Machine-learning and R in plastic surgery – – Classification and attractiveness of facial emotions

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satRday Belgrade

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Content

Quick introduction

- 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

Quick introduction

- total face impression is also dependent on presently expressed facial emotion
- there is no face without facial emotion at all

Aims of the study

- to identify geometric features of a face associated with an increase of facial attractiveness after undergoing rhinoplasty
- to explore how accurate classification of faces into sets of facial emotions and their facial manifestations is

Brief methodology of facial attractiveness evaluation

- profile facial image data were collected for each patient before and after rhinoplasty (about 80 images)
- images were
  - processed
  - landmarked
  - analyzed
- linear regression was performed to select predictors increasing facial attractiveness after undergoing rhinoplasty

Brief methodology of facial emotions classification

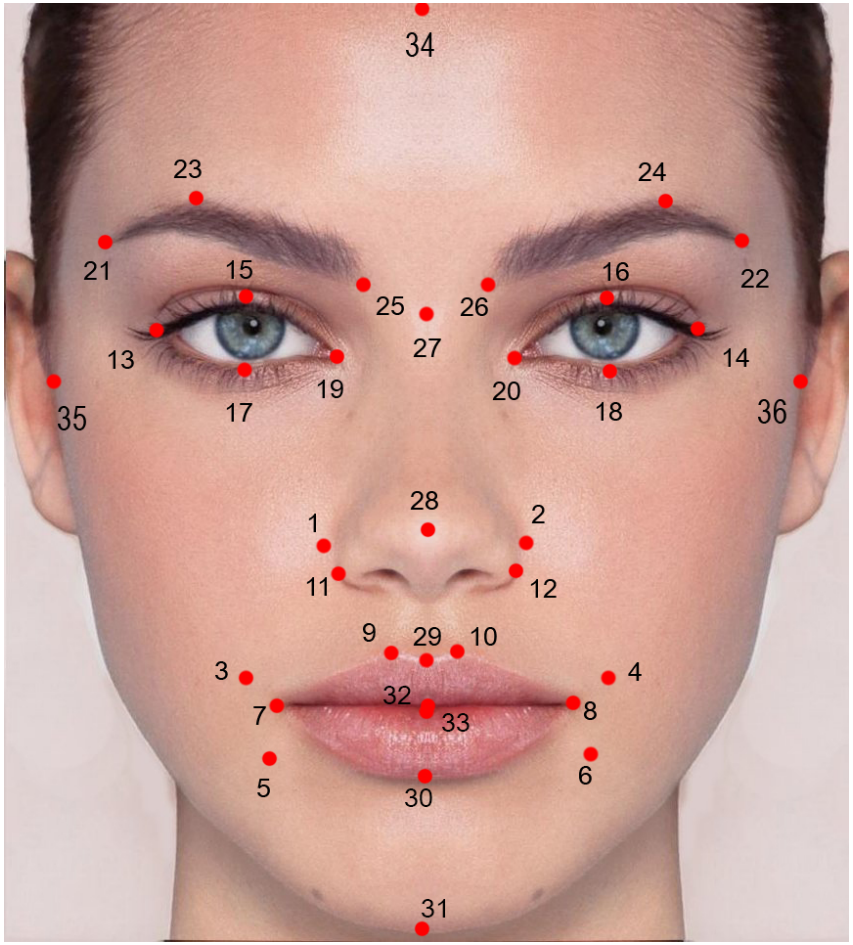
- portrait facial image data were collected for each person just in the moment they show a facial expression according to the given incentive (about 170 images)
- images were
  - processed
  - landmarked
  - analyzed
- Bayesian naive classifiers (`e1071`), decision trees (CART) (`rpart`) and neural networks (`neuralnet`) were learned to allow assigning a new face image data into one of facial emotions

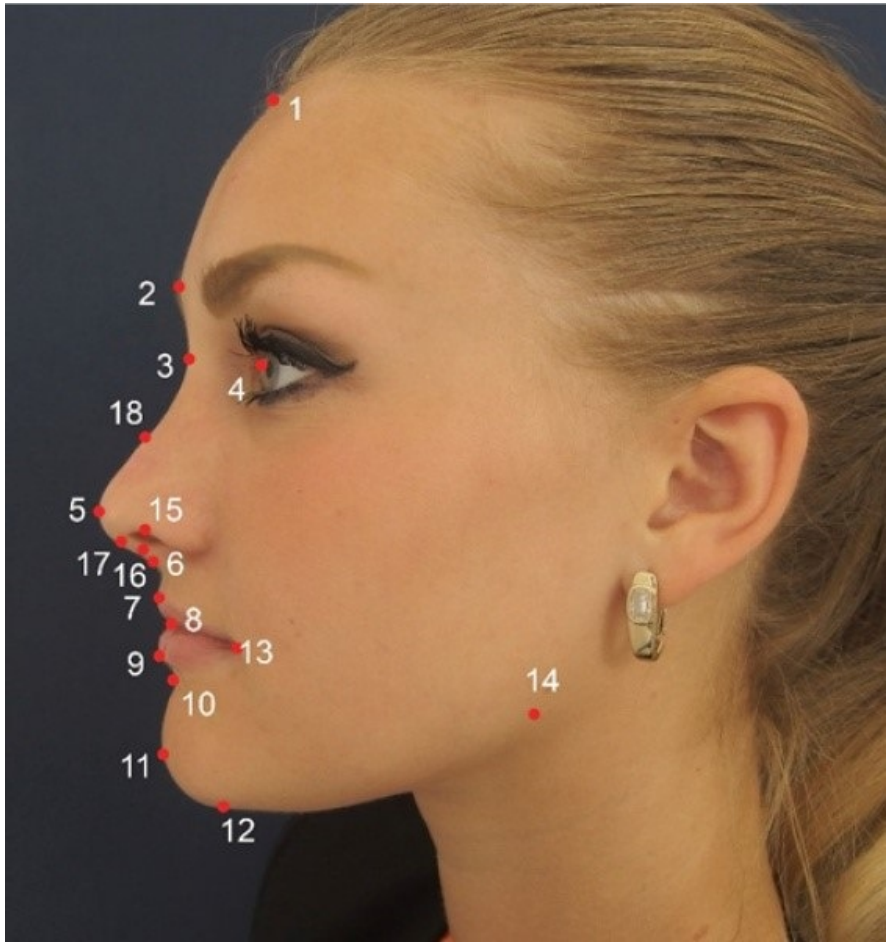
Data of interest

- facial attractiveness of patients' data was measured using Likert scale by a board of independent observers
- the sets of used facial emotions and other facial manifestation originate from Ekman-Friesen FACS scale, but was improved substantially

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

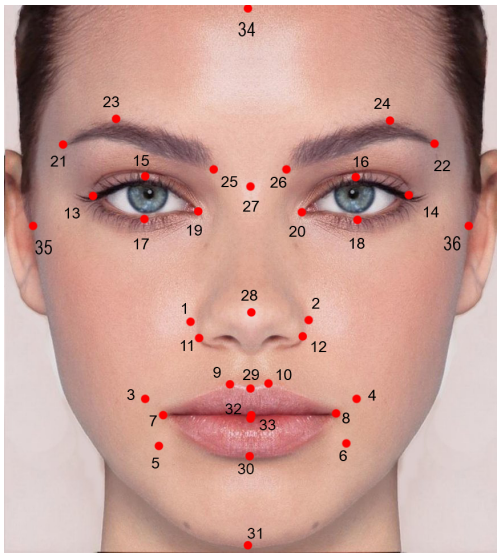
Landmarking

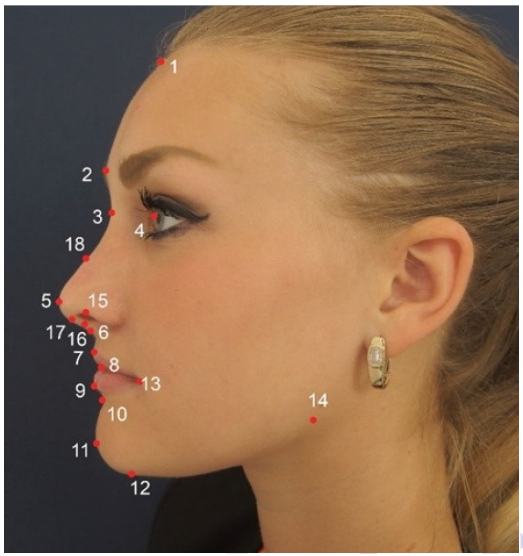




Some derived metrics and angles

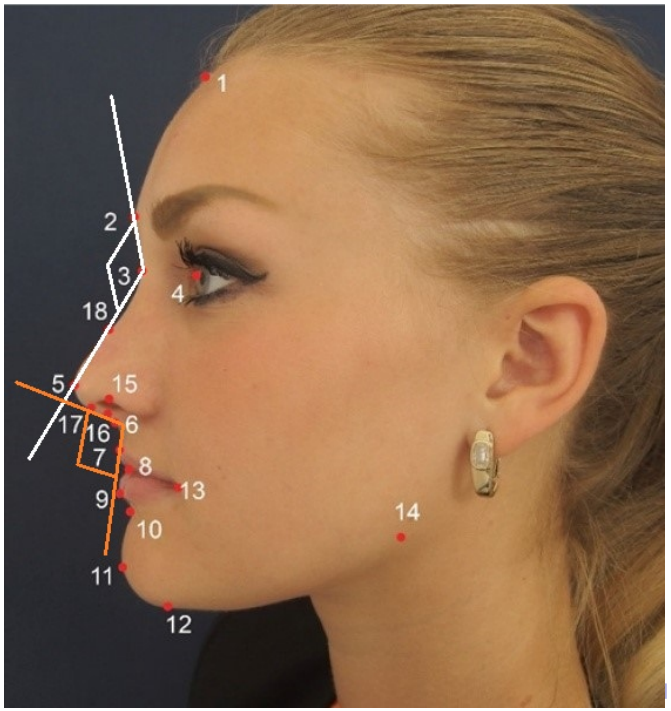
metrics/angles	definition
nasofrontal angle	angle between landmarks 2, 3, 18 (profile)
nasolabial angle	angle between landmarks 7, 6, 17 (profile)
nasal tip	horizontal Euclidean distance between landmarks 6, 5 (profile)
nostril prominence	Euclidean distance between landmarks 15, 16 (profile)
cornea-nasion 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)



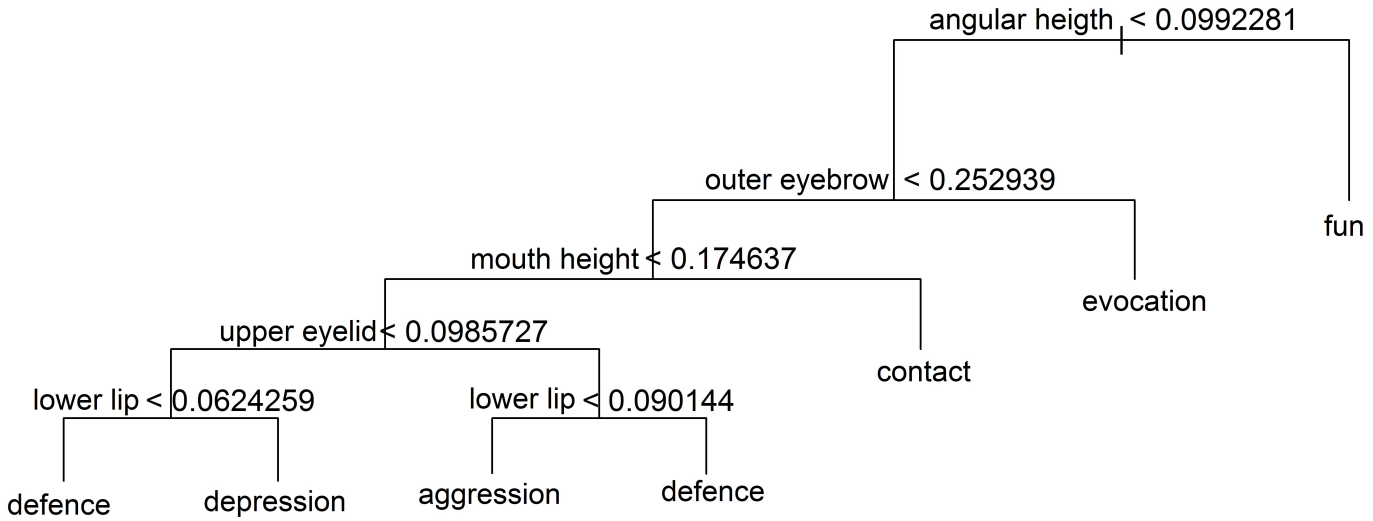


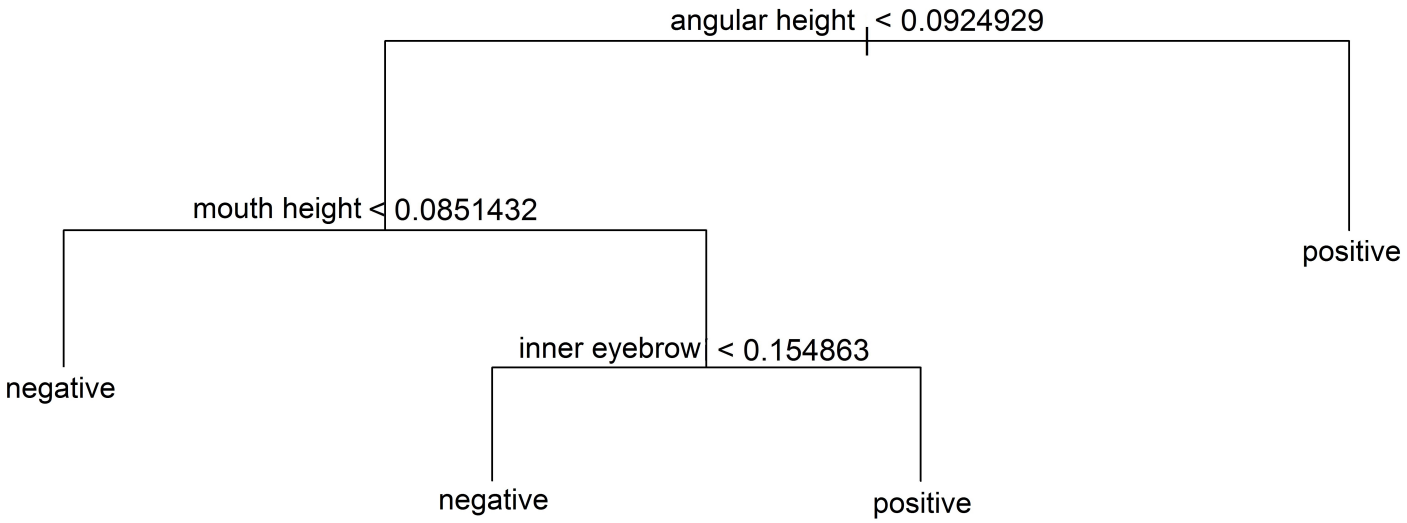
Evaluation of rhinoplasty effect on facial attractiveness

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



Trees for prediction of the cluster & quality of emotions





Predictions of the emotional quality based on the naive Bayes classifiers, CART's and neural networks, respectively

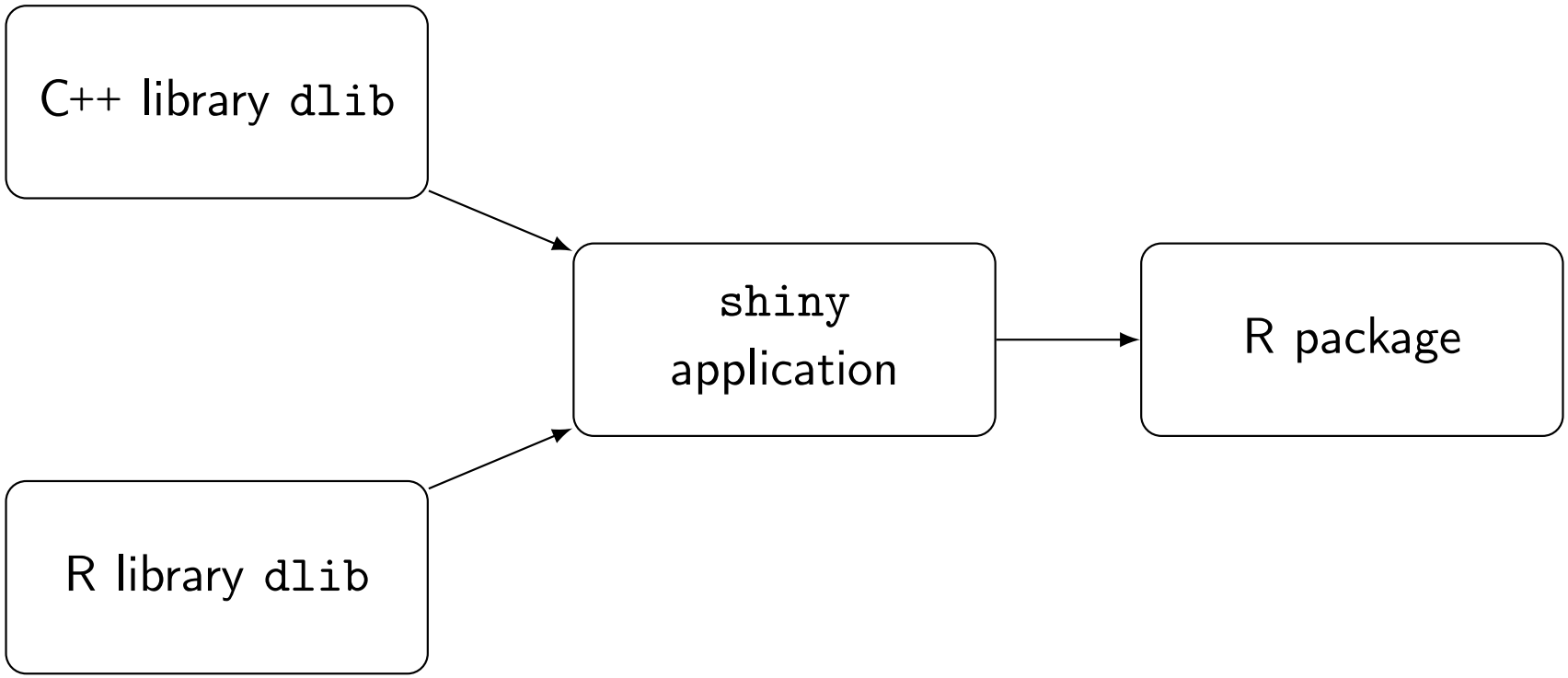
		predicted class		
		negative	neutral	positive
true class	negative	34	11	16
	neutral	16	39	8
	positive	4	10	30

		predicted class		
		negative	neutral	positive
true class	negative	35	7	15
	neutral	12	40	9
	positive	4	12	31

		predicted class		
		negative	neutral	positive
true class	negative	36	6	6
	neutral	12	54	18
	positive	3	4	32

Going further

- automated facial landmarking using C++ library `dlib`



Conclusion

- enlargements of both a nasolabial and nasofrontal angle within rhinoplasty were determined as statistically significant predictors increasing facial attractiveness
- neural networks manifested the highest predictive accuracy of a new face categorization into facial emotions
- geometrical shape of mouth, then eyebrows and finally eyes affect in descending order the classification of facial images into emotions and emotional qualities

Thank you for your attention!

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