##           26           51
```

```
smile__svm_model_3B.1_confM <- confusionMatrix(
  smile__svm_model_3B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_3B.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      16             10
## deliberate       21             30
##
##               Accuracy : 0.5974
##               95% CI : (0.4794, 0.7077)
##               No Information Rate : 0.5195
##               P-Value [Acc > NIR] : 0.10453
##
##               Kappa : 0.1845
##
## Mcnemar's Test P-Value : 0.07249
##
##               Sensitivity : 0.4324
##               Specificity : 0.7500
##               Pos Pred Value : 0.6154
##               Neg Pred Value : 0.5882
##               Prevalence : 0.4805
##               Detection Rate : 0.2078
##               Detection Prevalence : 0.3377
##               Balanced Accuracy : 0.5912
##
##               'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_3B.2_pred <- predict(smile__svm_model_3B, tst_smile_girls)
summary(smile__svm_model_3B.2_pred)
```

```
## spontaneous deliberate
##           24           41
```

```
smile__svm_model_3B.2_confM <- confusionMatrix(
  smile__svm_model_3B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_3B.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      14             10
## deliberate       19             22
##
##               Accuracy : 0.5538
##               95% CI : (0.4253, 0.6773)
##               No Information Rate : 0.5077
##               P-Value [Acc > NIR] : 0.2678
##
```

```
##                Kappa : 0.1113
##
## Mcnemar's Test P-Value : 0.1374
##
##          Sensitivity : 0.4242
##          Specificity : 0.6875
##          Pos Pred Value : 0.5833
##          Neg Pred Value : 0.5366
##          Prevalence : 0.5077
##          Detection Rate : 0.2154
##          Detection Prevalence : 0.3692
##          Balanced Accuracy : 0.5559
##
##          'Positive' Class : spontaneous
##
```

```
# model 3C lip
set.seed(1973)
smile__svm_model_3C <- train(smile_type ~ eye_mean + lip_mean + amplitude_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_3C$results
```

```
## C Accuracy      Kappa AccuracySD   KappaSD
## 1 1 0.5143661 0.02580907 0.08044698 0.1609386
```

```
summary(smile__svm_model_3C$finalModel)
```

```
## Length Class    Mode
##      1   ksvm     S4
```

```
smile__svm_model_3C_pred <- predict(smile__svm_model_3C, tst_smile)
summary(smile__svm_model_3C_pred)
```

```
## spontaneous deliberate
##           55           87
```

```
smile__svm_model_3C_confM <- confusionMatrix(
  smile__svm_model_3C_pred,
  tst_smile$smile_type
)
smile__svm_model_3C_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction   spontaneous deliberate
## spontaneous          31           24
## deliberate           39           48
```

```
##
##          Accuracy : 0.5563
##          95% CI : (0.4707, 0.6396)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.13758
##
##          Kappa : 0.1099
##
##    McNemar's Test P-Value : 0.07776
##
##          Sensitivity : 0.4429
##          Specificity : 0.6667
##    Pos Pred Value : 0.5636
##    Neg Pred Value : 0.5517
##    Prevalence : 0.4930
##    Detection Rate : 0.2183
##    Detection Prevalence : 0.3873
##    Balanced Accuracy : 0.5548
##
##    'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_3C.1_pred <- predict(smile__svm_model_3C, tst_smile_boys)
summary(smile__svm_model_3C.1_pred)
```

```
## spontaneous deliberate
##          28          49
```

```
smile__svm_model_3C.1_confM <- confusionMatrix(
  smile__svm_model_3C.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_3C.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
##  spontaneous          17          11
##  deliberate           20          29
##
##          Accuracy : 0.5974
##          95% CI : (0.4794, 0.7077)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.1045
##
##          Kappa : 0.1862
##
##    McNemar's Test P-Value : 0.1508
##
##          Sensitivity : 0.4595
```

```
##           Specificity : 0.7250
##           Pos Pred Value : 0.6071
##           Neg Pred Value : 0.5918
##           Prevalence : 0.4805
##           Detection Rate : 0.2208
##           Detection Prevalence : 0.3636
##           Balanced Accuracy : 0.5922
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_3C.2_pred <- predict(smile__svm_model_3C, tst_smile_girls)
summary(smile__svm_model_3C.2_pred)
```

```
## spontaneous deliberate
##           27           38
```

```
smile__svm_model_3C.2_confM <- confusionMatrix(
  smile__svm_model_3C.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_3C.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           14           13
## deliberate            19           19
##
##           Accuracy : 0.5077
##           95% CI : (0.3807, 0.634)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.5495
##
##           Kappa : 0.0179
##
## Mcnemar's Test P-Value : 0.3768
##
##           Sensitivity : 0.4242
##           Specificity : 0.5938
##           Pos Pred Value : 0.5185
##           Neg Pred Value : 0.5000
##           Prevalence : 0.5077
##           Detection Rate : 0.2154
##           Detection Prevalence : 0.4154
##           Balanced Accuracy : 0.5090
##
##           'Positive' Class : spontaneous
##
```



```
# model 4 AU features
set.seed(1973)
smile__svm_model_4 <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_4$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6932765 0.3879683 0.1209849 0.2395002
```

```
summary(smile__svm_model_4$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_4_pred <- predict(smile__svm_model_4, tst_smile)
summary(smile__svm_model_4_pred)
```

```
## spontaneous deliberate
##           60           82
```

```
smile__svm_model_4_confM <- confusionMatrix(
  smile__svm_model_4_pred,
  tst_smile$smile_type
)
smile__svm_model_4_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      35             25
## deliberate       35             47
##
##              Accuracy : 0.5775
##              95% CI : (0.4918, 0.6598)
##              No Information Rate : 0.507
##              P-Value [Acc > NIR] : 0.05517
##
##              Kappa : 0.1531
##
## Mcnemar's Test P-Value : 0.24528
##
##              Sensitivity : 0.5000
```

```
##           Specificity : 0.6528
##           Pos Pred Value : 0.5833
##           Neg Pred Value : 0.5732
##           Prevalence : 0.4930
##           Detection Rate : 0.2465
##           Detection Prevalence : 0.4225
##           Balanced Accuracy : 0.5764
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4.1_pred <- predict(smile__svm_model_4, tst_smile_boys)
summary(smile__svm_model_4.1_pred)
```

```
## spontaneous deliberate
##           34           43
```

```
smile__svm_model_4.1_confM <- confusionMatrix(
  smile__svm_model_4.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           21           13
## deliberate           16           27
##
##           Accuracy : 0.6234
##           95% CI : (0.5056, 0.7313)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.04297
##
##           Kappa : 0.2433
##
##           Mcnemar's Test P-Value : 0.71035
##
##           Sensitivity : 0.5676
##           Specificity : 0.6750
##           Pos Pred Value : 0.6176
##           Neg Pred Value : 0.6279
##           Prevalence : 0.4805
##           Detection Rate : 0.2727
##           Detection Prevalence : 0.4416
##           Balanced Accuracy : 0.6213
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4.2_pred <- predict(smile__svm_model_4, tst_smile_girls)
summary(smile__svm_model_4.2_pred)
```

```
## spontaneous deliberate
##          26          39
```

```
smile__svm_model_4.2_confM <- confusionMatrix(
  smile__svm_model_4.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous          14           12
## deliberate           19           20
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.4510
##
##              Kappa : 0.0491
##
##  Mcnemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.4242
##              Specificity : 0.6250
##      Pos Pred Value : 0.5385
##      Neg Pred Value : 0.5128
##      Prevalence : 0.5077
##      Detection Rate : 0.2154
##      Detection Prevalence : 0.4000
##      Balanced Accuracy : 0.5246
##
##      'Positive' Class : spontaneous
##
```

```
# model 4A AU happiness model
set.seed(1973)
smile__svm_model_4A <- train(smile_type ~ AU06_r_mean + AU12_r_mean,
  method = "svmLinear",
  data = trn_smile,
  trControl = trainControl(
    method = "cv",
    number = 10
  )
)

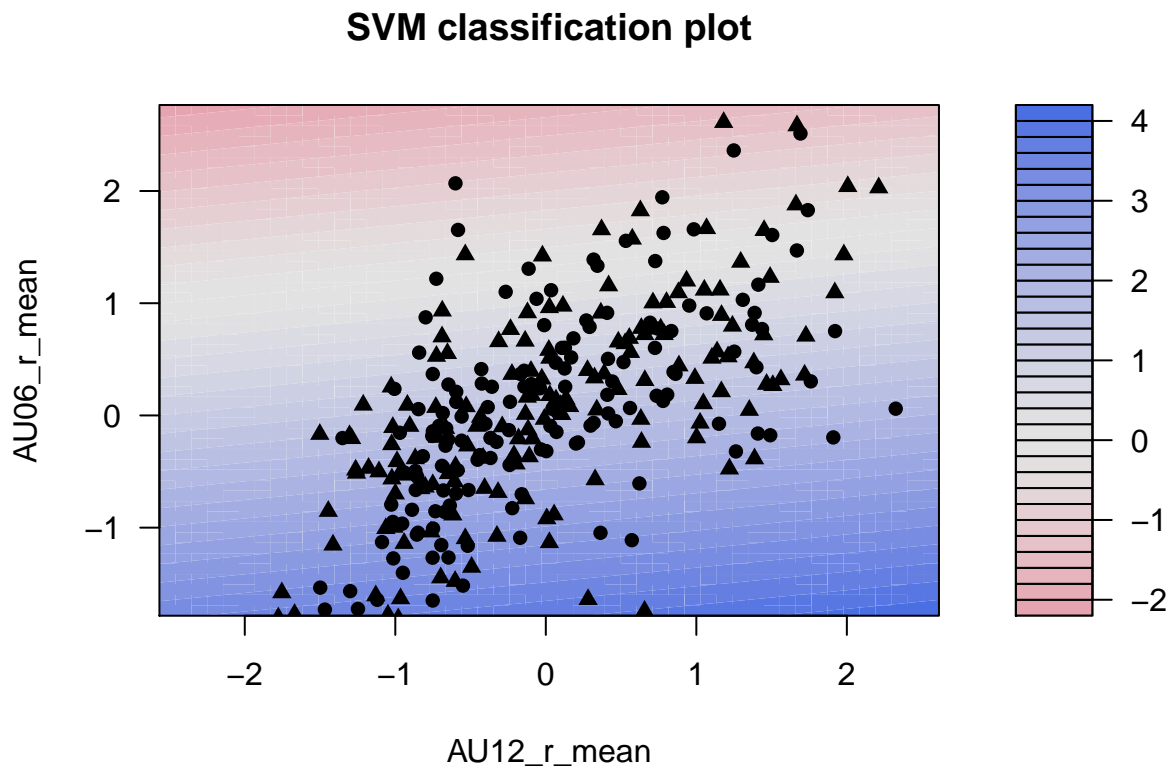
smile__svm_model_4A$results
```

```
## C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5249387 0.04894662 0.07451885 0.1516131
```

```
summary(smile__svm_model_4A$finalModel)
```

```
## Length Class      Mode
##      1    ksvm      S4
```

```
kernlab::plot(smile__svm_model_4A$finalModel, xlab = "AU12", ylab = "AU06")
```



```
smile__svm_model_4A_pred <- predict(smile__svm_model_4A, tst_smile)
summary(smile__svm_model_4A_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__svm_model_4A_confM <- confusionMatrix(
  smile__svm_model_4A_pred,
  tst_smile$smile_type
)
smile__svm_model_4A_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      23          18
##  deliberate      47          54
##
##           Accuracy : 0.5423
##           95% CI : (0.4567, 0.6261)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.2251326
##
##           Kappa : 0.079
##
## Mcnemar's Test P-Value : 0.0005147
##
##           Sensitivity : 0.3286
##           Specificity : 0.7500
##           Pos Pred Value : 0.5610
##           Neg Pred Value : 0.5347
##           Prevalence : 0.4930
##           Detection Rate : 0.1620
##    Detection Prevalence : 0.2887
##           Balanced Accuracy : 0.5393
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4A.1_pred <- predict(smile__svm_model_4A, tst_smile_boys)
summary(smile__svm_model_4A.1_pred)
```

```
## spontaneous deliberate
##           17          60
```

```
smile__svm_model_4A.1_confM <- confusionMatrix(
  smile__svm_model_4A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4A.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      10          7
##  deliberate      27          33
##
##           Accuracy : 0.5584
##           95% CI : (0.4407, 0.6716)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.28475
##
```

```
##                Kappa : 0.0972
##
## Mcnemar's Test P-Value : 0.00112
##
##          Sensitivity : 0.2703
##          Specificity : 0.8250
##          Pos Pred Value : 0.5882
##          Neg Pred Value : 0.5500
##          Prevalence : 0.4805
##          Detection Rate : 0.1299
##          Detection Prevalence : 0.2208
##          Balanced Accuracy : 0.5476
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4A.2_pred <- predict(smile__svm_model_4A, tst_smile_girls)
summary(smile__svm_model_4A.2_pred)
```

```
## spontaneous deliberate
##          24          41
```

```
smile__svm_model_4A.2_confM <- confusionMatrix(
  smile__svm_model_4A.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          13          11
## deliberate           20          21
##
##          Accuracy : 0.5231
##          95% CI : (0.3954, 0.6485)
##          No Information Rate : 0.5077
##          P-Value [Acc > NIR] : 0.4510
##
##          Kappa : 0.05
##
## Mcnemar's Test P-Value : 0.1508
##
##          Sensitivity : 0.3939
##          Specificity : 0.6562
##          Pos Pred Value : 0.5417
##          Neg Pred Value : 0.5122
##          Prevalence : 0.5077
##          Detection Rate : 0.2000
##          Detection Prevalence : 0.3692
##          Balanced Accuracy : 0.5251
```

```
##
##      'Positive' Class : spontaneous
##
```

```
# model 4B AU best model
set.seed(1973)
smile__svm_model_4B <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean,
method = "svmLinear",
data = trn_smile,
trControl = trainControl(
  method = "cv",
  number = 10
)
)

smile__svm_model_4B$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6304089 0.2607284 0.05916065 0.1174346
```

```
summary(smile__svm_model_4B$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_4B_pred <- predict(smile__svm_model_4B, tst_smile)
summary(smile__svm_model_4B_pred)
```

```
## spontaneous deliberate
##           63           79
```

```
smile__svm_model_4B_confM <- confusionMatrix(
  smile__svm_model_4B_pred,
  tst_smile$smile_type
)
smile__svm_model_4B_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction  spontaneous deliberate
##  spontaneous          41          22
##  deliberate           29          50
##
##              Accuracy : 0.6408
##              95% CI : (0.5561, 0.7196)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0008891
##
##              Kappa : 0.2805
```

```
##
## McNemar's Test P-Value : 0.4008142
##
##           Sensitivity : 0.5857
##           Specificity : 0.6944
##           Pos Pred Value : 0.6508
##           Neg Pred Value : 0.6329
##           Prevalence : 0.4930
##           Detection Rate : 0.2887
##           Detection Prevalence : 0.4437
##           Balanced Accuracy : 0.6401
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4B.1_pred <- predict(smile__svm_model_4B, tst_smile_boys)
summary(smile__svm_model_4B.1_pred)
```

```
## spontaneous deliberate
##           26           51
```

```
smile__svm_model_4B.1_confM <- confusionMatrix(
  smile__svm_model_4B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4B.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           20           6
## deliberate           17           34
##
##           Accuracy : 0.7013
##           95% CI : (0.5862, 0.8003)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.0008966
##
##           Kappa : 0.3949
##
## McNemar's Test P-Value : 0.0370562
##
##           Sensitivity : 0.5405
##           Specificity : 0.8500
##           Pos Pred Value : 0.7692
##           Neg Pred Value : 0.6667
##           Prevalence : 0.4805
##           Detection Rate : 0.2597
##           Detection Prevalence : 0.3377
##           Balanced Accuracy : 0.6953
```



```
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4B.2_pred <- predict(smile__svm_model_4B, tst_smile_girls)
summary(smile__svm_model_4B.2_pred)
```

```
## spontaneous deliberate
##      37      28
```

```
smile__svm_model_4B.2_confM <- confusionMatrix(
  smile__svm_model_4B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4B.2_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21          16
## deliberate       12          16
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.1927
##
##              Kappa : 0.1366
##
## Mcnemar's Test P-Value : 0.5708
##
##      Sensitivity : 0.6364
##      Specificity : 0.5000
##      Pos Pred Value : 0.5676
##      Neg Pred Value : 0.5714
##      Prevalence : 0.5077
##      Detection Rate : 0.3231
##      Detection Prevalence : 0.5692
##      Balanced Accuracy : 0.5682
##
##      'Positive' Class : spontaneous
##
```

```
# model 4C AU happiness model + blink
set.seed(1973)
smile__svm_model_4C <- train(smile_type ~ AU45_r_mean + AU06_r_mean +
  AU12_r_mean,
  method = "svmLinear",
  data = trn_smile,
  trControl = trainControl(
```

```

method = "cv",
number = 10
)
)

```

```
smile__svm_model_4C$results
```

```

##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5854947 0.1737161 0.0594244 0.1205028

```

```
summary(smile__svm_model_4C$finalModel)
```

```

## Length Class      Mode
##      1      ksvm      S4

```

```

smile__svm_model_4C_pred <- predict(smile__svm_model_4C, tst_smile)
summary(smile__svm_model_4C_pred)

```

```

## spontaneous deliberate
##           99           43

```

```

smile__svm_model_4C_confM <- confusionMatrix(
  smile__svm_model_4C_pred,
  tst_smile$smile_type
)
smile__svm_model_4C_confM

```

```

## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          52           47
## deliberate           18           25
##
##              Accuracy : 0.5423
##              95% CI : (0.4567, 0.6261)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.2251326
##
##              Kappa : 0.0896
##
##  Mcnemar's Test P-Value : 0.0005147
##
##              Sensitivity : 0.7429
##              Specificity : 0.3472
##              Pos Pred Value : 0.5253
##              Neg Pred Value : 0.5814
##              Prevalence : 0.4930
##              Detection Rate : 0.3662
##      Detection Prevalence : 0.6972
##              Balanced Accuracy : 0.5450

```

```
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4C.1_pred <- predict(smile__svm_model_4C, tst_smile_boys)
summary(smile__svm_model_4C.1_pred)
```

```
## spontaneous deliberate
##      50      27
```

```
smile__svm_model_4C.1_confM <- confusionMatrix(
  smile__svm_model_4C.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4C.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction      spontaneous deliberate
## spontaneous      26      24
## deliberate       11      16
##
##              Accuracy : 0.5455
##              95% CI : (0.4279, 0.6594)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.36674
##
##              Kappa : 0.1014
##
##      McNemar's Test P-Value : 0.04252
##
##              Sensitivity : 0.7027
##              Specificity : 0.4000
##              Pos Pred Value : 0.5200
##              Neg Pred Value : 0.5926
##              Prevalence : 0.4805
##              Detection Rate : 0.3377
##              Detection Prevalence : 0.6494
##              Balanced Accuracy : 0.5514
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4C.2_pred <- predict(smile__svm_model_4C, tst_smile_girls)
summary(smile__svm_model_4C.2_pred)
```

```
## spontaneous deliberate
##      49      16
```

```
smile__svm_model_4C.2_confM <- confusionMatrix(
  smile__svm_model_4C.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4C.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      26           23
## deliberate       7            9
##
##              Accuracy : 0.5385
##              95% CI : (0.4103, 0.663)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.35525
##
##              Kappa : 0.0697
##
## Mcnemar's Test P-Value : 0.00617
##
##      Sensitivity : 0.7879
##      Specificity : 0.2812
##      Pos Pred Value : 0.5306
##      Neg Pred Value : 0.5625
##      Prevalence : 0.5077
##      Detection Rate : 0.4000
##      Detection Prevalence : 0.7538
##      Balanced Accuracy : 0.5346
##
##      'Positive' Class : spontaneous
##
```

```
# model 4D AU45
set.seed(1973)
smile__svm_model_4D <-
  train(smile_type ~ AU45_r_mean,
    method = "svmLinear", data = trn_smile,
    trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_4D$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5853164 0.1741181 0.05423172 0.1090408
```

```
summary(smile__svm_model_4D$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_4D_pred <- predict(smile__svm_model_4D, tst_smile)
summary(smile__svm_model_4D_pred)
```

```
## spontaneous deliberate
##           96           46
```

```
smile__svm_model_4D_confM <- confusionMatrix(
  smile__svm_model_4D_pred,
  tst_smile$smile_type
)
smile__svm_model_4D_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           49           47
## deliberate           21           25
##
##              Accuracy : 0.5211
##              95% CI : (0.4358, 0.6056)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.400803
##
##              Kappa : 0.047
##
##  Mcnemar's Test P-Value : 0.002432
##
##              Sensitivity : 0.7000
##              Specificity : 0.3472
##              Pos Pred Value : 0.5104
##              Neg Pred Value : 0.5435
##              Prevalence : 0.4930
##              Detection Rate : 0.3451
##      Detection Prevalence : 0.6761
##              Balanced Accuracy : 0.5236
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4D.1_pred <- predict(smile__svm_model_4D, tst_smile_boys)
summary(smile__svm_model_4D.1_pred)
```

```
## spontaneous deliberate
##           51           26
```

```
smile__svm_model_4D.1_confM <- confusionMatrix(
  smile__svm_model_4D.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4D.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      25          26
## deliberate       12          14
##
##               Accuracy : 0.5065
##               95% CI : (0.39, 0.6224)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.63425
##
##               Kappa : 0.0253
##
## Mcnemar's Test P-Value : 0.03496
##
##       Sensitivity : 0.6757
##       Specificity : 0.3500
##       Pos Pred Value : 0.4902
##       Neg Pred Value : 0.5385
##       Prevalence : 0.4805
##       Detection Rate : 0.3247
##       Detection Prevalence : 0.6623
##       Balanced Accuracy : 0.5128
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4D.2_pred <- predict(smile__svm_model_4D, tst_smile_girls)
summary(smile__svm_model_4D.2_pred)
```

```
## spontaneous deliberate
##           45          20
```

```
smile__svm_model_4D.2_confM <- confusionMatrix(
  smile__svm_model_4D.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4D.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      24          21
## deliberate        9          11
##
##               Accuracy : 0.5385
##               95% CI : (0.4103, 0.663)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.35525
##
```

```
##                Kappa : 0.0714
##
## Mcnemar's Test P-Value : 0.04461
##
##          Sensitivity : 0.7273
##          Specificity : 0.3438
##          Pos Pred Value : 0.5333
##          Neg Pred Value : 0.5500
##          Prevalence : 0.5077
##          Detection Rate : 0.3692
##          Detection Prevalence : 0.6923
##          Balanced Accuracy : 0.5355
##
##          'Positive' Class : spontaneous
##
```

```
# model 4E AU12
set.seed(1973)
smile__svm_model_4E <-
  train(smile_type ~ AU12_r_mean,
        method = "svmLinear",
        data = trn_smile, trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_4E$results
```

```
## C Accuracy      Kappa AccuracySD   KappaSD
## 1 1 0.5399287 0.08094986 0.05983632 0.1207807
```

```
summary(smile__svm_model_4E$finalModel)
```

```
## Length Class    Mode
##      1   ksvm     S4
```

```
smile__svm_model_4E_pred <- predict(smile__svm_model_4E, tst_smile)
summary(smile__svm_model_4E_pred)
```

```
## spontaneous deliberate
##           55           87
```

```
smile__svm_model_4E_confM <- confusionMatrix(
  smile__svm_model_4E_pred,
  tst_smile$smile_type
)
smile__svm_model_4E_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction   spontaneous deliberate
## spontaneous      28           27
```

```
## deliberate          42          45
##
##           Accuracy : 0.5141
##           95% CI : (0.4288, 0.5987)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.46673
##
##           Kappa : 0.0251
##
## Mcnemar's Test P-Value : 0.09191
##
##           Sensitivity : 0.4000
##           Specificity : 0.6250
##       Pos Pred Value : 0.5091
##       Neg Pred Value : 0.5172
##           Prevalence : 0.4930
##       Detection Rate : 0.1972
##       Detection Prevalence : 0.3873
##       Balanced Accuracy : 0.5125
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4E.1_pred <- predict(smile__svm_model_4E, tst_smile_boys)
summary(smile__svm_model_4E.1_pred)
```

```
## spontaneous deliberate
##           20           57
```

```
smile__svm_model_4E.1_confM <- confusionMatrix(
  smile__svm_model_4E.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4E.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous          12           8
## deliberate           25          32
##
##           Accuracy : 0.5714
##           95% CI : (0.4535, 0.6837)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.212593
##
##           Kappa : 0.1265
##
## Mcnemar's Test P-Value : 0.005349
##
```



```
##           Sensitivity : 0.3243
##           Specificity : 0.8000
##           Pos Pred Value : 0.6000
##           Neg Pred Value : 0.5614
##           Prevalence : 0.4805
##           Detection Rate : 0.1558
##           Detection Prevalence : 0.2597
##           Balanced Accuracy : 0.5622
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4E.2_pred <- predict(smile__svm_model_4E, tst_smile_girls)
summary(smile__svm_model_4E.2_pred)
```

```
## spontaneous deliberate
##           35           30
```

```
smile__svm_model_4E.2_confM <- confusionMatrix(
  smile__svm_model_4E.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4E.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous           16           19
## deliberate           17           13
##
##           Accuracy : 0.4462
##           95% CI : (0.3227, 0.5747)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.8679
##
##           Kappa : -0.109
##
## Mcnemar's Test P-Value : 0.8676
##
##           Sensitivity : 0.4848
##           Specificity : 0.4062
##           Pos Pred Value : 0.4571
##           Neg Pred Value : 0.4333
##           Prevalence : 0.5077
##           Detection Rate : 0.2462
##           Detection Prevalence : 0.5385
##           Balanced Accuracy : 0.4455
##
##           'Positive' Class : spontaneous
##
```

```
# model 4F AU06
set.seed(1973)
smile__svm_model_4F <-
  train(smile_type ~ AU06_r_mean,
        method = "svmLinear",
        data = trn_smile, trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_4F$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5487411 0.09600249 0.07076652 0.1449534
```

```
summary(smile__svm_model_4F$finalModel)
```

```
## Length Class Mode
##      1  ksvm    S4
```

```
smile__svm_model_4F_pred <- predict(smile__svm_model_4F, tst_smile)
summary(smile__svm_model_4F_pred)
```

```
## spontaneous deliberate
##           44           98
```

```
smile__svm_model_4F_confM <- confusionMatrix(
  smile__svm_model_4F_pred,
  tst_smile$smile_type
)
smile__svm_model_4F_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      24             20
## deliberate       46             52
##
##              Accuracy : 0.5352
##              95% CI : (0.4497, 0.6193)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.278603
##
##              Kappa : 0.0654
##
##      Mcnemar's Test P-Value : 0.002089
##
##              Sensitivity : 0.3429
##              Specificity : 0.7222
##      Pos Pred Value : 0.5455
##      Neg Pred Value : 0.5306
##      Prevalence : 0.4930
```

```
##          Detection Rate : 0.1690
##    Detection Prevalence : 0.3099
##      Balanced Accuracy : 0.5325
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4F.1_pred <- predict(smile__svm_model_4F, tst_smile_boys)
summary(smile__svm_model_4F.1_pred)
```

```
## spontaneous deliberate
##          17          60
```

```
smile__svm_model_4F.1_confM <- confusionMatrix(
  smile__svm_model_4F.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4F.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
##    spontaneous          10           7
##    deliberate          27          33
##
##              Accuracy : 0.5584
##              95% CI : (0.4407, 0.6716)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.28475
##
##              Kappa : 0.0972
##
##    Mcnemar's Test P-Value : 0.00112
##
##              Sensitivity : 0.2703
##              Specificity : 0.8250
##              Pos Pred Value : 0.5882
##              Neg Pred Value : 0.5500
##              Prevalence : 0.4805
##              Detection Rate : 0.1299
##    Detection Prevalence : 0.2208
##              Balanced Accuracy : 0.5476
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4F.2_pred <- predict(smile__svm_model_4F, tst_smile_girls)
summary(smile__svm_model_4F.2_pred)
```

```
## spontaneous deliberate
##           27           38
```

```
smile__svm_model_4F.2_confM <- confusionMatrix(
  smile__svm_model_4F.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4F.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           14           13
## deliberate           19           19
##
##              Accuracy : 0.5077
##              95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
##              Kappa : 0.0179
##
##  McNemar's Test P-Value : 0.3768
##
##      Sensitivity : 0.4242
##      Specificity : 0.5938
##      Pos Pred Value : 0.5185
##      Neg Pred Value : 0.5000
##      Prevalence : 0.5077
##      Detection Rate : 0.2154
##      Detection Prevalence : 0.4154
##      Balanced Accuracy : 0.5090
##
##      'Positive' Class : spontaneous
##
```

```
# model 4G AU10
set.seed(1973)
smile__svm_model_4G <-
  train(smile_type ~ AU10_r_mean,
    method = "svmLinear", data = trn_smile,
    trControl = trainControl(method = "cv", number = 10)
  )
smile__svm_model_4G$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1      0.5729 0.1451991 0.08629806 0.1728594
```

```
summary(smile__svm_model_4G$finalModel)
```

```
## Length Class Mode
##      1   ksvm   S4
```

```
smile__svm_model_4G_pred <- predict(smile__svm_model_4G, tst_smile)
summary(smile__svm_model_4G_pred)
```

```
## spontaneous deliberate
##           52           90
```

```
smile__svm_model_4G_confM <- confusionMatrix(
  smile__svm_model_4G_pred,
  tst_smile$smile_type
)
smile__svm_model_4G_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction   spontaneous deliberate
## spontaneous           29           23
## deliberate           41           49
##
##              Accuracy : 0.5493
##              95% CI : (0.4636, 0.6328)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.17799
##
##              Kappa : 0.0952
##
## Mcnemar's Test P-Value : 0.03359
##
##              Sensitivity : 0.4143
##              Specificity : 0.6806
##              Pos Pred Value : 0.5577
##              Neg Pred Value : 0.5444
##              Prevalence : 0.4930
##              Detection Rate : 0.2042
##      Detection Prevalence : 0.3662
##              Balanced Accuracy : 0.5474
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4G.1_pred <- predict(smile__svm_model_4G, tst_smile_boys)
summary(smile__svm_model_4G.1_pred)
```

```
## spontaneous deliberate
##           19           58
```

```
smile__svm_model_4G.1_confM <- confusionMatrix(
  smile__svm_model_4G.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4G.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           13             6
## deliberate           24            34
##
##              Accuracy : 0.6104
##              95% CI : (0.4925, 0.7195)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.068593
##
##              Kappa : 0.2051
##
##  McNemar's Test P-Value : 0.001911
##
##      Sensitivity : 0.3514
##      Specificity : 0.8500
##      Pos Pred Value : 0.6842
##      Neg Pred Value : 0.5862
##      Prevalence : 0.4805
##      Detection Rate : 0.1688
##      Detection Prevalence : 0.2468
##      Balanced Accuracy : 0.6007
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4G.2_pred <- predict(smile__svm_model_4G, tst_smile_girls)
summary(smile__svm_model_4G.2_pred)
```

```
## spontaneous deliberate
##           33           32
```

```
smile__svm_model_4G.2_confM <- confusionMatrix(
  smile__svm_model_4G.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4G.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           16            17
```

```
## deliberate          17          15
##
##           Accuracy : 0.4769
##           95% CI : (0.3515, 0.6046)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.7324
##
##           Kappa : -0.0464
##
## Mcnemar's Test P-Value : 1.0000
##
##           Sensitivity : 0.4848
##           Specificity : 0.4688
##       Pos Pred Value : 0.4848
##       Neg Pred Value : 0.4688
##           Prevalence : 0.5077
##       Detection Rate : 0.2462
##       Detection Prevalence : 0.5077
##       Balanced Accuracy : 0.4768
##
##       'Positive' Class : spontaneous
##
```

```
# model 4H AU01
set.seed(1973)
smile__svm_model_4H <-
  train(smile_type ~ AU01_r_mean,
    method = "svmLinear",
    data = trn_smile, trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_4H$results
```

```
## C Accuracy      Kappa AccuracySD  KappaSD
## 1 1 0.5350546 0.07469541 0.08066542 0.1592671
```

```
summary(smile__svm_model_4H$finalModel)
```

```
## Length Class      Mode
##      1  ksvm      S4
```

```
smile__svm_model_4H_pred <- predict(smile__svm_model_4H, tst_smile)
summary(smile__svm_model_4H_pred)
```

```
## spontaneous deliberate
##           115           27
```

```
smile__svm_model_4H_confM <- confusionMatrix(
  smile__svm_model_4H_pred,
  tst_smile$smile_type
)
smile__svm_model_4H_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      60             55
## deliberate       10             17
##
##               Accuracy : 0.5423
##               95% CI : (0.4567, 0.6261)
##               No Information Rate : 0.507
##               P-Value [Acc > NIR] : 0.2251
##
##               Kappa : 0.0924
##
## Mcnemar's Test P-Value : 4.828e-08
##
##               Sensitivity : 0.8571
##               Specificity : 0.2361
##               Pos Pred Value : 0.5217
##               Neg Pred Value : 0.6296
##               Prevalence : 0.4930
##               Detection Rate : 0.4225
##               Detection Prevalence : 0.8099
##               Balanced Accuracy : 0.5466
##
##               'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4H.1_pred <- predict(smile__svm_model_4H, tst_smile_boys)
summary(smile__svm_model_4H.1_pred)
```

```
## spontaneous deliberate
##           65           12
```

```
smile__svm_model_4H.1_confM <- confusionMatrix(
  smile__svm_model_4H.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4H.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      34             31
## deliberate        3              9
##
##               Accuracy : 0.5584
##               95% CI : (0.4407, 0.6716)
##               No Information Rate : 0.5195
##               P-Value [Acc > NIR] : 0.2847
```



```
##
##           Kappa : 0.1399
##
## Mcnemar's Test P-Value : 3.649e-06
##
##           Sensitivity : 0.9189
##           Specificity : 0.2250
##           Pos Pred Value : 0.5231
##           Neg Pred Value : 0.7500
##           Prevalence : 0.4805
##           Detection Rate : 0.4416
##           Detection Prevalence : 0.8442
##           Balanced Accuracy : 0.5720
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4H.2_pred <- predict(smile__svm_model_4H, tst_smile_girls)
summary(smile__svm_model_4H.2_pred)
```

```
## spontaneous deliberate
##           50           15
```

```
smile__svm_model_4H.2_confM <- confusionMatrix(
  smile__svm_model_4H.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4H.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           26           24
## deliberate            7            8
##
##           Accuracy : 0.5231
##           95% CI : (0.3954, 0.6485)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.450951
##
##           Kappa : 0.0382
##
## Mcnemar's Test P-Value : 0.004057
##
##           Sensitivity : 0.7879
##           Specificity : 0.2500
##           Pos Pred Value : 0.5200
##           Neg Pred Value : 0.5333
##           Prevalence : 0.5077
##           Detection Rate : 0.4000
##           Detection Prevalence : 0.7692
```

```
##      Balanced Accuracy : 0.5189
##
##      'Positive' Class : spontaneous
##
```

```
# model 4I AU25
set.seed(1973)
smile__svm_model_4I <-
  train(smile_type ~ AU25_r_mean,
        method = "svmLinear",
        data = trn_smile,
        trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_4I$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5705158 0.143362 0.04911462 0.09427582
```

```
summary(smile__svm_model_4I$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_4I_pred <- predict(smile__svm_model_4I, tst_smile)
summary(smile__svm_model_4I_pred)
```

```
## spontaneous deliberate
##           106           36
```

```
smile__svm_model_4I_confM <- confusionMatrix(
  smile__svm_model_4I_pred,
  tst_smile$smile_type
)
smile__svm_model_4I_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           60           46
## deliberate           10           26
##
##              Accuracy : 0.6056
##              95% CI : (0.5202, 0.6865)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.01151
##
##              Kappa : 0.2167
##
##      McNemar's Test P-Value : 2.91e-06
```

```
##
##          Sensitivity : 0.8571
##          Specificity : 0.3611
##          Pos Pred Value : 0.5660
##          Neg Pred Value : 0.7222
##          Prevalence : 0.4930
##          Detection Rate : 0.4225
##          Detection Prevalence : 0.7465
##          Balanced Accuracy : 0.6091
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_4I.1_pred <- predict(smile__svm_model_4I, tst_smile_boys)
summary(smile__svm_model_4I.1_pred)
```

```
## spontaneous deliberate
##          62          15
```

```
smile__svm_model_4I.1_confM <- confusionMatrix(
  smile__svm_model_4I.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4I.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          34          28
## deliberate           3          12
##
##          Accuracy : 0.5974
##          95% CI : (0.4794, 0.7077)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.1045
##
##          Kappa : 0.2135
##
## Mcnemar's Test P-Value : 1.629e-05
##
##          Sensitivity : 0.9189
##          Specificity : 0.3000
##          Pos Pred Value : 0.5484
##          Neg Pred Value : 0.8000
##          Prevalence : 0.4805
##          Detection Rate : 0.4416
##          Detection Prevalence : 0.8052
##          Balanced Accuracy : 0.6095
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4I.2_pred <- predict(smile__svm_model_4I, tst_smile_girls)
summary(smile__svm_model_4I.2_pred)
```

```
## spontaneous deliberate
##           44           21
```

```
smile__svm_model_4I.2_confM <- confusionMatrix(
  smile__svm_model_4I.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4I.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      26           18
## deliberate       7           14
##
##              Accuracy : 0.6154
##              95% CI : (0.4864, 0.7335)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.05294
##
##              Kappa : 0.2266
##
## Mcnemar's Test P-Value : 0.04550
##
##      Sensitivity : 0.7879
##      Specificity : 0.4375
##      Pos Pred Value : 0.5909
##      Neg Pred Value : 0.6667
##      Prevalence : 0.5077
##      Detection Rate : 0.4000
##      Detection Prevalence : 0.6769
##      Balanced Accuracy : 0.6127
##
##      'Positive' Class : spontaneous
##
```

```
# model 4J AU09
set.seed(1973)
smile__svm_model_4J <-
  train(smile_type ~ AU09_r_mean,
    method = "svmLinear",
    data = trn_smile, trControl = trainControl(method = "cv", number = 10)
  )
smile__svm_model_4J$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5249276 0.04510716 0.08572585 0.1669863
```

```
summary(smile__svm_model_4J$finalModel)
```

```
## Length Class Mode  
##      1  ksvm   S4
```

```
smile__svm_model_4J_pred <- predict(smile__svm_model_4J, tst_smile)  
summary(smile__svm_model_4J_pred)
```

```
## spontaneous deliberate  
##           30          112
```

```
smile__svm_model_4J_confM <- confusionMatrix(  
  smile__svm_model_4J_pred,  
  tst_smile$smile_type  
)  
smile__svm_model_4J_confM
```

```
## Confusion Matrix and Statistics  
##  
##              Reference  
## Prediction    spontaneous deliberate  
## spontaneous           12           18  
## deliberate           58           54  
##  
##              Accuracy : 0.4648  
##              95% CI : (0.3807, 0.5503)  
##    No Information Rate : 0.507  
##    P-Value [Acc > NIR] : 0.8624  
##  
##              Kappa : -0.0792  
##  
##    McNemar's Test P-Value : 7.691e-06  
##  
##              Sensitivity : 0.17143  
##              Specificity : 0.75000  
##              Pos Pred Value : 0.40000  
##              Neg Pred Value : 0.48214  
##              Prevalence : 0.49296  
##              Detection Rate : 0.08451  
##    Detection Prevalence : 0.21127  
##              Balanced Accuracy : 0.46071  
##  
##              'Positive' Class : spontaneous  
##
```

```
# predicting boys, girls  
set.seed(1973)  
smile__svm_model_4J.1_pred <- predict(smile__svm_model_4J, tst_smile_boys)  
summary(smile__svm_model_4J.1_pred)
```

```
## spontaneous deliberate  
##           16          61
```

```
smile__svm_model_4J.1_confM <- confusionMatrix(
  smile__svm_model_4J.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_4J.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           6           10
## deliberate          31           30
##
##              Accuracy : 0.4675
##              95% CI : (0.3529, 0.5848)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.847647
##
##              Kappa : -0.0897
##
##  Mcnemar's Test P-Value : 0.001787
##
##      Sensitivity : 0.16216
##      Specificity : 0.75000
##      Pos Pred Value : 0.37500
##      Neg Pred Value : 0.49180
##      Prevalence : 0.48052
##      Detection Rate : 0.07792
##      Detection Prevalence : 0.20779
##      Balanced Accuracy : 0.45608
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_4J.2_pred <- predict(smile__svm_model_4J, tst_smile_girls)
summary(smile__svm_model_4J.2_pred)
```

```
## spontaneous deliberate
##           14           51
```

```
smile__svm_model_4J.2_confM <- confusionMatrix(
  smile__svm_model_4J.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_4J.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           6           8
```

```
## deliberate          27          24
##
## Accuracy : 0.4615
## 95% CI : (0.337, 0.5897)
## No Information Rate : 0.5077
## P-Value [Acc > NIR] : 0.807360
##
## Kappa : -0.0676
##
## McNemar's Test P-Value : 0.002346
##
## Sensitivity : 0.18182
## Specificity : 0.75000
## Pos Pred Value : 0.42857
## Neg Pred Value : 0.47059
## Prevalence : 0.50769
## Detection Rate : 0.09231
## Detection Prevalence : 0.21538
## Balanced Accuracy : 0.46591
##
## 'Positive' Class : spontaneous
##
```

```
# model 5 head pose features
```

```
set.seed(1973)
smile__svm_model_5 <-
  train(smile_type ~ pose_Rx_mean + pose_Ry_mean + pose_Rz_mean,
    method = "svmLinear", data = trn_smile,
    trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_5$results
```

```
## C Accuracy      Kappa AccuracySD  KappaSD
## 1 1 0.4505236 -0.09969948 0.06191438 0.1240377
```

```
summary(smile__svm_model_5$finalModel)
```

```
## Length Class    Mode
##      1  ksvm      S4
```

```
smile__svm_model_5_pred <- predict(smile__svm_model_5, tst_smile)
summary(smile__svm_model_5_pred)
```

```
## spontaneous deliberate
##           62           80
```

```
smile__svm_model_5_confM <- confusionMatrix(
  smile__svm_model_5_pred,
  tst_smile$smile_type
)
smile__svm_model_5_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      31           31
##  deliberate       39           41
##
##           Accuracy : 0.507
##           95% CI : (0.4219, 0.5919)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 0.5336
##
##           Kappa : 0.0123
##
##  Mcnemar's Test P-Value : 0.4028
##
##           Sensitivity : 0.4429
##           Specificity : 0.5694
##       Pos Pred Value : 0.5000
##       Neg Pred Value : 0.5125
##           Prevalence : 0.4930
##       Detection Rate : 0.2183
##       Detection Prevalence : 0.4366
##       Balanced Accuracy : 0.5062
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_5.1_pred <- predict(smile__svm_model_5, tst_smile_boys)
summary(smile__svm_model_5.1_pred)
```

```
## spontaneous deliberate
##           31           46
```

```
smile__svm_model_5.1_confM <- confusionMatrix(
  smile__svm_model_5.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_5.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      15           16
##  deliberate       22           24
##
##           Accuracy : 0.5065
##           95% CI : (0.39, 0.6224)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.6342
```



```
##
##           Kappa : 0.0054
##
## Mcnemar's Test P-Value : 0.4173
##
##           Sensitivity : 0.4054
##           Specificity : 0.6000
##           Pos Pred Value : 0.4839
##           Neg Pred Value : 0.5217
##           Prevalence : 0.4805
##           Detection Rate : 0.1948
##           Detection Prevalence : 0.4026
##           Balanced Accuracy : 0.5027
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_5.2_pred <- predict(smile__svm_model_5, tst_smile_girls)
summary(smile__svm_model_5.2_pred)
```

```
## spontaneous deliberate
##           31           34
```

```
smile__svm_model_5.2_confM <- confusionMatrix(
  smile__svm_model_5.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_5.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           16           15
## deliberate           17           17
##
##           Accuracy : 0.5077
##           95% CI : (0.3807, 0.634)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.5495
##
##           Kappa : 0.0161
##
## Mcnemar's Test P-Value : 0.8597
##
##           Sensitivity : 0.4848
##           Specificity : 0.5312
##           Pos Pred Value : 0.5161
##           Neg Pred Value : 0.5000
##           Prevalence : 0.5077
##           Detection Rate : 0.2462
##           Detection Prevalence : 0.4769
```

```
##          Balanced Accuracy : 0.5080
##
##          'Positive' Class : spontaneous
##
```

```
# model 5A gaze features
set.seed(1973)
smile__svm_model_5A <- train(smile_type ~ gaze_angle_x_mean + gaze_angle_y_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_5A$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.4712901 -0.05969345 0.04430412 0.08370863
```

```
summary(smile__svm_model_5A$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_5A_pred <- predict(smile__svm_model_5A, tst_smile)
summary(smile__svm_model_5A_pred)
```

```
## spontaneous deliberate
##           41           101
```

```
smile__svm_model_5A_confM <- confusionMatrix(
  smile__svm_model_5A_pred,
  tst_smile$smile_type
)
smile__svm_model_5A_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      30           11
## deliberate       40           61
##
##              Accuracy : 0.6408
##              95% CI : (0.5561, 0.7196)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0008891
##
##              Kappa : 0.2774
##
##      McNemar's Test P-Value : 8.826e-05
##
##              Sensitivity : 0.4286
```

```
##           Specificity : 0.8472
##           Pos Pred Value : 0.7317
##           Neg Pred Value : 0.6040
##           Prevalence : 0.4930
##           Detection Rate : 0.2113
##           Detection Prevalence : 0.2887
##           Balanced Accuracy : 0.6379
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_5A.1_pred <- predict(smile__svm_model_5A, tst_smile_boys)
summary(smile__svm_model_5A.1_pred)
```

```
## spontaneous deliberate
##           27           50
```

```
smile__svm_model_5A.1_confM <- confusionMatrix(
  smile__svm_model_5A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_5A.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous           18             9
## deliberate           19            31
##
##           Accuracy : 0.6364
##           95% CI : (0.5188, 0.743)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.02565
##
##           Kappa : 0.2642
##
##           Mcnemar's Test P-Value : 0.08897
##
##           Sensitivity : 0.4865
##           Specificity : 0.7750
##           Pos Pred Value : 0.6667
##           Neg Pred Value : 0.6200
##           Prevalence : 0.4805
##           Detection Rate : 0.2338
##           Detection Prevalence : 0.3506
##           Balanced Accuracy : 0.6307
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_5A.2_pred <- predict(smile__svm_model_5A, tst_smile_girls)
summary(smile__svm_model_5A.2_pred)
```

```
## spontaneous deliberate
##           14           51
```

```
smile__svm_model_5A.2_confM <- confusionMatrix(
  smile__svm_model_5A.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_5A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           12            2
## deliberate            21            30
##
##              Accuracy : 0.6462
##              95% CI : (0.5177, 0.7608)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.0169758
##
##              Kappa : 0.2985
##
##  Mcnemar's Test P-Value : 0.0001746
##
##              Sensitivity : 0.3636
##              Specificity : 0.9375
##              Pos Pred Value : 0.8571
##              Neg Pred Value : 0.5882
##              Prevalence : 0.5077
##              Detection Rate : 0.1846
##      Detection Prevalence : 0.2154
##              Balanced Accuracy : 0.6506
##
##      'Positive' Class : spontaneous
##
```

```
# model 5B gaze + head pose features
set.seed(1973)
smile__svm_model_5B <-
  train(smile_type ~ pose_Rx_mean + pose_Ry_mean + pose_Rz_mean +
    gaze_angle_x_mean + gaze_angle_y_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_5B$results
```

```
## C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.4737745 -0.05205384 0.0817408 0.162664
```

```
summary(smile__svm_model_5B$finalModel)
```

```
## Length Class Mode
##      1 ksvm S4
```

```
smile__svm_model_5B_pred <- predict(smile__svm_model_5B, tst_smile)
summary(smile__svm_model_5B_pred)
```

```
## spontaneous deliberate
##           55           87
```

```
smile__svm_model_5B_confM <- confusionMatrix(
  smile__svm_model_5B_pred,
  tst_smile$smile_type
)
smile__svm_model_5B_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      31           24
## deliberate       39           48
##
##              Accuracy : 0.5563
##              95% CI : (0.4707, 0.6396)
##              No Information Rate : 0.507
##              P-Value [Acc > NIR] : 0.13758
##
##              Kappa : 0.1099
##
## Mcnemar's Test P-Value : 0.07776
##
##              Sensitivity : 0.4429
##              Specificity : 0.6667
##              Pos Pred Value : 0.5636
##              Neg Pred Value : 0.5517
##              Prevalence : 0.4930
##              Detection Rate : 0.2183
##              Detection Prevalence : 0.3873
##              Balanced Accuracy : 0.5548
##
##              'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_5B.1_pred <- predict(smile__svm_model_5B, tst_smile_boys)
summary(smile__svm_model_5B.1_pred)
```

```
## spontaneous deliberate
##           30           47
```

```
smile__svm_model_5B.1_confM <- confusionMatrix(
  smile__svm_model_5B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_5B.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           14           16
## deliberate           23           24
##
##               Accuracy : 0.4935
##               95% CI : (0.3776, 0.61)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.7159
##
##               Kappa : -0.0218
##
## Mcnemar's Test P-Value : 0.3367
##
##       Sensitivity : 0.3784
##       Specificity : 0.6000
##       Pos Pred Value : 0.4667
##       Neg Pred Value : 0.5106
##       Prevalence : 0.4805
##       Detection Rate : 0.1818
##       Detection Prevalence : 0.3896
##       Balanced Accuracy : 0.4892
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_5B.2_pred <- predict(smile__svm_model_5B, tst_smile_girls)
summary(smile__svm_model_5B.2_pred)
```

```
## spontaneous deliberate
##           25           40
```

```
smile__svm_model_5B.2_confM <- confusionMatrix(
  smile__svm_model_5B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_5B.2_confM
```

```
## Confusion Matrix and Statistics
##
```

```
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      17           8
## deliberate       16          24
##
##           Accuracy : 0.6308
##           95% CI : (0.502, 0.7472)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.03086
##
##           Kappa : 0.2642
##
## Mcnemar's Test P-Value : 0.15304
##
##           Sensitivity : 0.5152
##           Specificity : 0.7500
##       Pos Pred Value : 0.6800
##       Neg Pred Value : 0.6000
##           Prevalence : 0.5077
##       Detection Rate : 0.2615
##       Detection Prevalence : 0.3846
##       Balanced Accuracy : 0.6326
##
##       'Positive' Class : spontaneous
##
```

```
# model 6 dynamics and movement
set.seed(1973)
smile__svm_model_6 <-
  train(smile_type ~ onset_mean + apex_mean + offset_mean + eye_mean + lip_mean,
        method = "svmLinear", data = trn_smile,
        trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_6$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.665781 0.3333057 0.08962779 0.1773316
```

```
summary(smile__svm_model_6$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_6_pred <- predict(smile__svm_model_6, tst_smile)
summary(smile__svm_model_6_pred)
```

```
## spontaneous deliberate
##           74           68
```

```
smile__svm_model_6_confM <- confusionMatrix(
  smile__svm_model_6_pred,
  tst_smile$smile_type
)
smile__svm_model_6_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           48           26
## deliberate           22           46
##
##              Accuracy : 0.662
##              95% CI : (0.5779, 0.7391)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0001362
##
##              Kappa : 0.3243
##
##  Mcnemar's Test P-Value : 0.6650055
##
##              Sensitivity : 0.6857
##              Specificity : 0.6389
##              Pos Pred Value : 0.6486
##              Neg Pred Value : 0.6765
##              Prevalence : 0.4930
##              Detection Rate : 0.3380
##      Detection Prevalence : 0.5211
##              Balanced Accuracy : 0.6623
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6.1_pred <- predict(smile__svm_model_6, tst_smile_boys)
summary(smile__svm_model_6.1_pred)
```

```
## spontaneous deliberate
##              33              44
```

```
smile__svm_model_6.1_confM <- confusionMatrix(
  smile__svm_model_6.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```



```
##      spontaneous      22      11
##      deliberate      15      29
##
##              Accuracy : 0.6623
##              95% CI : (0.5455, 0.7662)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.007868
##
##              Kappa : 0.3209
##
##      McNemar's Test P-Value : 0.556298
##
##              Sensitivity : 0.5946
##              Specificity : 0.7250
##      Pos Pred Value : 0.6667
##      Neg Pred Value : 0.6591
##      Prevalence : 0.4805
##      Detection Rate : 0.2857
##      Detection Prevalence : 0.4286
##      Balanced Accuracy : 0.6598
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6.2_pred <- predict(smile__svm_model_6, tst_smile_girls)
summary(smile__svm_model_6.2_pred)
```

```
## spontaneous deliberate
##           41           24
```

```
smile__svm_model_6.2_confM <- confusionMatrix(
  smile__svm_model_6.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      26      15
##      deliberate       7      17
##
##              Accuracy : 0.6615
##              95% CI : (0.5335, 0.7743)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.008794
##
##              Kappa : 0.3203
##
##      McNemar's Test P-Value : 0.135593
##
```

```
##           Sensitivity : 0.7879
##           Specificity : 0.5312
##           Pos Pred Value : 0.6341
##           Neg Pred Value : 0.7083
##           Prevalence : 0.5077
##           Detection Rate : 0.4000
##           Detection Prevalence : 0.6308
##           Balanced Accuracy : 0.6596
##
##           'Positive' Class : spontaneous
##
```

```
# model 6A dynamics and eye
set.seed(1973)
smile__svm_model_6A <-
  train(smile_type ~ onset_mean + apex_mean + offset_mean + eye_mean,
        method = "svmLinear", data = trn_smile,
        trControl = trainControl(method = "cv", number = 10)
  )

smile__svm_model_6A$results
```

```
##      C Accuracy   Kappa AccuracySD   KappaSD
## 1 1 0.6509024 0.30311 0.1167325 0.2316699
```

```
summary(smile__svm_model_6A$finalModel)
```

```
## Length Class   Mode
##      1   ksvm    S4
```

```
smile__svm_model_6A_pred <- predict(smile__svm_model_6A, tst_smile)
summary(smile__svm_model_6A_pred)
```

```
## spontaneous deliberate
##           78           64
```

```
smile__svm_model_6A_confM <- confusionMatrix(
  smile__svm_model_6A_pred,
  tst_smile$smile_type
)
smile__svm_model_6A_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous           51          27
##  deliberate            19          45
##
##           Accuracy : 0.6761
##           95% CI : (0.5925, 0.7521)
```

```
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 3.363e-05
##
##              Kappa : 0.353
##
##  Mcnemar's Test P-Value : 0.302
##
##      Sensitivity : 0.7286
##      Specificity : 0.6250
##      Pos Pred Value : 0.6538
##      Neg Pred Value : 0.7031
##      Prevalence : 0.4930
##      Detection Rate : 0.3592
##      Detection Prevalence : 0.5493
##      Balanced Accuracy : 0.6768
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6A.1_pred <- predict(smile__svm_model_6A, tst_smile_boys)
summary(smile__svm_model_6A.1_pred)
```

```
## spontaneous deliberate
##           37           40
```

```
smile__svm_model_6A.1_confM <- confusionMatrix(
  smile__svm_model_6A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6A.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           25           12
## deliberate           12           28
##
##              Accuracy : 0.6883
##              95% CI : (0.5726, 0.7891)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.001955
##
##              Kappa : 0.3757
##
##  Mcnemar's Test P-Value : 1.000000
##
##      Sensitivity : 0.6757
##      Specificity : 0.7000
##      Pos Pred Value : 0.6757
##      Neg Pred Value : 0.7000
```

```
##           Prevalence : 0.4805
##           Detection Rate : 0.3247
##           Detection Prevalence : 0.4805
##           Balanced Accuracy : 0.6878
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6A.2_pred <- predict(smile__svm_model_6A, tst_smile_girls)
summary(smile__svm_model_6A.2_pred)
```

```
## spontaneous deliberate
##           41           24
```

```
smile__svm_model_6A.2_confM <- confusionMatrix(
  smile__svm_model_6A.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6A.2_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      26           15
## deliberate       7           17
##
##           Accuracy : 0.6615
##           95% CI : (0.5335, 0.7743)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.008794
##
##           Kappa : 0.3203
##
##           McNemar's Test P-Value : 0.135593
##
##           Sensitivity : 0.7879
##           Specificity : 0.5312
##           Pos Pred Value : 0.6341
##           Neg Pred Value : 0.7083
##           Prevalence : 0.5077
##           Detection Rate : 0.4000
##           Detection Prevalence : 0.6308
##           Balanced Accuracy : 0.6596
##
##           'Positive' Class : spontaneous
##
```

```
# model 6B dynamics and lip
set.seed(1973)
smile__svm_model_6B <-
```

```
train(smile_type ~ onset_mean + apex_mean + offset_mean + lip_mean,
      method = "svmLinear", data = trn_smile,
      trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__svm_model_6B$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6691789 0.3392816 0.07023856 0.1394647
```

```
summary(smile__svm_model_6B$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_6B_pred <- predict(smile__svm_model_6B, tst_smile)
summary(smile__svm_model_6B_pred)
```

```
## spontaneous deliberate
##           71           71
```

```
smile__svm_model_6B_confM <- confusionMatrix(
  smile__svm_model_6B_pred,
  tst_smile$smile_type
)
smile__svm_model_6B_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      48              23
## deliberate      22              49
##
##              Accuracy : 0.6831
##              95% CI : (0.5998, 0.7586)
##              No Information Rate : 0.507
##              P-Value [Acc > NIR] : 1.596e-05
##
##              Kappa : 0.3662
##
## Mcnemar's Test P-Value : 1
##
##              Sensitivity : 0.6857
##              Specificity : 0.6806
##              Pos Pred Value : 0.6761
##              Neg Pred Value : 0.6901
##              Prevalence : 0.4930
##              Detection Rate : 0.3380
##              Detection Prevalence : 0.5000
##              Balanced Accuracy : 0.6831
```

```
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6B.1_pred <- predict(smile__svm_model_6B, tst_smile_boys)
summary(smile__svm_model_6B.1_pred)
```

```
## spontaneous deliberate
##      33      44
```

```
smile__svm_model_6B.1_confM <- confusionMatrix(
  smile__svm_model_6B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6B.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction      spontaneous deliberate
## spontaneous      23          10
## deliberate       14          30
##
##              Accuracy : 0.6883
##              95% CI : (0.5726, 0.7891)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.001955
##
##              Kappa : 0.3731
##
##      McNemar's Test P-Value : 0.540291
##
##              Sensitivity : 0.6216
##              Specificity : 0.7500
##              Pos Pred Value : 0.6970
##              Neg Pred Value : 0.6818
##              Prevalence : 0.4805
##              Detection Rate : 0.2987
##              Detection Prevalence : 0.4286
##              Balanced Accuracy : 0.6858
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6B.2_pred <- predict(smile__svm_model_6B, tst_smile_girls)
summary(smile__svm_model_6B.2_pred)
```

```
## spontaneous deliberate
##      38      27
```

```
smile__svm_model_6B.2_confM <- confusionMatrix(
  smile__svm_model_6B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6B.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      25          13
## deliberate       8          19
##
##              Accuracy : 0.6769
##              95% CI : (0.5495, 0.7877)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.004282
##
##              Kappa : 0.3522
##
## Mcnemar's Test P-Value : 0.382733
##
##      Sensitivity : 0.7576
##      Specificity : 0.5938
##      Pos Pred Value : 0.6579
##      Neg Pred Value : 0.7037
##      Prevalence : 0.5077
##      Detection Rate : 0.3846
##      Detection Prevalence : 0.5846
##      Balanced Accuracy : 0.6757
##
##      'Positive' Class : spontaneous
##
```

```
# model 6C onset and movement
set.seed(1973)
smile__svm_model_6C <- train(smile_type ~ onset_mean + eye_mean + lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_6C$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.660723 0.3212148 0.04400409 0.08849735
```

```
summary(smile__svm_model_6C$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_6C_pred <- predict(smile__svm_model_6C, tst_smile)
summary(smile__svm_model_6C_pred)
```

```
## spontaneous deliberate
##           77           65
```

```
smile__svm_model_6C_confM <- confusionMatrix(
  smile__svm_model_6C_pred,
  tst_smile$smile_type
)
smile__svm_model_6C_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           42           35
## deliberate           28           37
##
##              Accuracy : 0.5563
##              95% CI : (0.4707, 0.6396)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.1376
##
##              Kappa : 0.1137
##
##  Mcnemar's Test P-Value : 0.4497
##
##              Sensitivity : 0.6000
##              Specificity : 0.5139
##              Pos Pred Value : 0.5455
##              Neg Pred Value : 0.5692
##              Prevalence : 0.4930
##              Detection Rate : 0.2958
##      Detection Prevalence : 0.5423
##              Balanced Accuracy : 0.5569
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6C.1_pred <- predict(smile__svm_model_6C, tst_smile_boys)
summary(smile__svm_model_6C.1_pred)
```

```
## spontaneous deliberate
##           36           41
```

```
smile__svm_model_6C.1_confM <- confusionMatrix(
  smile__svm_model_6C.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6C.1_confM
```



```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous      21           15
##  deliberate       16           25
##
##               Accuracy : 0.5974
##               95% CI : (0.4794, 0.7077)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1045
##
##               Kappa : 0.1928
##
##  Mcnemar's Test P-Value : 1.0000
##
##      Sensitivity : 0.5676
##      Specificity : 0.6250
##      Pos Pred Value : 0.5833
##      Neg Pred Value : 0.6098
##      Prevalence : 0.4805
##      Detection Rate : 0.2727
##      Detection Prevalence : 0.4675
##      Balanced Accuracy : 0.5963
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6C.2_pred <- predict(smile__svm_model_6C, tst_smile_girls)
summary(smile__svm_model_6C.2_pred)
```

```
## spontaneous deliberate
##           41           24
```

```
smile__svm_model_6C.2_confM <- confusionMatrix(
  smile__svm_model_6C.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6C.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous      21           20
##  deliberate       12           12
##
##               Accuracy : 0.5077
##               95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
```

```
##                Kappa : 0.0114
##
## Mcnemar's Test P-Value : 0.2159
##
##          Sensitivity : 0.6364
##          Specificity : 0.3750
##          Pos Pred Value : 0.5122
##          Neg Pred Value : 0.5000
##          Prevalence : 0.5077
##          Detection Rate : 0.3231
##          Detection Prevalence : 0.6308
##          Balanced Accuracy : 0.5057
##
##          'Positive' Class : spontaneous
##
```

```
# model 6D onset + eye
set.seed(1973)
smile__svm_model_6D <- train(smile_type ~ onset_mean + eye_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_6D$results
```

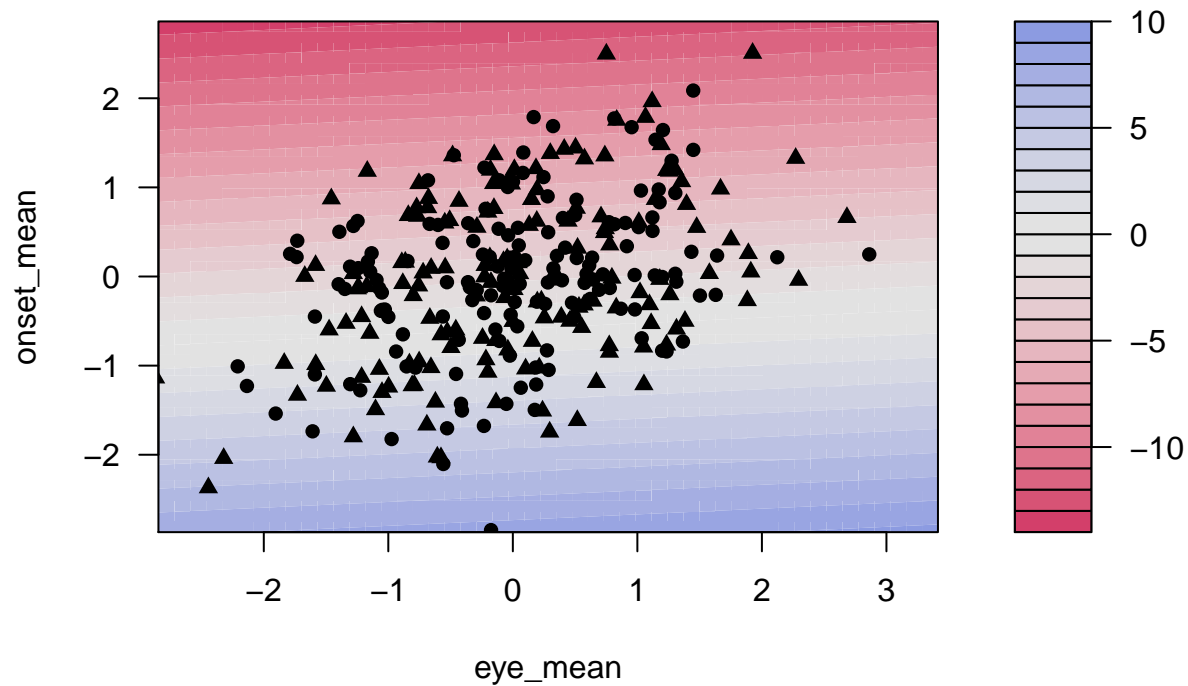
```
##      C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.5433155 0.08600491 0.1022142 0.206062
```

```
summary(smile__svm_model_6D$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
kernlab::plot(smile__svm_model_6D$finalModel)
```

SVM classification plot



```
smile__svm_model_6D_pred <- predict(smile__svm_model_6D, tst_smile)
summary(smile__svm_model_6D_pred)
```

```
## spontaneous deliberate
##           60           82
```

```
smile__svm_model_6D_confM <- confusionMatrix(
  smile__svm_model_6D_pred,
  tst_smile$smile_type
)
smile__svm_model_6D_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      33           27
## deliberate      37           45
##
##           Accuracy : 0.5493
##           95% CI : (0.4636, 0.6328)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.1780
##
##           Kappa : 0.0966
```

```
##
## McNemar's Test P-Value : 0.2606
##
##          Sensitivity : 0.4714
##          Specificity : 0.6250
##          Pos Pred Value : 0.5500
##          Neg Pred Value : 0.5488
##          Prevalence : 0.4930
##          Detection Rate : 0.2324
##          Detection Prevalence : 0.4225
##          Balanced Accuracy : 0.5482
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6D.1_pred <- predict(smile__svm_model_6D, tst_smile_boys)
summary(smile__svm_model_6D.1_pred)
```

```
## spontaneous deliberate
##          27          50
```

```
smile__svm_model_6D.1_confM <- confusionMatrix(
  smile__svm_model_6D.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6D.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          14          13
## deliberate           23          27
##
##          Accuracy : 0.5325
##          95% CI : (0.4152, 0.6471)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.4552
##
##          Kappa : 0.0539
##
## McNemar's Test P-Value : 0.1336
##
##          Sensitivity : 0.3784
##          Specificity : 0.6750
##          Pos Pred Value : 0.5185
##          Neg Pred Value : 0.5400
##          Prevalence : 0.4805
##          Detection Rate : 0.1818
##          Detection Prevalence : 0.3506
##          Balanced Accuracy : 0.5267
```

```
##
##      'Positive' Class : spontaneous
##

set.seed(1973)
smile__svm_model_6D.2_pred <- predict(smile__svm_model_6D, tst_smile_girls)
summary(smile__svm_model_6D.2_pred)

## spontaneous deliberate
##           33           32

smile__svm_model_6D.2_confM <- confusionMatrix(
  smile__svm_model_6D.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6D.2_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           19           14
## deliberate            14           18
##
##              Accuracy : 0.5692
##              95% CI : (0.4404, 0.6915)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.1927
##
##              Kappa : 0.1383
##
## Mcnemar's Test P-Value : 1.0000
##
##              Sensitivity : 0.5758
##              Specificity : 0.5625
##              Pos Pred Value : 0.5758
##              Neg Pred Value : 0.5625
##              Prevalence : 0.5077
##              Detection Rate : 0.2923
##      Detection Prevalence : 0.5077
##              Balanced Accuracy : 0.5691
##
##      'Positive' Class : spontaneous
##

# model 6E onset + lip
set.seed(1973)
smile__svm_model_6E <- train(smile_type ~ onset_mean + lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

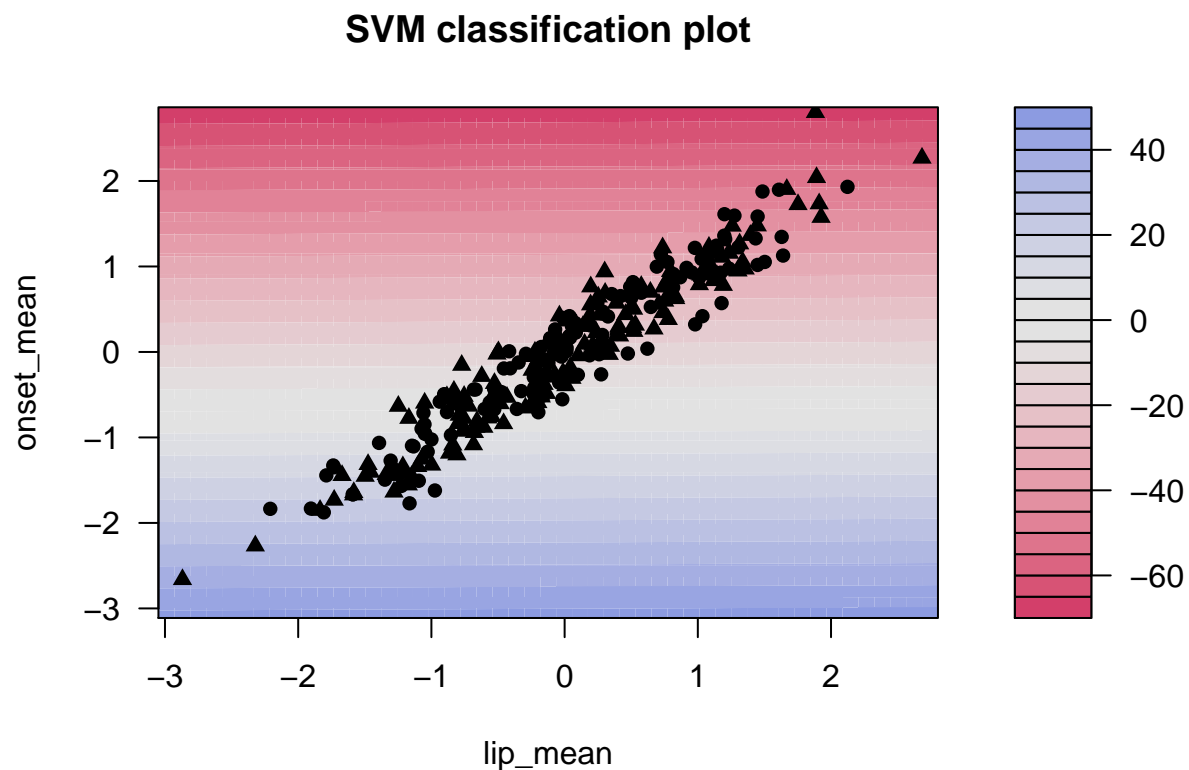
smile__svm_model_6E$results
```

```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.6483344 0.2962302 0.06798322 0.1368051
```

```
summary(smile__svm_model_6E$finalModel)
```

```
## Length Class Mode
##      1   ksvm   S4
```

```
kernlab::plot(smile__svm_model_6E$finalModel)
```



```
smile__svm_model_6E_pred <- predict(smile__svm_model_6E, tst_smile)
summary(smile__svm_model_6E_pred)
```

```
## spontaneous deliberate
##           77           65
```

```
smile__svm_model_6E_confM <- confusionMatrix(
  smile__svm_model_6E_pred,
  tst_smile$smile_type
)
print(smile__svm_model_6E_confM)
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      43          34
##  deliberate      27          38
##
##           Accuracy : 0.5704
##           95% CI : (0.4847, 0.6531)
##    No Information Rate : 0.507
##    P-Value [Acc > NIR] : 0.07664
##
##           Kappa : 0.1419
##
## Mcnemar's Test P-Value : 0.44236
##
##           Sensitivity : 0.6143
##           Specificity : 0.5278
##    Pos Pred Value : 0.5584
##    Neg Pred Value : 0.5846
##    Prevalence : 0.4930
##    Detection Rate : 0.3028
##    Detection Prevalence : 0.5423
##    Balanced Accuracy : 0.5710
##
##    'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6E.1_pred <- predict(smile__svm_model_6E, tst_smile_boys)
summary(smile__svm_model_6E.1_pred)
```

```
## spontaneous deliberate
##           36          41
```

```
smile__svm_model_6E.1_confM <- confusionMatrix(
  smile__svm_model_6E.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6E.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
##  spontaneous      21          15
##  deliberate      16          25
##
##           Accuracy : 0.5974
##           95% CI : (0.4794, 0.7077)
##    No Information Rate : 0.5195
##    P-Value [Acc > NIR] : 0.1045
##
```

```
##                Kappa : 0.1928
##
## Mcnemar's Test P-Value : 1.0000
##
##          Sensitivity : 0.5676
##          Specificity : 0.6250
##          Pos Pred Value : 0.5833
##          Neg Pred Value : 0.6098
##          Prevalence : 0.4805
##          Detection Rate : 0.2727
##          Detection Prevalence : 0.4675
##          Balanced Accuracy : 0.5963
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6E.2_pred <- predict(smile__svm_model_6E, tst_smile_girls)
summary(smile__svm_model_6E.2_pred)
```

```
## spontaneous deliberate
##          41          24
```

```
smile__svm_model_6E.2_confM <- confusionMatrix(
  smile__svm_model_6E.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6E.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          22          19
## deliberate           11          13
##
##          Accuracy : 0.5385
##          95% CI : (0.4103, 0.663)
##          No Information Rate : 0.5077
##          P-Value [Acc > NIR] : 0.3553
##
##          Kappa : 0.0732
##
## Mcnemar's Test P-Value : 0.2012
##
##          Sensitivity : 0.6667
##          Specificity : 0.4062
##          Pos Pred Value : 0.5366
##          Neg Pred Value : 0.5417
##          Prevalence : 0.5077
##          Detection Rate : 0.3385
##          Detection Prevalence : 0.6308
##          Balanced Accuracy : 0.5365
```



```

##
##      'Positive' Class : spontaneous
##

# model 6F apex + movements
set.seed(1973)
smile__svm_model_6F <- train(smile_type ~ apex_mean + eye_mean + lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_6F$results

##      C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.5406473 0.08103459 0.09625901 0.19191

summary(smile__svm_model_6F$finalModel)

## Length Class      Mode
##      1      ksvm      S4

smile__svm_model_6F_pred <- predict(smile__svm_model_6F, tst_smile)
summary(smile__svm_model_6F_pred)

## spontaneous deliberate
##           70           72

smile__svm_model_6F_confM <- confusionMatrix(
  smile__svm_model_6F_pred,
  tst_smile$smile_type
)
smile__svm_model_6F_confM

## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      41             29
## deliberate       29             43
##
##              Accuracy : 0.5915
##              95% CI : (0.506, 0.6732)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.02653
##
##              Kappa : 0.1829
##
##      McNemar's Test P-Value : 1.00000
##
##              Sensitivity : 0.5857
##              Specificity : 0.5972

```

```
##          Pos Pred Value : 0.5857
##          Neg Pred Value : 0.5972
##          Prevalence : 0.4930
##          Detection Rate : 0.2887
##          Detection Prevalence : 0.4930
##          Balanced Accuracy : 0.5915
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6F.1_pred <- predict(smile__svm_model_6F, tst_smile_boys)
summary(smile__svm_model_6F.1_pred)
```

```
## spontaneous deliberate
##          38          39
```

```
smile__svm_model_6F.1_confM <- confusionMatrix(
  smile__svm_model_6F.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6F.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction    spontaneous deliberate
## spontaneous         21          17
## deliberate         16          23
##
##          Accuracy : 0.5714
##          95% CI : (0.4535, 0.6837)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.2126
##
##          Kappa : 0.1424
##
##          Mcnemar's Test P-Value : 1.0000
##
##          Sensitivity : 0.5676
##          Specificity : 0.5750
##          Pos Pred Value : 0.5526
##          Neg Pred Value : 0.5897
##          Prevalence : 0.4805
##          Detection Rate : 0.2727
##          Detection Prevalence : 0.4935
##          Balanced Accuracy : 0.5713
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6F.2_pred <- predict(smile__svm_model_6F, tst_smile_girls)
summary(smile__svm_model_6F.2_pred)
```

```
## spontaneous deliberate
##           32           33
```

```
smile__svm_model_6F.2_confM <- confusionMatrix(
  smile__svm_model_6F.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6F.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction      spontaneous deliberate
## spontaneous           20           12
## deliberate           13           20
##
##               Accuracy : 0.6154
##               95% CI : (0.4864, 0.7335)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.05294
##
##               Kappa : 0.231
##
##  Mcnemar's Test P-Value : 1.00000
##
##       Sensitivity : 0.6061
##       Specificity : 0.6250
##       Pos Pred Value : 0.6250
##       Neg Pred Value : 0.6061
##       Prevalence : 0.5077
##       Detection Rate : 0.3077
##       Detection Prevalence : 0.4923
##       Balanced Accuracy : 0.6155
##
##       'Positive' Class : spontaneous
##
```

```
# model 6G apex + eye
set.seed(1973)
smile__svm_model_6G <- train(smile_type ~ apex_mean + eye_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

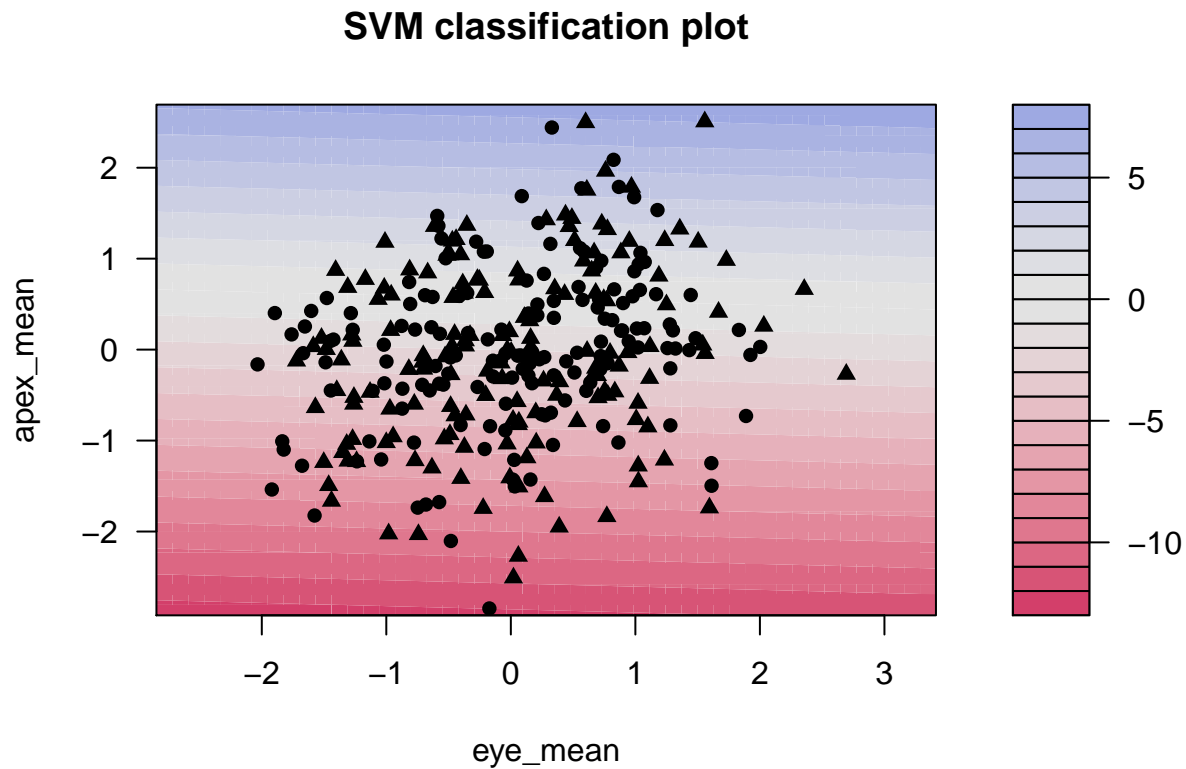
smile__svm_model_6G$results
```

```
## C Accuracy      Kappa AccuracySD   KappaSD
## 1 1 0.5381684 0.07448867 0.06085767 0.1208593
```

```
summary(smile__svm_model_6G$finalModel)
```

```
## Length Class Mode  
##      1   ksvm   S4
```

```
plot(smile__svm_model_6G$finalModel)
```



```
smile__svm_model_6G_pred <- predict(smile__svm_model_6G, tst_smile)  
summary(smile__svm_model_6G_pred)
```

```
## spontaneous deliberate  
##           51           91
```

```
smile__svm_model_6G_confM <- confusionMatrix(  
  smile__svm_model_6G_pred,  
  tst_smile$smile_type  
)  
smile__svm_model_6G_confM
```

```
## Confusion Matrix and Statistics  
##  
##           Reference  
## Prediction   spontaneous deliberate
```

```
##      spontaneous      26      25
##      deliberate      44      47
##
##              Accuracy : 0.5141
##              95% CI : (0.4288, 0.5987)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.46673
##
##              Kappa : 0.0243
##
##      McNemar's Test P-Value : 0.03024
##
##              Sensitivity : 0.3714
##              Specificity : 0.6528
##      Pos Pred Value : 0.5098
##      Neg Pred Value : 0.5165
##      Prevalence : 0.4930
##      Detection Rate : 0.1831
##      Detection Prevalence : 0.3592
##      Balanced Accuracy : 0.5121
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6G.1_pred <- predict(smile__svm_model_6G, tst_smile_boys)
summary(smile__svm_model_6G.1_pred)
```

```
## spontaneous deliberate
##           29           48
```

```
smile__svm_model_6G.1_confM <- confusionMatrix(
  smile__svm_model_6G.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6G.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      16      13
##      deliberate      21      27
##
##              Accuracy : 0.5584
##              95% CI : (0.4407, 0.6716)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.2847
##
##              Kappa : 0.1083
##
##      McNemar's Test P-Value : 0.2299
```

```
##
##           Sensitivity : 0.4324
##           Specificity : 0.6750
##           Pos Pred Value : 0.5517
##           Neg Pred Value : 0.5625
##           Prevalence : 0.4805
##           Detection Rate : 0.2078
##           Detection Prevalence : 0.3766
##           Balanced Accuracy : 0.5537
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6G.2_pred <- predict(smile__svm_model_6G, tst_smile_girls)
summary(smile__svm_model_6G.2_pred)
```

```
## spontaneous deliberate
##           22           43
```

```
smile__svm_model_6G.2_confM <- confusionMatrix(
  smile__svm_model_6G.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6G.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           10           12
## deliberate           23           20
##
##           Accuracy : 0.4615
##           95% CI : (0.337, 0.5897)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.80736
##
##           Kappa : -0.0716
##
## Mcnemar's Test P-Value : 0.09097
##
##           Sensitivity : 0.3030
##           Specificity : 0.6250
##           Pos Pred Value : 0.4545
##           Neg Pred Value : 0.4651
##           Prevalence : 0.5077
##           Detection Rate : 0.1538
##           Detection Prevalence : 0.3385
##           Balanced Accuracy : 0.4640
##
##           'Positive' Class : spontaneous
##
```

```
# model 6H apex + lip
set.seed(1973)
smile__svm_model_6H <- train(smile_type ~ apex_mean + lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

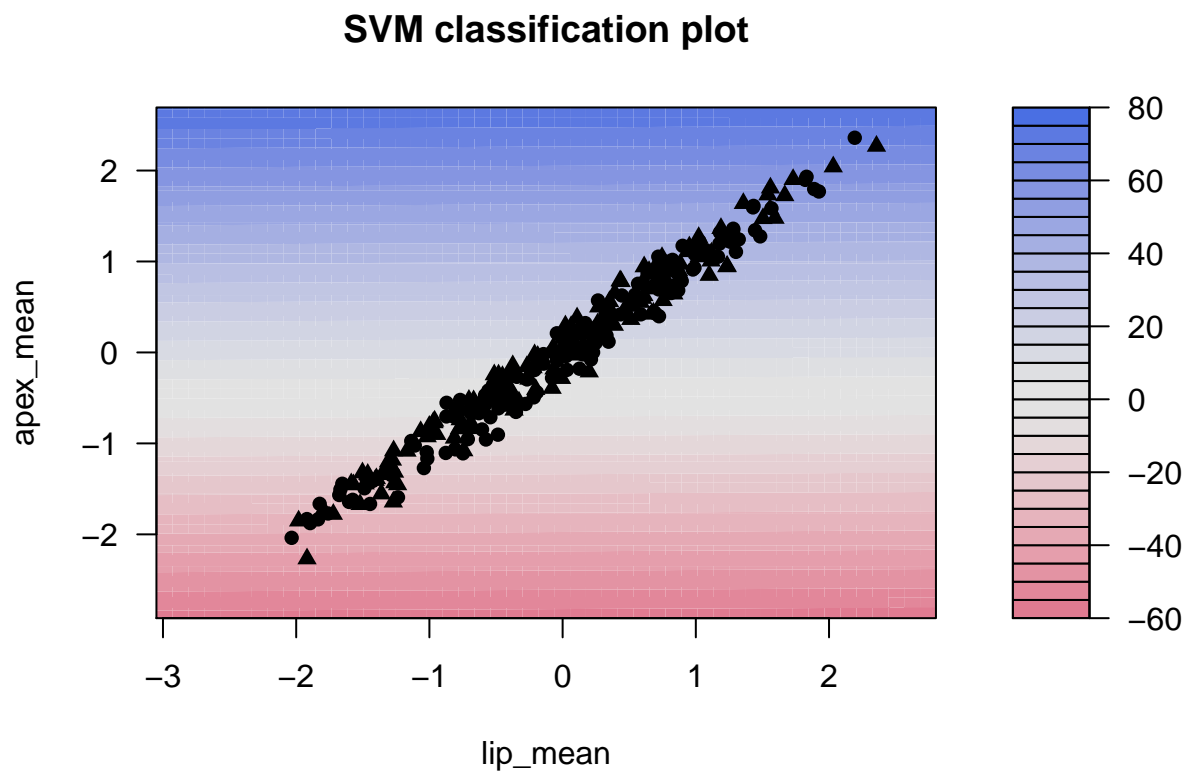
smile__svm_model_6H$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5642714 0.1292836 0.0968237 0.1914572
```

```
summary(smile__svm_model_6H$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
kernlab::plot(smile__svm_model_6H$finalModel)
```



```
smile__svm_model_6H_pred <- predict(smile__svm_model_6H, tst_smile)
summary(smile__svm_model_6H_pred)
```

```
## spontaneous deliberate
##           79           63
```

```
smile__svm_model_6H_confM <- confusionMatrix(
  smile__svm_model_6H_pred,
  tst_smile$smile_type
)
smile__svm_model_6H_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           46           33
## deliberate           24           39
##
##              Accuracy : 0.5986
##              95% CI : (0.5131, 0.6799)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0177
##
##              Kappa : 0.1985
##
##  Mcnemar's Test P-Value : 0.2893
##
##              Sensitivity : 0.6571
##              Specificity : 0.5417
##              Pos Pred Value : 0.5823
##              Neg Pred Value : 0.6190
##              Prevalence : 0.4930
##              Detection Rate : 0.3239
##      Detection Prevalence : 0.5563
##              Balanced Accuracy : 0.5994
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6H.1_pred <- predict(smile__svm_model_6H, tst_smile_boys)
summary(smile__svm_model_6H.1_pred)
```

```
## spontaneous deliberate
##              40              37
```

```
smile__svm_model_6H.1_confM <- confusionMatrix(
  smile__svm_model_6H.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6H.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```



```
##      spontaneous      23      17
##      deliberate      14      23
##
##              Accuracy : 0.5974
##              95% CI : (0.4794, 0.7077)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1045
##
##              Kappa : 0.196
##
##      McNemar's Test P-Value : 0.7194
##
##              Sensitivity : 0.6216
##              Specificity : 0.5750
##              Pos Pred Value : 0.5750
##              Neg Pred Value : 0.6216
##              Prevalence : 0.4805
##              Detection Rate : 0.2987
##      Detection Prevalence : 0.5195
##              Balanced Accuracy : 0.5983
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6H.2_pred <- predict(smile__svm_model_6H, tst_smile_girls)
summary(smile__svm_model_6H.2_pred)
```

```
## spontaneous deliberate
##           39           26
```

```
smile__svm_model_6H.2_confM <- confusionMatrix(
  smile__svm_model_6H.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6H.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      23      16
##      deliberate      10      16
##
##              Accuracy : 0.6
##              95% CI : (0.471, 0.7196)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.08588
##
##              Kappa : 0.1975
##
##      McNemar's Test P-Value : 0.32680
##
```

```
##          Sensitivity : 0.6970
##          Specificity : 0.5000
##          Pos Pred Value : 0.5897
##          Neg Pred Value : 0.6154
##          Prevalence : 0.5077
##          Detection Rate : 0.3538
##          Detection Prevalence : 0.6000
##          Balanced Accuracy : 0.5985
##
##          'Positive' Class : spontaneous
##
```

```
# model 6I offset and movement
set.seed(1973)
smile__svm_model_6I <- train(smile_type ~ offset_mean + eye_mean + lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_6I$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6662377 0.3343434 0.07243843 0.1434402
```

```
summary(smile__svm_model_6I$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_6I_pred <- predict(smile__svm_model_6I, tst_smile)
summary(smile__svm_model_6I_pred)
```

```
## spontaneous deliberate
##           82           60
```

```
smile__svm_model_6I_confM <- confusionMatrix(
  smile__svm_model_6I_pred,
  tst_smile$smile_type
)
smile__svm_model_6I_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           51           31
## deliberate            19           41
##
##              Accuracy : 0.6479
##              95% CI : (0.5634, 0.7261)
##      No Information Rate : 0.507
```

```
##      P-Value [Acc > NIR] : 0.0004898
##
##              Kappa : 0.2973
##
## Mcnemar's Test P-Value : 0.1197949
##
##      Sensitivity : 0.7286
##      Specificity : 0.5694
##      Pos Pred Value : 0.6220
##      Neg Pred Value : 0.6833
##      Prevalence : 0.4930
##      Detection Rate : 0.3592
##      Detection Prevalence : 0.5775
##      Balanced Accuracy : 0.6490
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6I.1_pred <- predict(smile__svm_model_6I, tst_smile_boys)
summary(smile__svm_model_6I.1_pred)
```

```
## spontaneous deliberate
##           38           39
```

```
smile__svm_model_6I.1_confM <- confusionMatrix(
  smile__svm_model_6I.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6I.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           25           13
## deliberate           12           27
##
##      Accuracy : 0.6753
##      95% CI : (0.559, 0.7777)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.00403
##
##              Kappa : 0.3503
##
## Mcnemar's Test P-Value : 1.00000
##
##      Sensitivity : 0.6757
##      Specificity : 0.6750
##      Pos Pred Value : 0.6579
##      Neg Pred Value : 0.6923
##      Prevalence : 0.4805
```

```
##          Detection Rate : 0.3247
##    Detection Prevalence : 0.4935
##      Balanced Accuracy : 0.6753
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6I.2_pred <- predict(smile__svm_model_6I, tst_smile_girls)
summary(smile__svm_model_6I.2_pred)
```

```
## spontaneous deliberate
##          44          21
```

```
smile__svm_model_6I.2_confM <- confusionMatrix(
  smile__svm_model_6I.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6I.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
##  spontaneous      26          18
##  deliberate       7          14
##
##              Accuracy : 0.6154
##              95% CI : (0.4864, 0.7335)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.05294
##
##              Kappa : 0.2266
##
##  Mcnemar's Test P-Value : 0.04550
##
##              Sensitivity : 0.7879
##              Specificity : 0.4375
##              Pos Pred Value : 0.5909
##              Neg Pred Value : 0.6667
##              Prevalence : 0.5077
##              Detection Rate : 0.4000
##      Detection Prevalence : 0.6769
##      Balanced Accuracy : 0.6127
##
##      'Positive' Class : spontaneous
##
```

```
# model 6J offset + eye
set.seed(1973)
smile__svm_model_6J <- train(smile_type ~ offset_mean + eye_mean,
  method = "svmLinear", data = trn_smile,
```

```
trControl = trainControl(method = "cv", number = 10)
)
```

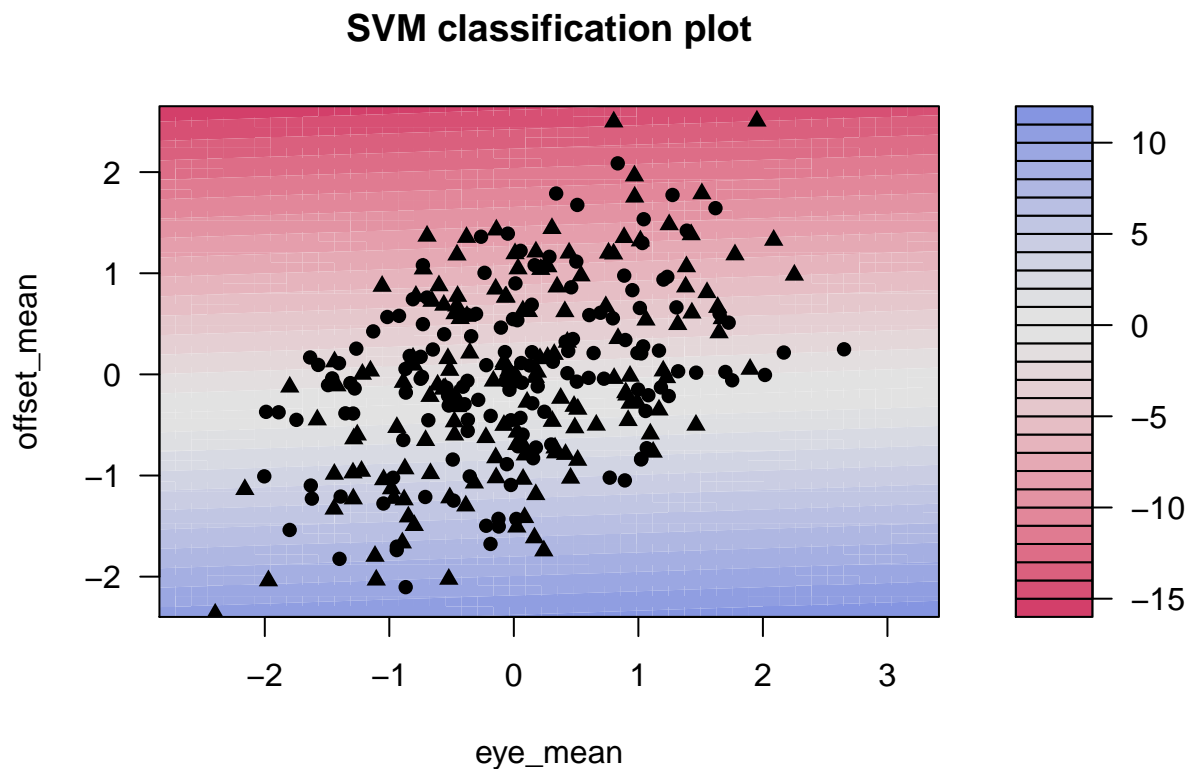
```
smile__svm_model_6J$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.552217 0.1031459 0.1055909 0.2110006
```

```
summary(smile__svm_model_6J$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
kernlab::plot(smile__svm_model_6J$finalModel)
```



```
smile__svm_model_6J_pred <- predict(smile__svm_model_6J, tst_smile)
summary(smile__svm_model_6J_pred)
```

```
## spontaneous deliberate
##           62           80
```

```
smile__svm_model_6J_confM <- confusionMatrix(
  smile__svm_model_6J_pred,
  tst_smile$smile_type
)
smile__svm_model_6J_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      40             22
## deliberate       30             50
##
##              Accuracy : 0.6338
##              95% CI : (0.5489, 0.713)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.001568
##
##              Kappa : 0.2663
##
##  Mcnemar's Test P-Value : 0.331685
##
##              Sensitivity : 0.5714
##              Specificity : 0.6944
##              Pos Pred Value : 0.6452
##              Neg Pred Value : 0.6250
##              Prevalence : 0.4930
##              Detection Rate : 0.2817
##      Detection Prevalence : 0.4366
##              Balanced Accuracy : 0.6329
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6J.1_pred <- predict(smile__svm_model_6J, tst_smile_boys)
summary(smile__svm_model_6J.1_pred)
```

```
## spontaneous deliberate
##              30             47
```

```
smile__svm_model_6J.1_confM <- confusionMatrix(
  smile__svm_model_6J.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6J.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      18      12
##      deliberate      19      28
##
##              Accuracy : 0.5974
##              95% CI : (0.4794, 0.7077)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1045
##
##              Kappa : 0.1878
##
##      McNemar's Test P-Value : 0.2812
##
##              Sensitivity : 0.4865
##              Specificity : 0.7000
##              Pos Pred Value : 0.6000
##              Neg Pred Value : 0.5957
##              Prevalence : 0.4805
##              Detection Rate : 0.2338
##      Detection Prevalence : 0.3896
##              Balanced Accuracy : 0.5932
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6J.2_pred <- predict(smile__svm_model_6J, tst_smile_girls)
summary(smile__svm_model_6J.2_pred)
```

```
## spontaneous deliberate
##           32           33
```

```
smile__svm_model_6J.2_confM <- confusionMatrix(
  smile__svm_model_6J.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6J.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      22      10
##      deliberate      11      22
##
##              Accuracy : 0.6769
##              95% CI : (0.5495, 0.7877)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.004282
##
##              Kappa : 0.354
##
##      McNemar's Test P-Value : 1.000000
##
```

```
##           Sensitivity : 0.6667
##           Specificity : 0.6875
##           Pos Pred Value : 0.6875
##           Neg Pred Value : 0.6667
##           Prevalence : 0.5077
##           Detection Rate : 0.3385
##           Detection Prevalence : 0.4923
##           Balanced Accuracy : 0.6771
##
##           'Positive' Class : spontaneous
##
```

```
# model 6K offset + lip
set.seed(1973)
smile__svm_model_6K <- train(smile_type ~ offset_mean + lip_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_6K
```

```
## Support Vector Machines with Linear Kernel
##
## 333 samples
## 2 predictor
## 2 classes: 'spontaneous', 'deliberate '
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 300, 300, 300, 299, 299, 300, ...
## Resampling results:
##
## Accuracy Kappa
## 0.6787322 0.3589939
##
## Tuning parameter 'C' was held constant at a value of 1
```

```
smile__svm_model_6K$results
```

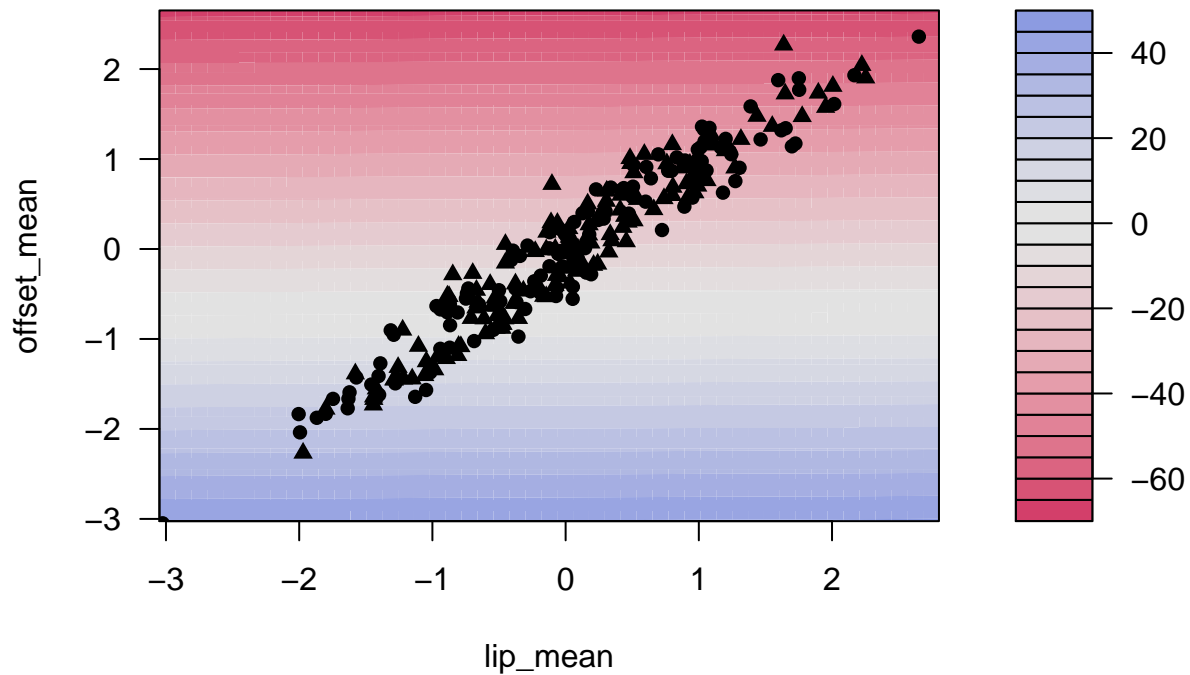
```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.6787322 0.3589939 0.07408875 0.1473768
```

```
summary(smile__svm_model_6K$finalModel)
```

```
## Length Class Mode
##      1 ksvm S4
```

```
kernlab::plot(smile__svm_model_6K$finalModel)
```


SVM classification plot



```
smile__svm_model_6K$bestTune
```

```
## C
## 1 1
```

```
smile__svm_model_6K_pred <- predict(smile__svm_model_6K, tst_smile)
summary(smile__svm_model_6K_pred)
```

```
## spontaneous deliberate
##           83           59
```

```
smile__svm_model_6K_confM <- confusionMatrix(
  smile__svm_model_6K_pred,
  tst_smile$smile_type
)
smile__svm_model_6K_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      53           30
## deliberate       17           42
##
```

```
##               Accuracy : 0.669
##               95% CI : (0.5852, 0.7456)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 6.871e-05
##
##               Kappa : 0.3396
##
##  McNemar's Test P-Value : 0.08005
##
##      Sensitivity : 0.7571
##      Specificity : 0.5833
##      Pos Pred Value : 0.6386
##      Neg Pred Value : 0.7119
##      Prevalence : 0.4930
##      Detection Rate : 0.3732
##      Detection Prevalence : 0.5845
##      Balanced Accuracy : 0.6702
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_6K.1_pred <- predict(smile__svm_model_6K, tst_smile_boys)
summary(smile__svm_model_6K.1_pred)
```

```
## spontaneous deliberate
##           42           35
```

```
smile__svm_model_6K.1_confM <- confusionMatrix(
  smile__svm_model_6K.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_6K.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           27           15
## deliberate            10           25
##
##               Accuracy : 0.6753
##               95% CI : (0.559, 0.7777)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.00403
##
##               Kappa : 0.3529
##
##  McNemar's Test P-Value : 0.42371
##
##      Sensitivity : 0.7297
##      Specificity : 0.6250
```

```
##          Pos Pred Value : 0.6429
##          Neg Pred Value : 0.7143
##          Prevalence : 0.4805
##          Detection Rate : 0.3506
##          Detection Prevalence : 0.5455
##          Balanced Accuracy : 0.6774
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_6K.2_pred <- predict(smile__svm_model_6K, tst_smile_girls)
summary(smile__svm_model_6K.2_pred)
```

```
## spontaneous deliberate
##          41          24
```

```
smile__svm_model_6K.2_confM <- confusionMatrix(
  smile__svm_model_6K.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_6K.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      26          15
## deliberate       7           17
##
##              Accuracy : 0.6615
##              95% CI : (0.5335, 0.7743)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.008794
##
##              Kappa : 0.3203
##
##      Mcnemar's Test P-Value : 0.135593
##
##              Sensitivity : 0.7879
##              Specificity : 0.5312
##              Pos Pred Value : 0.6341
##              Neg Pred Value : 0.7083
##              Prevalence : 0.5077
##              Detection Rate : 0.4000
##      Detection Prevalence : 0.6308
##              Balanced Accuracy : 0.6596
##
##              'Positive' Class : spontaneous
##
```

```
# dynamics and AU's
set.seed(1973)
smile__svm_model_7 <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7$results
```

```
##      C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.7498552 0.4990742 0.1107154 0.221964
```

```
summary(smile__svm_model_7$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7_pred <- predict(smile__svm_model_7, tst_smile)
summary(smile__svm_model_7_pred)
```

```
## spontaneous deliberate
##           68           74
```

```
smile__svm_model_7_confM <- confusionMatrix(
  smile__svm_model_7_pred,
  tst_smile$smile_type
)
smile__svm_model_7_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      46             22
## deliberate       24             50
##
##              Accuracy : 0.6761
##              95% CI : (0.5925, 0.7521)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 3.363e-05
##
##              Kappa : 0.3517
##
##      McNemar's Test P-Value : 0.8828
##
```

```
##           Sensitivity : 0.6571
##           Specificity : 0.6944
##           Pos Pred Value : 0.6765
##           Neg Pred Value : 0.6757
##           Prevalence : 0.4930
##           Detection Rate : 0.3239
##           Detection Prevalence : 0.4789
##           Balanced Accuracy : 0.6758
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7.1_pred <- predict(smile__svm_model_7, tst_smile_boys)
summary(smile__svm_model_7.1_pred)
```

```
## spontaneous deliberate
##           35           42
```

```
smile__svm_model_7.1_confM <- confusionMatrix(
  smile__svm_model_7.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous          24           11
## deliberate          13           29
##
##           Accuracy : 0.6883
##           95% CI : (0.5726, 0.7891)
##           No Information Rate : 0.5195
##           P-Value [Acc > NIR] : 0.001955
##
##           Kappa : 0.3744
##
## Mcnemar's Test P-Value : 0.838256
##
##           Sensitivity : 0.6486
##           Specificity : 0.7250
##           Pos Pred Value : 0.6857
##           Neg Pred Value : 0.6905
##           Prevalence : 0.4805
##           Detection Rate : 0.3117
##           Detection Prevalence : 0.4545
##           Balanced Accuracy : 0.6868
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7.2_pred <- predict(smile__svm_model_7, tst_smile_girls)
summary(smile__svm_model_7.2_pred)
```

```
## spontaneous deliberate
##           33           32
```

```
smile__svm_model_7.2_confM <- confusionMatrix(
  smile__svm_model_7.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7.2_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous         22           11
## deliberate         11           21
##
##              Accuracy : 0.6615
##              95% CI : (0.5335, 0.7743)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.008794
##
##              Kappa : 0.3229
##
##  Mcnemar's Test P-Value : 1.000000
##
##      Sensitivity : 0.6667
##      Specificity : 0.6562
##      Pos Pred Value : 0.6667
##      Neg Pred Value : 0.6562
##      Prevalence : 0.5077
##      Detection Rate : 0.3385
##      Detection Prevalence : 0.5077
##      Balanced Accuracy : 0.6615
##
##      'Positive' Class : spontaneous
##
```

```
# 7A AU's and onset
```

```
set.seed(1973)
smile__svm_model_7A <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  onset_mean,
method = "svmLinear", data = trn_smile,
```

```
trControl = trainControl(method = "cv", number = 10)
)
```

```
smile__svm_model_7A$results
```

```
##      C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.6871992 0.3758363 0.1064631 0.210235
```

```
summary(smile__svm_model_7A$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7A_pred <- predict(smile__svm_model_7A, tst_smile)
summary(smile__svm_model_7A_pred)
```

```
## spontaneous deliberate
##           61           81
```

```
smile__svm_model_7A_confM <- confusionMatrix(
  smile__svm_model_7A_pred,
  tst_smile$smile_type
)
smile__svm_model_7A_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous           36           25
## deliberate           34           47
##
##              Accuracy : 0.5845
##              95% CI : (0.4989, 0.6665)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.03874
##
##              Kappa : 0.1674
##
##  Mcnemar's Test P-Value : 0.29764
##
##              Sensitivity : 0.5143
##              Specificity : 0.6528
##              Pos Pred Value : 0.5902
##              Neg Pred Value : 0.5802
##              Prevalence : 0.4930
##              Detection Rate : 0.2535
##      Detection Prevalence : 0.4296
##              Balanced Accuracy : 0.5835
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7A.1_pred <- predict(smile__svm_model_7A, tst_smile_boys)
summary(smile__svm_model_7A.1_pred)
```

```
## spontaneous deliberate
##          33          44
```

```
smile__svm_model_7A.1_confM <- confusionMatrix(
  smile__svm_model_7A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7A.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous         20          13
## deliberate         17          27
##
##              Accuracy : 0.6104
##              95% CI : (0.4925, 0.7195)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.06859
##
##              Kappa : 0.2164
##
##  Mcnemar's Test P-Value : 0.58388
##
##      Sensitivity : 0.5405
##      Specificity : 0.6750
##      Pos Pred Value : 0.6061
##      Neg Pred Value : 0.6136
##      Prevalence : 0.4805
##      Detection Rate : 0.2597
##      Detection Prevalence : 0.4286
##      Balanced Accuracy : 0.6078
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7A.2_pred <- predict(smile__svm_model_7A, tst_smile_girls)
summary(smile__svm_model_7A.2_pred)
```

```
## spontaneous deliberate
##          28          37
```

```
smile__svm_model_7A.2_confM <- confusionMatrix(
  smile__svm_model_7A.2_pred,
```



```

    tst_smile_girls$smile_type
)
smile__svm_model_7A.2_confM

```

```

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      16             12
## deliberate       17             20
##
##              Accuracy : 0.5538
##              95% CI : (0.4253, 0.6773)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.2678
##
##              Kappa : 0.1096
##
## Mcnemar's Test P-Value : 0.4576
##
##      Sensitivity : 0.4848
##      Specificity : 0.6250
##      Pos Pred Value : 0.5714
##      Neg Pred Value : 0.5405
##      Prevalence : 0.5077
##      Detection Rate : 0.2462
##      Detection Prevalence : 0.4308
##      Balanced Accuracy : 0.5549
##
##      'Positive' Class : spontaneous
##

```

7B AU's and apex

```

set.seed(1973)
smile__svm_model_7B <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  apex_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7B$results

```

```

##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6873886 0.3751691 0.1010571 0.2013494

```

```
summary(smile__svm_model_7B$finalModel)
```

```
## Length Class Mode  
##      1  ksvm  S4
```

```
smile__svm_model_7B_pred <- predict(smile__svm_model_7B, tst_smile)  
summary(smile__svm_model_7B_pred)
```

```
## spontaneous deliberate  
##           60           82
```

```
smile__svm_model_7B_confM <- confusionMatrix(  
  smile__svm_model_7B_pred,  
  tst_smile$smile_type  
)  
smile__svm_model_7B_confM
```

```
## Confusion Matrix and Statistics  
##  
##              Reference  
## Prediction    spontaneous deliberate  
## spontaneous           35           25  
## deliberate           35           47  
##  
##              Accuracy : 0.5775  
##              95% CI : (0.4918, 0.6598)  
##    No Information Rate : 0.507  
##    P-Value [Acc > NIR] : 0.05517  
##  
##              Kappa : 0.1531  
##  
##    McNemar's Test P-Value : 0.24528  
##  
##              Sensitivity : 0.5000  
##              Specificity : 0.6528  
##              Pos Pred Value : 0.5833  
##              Neg Pred Value : 0.5732  
##              Prevalence : 0.4930  
##              Detection Rate : 0.2465  
##    Detection Prevalence : 0.4225  
##              Balanced Accuracy : 0.5764  
##  
##              'Positive' Class : spontaneous  
##
```

```
# predicting boys, girls  
set.seed(1973)  
smile__svm_model_7B.1_pred <- predict(smile__svm_model_7B, tst_smile_boys)  
summary(smile__svm_model_7B.1_pred)
```

```
## spontaneous deliberate  
##           32           45
```

```
smile__svm_model_7B.1_confM <- confusionMatrix(
  smile__svm_model_7B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7B.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           19           13
## deliberate           18           27
##
##               Accuracy : 0.5974
##               95% CI : (0.4794, 0.7077)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.1045
##
##               Kappa : 0.1895
##
##  Mcnemar's Test P-Value : 0.4725
##
##       Sensitivity : 0.5135
##       Specificity : 0.6750
##       Pos Pred Value : 0.5938
##       Neg Pred Value : 0.6000
##       Prevalence : 0.4805
##       Detection Rate : 0.2468
##       Detection Prevalence : 0.4156
##       Balanced Accuracy : 0.5943
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7B.2_pred <- predict(smile__svm_model_7B, tst_smile_girls)
summary(smile__svm_model_7B.2_pred)
```

```
## spontaneous deliberate
##           28           37
```

```
smile__svm_model_7B.2_confM <- confusionMatrix(
  smile__svm_model_7B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7B.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           16           12
```

```
## deliberate          17          20
##
##           Accuracy : 0.5538
##           95% CI : (0.4253, 0.6773)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.2678
##
##           Kappa : 0.1096
##
## Mcnemar's Test P-Value : 0.4576
##
##           Sensitivity : 0.4848
##           Specificity : 0.6250
##       Pos Pred Value : 0.5714
##       Neg Pred Value : 0.5405
##           Prevalence : 0.5077
##       Detection Rate : 0.2462
##       Detection Prevalence : 0.4308
##       Balanced Accuracy : 0.5549
##
##       'Positive' Class : spontaneous
##
```

```
# 7C AU's and offset
```

```
set.seed(1973)
smile__svm_model_7C <- train(smile_type ~ AU01_r_mean + AU02_r_mean +
  AU04_r_mean + AU05_r_mean + AU06_r_mean +
  AU07_r_mean + AU09_r_mean + AU10_r_mean +
  AU12_r_mean + AU14_r_mean + AU15_r_mean +
  AU17_r_mean + AU20_r_mean + AU23_r_mean +
  AU25_r_mean + AU26_r_mean + AU45_r_mean +
  offset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7C$results
```

```
## C Accuracy      Kappa AccuracySD  KappaSD
## 1 1 0.6780136 0.3569963 0.09684482 0.1925157
```

```
summary(smile__svm_model_7C$finalModel)
```

```
## Length Class    Mode
##      1   ksvm     S4
```

```
# visualize the svm using the rattle package
# plot(smile__svm_model_7C$finalModel)
```

```
smile__svm_model_7C_pred <- predict(smile__svm_model_7C, tst_smile)
summary(smile__svm_model_7C_pred)
```

```
## spontaneous deliberate
##           64           78
```

```
smile__svm_model_7C_confM <- confusionMatrix(
  smile__svm_model_7C_pred,
  tst_smile$smile_type
)
smile__svm_model_7C_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      39           25
## deliberate       31           47
##
##              Accuracy : 0.6056
##              95% CI : (0.5202, 0.6865)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.01151
##
##              Kappa : 0.2102
##
##  Mcnemar's Test P-Value : 0.50404
##
##      Sensitivity : 0.5571
##      Specificity : 0.6528
##      Pos Pred Value : 0.6094
##      Neg Pred Value : 0.6026
##      Prevalence : 0.4930
##      Detection Rate : 0.2746
##      Detection Prevalence : 0.4507
##      Balanced Accuracy : 0.6050
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7C.1_pred <- predict(smile__svm_model_7C, tst_smile_boys)
summary(smile__svm_model_7C.1_pred)
```

```
## spontaneous deliberate
##           34           43
```

```
smile__svm_model_7C.1_confM <- confusionMatrix(
  smile__svm_model_7C.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7C.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous          21          13
## deliberate          16          27
##
##           Accuracy : 0.6234
##           95% CI : (0.5056, 0.7313)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.04297
##
##           Kappa : 0.2433
##
## Mcnemar's Test P-Value : 0.71035
##
##           Sensitivity : 0.5676
##           Specificity : 0.6750
##       Pos Pred Value : 0.6176
##       Neg Pred Value : 0.6279
##           Prevalence : 0.4805
##       Detection Rate : 0.2727
##       Detection Prevalence : 0.4416
##       Balanced Accuracy : 0.6213
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7C.2_pred <- predict(smile__svm_model_7C, tst_smile_girls)
summary(smile__svm_model_7C.2_pred)
```

```
## spontaneous deliberate
##           30           35
```

```
smile__svm_model_7C.2_confM <- confusionMatrix(
  smile__svm_model_7C.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7C.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
## spontaneous          18          12
## deliberate          15          20
##
##           Accuracy : 0.5846
##           95% CI : (0.4556, 0.7056)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.1320
##
##           Kappa : 0.1702
```

```
##
## McNemar's Test P-Value : 0.7003
##
##          Sensitivity : 0.5455
##          Specificity : 0.6250
##          Pos Pred Value : 0.6000
##          Neg Pred Value : 0.5714
##          Prevalence : 0.5077
##          Detection Rate : 0.2769
##          Detection Prevalence : 0.4615
##          Balanced Accuracy : 0.5852
##
##          'Positive' Class : spontaneous
##
```

```
# 7D AU's selection and dynamics
```

```
set.seed(1973)
smile__svm_model_7D <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7D$results
```

```
## C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6690842 0.3379967 0.08313076 0.1670725
```

```
summary(smile__svm_model_7D$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7D_pred <- predict(smile__svm_model_7D, tst_smile)
summary(smile__svm_model_7D_pred)
```

```
## spontaneous deliberate
##           60           82
```

```
smile__svm_model_7D_confM <- confusionMatrix(
  smile__svm_model_7D_pred,
  tst_smile$smile_type
)
smile__svm_model_7D_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction      spontaneous deliberate
## spontaneous           42           18
```

```
## deliberate          28          54
##
##           Accuracy : 0.6761
##           95% CI : (0.5925, 0.7521)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 3.363e-05
##
##           Kappa : 0.3507
##
##  McNemar's Test P-Value : 0.1845
##
##           Sensitivity : 0.6000
##           Specificity : 0.7500
##       Pos Pred Value : 0.7000
##       Neg Pred Value : 0.6585
##           Prevalence : 0.4930
##       Detection Rate : 0.2958
##       Detection Prevalence : 0.4225
##       Balanced Accuracy : 0.6750
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7D.1_pred <- predict(smile__svm_model_7D, tst_smile_boys)
summary(smile__svm_model_7D.1_pred)
```

```
## spontaneous deliberate
##           25          52
```

```
smile__svm_model_7D.1_confM <- confusionMatrix(
  smile__svm_model_7D.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7D.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous          19           6
## deliberate           18          34
##
##           Accuracy : 0.6883
##           95% CI : (0.5726, 0.7891)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.001955
##
##           Kappa : 0.368
##
##  McNemar's Test P-Value : 0.024745
##
```



```
##           Sensitivity : 0.5135
##           Specificity : 0.8500
##           Pos Pred Value : 0.7600
##           Neg Pred Value : 0.6538
##           Prevalence : 0.4805
##           Detection Rate : 0.2468
##           Detection Prevalence : 0.3247
##           Balanced Accuracy : 0.6818
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7D.2_pred <- predict(smile__svm_model_7D, tst_smile_girls)
summary(smile__svm_model_7D.2_pred)
```

```
## spontaneous deliberate
##           35           30
```

```
smile__svm_model_7D.2_confM <- confusionMatrix(
  smile__svm_model_7D.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7D.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   spontaneous deliberate
## spontaneous      23           12
## deliberate      10           20
##
##           Accuracy : 0.6615
##           95% CI : (0.5335, 0.7743)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.008794
##
##           Kappa : 0.3223
##
## Mcnemar's Test P-Value : 0.831170
##
##           Sensitivity : 0.6970
##           Specificity : 0.6250
##           Pos Pred Value : 0.6571
##           Neg Pred Value : 0.6667
##           Prevalence : 0.5077
##           Detection Rate : 0.3538
##           Detection Prevalence : 0.5385
##           Balanced Accuracy : 0.6610
##
##           'Positive' Class : spontaneous
##
```

```
# 7E AU's selection and onset
```

```
set.seed(1973)
smile__svm_model_7E <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7E$results
```

```
##      C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.582002 0.1671039 0.06536007 0.131873
```

```
summary(smile__svm_model_7E$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7E_pred <- predict(smile__svm_model_7E, tst_smile)
summary(smile__svm_model_7E_pred)
```

```
## spontaneous deliberate
##           99           43
```

```
smile__svm_model_7E_confM <- confusionMatrix(
  smile__svm_model_7E_pred,
  tst_smile$smile_type
)
smile__svm_model_7E_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          51           48
## deliberate           19           24
##
##              Accuracy : 0.5282
##              95% CI : (0.4427, 0.6124)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.3375712
##
##              Kappa : 0.0616
##
##      McNemar's Test P-Value : 0.0006245
##
##              Sensitivity : 0.7286
##              Specificity : 0.3333
##              Pos Pred Value : 0.5152
##              Neg Pred Value : 0.5581
```

```
##           Prevalence : 0.4930
##           Detection Rate : 0.3592
##       Detection Prevalence : 0.6972
##           Balanced Accuracy : 0.5310
##
##           'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7E.1_pred <- predict(smile__svm_model_7E, tst_smile_boys)
summary(smile__svm_model_7E.1_pred)
```

```
## spontaneous deliberate
##           51           26
```

```
smile__svm_model_7E.1_confM <- confusionMatrix(
  smile__svm_model_7E.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7E.1_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    spontaneous deliberate
##   spontaneous         26          25
##   deliberate         11          15
##
##           Accuracy : 0.5325
##           95% CI : (0.4152, 0.6471)
##   No Information Rate : 0.5195
##   P-Value [Acc > NIR] : 0.45523
##
##           Kappa : 0.0766
##
##   McNemar's Test P-Value : 0.03026
##
##           Sensitivity : 0.7027
##           Specificity : 0.3750
##           Pos Pred Value : 0.5098
##           Neg Pred Value : 0.5769
##           Prevalence : 0.4805
##           Detection Rate : 0.3377
##       Detection Prevalence : 0.6623
##           Balanced Accuracy : 0.5389
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7E.2_pred <- predict(smile__svm_model_7E, tst_smile_girls)
summary(smile__svm_model_7E.2_pred)
```

```
## spontaneous deliberate
##           48           17
```

```
smile__svm_model_7E.2_confM <- confusionMatrix(
  smile__svm_model_7E.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7E.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      25           23
## deliberate       8            9
##
##              Accuracy : 0.5231
##              95% CI : (0.3954, 0.6485)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.45095
##
##              Kappa : 0.0391
##
##  Mcnemar's Test P-Value : 0.01192
##
##      Sensitivity : 0.7576
##      Specificity : 0.2812
##      Pos Pred Value : 0.5208
##      Neg Pred Value : 0.5294
##      Prevalence : 0.5077
##      Detection Rate : 0.3846
##      Detection Prevalence : 0.7385
##      Balanced Accuracy : 0.5194
##
##      'Positive' Class : spontaneous
##
```

```
# 7B apex AU's selection and apex
```

```
set.seed(1973)
smile__svm_model_7F <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + apex_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_7F$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5768549 0.1536795 0.07359117 0.1488513
```

```
summary(smile__svm_model_7F$finalModel)
```

```
## Length Class Mode  
##      1  ksvm  S4
```

```
smile__svm_model_7F_pred <- predict(smile__svm_model_7F, tst_smile)  
summary(smile__svm_model_7F_pred)
```

```
## spontaneous deliberate  
##           73           69
```

```
smile__svm_model_7F_confM <- confusionMatrix(  
  smile__svm_model_7F_pred,  
  tst_smile$smile_type  
)  
smile__svm_model_7F_confM
```

```
## Confusion Matrix and Statistics  
##  
##              Reference  
## Prediction    spontaneous deliberate  
## spontaneous           38           35  
## deliberate           32           37  
##  
##              Accuracy : 0.5282  
##              95% CI : (0.4427, 0.6124)  
##    No Information Rate : 0.507  
##    P-Value [Acc > NIR] : 0.3376  
##  
##              Kappa : 0.0567  
##  
## Mcnemar's Test P-Value : 0.8070  
##  
##              Sensitivity : 0.5429  
##              Specificity : 0.5139  
##              Pos Pred Value : 0.5205  
##              Neg Pred Value : 0.5362  
##              Prevalence : 0.4930  
##              Detection Rate : 0.2676  
##    Detection Prevalence : 0.5141  
##    Balanced Accuracy : 0.5284  
##  
##    'Positive' Class : spontaneous  
##
```

```
# predicting boys, girls
```

```
set.seed(1973)  
smile__svm_model_7F.1_pred <- predict(smile__svm_model_7F, tst_smile_boys)  
summary(smile__svm_model_7F.1_pred)
```

```
## spontaneous deliberate  
##           33           44
```

```
smile__svm_model_7F.1_confM <- confusionMatrix(
  smile__svm_model_7F.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7F.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           19           14
## deliberate           18           26
##
##              Accuracy : 0.5844
##              95% CI : (0.4664, 0.6957)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.1523
##
##              Kappa : 0.1642
##
##  Mcnemar's Test P-Value : 0.5959
##
##      Sensitivity : 0.5135
##      Specificity : 0.6500
##      Pos Pred Value : 0.5758
##      Neg Pred Value : 0.5909
##      Prevalence : 0.4805
##      Detection Rate : 0.2468
##      Detection Prevalence : 0.4286
##      Balanced Accuracy : 0.5818
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7F.2_pred <- predict(smile__svm_model_7F, tst_smile_girls)
summary(smile__svm_model_7F.2_pred)
```

```
## spontaneous deliberate
##           40           25
```

```
smile__svm_model_7F.2_confM <- confusionMatrix(
  smile__svm_model_7F.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7F.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           19           21
```

```
## deliberate          14          11
##
## Accuracy : 0.4615
## 95% CI : (0.337, 0.5897)
## No Information Rate : 0.5077
## P-Value [Acc > NIR] : 0.8074
##
## Kappa : -0.0808
##
## McNemar's Test P-Value : 0.3105
##
## Sensitivity : 0.5758
## Specificity : 0.3438
## Pos Pred Value : 0.4750
## Neg Pred Value : 0.4400
## Prevalence : 0.5077
## Detection Rate : 0.2923
## Detection Prevalence : 0.6154
## Balanced Accuracy : 0.4598
##
## 'Positive' Class : spontaneous
##
```

```
# 7G AU's selection and offset
```

```
set.seed(1973)
smile__svm_model_7G <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + offset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7G$results
```

```
## C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5761141 0.1547211 0.06019134 0.1219688
```

```
summary(smile__svm_model_7G$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7G_pred <- predict(smile__svm_model_7G, tst_smile)
summary(smile__svm_model_7G_pred)
```

```
## spontaneous deliberate
##          92          50
```

```
smile__svm_model_7G_confM <- confusionMatrix(
  smile__svm_model_7G_pred,
  tst_smile$smile_type
)
smile__svm_model_7G_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous          50           42
##  deliberate           20           30
##
##               Accuracy : 0.5634
##               95% CI : (0.4777, 0.6464)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.103915
##
##               Kappa : 0.1304
##
##  Mcnemar's Test P-Value : 0.007653
##
##      Sensitivity : 0.7143
##      Specificity : 0.4167
##      Pos Pred Value : 0.5435
##      Neg Pred Value : 0.6000
##      Prevalence : 0.4930
##      Detection Rate : 0.3521
##      Detection Prevalence : 0.6479
##      Balanced Accuracy : 0.5655
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7G.1_pred <- predict(smile__svm_model_7G, tst_smile_boys)
summary(smile__svm_model_7G.1_pred)
```

```
## spontaneous deliberate
##           49           28
```

```
smile__svm_model_7G.1_confM <- confusionMatrix(
  smile__svm_model_7G.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7G.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous          25           24
##  deliberate           12           16
##
##               Accuracy : 0.5325
##               95% CI : (0.4152, 0.6471)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.45523
```



```
##
##           Kappa : 0.0748
##
## Mcnemar's Test P-Value : 0.06675
##
##           Sensitivity : 0.6757
##           Specificity : 0.4000
##           Pos Pred Value : 0.5102
##           Neg Pred Value : 0.5714
##           Prevalence : 0.4805
##           Detection Rate : 0.3247
##           Detection Prevalence : 0.6364
##           Balanced Accuracy : 0.5378
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7G.2_pred <- predict(smile__svm_model_7G, tst_smile_girls)
summary(smile__svm_model_7G.2_pred)
```

```
## spontaneous deliberate
##           43           22
```

```
smile__svm_model_7G.2_confM <- confusionMatrix(
  smile__svm_model_7G.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7G.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           25           18
## deliberate            8           14
##
##           Accuracy : 0.6
##           95% CI : (0.471, 0.7196)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.08588
##
##           Kappa : 0.196
##
## Mcnemar's Test P-Value : 0.07756
##
##           Sensitivity : 0.7576
##           Specificity : 0.4375
##           Pos Pred Value : 0.5814
##           Neg Pred Value : 0.6364
##           Prevalence : 0.5077
##           Detection Rate : 0.3846
##           Detection Prevalence : 0.6615
```

```
##          Balanced Accuracy : 0.5975
##
##          'Positive' Class : spontaneous
##
```

```
# 7H selection AU's + temporal features
set.seed(1973)
smile__svm_model_7H <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7H$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6985851 0.3968121 0.09919617 0.1981549
```

```
summary(smile__svm_model_7H$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7H_pred <- predict(smile__svm_model_7H, tst_smile)
summary(smile__svm_model_7H_pred)
```

```
## spontaneous deliberate
##           59           83
```

```
smile__svm_model_7H_confM <- confusionMatrix(
  smile__svm_model_7H_pred,
  tst_smile$smile_type
)
smile__svm_model_7H_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      43             16
## deliberate       27             56
##
##              Accuracy : 0.6972
##              95% CI : (0.6145, 0.7714)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 3.274e-06
##
##              Kappa : 0.3929
##
##      McNemar's Test P-Value : 0.1273
```

```
##
##          Sensitivity : 0.6143
##          Specificity : 0.7778
##          Pos Pred Value : 0.7288
##          Neg Pred Value : 0.6747
##          Prevalence : 0.4930
##          Detection Rate : 0.3028
##          Detection Prevalence : 0.4155
##          Balanced Accuracy : 0.6960
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7H.1_pred <- predict(smile__svm_model_7H, tst_smile_boys)
summary(smile__svm_model_7H.1_pred)
```

```
## spontaneous deliberate
##          25          52
```

```
smile__svm_model_7H.1_confM <- confusionMatrix(
  smile__svm_model_7H.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7H.1_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          20           5
## deliberate          17          35
##
##          Accuracy : 0.7143
##          95% CI : (0.6, 0.8115)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.0003882
##
##          Kappa : 0.4207
##
## Mcnemar's Test P-Value : 0.0190165
##
##          Sensitivity : 0.5405
##          Specificity : 0.8750
##          Pos Pred Value : 0.8000
##          Neg Pred Value : 0.6731
##          Prevalence : 0.4805
##          Detection Rate : 0.2597
##          Detection Prevalence : 0.3247
##          Balanced Accuracy : 0.7078
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7H.2_pred <- predict(smile__svm_model_7H, tst_smile_girls)
summary(smile__svm_model_7H.2_pred)
```

```
## spontaneous deliberate
##           34           31
```

```
smile__svm_model_7H.2_confM <- confusionMatrix(
  smile__svm_model_7H.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7H.2_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           23           11
## deliberate           10           21
##
##              Accuracy : 0.6769
##              95% CI : (0.5495, 0.7877)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.004282
##
##              Kappa : 0.3534
##
##  McNemar's Test P-Value : 1.000000
##
##      Sensitivity : 0.6970
##      Specificity : 0.6562
##      Pos Pred Value : 0.6765
##      Neg Pred Value : 0.6774
##      Prevalence : 0.5077
##      Detection Rate : 0.3538
##      Detection Prevalence : 0.5231
##      Balanced Accuracy : 0.6766
##
##      'Positive' Class : spontaneous
##
```

```
# 7I
```

```
set.seed(1973)
smile__svm_model_7I <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7I$results
```

```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.6392324 0.2786654 0.06036414 0.1196935
```

```
summary(smile__svm_model_7I$finalModel)
```

```
## Length Class Mode
##      1 ksvm S4
```

```
smile__svm_model_7I_pred <- predict(smile__svm_model_7I, tst_smile)
summary(smile__svm_model_7I_pred)
```

```
## spontaneous deliberate
##           62           80
```

```
smile__svm_model_7I_confM <- confusionMatrix(
  smile__svm_model_7I_pred,
  tst_smile$smile_type
)
smile__svm_model_7I_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           41           21
## deliberate            29           51
##
##              Accuracy : 0.6479
##              95% CI : (0.5634, 0.7261)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0004898
##
##              Kappa : 0.2945
##
## Mcnemar's Test P-Value : 0.3221988
##
##              Sensitivity : 0.5857
##              Specificity : 0.7083
##              Pos Pred Value : 0.6613
##              Neg Pred Value : 0.6375
##              Prevalence : 0.4930
##              Detection Rate : 0.2887
##      Detection Prevalence : 0.4366
##              Balanced Accuracy : 0.6470
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
```

```
set.seed(1973)
smile__svm_model_7I.1_pred <- predict(smile__svm_model_7I, tst_smile_boys)
summary(smile__svm_model_7I.1_pred)
```

```
## spontaneous deliberate
##           27           50
```

```
smile__svm_model_7I.1_confM <- confusionMatrix(
  smile__svm_model_7I.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7I.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      21           6
## deliberate       16          34
##
##              Accuracy : 0.7143
##              95% CI : (0.6, 0.8115)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.0003882
##
##              Kappa : 0.4218
##
##  McNemar's Test P-Value : 0.0550088
##
##      Sensitivity : 0.5676
##      Specificity : 0.8500
##      Pos Pred Value : 0.7778
##      Neg Pred Value : 0.6800
##      Prevalence : 0.4805
##      Detection Rate : 0.2727
##      Detection Prevalence : 0.3506
##      Balanced Accuracy : 0.7088
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7I.2_pred <- predict(smile__svm_model_7I, tst_smile_girls)
summary(smile__svm_model_7I.2_pred)
```

```
## spontaneous deliberate
##           35           30
```

```
smile__svm_model_7I.2_confM <- confusionMatrix(
  smile__svm_model_7I.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7I.2_confM
```

```
## Confusion Matrix and Statistics
##
```

```
##           Reference
## Prediction    spontaneous deliberate
## spontaneous      20          15
## deliberate       13          17
##
##           Accuracy : 0.5692
##           95% CI : (0.4404, 0.6915)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.1927
##
##           Kappa : 0.1374
##
## Mcnemar's Test P-Value : 0.8501
##
##           Sensitivity : 0.6061
##           Specificity : 0.5312
##       Pos Pred Value : 0.5714
##       Neg Pred Value : 0.5667
##           Prevalence : 0.5077
##       Detection Rate : 0.3077
##       Detection Prevalence : 0.5385
##       Balanced Accuracy : 0.5687
##
##       'Positive' Class : spontaneous
##
```

```
# 7J
```

```
set.seed(1973)
smile__svm_model_7J <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  apex_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7J$results
```

```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.6424465 0.284497 0.07854931 0.1560307
```

```
summary(smile__svm_model_7J$finalModel)
```

```
## Length Class Mode
##      1 ksvm S4
```

```
smile__svm_model_7J_pred <- predict(smile__svm_model_7J, tst_smile)
summary(smile__svm_model_7J_pred)
```

```
## spontaneous deliberate
##           65          77
```

```
smile__svm_model_7J_confM <- confusionMatrix(
  smile__svm_model_7J_pred,
  tst_smile$smile_type
)
smile__svm_model_7J_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           43           22
## deliberate           27           50
##
##              Accuracy : 0.6549
##              95% CI : (0.5706, 0.7326)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0002621
##
##              Kappa : 0.309
##
##  Mcnemar's Test P-Value : 0.5677092
##
##              Sensitivity : 0.6143
##              Specificity : 0.6944
##              Pos Pred Value : 0.6615
##              Neg Pred Value : 0.6494
##              Prevalence : 0.4930
##              Detection Rate : 0.3028
##      Detection Prevalence : 0.4577
##              Balanced Accuracy : 0.6544
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7J.1_pred <- predict(smile__svm_model_7J, tst_smile_boys)
summary(smile__svm_model_7J.1_pred)
```

```
## spontaneous deliberate
##              30              47
```

```
smile__svm_model_7J.1_confM <- confusionMatrix(
  smile__svm_model_7J.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7J.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```



```
##      spontaneous      24      6
##      deliberate      13     34
##
##              Accuracy : 0.7532
##              95% CI : (0.6418, 0.8444)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 2.185e-05
##
##              Kappa : 0.5022
##
##      McNemar's Test P-Value : 0.1687
##
##              Sensitivity : 0.6486
##              Specificity : 0.8500
##              Pos Pred Value : 0.8000
##              Neg Pred Value : 0.7234
##              Prevalence : 0.4805
##              Detection Rate : 0.3117
##      Detection Prevalence : 0.3896
##              Balanced Accuracy : 0.7493
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7J.2_pred <- predict(smile__svm_model_7J, tst_smile_girls)
summary(smile__svm_model_7J.2_pred)
```

```
## spontaneous deliberate
##           35           30
```

```
smile__svm_model_7J.2_confM <- confusionMatrix(
  smile__svm_model_7J.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7J.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      19      16
##      deliberate      14      16
##
##              Accuracy : 0.5385
##              95% CI : (0.4103, 0.663)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.3553
##
##              Kappa : 0.0758
##
##      McNemar's Test P-Value : 0.8551
##
```

```
##           Sensitivity : 0.5758
##           Specificity : 0.5000
##           Pos Pred Value : 0.5429
##           Neg Pred Value : 0.5333
##           Prevalence : 0.5077
##           Detection Rate : 0.2923
##           Detection Prevalence : 0.5385
##           Balanced Accuracy : 0.5379
##
##           'Positive' Class : spontaneous
##
```

```
# 7K
```

```
set.seed(1973)
smile__svm_model_7K <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  offset_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_7K$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6302306 0.2607177 0.0555369 0.1093455
```

```
summary(smile__svm_model_7K$finalModel)
```

```
## Length Class      Mode
##      1      ksvm      S4
```

```
smile__svm_model_7K_pred <- predict(smile__svm_model_7K, tst_smile)
summary(smile__svm_model_7K_pred)
```

```
## spontaneous deliberate
##           64           78
```

```
smile__svm_model_7K_confM <- confusionMatrix(
  smile__svm_model_7K_pred,
  tst_smile$smile_type
)
smile__svm_model_7K_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction      spontaneous deliberate
##      spontaneous           42           22
##      deliberate           28           50
##
```

```
##               Accuracy : 0.6479
##               95% CI : (0.5634, 0.7261)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0004898
##
##               Kappa : 0.2948
##
##  McNemar's Test P-Value : 0.4795001
##
##               Sensitivity : 0.6000
##               Specificity : 0.6944
##      Pos Pred Value : 0.6562
##      Neg Pred Value : 0.6410
##      Prevalence : 0.4930
##      Detection Rate : 0.2958
##      Detection Prevalence : 0.4507
##      Balanced Accuracy : 0.6472
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_7K.1_pred <- predict(smile__svm_model_7K, tst_smile_boys)
summary(smile__svm_model_7K.1_pred)
```

```
## spontaneous deliberate
##           30           47
```

```
smile__svm_model_7K.1_confM <- confusionMatrix(
  smile__svm_model_7K.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_7K.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction  spontaneous deliberate
## spontaneous           22           8
## deliberate           15          32
##
##               Accuracy : 0.7013
##               95% CI : (0.5862, 0.8003)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.0008966
##
##               Kappa : 0.3974
##
##  McNemar's Test P-Value : 0.2109029
##
##               Sensitivity : 0.5946
##               Specificity : 0.8000
```

```
##          Pos Pred Value : 0.7333
##          Neg Pred Value : 0.6809
##          Prevalence : 0.4805
##          Detection Rate : 0.2857
##          Detection Prevalence : 0.3896
##          Balanced Accuracy : 0.6973
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_7K.2_pred <- predict(smile__svm_model_7K, tst_smile_girls)
summary(smile__svm_model_7K.2_pred)
```

```
## spontaneous deliberate
##          34          31
```

```
smile__svm_model_7K.2_confM <- confusionMatrix(
  smile__svm_model_7K.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_7K.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous         20          14
## deliberate         13          18
##
##              Accuracy : 0.5846
##              95% CI : (0.4556, 0.7056)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.132
##
##              Kappa : 0.1686
##
##      Mcnemar's Test P-Value : 1.000
##
##              Sensitivity : 0.6061
##              Specificity : 0.5625
##              Pos Pred Value : 0.5882
##              Neg Pred Value : 0.5806
##              Prevalence : 0.5077
##              Detection Rate : 0.3077
##      Detection Prevalence : 0.5231
##              Balanced Accuracy : 0.5843
##
##              'Positive' Class : spontaneous
##
```

```
# 8 strongest features
```

```
# 8A
```

```
set.seed(1973)
```

```
smile__svm_model_8A <- train(smile_type ~ AU06_r_mean + AU12_r_mean +  
  AU45_r_mean + onset_mean + apex_mean +  
  offset_mean + lip_mean + eye_mean,  
method = "svmLinear", data = trn_smile,  
trnControl = trainControl(method = "cv", number = 10)  
)
```

```
smile__svm_model_8A$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD  
## 1 1 0.6927028 0.3855624 0.08658439 0.1737373
```

```
smile__svm_model_8A_pred <- predict(smile__svm_model_8A, tst_smile)  
summary(smile__svm_model_8A_pred)
```

```
## spontaneous deliberate  
##           68           74
```

```
smile__svm_model_8A_confM <- confusionMatrix(  
  smile__svm_model_8A_pred,  
  tst_smile$smile_type  
)  
smile__svm_model_8A_confM
```

```
## Confusion Matrix and Statistics
```

```
##  
##              Reference  
## Prediction  spontaneous deliberate  
## spontaneous      44             24  
## deliberate      26             48  
##  
##              Accuracy : 0.6479  
##              95% CI : (0.5634, 0.7261)  
##      No Information Rate : 0.507  
##      P-Value [Acc > NIR] : 0.0004898  
##  
##              Kappa : 0.2954  
##  
##      McNemar's Test P-Value : 0.8875371  
##  
##              Sensitivity : 0.6286  
##              Specificity : 0.6667  
##              Pos Pred Value : 0.6471  
##              Neg Pred Value : 0.6486  
##              Prevalence : 0.4930  
##              Detection Rate : 0.3099  
##      Detection Prevalence : 0.4789  
##              Balanced Accuracy : 0.6476
```

```
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8A.1_pred <- predict(smile__svm_model_8A, tst_smile_boys)
summary(smile__svm_model_8A.1_pred)
```

```
## spontaneous deliberate
##      27      50
```

```
smile__svm_model_8A.1_confM <- confusionMatrix(
  smile__svm_model_8A.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8A.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction      spontaneous deliberate
## spontaneous      19          8
## deliberate       18         32
##
##              Accuracy : 0.6623
##              95% CI : (0.5455, 0.7662)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.007868
##
##              Kappa : 0.3167
##
##      McNemar's Test P-Value : 0.077556
##
##              Sensitivity : 0.5135
##              Specificity : 0.8000
##              Pos Pred Value : 0.7037
##              Neg Pred Value : 0.6400
##              Prevalence : 0.4805
##              Detection Rate : 0.2468
##              Detection Prevalence : 0.3506
##              Balanced Accuracy : 0.6568
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8A.2_pred <- predict(smile__svm_model_8A, tst_smile_girls)
summary(smile__svm_model_8A.2_pred)
```

```
## spontaneous deliberate
##      41      24
```

```
smile__svm_model_8A.2_confM <- confusionMatrix(
  smile__svm_model_8A.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8A.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           25           16
## deliberate            8           16
##
##              Accuracy : 0.6308
##              95% CI : (0.502, 0.7472)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.03086
##
##              Kappa : 0.2586
##
## Mcnemar's Test P-Value : 0.15304
##
##      Sensitivity : 0.7576
##      Specificity : 0.5000
##      Pos Pred Value : 0.6098
##      Neg Pred Value : 0.6667
##      Prevalence : 0.5077
##      Detection Rate : 0.3846
##      Detection Prevalence : 0.6308
##      Balanced Accuracy : 0.6288
##
##      'Positive' Class : spontaneous
##
```

```
# 8B
set.seed(1973)
smile__svm_model_8B <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + lip_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8B$results
```

```
##      C Accuracy      Kappa AccuracySD KappaSD
## 1 1 0.6633857 0.327155 0.06435706 0.12877
```

```
smile__svm_model_8B_pred <- predict(smile__svm_model_8B, tst_smile)
summary(smile__svm_model_8B_pred)
```

```
## spontaneous deliberate
##              74              68
```

```
smile__svm_model_8B_confM <- confusionMatrix(
  smile__svm_model_8B_pred,
  tst_smile$smile_type
)
smile__svm_model_8B_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      44             30
## deliberate       26             42
##
##              Accuracy : 0.6056
##              95% CI : (0.5202, 0.6865)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.01151
##
##              Kappa : 0.2117
##
##  Mcnemar's Test P-Value : 0.68850
##
##              Sensitivity : 0.6286
##              Specificity : 0.5833
##              Pos Pred Value : 0.5946
##              Neg Pred Value : 0.6176
##              Prevalence : 0.4930
##              Detection Rate : 0.3099
##      Detection Prevalence : 0.5211
##              Balanced Accuracy : 0.6060
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8B.1_pred <- predict(smile__svm_model_8B, tst_smile_boys)
summary(smile__svm_model_8B.1_pred)
```

```
## spontaneous deliberate
##              34             43
```

```
smile__svm_model_8B.1_confM <- confusionMatrix(
  smile__svm_model_8B.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8B.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```



```
##      spontaneous      21      13
##      deliberate      16      27
##
##              Accuracy : 0.6234
##              95% CI : (0.5056, 0.7313)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.04297
##
##              Kappa : 0.2433
##
##      McNemar's Test P-Value : 0.71035
##
##              Sensitivity : 0.5676
##              Specificity : 0.6750
##      Pos Pred Value : 0.6176
##      Neg Pred Value : 0.6279
##      Prevalence : 0.4805
##      Detection Rate : 0.2727
##      Detection Prevalence : 0.4416
##      Balanced Accuracy : 0.6213
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8B.2_pred <- predict(smile__svm_model_8B, tst_smile_girls)
summary(smile__svm_model_8B.2_pred)
```

```
## spontaneous deliberate
##           40           25
```

```
smile__svm_model_8B.2_confM <- confusionMatrix(
  smile__svm_model_8B.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8B.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      23      17
##      deliberate      10      15
##
##              Accuracy : 0.5846
##              95% CI : (0.4556, 0.7056)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.1320
##
##              Kappa : 0.1663
##
##      McNemar's Test P-Value : 0.2482
##
```

```
##           Sensitivity : 0.6970
##           Specificity : 0.4688
##           Pos Pred Value : 0.5750
##           Neg Pred Value : 0.6000
##           Prevalence : 0.5077
##           Detection Rate : 0.3538
##           Detection Prevalence : 0.6154
##           Balanced Accuracy : 0.5829
##
##           'Positive' Class : spontaneous
##
```

```
# 8C
set.seed(1973)
smile__svm_model_8C <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + apex_mean + lip_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8C$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5919285 0.1842753 0.09834628 0.1972986
```

```
smile__svm_model_8C_pred <- predict(smile__svm_model_8C, tst_smile)
summary(smile__svm_model_8C_pred)
```

```
## spontaneous deliberate
##           71           71
```

```
smile__svm_model_8C_confM <- confusionMatrix(
  smile__svm_model_8C_pred,
  tst_smile$smile_type
)
smile__svm_model_8C_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous      41           30
## deliberate      29           42
##
##           Accuracy : 0.5845
##           95% CI : (0.4989, 0.6665)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 0.03874
##
##           Kappa : 0.169
##
##           Mcnemar's Test P-Value : 1.00000
```

```
##
##          Sensitivity : 0.5857
##          Specificity : 0.5833
##          Pos Pred Value : 0.5775
##          Neg Pred Value : 0.5915
##          Prevalence : 0.4930
##          Detection Rate : 0.2887
##          Detection Prevalence : 0.5000
##          Balanced Accuracy : 0.5845
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8C.1_pred <- predict(smile__svm_model_8C, tst_smile_boys)
summary(smile__svm_model_8C.1_pred)
```

```
## spontaneous deliberate
##          34          43
```

```
smile__svm_model_8C.1_confM <- confusionMatrix(
  smile__svm_model_8C.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8C.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          19          15
## deliberate          18          25
##
##          Accuracy : 0.5714
##          95% CI : (0.4535, 0.6837)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.2126
##
##          Kappa : 0.1389
##
## Mcnemar's Test P-Value : 0.7277
##
##          Sensitivity : 0.5135
##          Specificity : 0.6250
##          Pos Pred Value : 0.5588
##          Neg Pred Value : 0.5814
##          Prevalence : 0.4805
##          Detection Rate : 0.2468
##          Detection Prevalence : 0.4416
##          Balanced Accuracy : 0.5693
##
##          'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8C.2_pred <- predict(smile__svm_model_8C, tst_smile_girls)
summary(smile__svm_model_8C.2_pred)
```

```
## spontaneous deliberate
##           37           28
```

```
smile__svm_model_8C.2_confM <- confusionMatrix(
  smile__svm_model_8C.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8C.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           22           15
## deliberate            11           17
##
##              Accuracy : 0.6
##              95% CI : (0.471, 0.7196)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.08588
##
##              Kappa : 0.1983
##
##  Mcnemar's Test P-Value : 0.55630
##
##              Sensitivity : 0.6667
##              Specificity : 0.5312
##              Pos Pred Value : 0.5946
##              Neg Pred Value : 0.6071
##              Prevalence : 0.5077
##              Detection Rate : 0.3385
##      Detection Prevalence : 0.5692
##              Balanced Accuracy : 0.5990
##
##      'Positive' Class : spontaneous
##
```

```
# 8D
set.seed(1973)
smile__svm_model_8D <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + offset_mean + lip_mean +
  eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)
smile__svm_model_8D$results
```

```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.6632074 0.3276323 0.06838694 0.1362339
```

```
smile__svm_model_8D_pred <- predict(smile__svm_model_8D, tst_smile)
summary(smile__svm_model_8D_pred)
```

```
## spontaneous deliberate
##          78          64
```

```
smile__svm_model_8D_confM <- confusionMatrix(
  smile__svm_model_8D_pred,
  tst_smile$smile_type
)
smile__svm_model_8D_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      52          26
## deliberate       18          46
##
##              Accuracy : 0.6901
##              95% CI : (0.6072, 0.765)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 7.345e-06
##
##              Kappa : 0.3811
##
##  McNemar's Test P-Value : 0.2913
##
##              Sensitivity : 0.7429
##              Specificity : 0.6389
##              Pos Pred Value : 0.6667
##              Neg Pred Value : 0.7188
##              Prevalence : 0.4930
##              Detection Rate : 0.3662
##      Detection Prevalence : 0.5493
##              Balanced Accuracy : 0.6909
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8D.1_pred <- predict(smile__svm_model_8D, tst_smile_boys)
summary(smile__svm_model_8D.1_pred)
```

```
## spontaneous deliberate
##          32          45
```

```
smile__svm_model_8D.1_confM <- confusionMatrix(
  smile__svm_model_8D.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8D.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           23           9
## deliberate           14          31
##
##               Accuracy : 0.7013
##               95% CI : (0.5862, 0.8003)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 0.0008966
##
##               Kappa : 0.3986
##
##  Mcnemar's Test P-Value : 0.4042485
##
##       Sensitivity : 0.6216
##       Specificity : 0.7750
##       Pos Pred Value : 0.7188
##       Neg Pred Value : 0.6889
##       Prevalence : 0.4805
##       Detection Rate : 0.2987
##       Detection Prevalence : 0.4156
##       Balanced Accuracy : 0.6983
##
##       'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8D.2_pred <- predict(smile__svm_model_8D, tst_smile_girls)
summary(smile__svm_model_8D.2_pred)
```

```
## spontaneous deliberate
##           46           19
```

```
smile__svm_model_8D.2_confM <- confusionMatrix(
  smile__svm_model_8D.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8D.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous           29           17
```

```
## deliberate          4          15
##
##           Accuracy : 0.6769
##           95% CI : (0.5495, 0.7877)
##       No Information Rate : 0.5077
##       P-Value [Acc > NIR] : 0.004282
##
##           Kappa : 0.3497
##
## Mcnemar's Test P-Value : 0.008829
##
##           Sensitivity : 0.8788
##           Specificity : 0.4688
##       Pos Pred Value : 0.6304
##       Neg Pred Value : 0.7895
##           Prevalence : 0.5077
##       Detection Rate : 0.4462
##       Detection Prevalence : 0.7077
##       Balanced Accuracy : 0.6738
##
##       'Positive' Class : spontaneous
##
```

```
# 8E
set.seed(1973)
smile__svm_model_8E <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean + lip_mean +
  eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8E$results
```

```
## C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.7105336 0.4206647 0.1096118 0.2191265
```

```
smile__svm_model_8E_pred <- predict(smile__svm_model_8E, tst_smile)
summary(smile__svm_model_8E_pred)
```

```
## spontaneous deliberate
##           61           81
```

```
smile__svm_model_8E_confM <- confusionMatrix(
  smile__svm_model_8E_pred,
  tst_smile$smile_type
)
smile__svm_model_8E_confM
```

```
## Confusion Matrix and Statistics
##
```

```
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      47           14
## deliberate       23           58
##
##               Accuracy : 0.7394
##               95% CI : (0.6592, 0.8094)
##       No Information Rate : 0.507
##       P-Value [Acc > NIR] : 1.288e-08
##
##               Kappa : 0.4778
##
## Mcnemar's Test P-Value : 0.1884
##
##       Sensitivity : 0.6714
##       Specificity : 0.8056
##       Pos Pred Value : 0.7705
##       Neg Pred Value : 0.7160
##       Prevalence : 0.4930
##       Detection Rate : 0.3310
##       Detection Prevalence : 0.4296
##       Balanced Accuracy : 0.7385
##
##       'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8E.1_pred <- predict(smile__svm_model_8E, tst_smile_boys)
summary(smile__svm_model_8E.1_pred)
```

```
## spontaneous deliberate
##           25           52
```

```
smile__svm_model_8E.1_confM <- confusionMatrix(
  smile__svm_model_8E.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8E.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
## spontaneous      21           4
## deliberate       16          36
##
##               Accuracy : 0.7403
##               95% CI : (0.6277, 0.8336)
##       No Information Rate : 0.5195
##       P-Value [Acc > NIR] : 6.073e-05
##
##               Kappa : 0.4733
```



```
##
## McNemar's Test P-Value : 0.01391
##
##           Sensitivity : 0.5676
##           Specificity : 0.9000
##           Pos Pred Value : 0.8400
##           Neg Pred Value : 0.6923
##           Prevalence : 0.4805
##           Detection Rate : 0.2727
##           Detection Prevalence : 0.3247
##           Balanced Accuracy : 0.7338
##
##           'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8E.2_pred <- predict(smile__svm_model_8E, tst_smile_girls)
summary(smile__svm_model_8E.2_pred)
```

```
## spontaneous deliberate
##           36           29
```

```
smile__svm_model_8E.2_confM <- confusionMatrix(
  smile__svm_model_8E.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8E.2_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           26           10
## deliberate            7           22
##
##           Accuracy : 0.7385
##           95% CI : (0.6146, 0.8397)
##           No Information Rate : 0.5077
##           P-Value [Acc > NIR] : 0.0001234
##
##           Kappa : 0.4761
##
## McNemar's Test P-Value : 0.6276258
##
##           Sensitivity : 0.7879
##           Specificity : 0.6875
##           Pos Pred Value : 0.7222
##           Neg Pred Value : 0.7586
##           Prevalence : 0.5077
##           Detection Rate : 0.4000
##           Detection Prevalence : 0.5538
##           Balanced Accuracy : 0.7377
##
```

```
##      'Positive' Class : spontaneous
##
```

```
# 8F
set.seed(1973)
smile__svm_model_8F <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8F$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6602607 0.3204802 0.09509904 0.1915229
```

```
smile__svm_model_8F_pred <- predict(smile__svm_model_8F, tst_smile)
summary(smile__svm_model_8F_pred)
```

```
## spontaneous deliberate
##           64           78
```

```
smile__svm_model_8F_confM <- confusionMatrix(
  smile__svm_model_8F_pred,
  tst_smile$smile_type
)
smile__svm_model_8F_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous      43           21
## deliberate       27           51
##
##              Accuracy : 0.662
##              95% CI : (0.5779, 0.7391)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.0001362
##
##              Kappa : 0.323
##
##      McNemar's Test P-Value : 0.4704864
##
##              Sensitivity : 0.6143
##              Specificity : 0.7083
##      Pos Pred Value : 0.6719
##      Neg Pred Value : 0.6538
##              Prevalence : 0.4930
##      Detection Rate : 0.3028
##      Detection Prevalence : 0.4507
```

```
##          Balanced Accuracy : 0.6613
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8F.1_pred <- predict(smile__svm_model_8F, tst_smile_boys)
summary(smile__svm_model_8F.1_pred)
```

```
## spontaneous deliberate
##          26          51
```

```
smile__svm_model_8F.1_confM <- confusionMatrix(
  smile__svm_model_8F.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8F.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous          19           7
## deliberate          18          33
##
##              Accuracy : 0.6753
##              95% CI : (0.559, 0.7777)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.00403
##
##              Kappa : 0.3423
##
##  McNemar's Test P-Value : 0.04550
##
##      Sensitivity : 0.5135
##      Specificity : 0.8250
##      Pos Pred Value : 0.7308
##      Neg Pred Value : 0.6471
##      Prevalence : 0.4805
##      Detection Rate : 0.2468
##      Detection Prevalence : 0.3377
##      Balanced Accuracy : 0.6693
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8F.2_pred <- predict(smile__svm_model_8F, tst_smile_girls)
summary(smile__svm_model_8F.2_pred)
```

```
## spontaneous deliberate
##          38          27
```

```
smile__svm_model_8F.2_confM <- confusionMatrix(
  smile__svm_model_8F.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8F.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           24           14
## deliberate            9           18
##
##              Accuracy : 0.6462
##              95% CI : (0.5177, 0.7608)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.01698
##
##              Kappa : 0.2905
##
##  Mcnemar's Test P-Value : 0.40425
##
##      Sensitivity : 0.7273
##      Specificity : 0.5625
##      Pos Pred Value : 0.6316
##      Neg Pred Value : 0.6667
##      Prevalence : 0.5077
##      Detection Rate : 0.3692
##      Detection Prevalence : 0.5846
##      Balanced Accuracy : 0.6449
##
##      'Positive' Class : spontaneous
##
```

```
# 8G
set.seed(1973)
smile__svm_model_8G <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + eye_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8G$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5408422 0.08175117 0.04353818 0.08936622
```

```
smile__svm_model_8G_pred <- predict(smile__svm_model_8G, tst_smile)
summary(smile__svm_model_8G_pred)
```

```
## spontaneous deliberate
##              73              69
```

```
smile__svm_model_8G_confM <- confusionMatrix(
  smile__svm_model_8G_pred,
  tst_smile$smile_type
)
smile__svm_model_8G_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           42           31
## deliberate           28           41
##
##              Accuracy : 0.5845
##              95% CI : (0.4989, 0.6665)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.03874
##
##              Kappa : 0.1693
##
##  Mcnemar's Test P-Value : 0.79457
##
##              Sensitivity : 0.6000
##              Specificity : 0.5694
##              Pos Pred Value : 0.5753
##              Neg Pred Value : 0.5942
##              Prevalence : 0.4930
##              Detection Rate : 0.2958
##      Detection Prevalence : 0.5141
##              Balanced Accuracy : 0.5847
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8G.1_pred <- predict(smile__svm_model_8G, tst_smile_boys)
summary(smile__svm_model_8G.1_pred)
```

```
## spontaneous deliberate
##              33              44
```

```
smile__svm_model_8G.1_confM <- confusionMatrix(
  smile__svm_model_8G.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8G.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      17      16
##      deliberate      20      24
##
##              Accuracy : 0.5325
##              95% CI : (0.4152, 0.6471)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.4552
##
##              Kappa : 0.0597
##
##      McNemar's Test P-Value : 0.6171
##
##              Sensitivity : 0.4595
##              Specificity : 0.6000
##      Pos Pred Value : 0.5152
##      Neg Pred Value : 0.5455
##      Prevalence : 0.4805
##      Detection Rate : 0.2208
##      Detection Prevalence : 0.4286
##      Balanced Accuracy : 0.5297
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8G.2_pred <- predict(smile__svm_model_8G, tst_smile_girls)
summary(smile__svm_model_8G.2_pred)
```

```
## spontaneous deliberate
##           40           25
```

```
smile__svm_model_8G.2_confM <- confusionMatrix(
  smile__svm_model_8G.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8G.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      25      15
##      deliberate       8      17
##
##              Accuracy : 0.6462
##              95% CI : (0.5177, 0.7608)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.01698
##
##              Kappa : 0.2898
##
##      McNemar's Test P-Value : 0.21090
##
```

```
##           Sensitivity : 0.7576
##           Specificity : 0.5312
##           Pos Pred Value : 0.6250
##           Neg Pred Value : 0.6800
##           Prevalence : 0.5077
##           Detection Rate : 0.3846
##           Detection Prevalence : 0.6154
##           Balanced Accuracy : 0.6444
##
##           'Positive' Class : spontaneous
##
```

```
# 8H
set.seed(1973)
smile__svm_model_8H <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + apex_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8H$results
```

```
## C Accuracy Kappa AccuracySD KappaSD
## 1 1 0.5591188 0.118238 0.06334477 0.1273335
```

```
smile__svm_model_8H_pred <- predict(smile__svm_model_8H, tst_smile)
summary(smile__svm_model_8H_pred)
```

```
## spontaneous deliberate
##           66           76
```

```
smile__svm_model_8H_confM <- confusionMatrix(
  smile__svm_model_8H_pred,
  tst_smile$smile_type
)
smile__svm_model_8H_confM
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  spontaneous deliberate
## spontaneous           36           30
## deliberate           34           42
##
##           Accuracy : 0.5493
##           95% CI : (0.4636, 0.6328)
##           No Information Rate : 0.507
##           P-Value [Acc > NIR] : 0.1780
##
##           Kappa : 0.0977
##
##           Mcnemar's Test P-Value : 0.7077
```

```
##
##          Sensitivity : 0.5143
##          Specificity : 0.5833
##          Pos Pred Value : 0.5455
##          Neg Pred Value : 0.5526
##          Prevalence : 0.4930
##          Detection Rate : 0.2535
##          Detection Prevalence : 0.4648
##          Balanced Accuracy : 0.5488
##
##          'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8H.1_pred <- predict(smile__svm_model_8H, tst_smile_boys)
summary(smile__svm_model_8H.1_pred)
```

```
## spontaneous deliberate
##          27          50
```

```
smile__svm_model_8H.1_confM <- confusionMatrix(
  smile__svm_model_8H.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8H.1_confM
```

```
## Confusion Matrix and Statistics
```

```
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          16          11
## deliberate          21          29
##
##          Accuracy : 0.5844
##          95% CI : (0.4664, 0.6957)
##          No Information Rate : 0.5195
##          P-Value [Acc > NIR] : 0.1523
##
##          Kappa : 0.159
##
## Mcnemar's Test P-Value : 0.1116
##
##          Sensitivity : 0.4324
##          Specificity : 0.7250
##          Pos Pred Value : 0.5926
##          Neg Pred Value : 0.5800
##          Prevalence : 0.4805
##          Detection Rate : 0.2078
##          Detection Prevalence : 0.3506
##          Balanced Accuracy : 0.5787
##
##          'Positive' Class : spontaneous
##
```



```
set.seed(1973)
smile__svm_model_8H.2_pred <- predict(smile__svm_model_8H, tst_smile_girls)
summary(smile__svm_model_8H.2_pred)
```

```
## spontaneous deliberate
##           39           26
```

```
smile__svm_model_8H.2_confM <- confusionMatrix(
  smile__svm_model_8H.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8H.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           20           19
## deliberate           13           13
##
##              Accuracy : 0.5077
##              95% CI : (0.3807, 0.634)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.5495
##
##              Kappa : 0.0123
##
##  Mcnemar's Test P-Value : 0.3768
##
##              Sensitivity : 0.6061
##              Specificity : 0.4062
##              Pos Pred Value : 0.5128
##              Neg Pred Value : 0.5000
##              Prevalence : 0.5077
##              Detection Rate : 0.3077
##      Detection Prevalence : 0.6000
##              Balanced Accuracy : 0.5062
##
##      'Positive' Class : spontaneous
##
```

```
# 8I
set.seed(1973)
smile__svm_model_8I <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + offset_mean + eye_mean,
  method = "svmLinear", data = trn_smile,
  trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8I$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5761308 0.152213 0.07350272 0.1491875
```

```
smile__svm_model_8I_pred <- predict(smile__svm_model_8I, tst_smile)
summary(smile__svm_model_8I_pred)
```

```
## spontaneous deliberate
##           67           75
```

```
smile__svm_model_8I_confM <- confusionMatrix(
  smile__svm_model_8I_pred,
  tst_smile$smile_type
)
smile__svm_model_8I_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           39           28
## deliberate           31           44
##
##              Accuracy : 0.5845
##              95% CI : (0.4989, 0.6665)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 0.03874
##
##              Kappa : 0.1684
##
##  Mcnemar's Test P-Value : 0.79457
##
##      Sensitivity : 0.5571
##      Specificity : 0.6111
##      Pos Pred Value : 0.5821
##      Neg Pred Value : 0.5867
##      Prevalence : 0.4930
##      Detection Rate : 0.2746
##      Detection Prevalence : 0.4718
##      Balanced Accuracy : 0.5841
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8I.1_pred <- predict(smile__svm_model_8I, tst_smile_boys)
summary(smile__svm_model_8I.1_pred)
```

```
## spontaneous deliberate
##           29           48
```

```
smile__svm_model_8I.1_confM <- confusionMatrix(
  smile__svm_model_8I.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8I.1_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous         15          14
##  deliberate          22          26
##
##               Accuracy : 0.5325
##               95% CI : (0.4152, 0.6471)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.4552
##
##               Kappa : 0.0559
##
##  Mcnemar's Test P-Value : 0.2433
##
##      Sensitivity : 0.4054
##      Specificity : 0.6500
##      Pos Pred Value : 0.5172
##      Neg Pred Value : 0.5417
##      Prevalence : 0.4805
##      Detection Rate : 0.1948
##      Detection Prevalence : 0.3766
##      Balanced Accuracy : 0.5277
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8I.2_pred <- predict(smile__svm_model_8I, tst_smile_girls)
summary(smile__svm_model_8I.2_pred)
```

```
## spontaneous deliberate
##           38           27
```

```
smile__svm_model_8I.2_confM <- confusionMatrix(
  smile__svm_model_8I.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8I.2_confM
```

```
## Confusion Matrix and Statistics
##
##               Reference
## Prediction    spontaneous deliberate
##  spontaneous         24          14
##  deliberate           9          18
##
##               Accuracy : 0.6462
##               95% CI : (0.5177, 0.7608)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.01698
##
```

```
##                      Kappa : 0.2905
##
## Mcnemar's Test P-Value : 0.40425
##
##          Sensitivity : 0.7273
##          Specificity : 0.5625
##          Pos Pred Value : 0.6316
##          Neg Pred Value : 0.6667
##          Prevalence : 0.5077
##          Detection Rate : 0.3692
##          Detection Prevalence : 0.5846
##          Balanced Accuracy : 0.6449
##
##          'Positive' Class : spontaneous
##
```

```
# 8J
set.seed(1973)
smile__svm_model_8J <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean + onset_mean + apex_mean +
  offset_mean + lip_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8J$results
```

```
## C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6926081 0.3854562 0.0926346 0.1859359
```

```
smile__svm_model_8J_pred <- predict(smile__svm_model_8J, tst_smile)
summary(smile__svm_model_8J_pred)
```

```
## spontaneous deliberate
##          69          73
```

```
smile__svm_model_8J_confM <- confusionMatrix(
  smile__svm_model_8J_pred,
  tst_smile$smile_type
)
smile__svm_model_8J_confM
```

```
## Confusion Matrix and Statistics
##
##          Reference
## Prediction  spontaneous deliberate
## spontaneous          47          22
## deliberate          23          50
##
##          Accuracy : 0.6831
##          95% CI : (0.5998, 0.7586)
##          No Information Rate : 0.507
```

```
##      P-Value [Acc > NIR] : 1.596e-05
##
##              Kappa : 0.3659
##
## Mcnemar's Test P-Value : 1
##
##      Sensitivity : 0.6714
##      Specificity : 0.6944
##      Pos Pred Value : 0.6812
##      Neg Pred Value : 0.6849
##      Prevalence : 0.4930
##      Detection Rate : 0.3310
##      Detection Prevalence : 0.4859
##      Balanced Accuracy : 0.6829
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8J.1_pred <- predict(smile__svm_model_8J, tst_smile_boys)
summary(smile__svm_model_8J.1_pred)
```

```
## spontaneous deliberate
##           30           47
```

```
smile__svm_model_8J.1_confM <- confusionMatrix(
  smile__svm_model_8J.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8J.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
## spontaneous          22           8
## deliberate           15          32
##
##      Accuracy : 0.7013
##      95% CI : (0.5862, 0.8003)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 0.0008966
##
##              Kappa : 0.3974
##
## Mcnemar's Test P-Value : 0.2109029
##
##      Sensitivity : 0.5946
##      Specificity : 0.8000
##      Pos Pred Value : 0.7333
##      Neg Pred Value : 0.6809
##      Prevalence : 0.4805
```

```
##          Detection Rate : 0.2857
##    Detection Prevalence : 0.3896
##      Balanced Accuracy : 0.6973
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8J.2_pred <- predict(smile__svm_model_8J, tst_smile_girls)
summary(smile__svm_model_8J.2_pred)
```

```
## spontaneous deliberate
##          39          26
```

```
smile__svm_model_8J.2_confM <- confusionMatrix(
  smile__svm_model_8J.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8J.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
##    spontaneous      25          14
##    deliberate       8          18
##
##              Accuracy : 0.6615
##              95% CI : (0.5335, 0.7743)
##    No Information Rate : 0.5077
##    P-Value [Acc > NIR] : 0.008794
##
##              Kappa : 0.321
##
##    Mcnemar's Test P-Value : 0.286422
##
##              Sensitivity : 0.7576
##              Specificity : 0.5625
##              Pos Pred Value : 0.6410
##              Neg Pred Value : 0.6923
##              Prevalence : 0.5077
##              Detection Rate : 0.3846
##    Detection Prevalence : 0.6000
##              Balanced Accuracy : 0.6600
##
##      'Positive' Class : spontaneous
##
```

```
# 8K
set.seed(1973)
smile__svm_model_8K <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
```

```

onset_mean + apex_mean + offset_mean + lip_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

```

```
smile__svm_model_8K$results
```

```

##      C      Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.7196301 0.4390769 0.1031942 0.205939

```

```

smile__svm_model_8K_pred <- predict(smile__svm_model_8K, tst_smile)
summary(smile__svm_model_8K_pred)

```

```

## spontaneous deliberate
##           63           79

```

```

smile__svm_model_8K_confM <- confusionMatrix(
  smile__svm_model_8K_pred,
  tst_smile$smile_type
)
smile__svm_model_8K_confM

```

```

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      48          15
## deliberate       22          57
##
##              Accuracy : 0.7394
##              95% CI : (0.6592, 0.8094)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 1.288e-08
##
##              Kappa : 0.478
##
##  Mcnemar's Test P-Value : 0.3239
##
##              Sensitivity : 0.6857
##              Specificity : 0.7917
##      Pos Pred Value : 0.7619
##      Neg Pred Value : 0.7215
##      Prevalence : 0.4930
##      Detection Rate : 0.3380
##      Detection Prevalence : 0.4437
##      Balanced Accuracy : 0.7387
##
##      'Positive' Class : spontaneous
##

```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8K.1_pred <- predict(smile__svm_model_8K, tst_smile_boys)
summary(smile__svm_model_8K.1_pred)
```

```
## spontaneous deliberate
##           26           51
```

```
smile__svm_model_8K.1_confM <- confusionMatrix(
  smile__svm_model_8K.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8K.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous           22           4
## deliberate           15           36
##
##              Accuracy : 0.7532
##              95% CI : (0.6418, 0.8444)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 2.185e-05
##
##              Kappa : 0.5002
##
##  Mcnemar's Test P-Value : 0.02178
##
##      Sensitivity : 0.5946
##      Specificity : 0.9000
##      Pos Pred Value : 0.8462
##      Neg Pred Value : 0.7059
##      Prevalence : 0.4805
##      Detection Rate : 0.2857
##      Detection Prevalence : 0.3377
##      Balanced Accuracy : 0.7473
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8K.2_pred <- predict(smile__svm_model_8K, tst_smile_girls)
summary(smile__svm_model_8K.2_pred)
```

```
## spontaneous deliberate
##           37           28
```

```
smile__svm_model_8K.2_confM <- confusionMatrix(
  smile__svm_model_8K.2_pred,
```



```

    tst_smile_girls$smile_type
)
smile__svm_model_8K.2_confM

```

```

## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous      26           11
## deliberate       7            21
##
##              Accuracy : 0.7231
##              95% CI : (0.5981, 0.8269)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.0003328
##
##              Kappa : 0.445
##
##  Mcnemar's Test P-Value : 0.4795001
##
##      Sensitivity : 0.7879
##      Specificity : 0.6562
##      Pos Pred Value : 0.7027
##      Neg Pred Value : 0.7500
##      Prevalence : 0.5077
##      Detection Rate : 0.4000
##      Detection Prevalence : 0.5692
##      Balanced Accuracy : 0.7221
##
##      'Positive' Class : spontaneous
##

```

```

# 8L
set.seed(1973)
smile__svm_model_8L <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  onset_mean + apex_mean + offset_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_8L$results

```

```

##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6897616 0.3788924 0.08931016 0.1785103

```

```

smile__svm_model_8L_pred <- predict(smile__svm_model_8L, tst_smile)
summary(smile__svm_model_8L_pred)

```

```

## spontaneous deliberate
##           60           82

```

```
smile__svm_model_8L_confM <- confusionMatrix(
  smile__svm_model_8L_pred,
  tst_smile$smile_type
)
smile__svm_model_8L_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
## spontaneous          44           16
## deliberate          26           56
##
##              Accuracy : 0.7042
##              95% CI : (0.6219, 0.7778)
##      No Information Rate : 0.507
##      P-Value [Acc > NIR] : 1.414e-06
##
##              Kappa : 0.4072
##
##  Mcnemar's Test P-Value : 0.1649
##
##      Sensitivity : 0.6286
##      Specificity : 0.7778
##      Pos Pred Value : 0.7333
##      Neg Pred Value : 0.6829
##      Prevalence : 0.4930
##      Detection Rate : 0.3099
##      Detection Prevalence : 0.4225
##      Balanced Accuracy : 0.7032
##
##      'Positive' Class : spontaneous
##
```

```
# predicting boys, girls
set.seed(1973)
smile__svm_model_8L.1_pred <- predict(smile__svm_model_8L, tst_smile_boys)
summary(smile__svm_model_8L.1_pred)
```

```
## spontaneous deliberate
##           25           52
```

```
smile__svm_model_8L.1_confM <- confusionMatrix(
  smile__svm_model_8L.1_pred,
  tst_smile_boys$smile_type
)
smile__svm_model_8L.1_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction    spontaneous deliberate
```

```
##      spontaneous      21      4
##      deliberate      16     36
##
##              Accuracy : 0.7403
##              95% CI : (0.6277, 0.8336)
##      No Information Rate : 0.5195
##      P-Value [Acc > NIR] : 6.073e-05
##
##              Kappa : 0.4733
##
##      McNemar's Test P-Value : 0.01391
##
##              Sensitivity : 0.5676
##              Specificity : 0.9000
##              Pos Pred Value : 0.8400
##              Neg Pred Value : 0.6923
##              Prevalence : 0.4805
##              Detection Rate : 0.2727
##      Detection Prevalence : 0.3247
##              Balanced Accuracy : 0.7338
##
##      'Positive' Class : spontaneous
##
```

```
set.seed(1973)
smile__svm_model_8L.2_pred <- predict(smile__svm_model_8L, tst_smile_girls)
summary(smile__svm_model_8L.2_pred)
```

```
## spontaneous deliberate
##           35           30
```

```
smile__svm_model_8L.2_confM <- confusionMatrix(
  smile__svm_model_8L.2_pred,
  tst_smile_girls$smile_type
)
smile__svm_model_8L.2_confM
```

```
## Confusion Matrix and Statistics
##
##              Reference
## Prediction  spontaneous deliberate
##      spontaneous      23      12
##      deliberate      10      20
##
##              Accuracy : 0.6615
##              95% CI : (0.5335, 0.7743)
##      No Information Rate : 0.5077
##      P-Value [Acc > NIR] : 0.008794
##
##              Kappa : 0.3223
##
##      McNemar's Test P-Value : 0.831170
##
```

```
##           Sensitivity : 0.6970
##           Specificity : 0.6250
##           Pos Pred Value : 0.6571
##           Neg Pred Value : 0.6667
##           Prevalence : 0.5077
##           Detection Rate : 0.3538
##           Detection Prevalence : 0.5385
##           Balanced Accuracy : 0.6610
##
##           'Positive' Class : spontaneous
##
```

```
# test two models without temporal features
# they do not improve the accuracy scores
set.seed(1973)
smile__svm_model_9 <- train(smile_type ~ AU01_r_mean + AU09_r_mean +
  AU10_r_mean + AU25_r_mean + AU45_r_mean +
  lip_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_9$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.6362021 0.2726033 0.0691034 0.1362343
```

```
set.seed(1973)
smile__svm_model_10 <- train(smile_type ~ AU06_r_mean + AU12_r_mean +
  AU45_r_mean +
  lip_mean + eye_mean,
method = "svmLinear", data = trn_smile,
trControl = trainControl(method = "cv", number = 10)
)

smile__svm_model_10$results
```

```
##      C Accuracy      Kappa AccuracySD      KappaSD
## 1 1 0.5677585 0.1365759 0.05687368 0.1156556
```

Part 4: packages and other information

Installing other libraries and packages

In the exploration phase of the thesis the OpenFaceR package was tested. This package published on GitHub, needed installation via the devtools package. The installation code is shown below.

```
# install_github("davidcannatanuig/openFaceR")
library(openfacer)
# citation("openfacer")
# library(devtools)
# citation("devtools")
```

Using Openfacer

Openfacer is a tool developed for social scientists. This tool is used to set up feature creation of this study and as its resources were limited, the results on the descriptive statistics were compared. They show the same outcome, and the choice was made to move on with the database which was built by myself, because of more flexibility in the analysis.

```
# loading packages
library(openfacer)
library(readr)
library(tidyverse)

# read the CSV files at once into RStudio
UvA_face <- read_face_csvs("Data_Openface/CSV/")

# create features using a pipeline
UvA_final_face <- UvA_face %>%
  select_faces(
    starts_with("gaze_"), starts_with("pose_"), starts_with("AU06"),
    starts_with("AU12"), x_36, x_37, x_38, x_39, x_42, x_43, x_44, x_45,
    x_48, x_54, y_36, y_37, y_38, y_39, y_42, y_43, y_44, y_45, y_48,
    y_54
  ) %>%
  mutate_faces(AU06_12_c = ifelse(AU06_c == 1 & AU12_c == 1, 1, 0)) %>%
  mutate_faces(lip = sqrt((x_48 - x_54)^2 + (y_48 - y_54)^2)) %>%
  mutate_faces(eye_x_m_l = (x_36 + x_39) / 2) %>%
  mutate_faces(eye_y_m_l = (y_36 + y_39) / 2) %>%
  mutate_faces(eye_x_m_r = (x_42 + x_45) / 2) %>%
  mutate_faces(eye_y_m_r = (y_42 + y_45) / 2) %>%
  mutate_faces(eye_x_u_l = (x_37 + x_38) / 2) %>%
  mutate_faces(eye_y_u_l = (y_37 + y_38) / 2) %>%
  mutate_faces(eye_x_u_r = (x_43 + x_44) / 2) %>%
  mutate_faces(eye_y_u_r = (y_43 + y_44) / 2) %>%
  mutate_faces(eye_l = sqrt((eye_x_m_l - eye_x_u_l)^2 +
    (eye_y_m_l - eye_y_u_l)^2)) %>%
  mutate_faces(eye_r = sqrt((eye_x_m_r - eye_x_u_r)^2 +
    (eye_y_m_r - eye_y_u_r)^2)) %>%
  mutate_faces(eye = (eye_l + eye_r) / 2) %>%
  select_faces(
    starts_with("gaze_"), starts_with("pose_"), starts_with("AU06"),
    starts_with("AU12"), lip, eye_l, eye_r, eye
  ) %>%
  tidy_face()

# save the data frame
write_csv(UvA_final_face, "UvA_final_face")

# create a check file to the own created summary file.
# compare two files have the same content using all()
UvA_face_check <- read_csv("UvA_final_face")
# all()
```

Creation of a face figure as illustration

To support the thesis a figure is created displaying all the 2D landmark features. This is done based on subject number 20, as this subject is the only in database which data can be used in the report with permission of the data holder. The picture can be found in the thesis file.

```
library(ggplot2)
library(dplyr)
library(reshape2)
# citation("reshape2")

figure_1 <- read.csv("masterfile_connected")

figure_2 <- figure_1 %>%
  select(starts_with("x_"))

figure_2 <- figure_2[50, ]

fig_3 <- dcast(melt(as.matrix(figure_2)),
  Var2 ~ paste0("x", Var1),
  value.var = "value"
)

figure_4 <- figure_1 %>%
  select(starts_with("y_"))

figure_4 <- figure_4[50, ]

fig_5 <- dcast(melt(as.matrix(figure_4)),
  Var2 ~ paste0("y", Var1),
  value.var = "value"
)

fig_6 <- cbind(fig_5, fig_3)
fig_6 <- fig_6[1:68, ]
fig_6$Var2 <- gsub("y_", "", fig_6$Var2)

par(mfrow = c(1, 1))
dev.new(width = 5, height = 8)
plot(fig_6$x50, fig_6$y50,
  xlim = c(950, 400), ylim = c(850, 300),
  col = "blue",
  xlab = "landmark x points", ylab = "landmark y points"
)
text(fig_6$x50, fig_6$y50, labels = fig_6$Var2, cex = .6, pos = 4)
```