# Facial attractiveness evaluation for purposes of plastic surgery using web-based `shiny` application

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## Introduction

Many current studies come to conclusion that human facial attractiveness perception is data-based and irrespective of the perceiver. Current plastic surgery deals with aesthetic indications such as an improvement of the attractiveness of a smile or other facial emotions, therefore it should take into consideration the fact that total face impression is also dependent on presently expressed facial emotion.

## Aims

We have applied machine-learning methods and a power of R language (and some of its packages) to explore how accurate classification of photographed faces into sets of facial emotions and their facial manifestations is, and – furthermore – to identify geometric features of a face associated with an increase of facial attractiveness after undergoing rhinoplasty.

## Methodology

Both profile and portrait facial image data were collected for each of a patient (exposed to an emotion incentive) (about 170 images), then processed, landmarked and analysed using R language and the developed web-based **shiny** application. The sets of used facial emotions and other facial manifestation originate from Ekman-Friesen FACS scale but were improved substantially. Facial attractiveness was measured using 7-point Likert scale $(-3, -2, -1, 0, 1, 2, 3)$ by a board of independent observers. Multivariate linear regression was performed to select predictors increasing facial attractiveness after undergoing rhinoplasty. Bayesian naive classifiers using `e1071` package, classification trees (CART) via `tree` and `rpart` packages and, finally, neural networks by `neuralnet` package were learned to allow assigning a new face image data into one of the facial emotions.

The web-based shiny application providing face landmarking, facial geometry computations and regression model fitting allows to identify geometric features of such face increasing facial attractiveness level after undergoing rhinoplasty.

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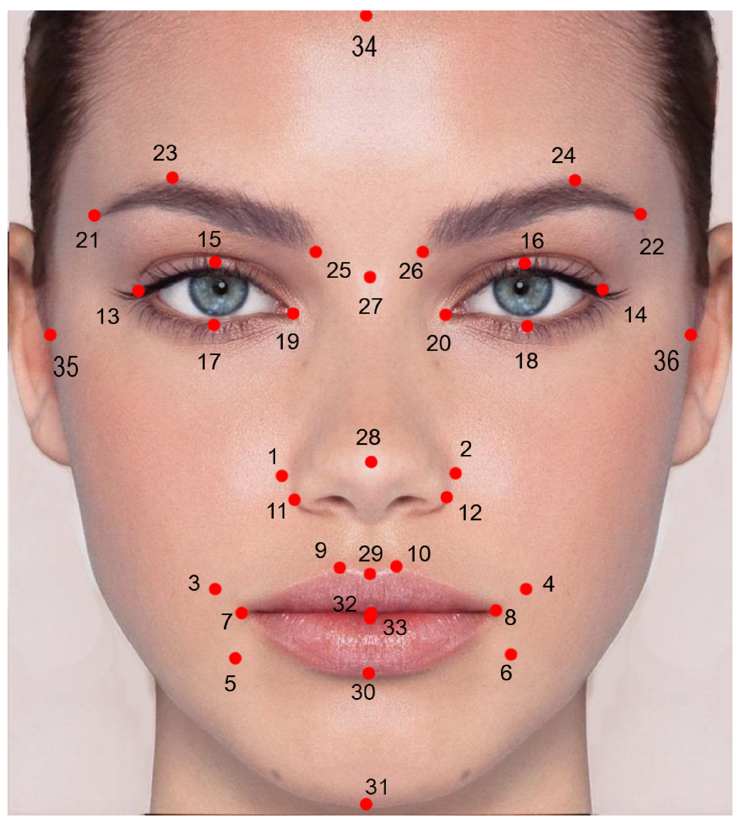
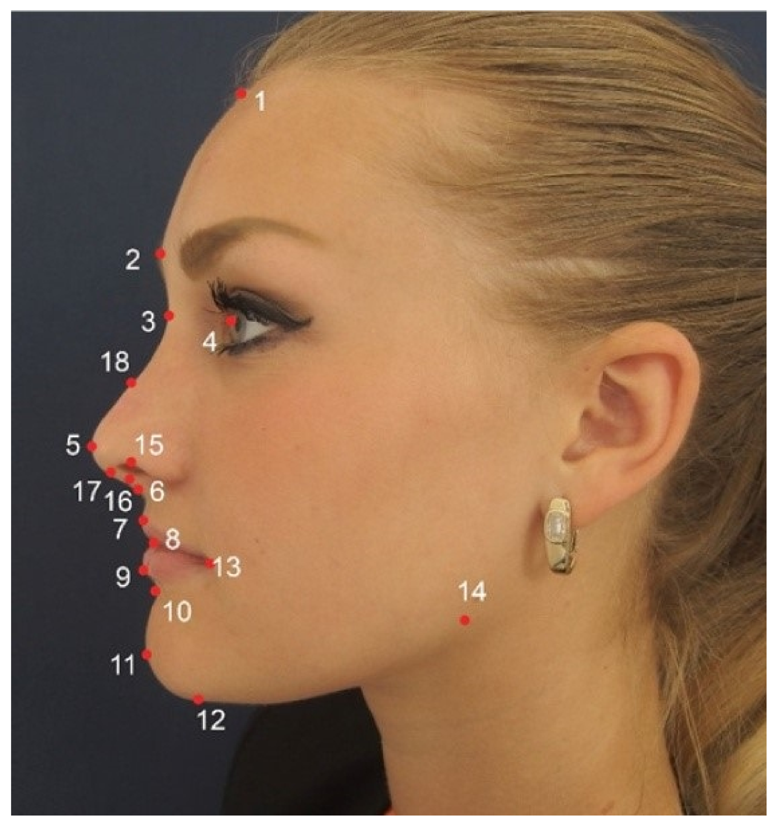
## Landmarking and derived metrics/angles

Landmarks were plotted manually using the developed **shiny** application, by which the coordinates of all of them were collected. After that, each of original coordinates $x \in \boldsymbol{x}$ was normalized in the range $x' \in (0, 1)$ by the terms of

$$x' = \frac{x - \min(\boldsymbol{x})}{\max(\boldsymbol{x}) - \min(\boldsymbol{x})},$$

assuming that all faces taken in the pictures are of equal size.

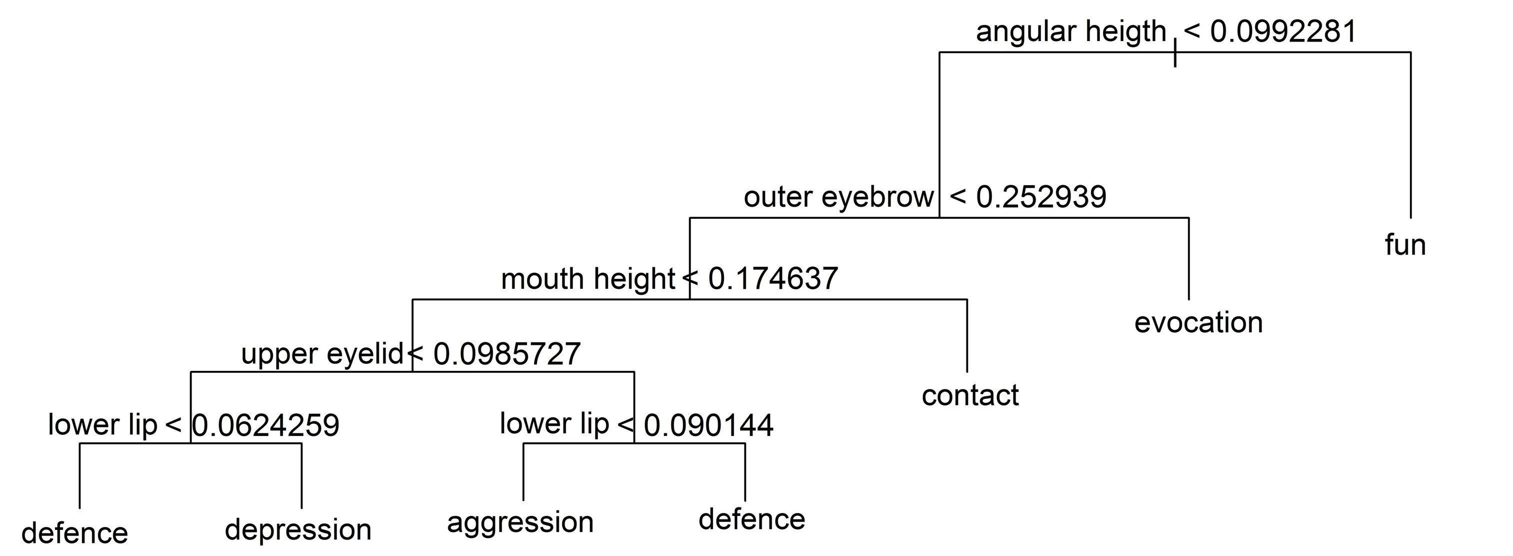




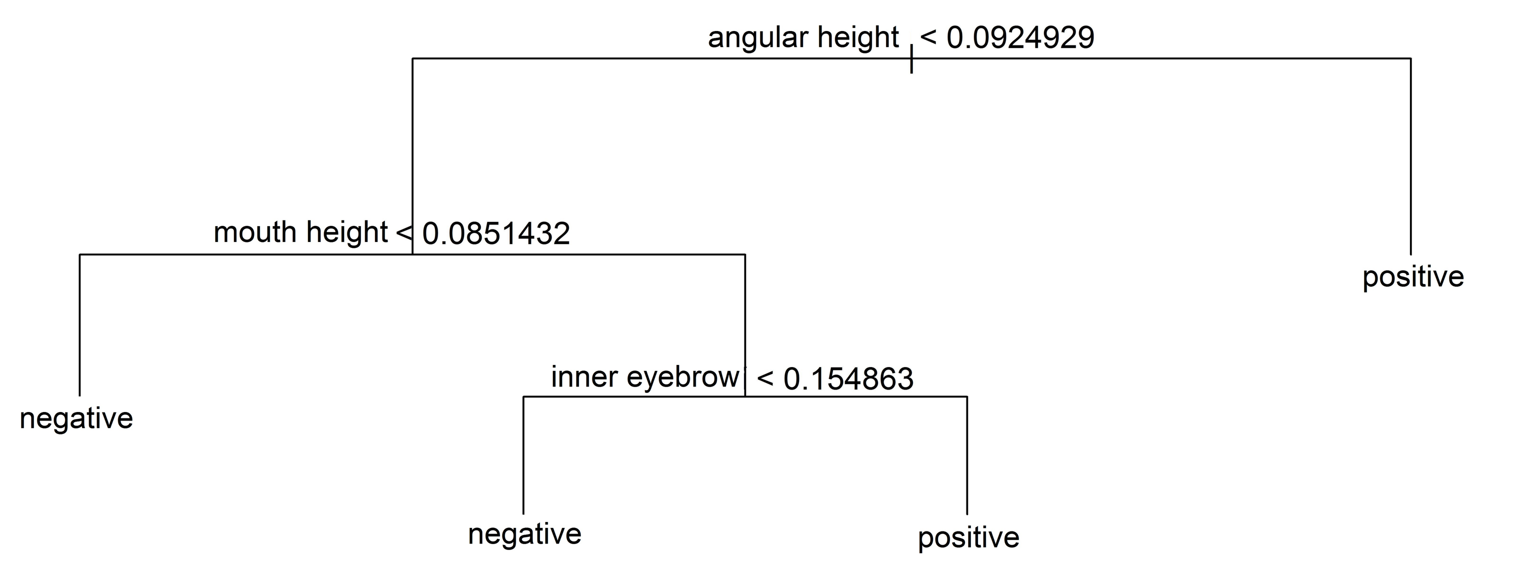
| metrics/angles | definition |
|---|---|
| nasofrontal angle | angle between landmarks 2, 3, 18 (profile) |
| nasolabial angle | angle between landmarks 7, 6, 17 (profile) |
| nasal tip | horizontal Euclidean distance between landmarks 6, 5 (profile) |
| nostril prominence | Euclidean distance between landmarks 15, 16 (profile) |
| cornea-nasion distance | horizontal Euclidean distance between landmarks 3, 4 (profile) |
| outer eyebrow | Euclidean distance between landmarks 21, 22 (portrait) |
| inner eyebrow | Euclidean distance between landmarks 25, 26 (portrait) |
| lower lip | Euclidean distance between landmarks 30, 33 (portrait) |
| mouth height | Euclidean distance between landmarks 6, 8 (profile) |
| angular height | Euclidean distance between landmarks 7 (or 8) and 33 (portrait) |

## Classification of emotions using CART trees

Relations between the clusters of emotions and the quality of the emotions are described below. First CART tree (top right) describes classification of a face into the cluster of emotions, the second tree (bottom right) describes classification of a face into the quality of emotion.




| cluster of emotions | quality |
|---|---|
| contact | positive |
| helpfulness | positive |
| evocation | positive |
| defence | negative |
| aggression | negative |
| reaction | neutral |
| decision | neutral |
| well-being | positive |
| fun | positive |
| rejection | negative |
| depression | negative |
| fear | negative |
| deliberation | positive |
| expectation | positive |




## Facial attractiveness after undergoing the rhinoplasty

The mean increase of facial attractiveness level after undergoing the rhinoplasty is about 3.8 Likert point, $p \doteq 0.043$. Per each radian of nasofrontal angle enlargement, there is an expectation of mean increase about 0.353 Likert point in facial attractiveness after undergoing the rhinoplasty, $p \doteq 0.049$. Similarly, per each radian of nasolabial angle enlargement, there is an expectation of mean increase about 0.439 Likert point in facial attractiveness after undergoing the rhinoplasty, $p \doteq 0.047$.

| predictor | estimate | $t$-value | $p$-value |
|---|---|---|---|
| intercept$_{\text{after-before}}$ | 3.832 | 1.696 | 0.043 |
| nasofrontal angle$_{\text{after-before}}$ | 0.353 | 1.969 | 0.049 |
| nasolabial angle$_{\text{after-before}}$ | 0.439 | 1.986 | 0.047 |
| nasal tip$_{\text{after-before}}$ | -3.178 | 0.234 | 0.068 |
| nostril prominence$_{\text{after-before}}$ | -0.145 | 0.128 | 0.266 |
| cornea-nasion distance$_{\text{after-before}}$ | -0.014 | 0.035 | 0.694 |

## Summary

Enlargement of both a nasolabial and nasofrontal angle within rhinoplasty significantly increases facial attractiveness. Geometrical shape of mouth, then eyebrows and finally eyes affect in descending order the (quality of) classified emotion, as was identified using decision trees.

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