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Modern physiognomy: an investigation on predicting personality traits and intelligence from the human face

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Even in ancient China, Egypt and Greece, people had tried to establish the relationship between facial morphological features and personality traits of an individual. The modern psychological studies revealed that people tend to evaluate others on their appearance and then move on to interact with them based on these first impressions. Nowadays, it has been a well-established fact the face plays a central role in the everyday assessments of other people. For example, humans perform trait judgments from faces and the results of this unconscious behavior can sometimes decisively affect the results of important social events, such as an electoral process [1].

Currently, the following two points hold on automatic face evaluation: First, some self-reported personality traits and the intelligence can be evaluated by the human based on the facial features to a certain extent. Second, the commonalities existing in the evaluation behavior of the human can be mined by the machine learning methods. The following are some related work in the literature.

In [2], the authors studied the human tendency to evaluate others on their faces and identified some important facial features that generate first impressions. Humans can make valid inferences for at least four personality traits from facial features [3]. In [4], the relationship between self-reported personality traits and first impressions was studied. The results of [5] showed that the people were able to accurately evaluate intelligence of men by viewing their facial photographs, but not intelligence of women.

To investigate whether the trait evaluations performed by humans can be learned by computers, [6] used machine learning methods to construct an automatic trait predictor based on facial structural descriptors and appearance descriptors. They found that all the analyzed personality traits could be predicted accurately.

In this work, we further explore whether the self-reported personality traits and intelligence can be automatically predicted from facial features by casting it separately as a classification and a regression problem by gathering more samples, extracting more diverse features. Our experiments show that some personality traits are more related to the tested facial features and can be predicted reliably, such as "Rule-Consciousness" and "Vigilance", while some other personality traits may

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largely depend on the social environment, and little correlation seems to exist between them and facial features. As for intelligence, neither the structural feature nor the appearance feature provides any reliable prediction for either male or female.

Ethics statement. The Institutional Review Board of the Institute of Automation of the Chinese Academy of Sciences has approved this research. The participants were asked to give verbal informed consent to participate in the research and no data were collected until this consent was obtained. The consent was thereby documented by the recording of the data. This was in accordance with guidelines of the Ethics Committee, Ministry of Health of the People's Republic of China which state that written consent is only required if biological samples are collected, which was not the case in our study. And all methods were performed in accordance with the Declaration of Helsinki. In addition, the data for self-reported personality traits and intelligence were analyzed anonymously.

Photographs. Facial photographs of 186 students (94 men and 92 women) from the College of Computer and Information Engineering and School of Business, Xiamen University of Technology, China, were used as stimuli. The participants were asked to sit in front of a white background to be photographed. They were also requested to show a neutral, non-smiling expression and avoid facial cosmetics, jewelry, and other decorations.

Personality traits and intelligence measurement. The Cattell Sixteen Personality Factors Questionnaire (16PF) was used to measure personality traits of the participants. The traits measured by 16PF are Warmth, Reasoning, Emotional Stability, Dominance, Liveliness, Rule-Consciousness, Social Boldness, Sensitivity, Vigilance, Abstractedness, Privateness, Apprehension, Openness to Change, Self-Reliance, Perfectionism and Tension. For each personality trait, a score ranging from 1 to 10 was assessed by the software developed by Beijing Normal University Education Training Center according to the responses of each participant on the questionnaire. The norms of this Chinese questionnaire are the students of China, so it is suitable for testing personality traits of Chinese people. In addition, the four second-order factors were also acquired from these sixteen personality factors: Adaptation/Anxiety, Introversion/Extroversion, Impetuous Action/Undisturbed Intellect, and Cowardice/Resolution. Hence, we used these 20 traits to describe the personality of each participant. In our experiments, The Raven's Standard Progressive Matrices was used to measure participants' intelligence. This test primarily measures the participant's observational ability and ability to think clearly. The total score for the right answers is calculated and converted to a percentile score to measure the intelligence level of the participant.

In this work, the personality trait prediction is implemented in two steps: At first, two kinds of feature descriptors are constructed from the face image, then the traits prediction is converted into either a classification or regression problem.

Feature descriptors. In this work, a 1134-D structural descriptor is constructed by 21 salient facial points and their spatial relations as did in [6]. Four local descriptors: HOG, LBP, Gabor, SIFT, and a global descriptor: Gist, are first constructed, then concatenated into the final appearance descriptor, details are referred to [7].

Classification and regression. The personality trait prediction is casted separately into a classification and a regression problem. For the classification, 5 discriminative classification methods are used: Parzen Window, Decision Tree, K-Nearest Neighbor, Naive Bayes and Random Forest. For the regression, 6 methods are selected: Linear Regression, Ridge Regression, Lasso Regression, Pseudo-Inverse Regression, K-Nearest Neighbor Regression and Support Vector Regression.

Since the structural and appearance descriptors are of high dimension, PCA is used to gradually reduce the dimensionality to empirically select the suitable dimension, details are referred to [7].

For the classification, since the score of each personality trait measured is the discrete number ranging from 1 to 10, we first binarize the personality traits by setting the highest 5 as the "have-trait" class and the lowest 5 as the "do-not-have-trait" class. Then a binary classification is formed. For the regression, trait scores are directly used.

For classification and regression experiments, the classification accuracy and the regression error were estimated with a 10-fold cross-validation scheme and the experiments were repeated 30 times to obtain reliable standard deviations. For regression experiments, the Root Mean Square Error and the Pearson Correlation Coefficient were adopted to evaluate the performance of regression methods. In addition, the confidence interval for a 95% confidence level was also computed to attest the reliability of these results. Furthermore we also used the residual plots to measure the correlations between the predicted scores and the measured scores of personality traits and intelligence.

Main results. The main results are summarized in Table 1, where the best predicting performance for 2 kinds of features with the optimal dimension of the feature vector is marked by "$\surd$".

The results of classification experiments show

Table 1 Personality traits prediction by classification and regression methods

Gender	Male				Female			
feature	Classification	Dim.	Regression	Dim.	Classification	Dim.	Regression	Dim.
Structural	Parzen (√)	30	Linear	2	Parzen (√)	30	Linear	2
	DTree	30	Ridge	2	DTree	15	Ridge	2
	KNN	20	Lasso	2	KNN	30	Lasso	2
	NaiveB	5	Pinv	2	NavieB	30	Pinv	2
	RF	20	KNN	2	RF	20	KNN	10
			SVM (√)	5			SVM (√)	5
Appearance	Parzen (√)	5	Linear	2	Parzen (√)	15	Linear	2
	DTree	20	Ridge	2	DTree	5	Ridge	2
	KNN	10	Lasso	20	KNN	10	Lasso (√)	15
	NaiveB	5	Pinv	2	NavieB	5	Pinv	2
	RF	20	KNN	30	RF	30	KNN	2
			SVM (√)	5			SVM	20

that both our structural and appearance features are more related to personality traits "Rule-consciousness" and "Vigilance", which can be predicted well beyond chance levels for all classification methods for both genders. These two traits may be more related to facial characteristics and that this relevance can also be recognized more accurately. Generally speaking, personality traits of women can be predicted more accurately than men. Our results also suggest that compared with the structural feature, the appearance feature is more information-rich for the traits evaluation. However we find predicting intelligence from these 2 types of features is difficult, if not impossible.

The results of regression experiments show that predicting the exact scores of personality traits or intelligence is more difficult than classifying personality traits or intelligence into the binary category. In addition, the regression errors of the traits "Warmth", "Social boldness", "Vigilance" and "Introversion/Extroversion" are all too high for both 2 types of features, it suggests that these four traits have little correlation with facial features. Generally speaking, when predicting the precise scores of personality traits or intelligence, the 2 types of features perform similarly. However, like the classification experiments, the correlation between intelligence and the features is weak, and it is difficult to predict intelligence score reliably.

We also investigated the prediction performance on the combined descriptor of the structural and appearance ones, and surprisingly, the combined one does not perform better than the individuals considering the apparent complementary information in facial appearance and shape structure.

Note that for such personality traits prediction problems, lack of sufficient samples and representative samples is an eternal problem. In this study, only college students are investigated, which will inevitably bring up biases. In addition, although 186 samples in our study are larger than those used in previous studies, we think more samples are needed, in particular, more representative samples across different walks of life are needed.

In this study as well as in other related studies, used facial features are generally similar to those for face recognition, which could be a potentially fatal weakness. It is quite possible human use different features for personality prediction. Hence how to learn appropriate features for personality traits prediction is one of our future directions.

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