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# Persons' Personality Traits Recognition using Machine Learning Algorithms and Image Processing Techniques

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## Abstract

The context of this work is the development of persons' personality recognition system using machine learning techniques. Identifying the personality traits from a face image are helpful in many situations, such as identification of criminal behavior in criminology, students' learning attitudes in education sector and recruiting employees.

Identifying the personality traits from a face image has rarely been studied. In this research identifying the personality traits from a face image includes three separate methods; ANN, SVM and deep learning. Face area of an image is identified by a color segmentation algorithm. Then that extracted image is input to personality recognition process. Features of the face are identified manually and input them to ANN and SVM. Each personality trait is valued from 1 to 9. In the second attempt m-SVM is used because outputs are multi-valued. ANN gave better results than m-SVM. In the third attempt we propose a methodology to identify personality traits using deep learning.

**Keywords:** Artificial Neural Networks (ANN); Support Vector Machine (SVM); Multi Valued Multi Class Support Vector Machine (m-SVM); Deep learning; Personality trait

## 1. Introduction

Recognition of a person's personality using the face images is one of the main interesting areas in Psychology. Some people believe that it is not possible to deduce a person's characteristics using the features of the face, but there are some researches which have proved that it is possible to deduce a person's characteristics using the face images. Such characteristics are known as psychological characteristics. Some psychological characteristics which have identified and studied by psychologists are emotional stability, dominance, sensitivity, intelligence, confidence, trustworthy, responsibility. Physiognomy is a broadly used approach for psychological characteristics recognition using the face. There are two other approaches also; they are phase facial portrait and ophthalmogeometry [1]. Identifying psychological characteristics using a face is helpful in many situations. In day-to-day social affairs it is very useful and easy to deal if we can find personality type of each person. There are some areas which we can apply

automatic personality traits identification and get benefits. Such as when recruiting employees for a job it is very useful if we can identify the applicant's personality type because the development of a company depends on the employees who are working in the company. Another example is identifying criminals' behavior in criminology. Also automatic personality recognition system can help teachers to identify students' characteristics and change the teaching methods accordingly. The main reason of this research is to seek better solution for recognizing psychological characteristics using a face image by applying machine learning algorithms and image processing techniques.

## 2. Related works

The article Recognition of Psychological Characteristics from Face [1] describes that personality is a complex combination of traits and characteristics which determines our expectations, self-perceptions, values and attitudes, and predicts our reactions to people, subjects and events. Traits and characteristics are same things, but trait is distinguishing from characteristic since traits consider about feature or quality. So when considering traits theorists assume that traits are relatively stable over time, traits differ among individuals, and traits have influence behavior. To measure personality characteristics psychological researches apply psychometrics. Psychometrics is the construction of instrument and procedure for measurement and development of theoretical approaches to measurement. When applying psychology for personality traits recognition not only face, it can be applied to body, skull, fingers, hand, leg etc. This article describes three main approaches to psychological recognition from a face; they are physiognomy, phase facial portrait and ophthalmogeometry. Physiognomy is originally interprets different facial features as this method is based upon the idea that the assessment of the person's outer appearance, primarily the face, facial features, skin texture and quality, may give insights into one's character or personality. Phase facial portrait is mainly based on

calculating angles of facial feature lines directions. Ophthalmogeometry is based on the idea that person's emotional, physical and psychological states can be recognized by 22 parameters of eye part of the face.

There is less number of researches regarding to the current research area but facial expression recognition and age estimation using ANN and SVM have been done in several researches [2], [3], [4], [5].

To detect face area from an image, different techniques such as integral projection method [3] and color based segmentation algorithm [6] can be used. Color based segmentation is mostly used approach in face detection than other methods because it is the almost invariant against the changes of the size of the face, orientation of the face.

There is an existing application used to identify the personality traits from a face image [7]. This software uses a neural-network to identify corrections between facial features and psychological characteristics using photo identification techniques recognized by law enforcement professionals.

### 3. Technologies

#### 3.1 Artificial neural networks

An Artificial Neural Network (ANN) is an information processing system which imitates the process of human brain. Human brain composed with neurons which are responsible for processing information and produce an output. An ANN also like brain, it processes information and solves problems and also learns through examples.

Since ANN has the ability to derive information from complex and noisy data, ANN can be used in specific applications such as pattern recognition, face recognition, age estimation, different objects identification and emotion identification. A well trained ANN can predict the category of a new input by extracting its features. The optimum neural network for a specific problem is difficult to obtain and the solution is depend on the training dataset.

#### 3.2 Backpropagation algorithm

The backpropagation algorithm is an algorithm used to train the multilayer neural networks. Backpropagation is a supervised learning method for multilayer neural networks and also known as the generalized delta rule. This method is used by different research communities in different contexts. First algorithm to train multilayer neural networks was introduced in the thesis of Paul Werbos in 1974 [8], but it was not disseminated in the neural network community. And rediscovered by David Rumelhart, Geoffrey Hinton, and Ronald Williams in 1986 [9]; David Parker in 1985 published it at M.I.T. [10]; Yann Le Cun in 1985 [11] independently.

Since backpropagation is a variation of gradient search algorithm, it is converged to a local minimum while search space has many local minimums and one global minimum. The converged point depends on the initial weights and biases. The network learning time becomes large when sample size is large. The network can be over learning if training does not stop at right time.

#### 3.3 Leave some out multi-fold cross validation method

The Marsland's book [12] describes neural network training ratios depending on the dataset size. There is a common ratio which is used when dividing the dataset into training, testing and validation portions in network design. That is if it is plenty of data applicable then use 50:25:25 otherwise 60:20:20 ratios for training, testing and validation respectively. These datasets should be selected randomly so that they represent all classes.

If the training dataset is really small and if there are separate testing and validation datasets then one cannot guarantee that the network will be sufficiently trained. Then it is possible to perform leave-some-out, multi-fold cross-validation. In this method dataset is randomly partitioned into K subsets, and one subset is used as a validation set, while the neural network is trained on all the others. A different subset is then left out and a new network is trained on that subset, repeating the same process for all of the different subsets. Finally, the network that produces the lowest validation error is tested and used. In the most extreme case of this is leave-one-out cross-validation, where network is validated on just one piece of data, training on all of the rest.

#### 3.4 Support vector machine

Support Vector Machine (SVM) was first introduced by Boser, Guyon, and Vapnik in COLT-92 in 1993 [13]. SVM provides significant classification than the other machine learning algorithms. SVM modifies the data to solve the problem by changing the data so that it uses more dimensions than the original data. Its implementation includes matrix calculation so works on reasonably sized data sets. SVM finds maximum margin which separate classes. That is SVM gives optimal separation between classes.

#### 3.5 Multi class classification SVM

If there are more than two classes in the classification problem, one can use m-class SVM. But m-class SVM is in under research. Common approaches used in m-class SVM are one against all method and one against one strategy. Out of these two strategies one against all is the most common approach when considering about m-class SVM. The one against all strategy defines M number of

classifiers for m-class problem and in the  $i$ th iteration,  $i$ th class is assigned as positive and all others are assigned as negative. Finally all classifiers are combined to get the final solution.

### 3.6 Physiognomy

Backbone of physiognomy dates back to ancient Greece, and is still very popular. Physiognomy refers to identify person's psychological characteristics or personality using outer appearance, mainly using the face. So physiognomy also refers the relatively unchanging facial features which might use to interpret inner or hidden aspects of a person. These features include details of the forehead, eyebrows, eyes, nose and mouth.

Some people believe that it's not possible to deduce person's characteristics using the features of the face, but there are research studies proved that the possibility of deduce person's characteristics using face images. In 1772 J. C. Lavater said that physiognomy is a science and he proved the truth of the physiognomy on his book Essays on Physiognomy [14]. This is a historical article about physiognomy and it is still accepted. Since thousands of years researchers try to study the relationship between psychological characteristics and facial features. After doing such researches they have reached to judge person's personality via face features with a high degree of confidence. Simply we can say that physiognomy is true because people who look alike tend to behave in the same way or at least have some common behaviors. We got our outer appearance from genes that are from the parents and ancestors. Because of that we have same appearance to our parents. This implies that we should have approximately same personality with our parents. In day-to-day life we heard something like "She is smart just like her mother" which prove the truth of the physiognomy.

### 3.7 Deep learning

Deep learning is a machine learning technique which comes with ANN. It is emerged to machine learning research from 2006. Deep learning is also called as deep structured learning or hierarchical learning. Deep learning is mostly used with signal and machine learning researches. Deep Learning is a set of algorithms in machine learning that attempts to model high level abstractions in data by using architectures composed of multiple non-linear transformations [15].

When consider ANN, SVM, logistic regression and hidden markov model they are known as shallow architectures. For example SVM uses a shallow linear pattern separation model with one or zero feature transformation layer. Shallow architectures have been showed good results when dealing with real world problems but in some context we faced difficulties with those shallow architectures. For example when choosing input to the

ANN, it is depending on the problem. So suggest the need of deep architectures for extracting complex structure and building internal representation from rich inputs. For an example the image classification system gets inputs as images. The Foundation to deep learning is artificial neural network and feed-forward neural network or MLPs with many hidden layers which are often referred to as deep neural networks. Deep learning is categorized in to three classes such as deep networks for unsupervised or generative learning, deep networks for supervised learning and hybrid deep networks. Deep networks for unsupervised or generative learning are used to capture unknown pattern in the data and categorized data depending on those patterns. Deep networks for supervised learning used for pattern classification purposes. Target label data are always available.

## 4. Methodology

The proposed system applies ANN, SVM and image processing techniques. The development stage is divided into three stages depending on the machine learning techniques used, first stage of implementation includes ANN; second stage of implementation used SVM and in the third stage proposed a methodology to identify personality traits using deep learning. The data set used in this research is obtained from social cognition and social neuroscience lab Alexander Todorov, Department of Psychology, Princeton University [16]. This database include several databases created for psychological research purposes out of them chose mean ratings on 66 faces from the Karolinska data set on 14 trait dimensions [17].

### 4.1 First stage of implementation

The main goal of this research was to identify the personality traits of a person using the face image by applying the technique neural networks. First put same number of landmarks on each face image as shown in Fig.1. The structure of the landmarks is defined after studying on physiognomy.

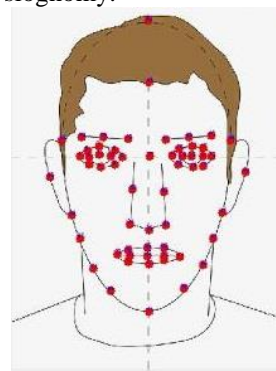


Fig.1 Image after put landmarks.

After the process of putting landmarks on each image, the coordinates of each landmark point and the expected trait values are saved in a text file.

The input to the neural network is corresponding landmark point coordinate values of each image which are stored in the text files. The text file includes 60 point coordinates and expected traits values. Since the dataset is small, the leave some out multi-fold cross validation method has been used by randomizing the dataset and ran several times to obtain better training, testing and validation results.

#### 4.2 Second stage of implementation

In this stage SVM is used as the technology to identify personality traits. Input to the algorithm is coordinate values of landmark points stored in text files as first stage. In SVM expected values are considered as classes. Since our problem has multiple classes, an m-class SVM classifier has been used.

#### 4.3 Third stage of implementation

In this stage color segmentation algorithm is used to detect face automatically. As next phase a deep neural network is proposed to design in recognizing personality traits from face image. Input to the network is face area of the image which is the output of automatic face detection algorithm. Many research have proved that Deep Neural Networks (DNN) is extremely good with performing recognition and classification tasks.

A DNN extract features from images automatically during the training process. Training of DNNs is computationally expensive and they need large datasets. Training of DNNs is computationally expensive and they need large datasets. It is proposed to use a supervised DNN (e.g. Convolution Neural Network) to train the system to identify personality traits from a face image.

### 5. Results

#### 5.1 First stage results

The neural network is tested using portion of the dataset and the best validation performance obtained in this process is 0.80706. Fig. 2 shows the performance plot of the network.

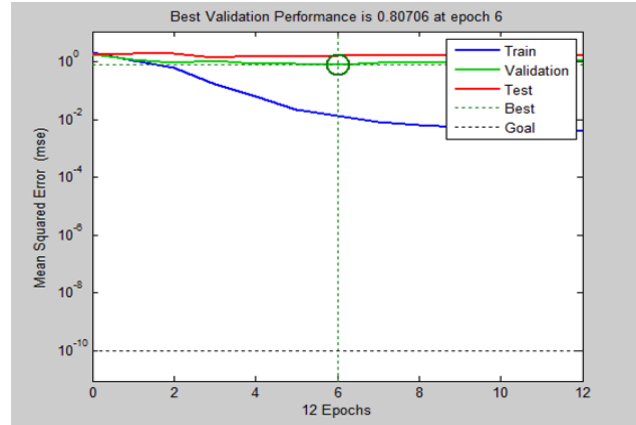


Fig.2 Performance plot of neural network.

#### 5.2 Second stage results

Separate SVM models have been designed for each personality trait value, for instance if a trait has three unique values then built three models. Then each model is tested with four kernel functions. They are linear, quadratic, polynomial and RBF. Some personality traits were not classified and some traits were successfully classified with these four kernels. Table 1 shows the results obtained in this stage.

Table 1: SVM results with different kernels

<i>Trait</i>	<i>Linear</i>	<i>Quadratic</i>	<i>Polynomial</i>	<i>RBF</i>
Attractive	√	×	×	×
Caring	√	×	×	×
Aggressive	×	×	×	×
Mean	×	√	×	×
Intelligent	√	√	√	×
Confident	×	×	×	×
Emotionally stable	√	×	×	×
Trustworthy	×	×	×	×
Responsible	√	×	×	×
Weird	×	×	×	×
Unhappy	√	×	√	×
Dominant	×	√	√	×

#### 5.3 Third stage results

The color segmentation algorithm used in this stage obtained 98.5% accuracy of detecting face area.



## 6. Conclusions

The first stage of implementation (using a neural network) gave better results than the second stage of implementation (using a support vector machine). In this research study, m-class SVM was used because each personality trait is multi valued. The dataset used in this research is small. The size of the dataset may affect to the results obtained. So accuracy of the results may increase by using a large dataset.

The m-SVM strategy used in this research is one against all. There is an another strategy called one against one. One can develop the one against one strategy.

In third stage of implementation involved automatic face detection algorithm to detect face area from face image which includes non-face areas. To detect the face color based segmentation method was used. This algorithm gave 98.5% accuracy without any preprocessing on images and with preprocessing on images may obtain higher accuracy in automatic face detection phase.

There may be hidden factors other than introduced in this study in feature extraction phase in ANN and SVM stages. So study more on psychology and improve feature extraction phase may improve the final results.

The third stage of implementation proposed to use supervised deep neural network. By implementing a deep neural network with a large dataset can improve the accuracy of the classification.

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