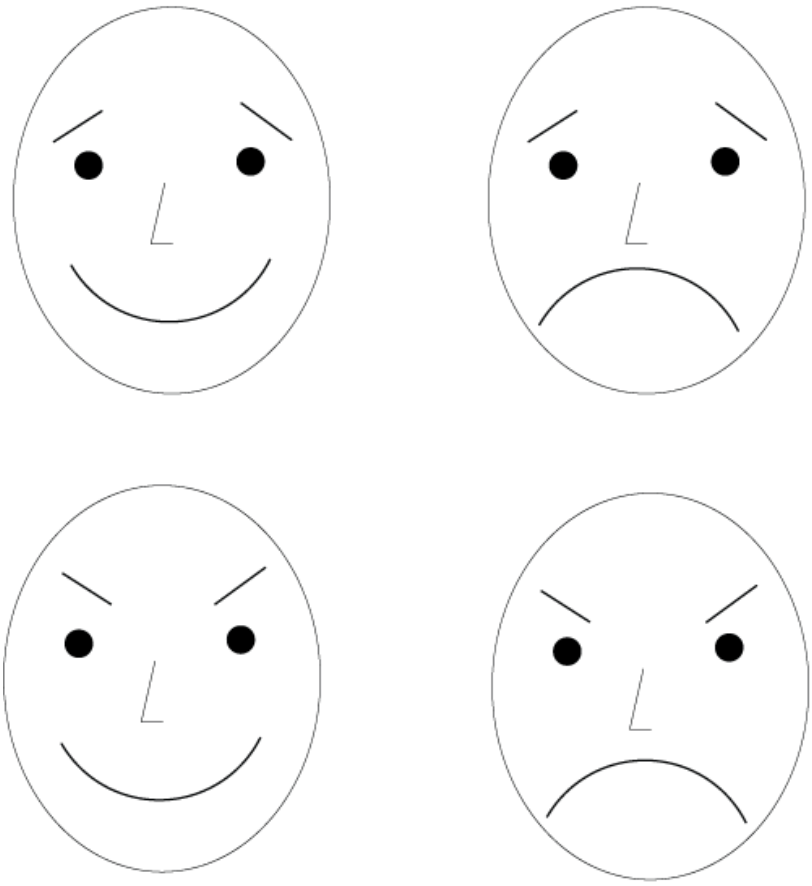
ARTIFICIAL NEURAL NETWORK

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (5DV121) : LAB 02 : REPORT



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Contents

1.0 Problem Overview 3

2.0 Solution Approach 3

2.1 Data Collection 3

2.2 Methodogy 3

2.3 Image pre-processing 5

2.4 Complexity 5

2.5 Multi-layer perceptron neural network 6

2.5.1 Neural nodes 6

3.0 Conclusion 7

3.1 Problems Faced 7

3.2 Overall Picture 7

1.0 Problem Overview

The problem is about build a perceptron based classification system that guesses the emotional state of faces presented as input where the recognition of facial expression and hence emotion and mood of a person is presented. The system for classifying the expressions of supplied face into four basic categories like **Happy, Sad, Mischievous or Mad**

2.0 Solution Approach

We use Artificial Neural Network (ANN) methodlogy that has a natural tendency for storing experiential knowledge. A key benefit of neural networks is that a model of the system can be built from the available data.

For classifying facial expressions into different categories, it is necessary to extract important facial features which contribute in identifying proper and particular expressions. Feed forward back propagation neural network is used as a classifier for classifying the expressions of supplied face into above four basic categories

2.1 Data Collection

Data required for experimentation is collected from FaceTest input for neural network training and testing. The training inputs contains 200 images of 4 facial expressions where the testing inputs contain new 100 images

2.2 Methodogy

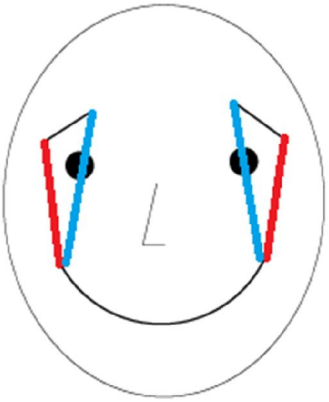
Here's the complete pseudo code for ANN image classification system:

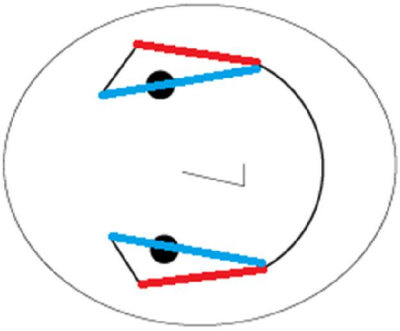
1) Read input image from database and localize face using morphological image processing operations
2) Crop the face image.
3) Extract features from cropped face.
4) Find facial feature vectors.
5) Train neural network.
6) Recognize expression

We avoid considering single layer perceptron ANN where we don't know about the traning images in the long run. We implemented multi layer perceptron ANN where it's generic for a lot of neural problems now days.

We think it's important to preprocess data to detect features where we want a Feature Vector (FD) as input layer. There're a set of ways we can go in achieving an efficient FD. Let's take some approaches;

Approach 01:



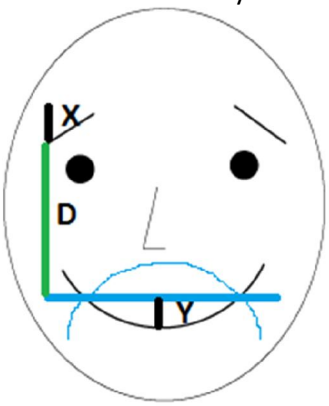


We can take the distances between edges of eye brows & mouth. This does seems a good way because the distances are not changing when we rotate the image, Even though in one image it actually has 2 variables. Because we can only take one eye brow edges & mouth edge since the image is symmetric.

Like that we can produce unique FDs for four different expression categories.

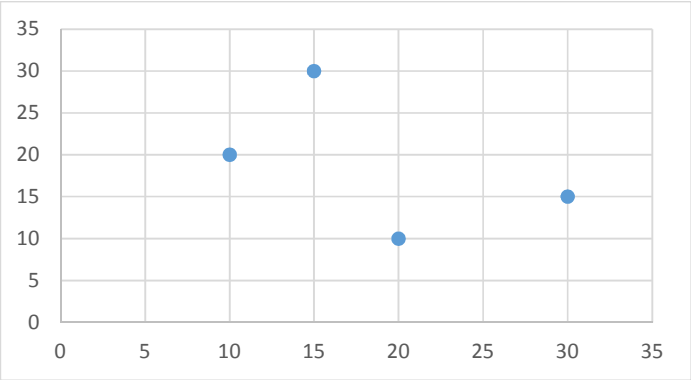
Fdv = {distance_1, distance_2}

Let's graph above FDs & discuss what the best ANN layer network to apply is:



FD(Happy) = {D-Y,D-Y+X}	FD(Happy) = {D1,D2}
FD(Sad) = {D+Y,D+Y+X}	FD(Sad) = {D3,D4}
FD(Mischievous) = {D-Y+X,D-Y}	FD(Mischievous) = {D2,D1}
FD(Mad) = {D+Y+X,D+Y}	FD(Sad) = {D4,D3}

Let's take random values: D1=10, D2=20,D3=15,D4=30



But when we're analyzing the graph we concluse that above problem is not linear seperable. If we take more & more train images the problem become more complex. So we use multi-layer perceptron ANN to train the neural network.

In our implementation we use this approach to train the ANN.

Approach 2

Another approach to set FD is to take the angle between two eye brows & the curvature of mouth which we can uniqule identify each expressions

2.3 Image pre-processing

For face portion segmentation and localization, morphological image processing operations are used. Permanent facial features like eyebrows, eyes, mouth and nose are extracted using SUSAN edge detection operator, facial geometry, edge projection analysis.

The Harris (or Harris & Stephens) corner detection algorithm is one of the simplest corner indicators available. The general idea is to locate points where the surrounding neighborhood shows edges in more than one direction, these are then corners or *interest points*.

2.4 Complexity

It's been complex to detect the edges we want. In our approach 1 we only need to detect 3 edge coordinates to traverse through our multi-layer perceptron ANN, Since the complexity in the implementation we detect all the line edges & take all possible combinations to achive what wee need.

In one image block avoiding eyes & nose:

Detect: 6 points

Combinations: ${}^{6}C_{2} = 15$

Then we feed the input layer of the neural network 15 times in one image block with targeted output

2.5 Multi-layer perceptron neural network

We use 3 layer network for simplicity where it contains a input layer, a hidden layer & a output layer.

Back-Propagation Networks is most widely used neural network algorithm than other algorithms due to its simplicity, together with its universal approximation capacity. The back-propagation algorithm defines a systematic way to update the synaptic weights of multi-layer perceptron (MLP) networks. The supervised learning is based on the gradient descent method, minimizing the global error on the output layer. The learning algorithm is performed in two stages feed-forward and feed- backward. In the first phase the inputs are propagated through the layers of processing elements, generating an output pattern in response to the input pattern presented. In the second phase, the errors calculated in the output layer are then back propagated to the hidden layers where the synaptic weights are updated to reduce the error. This learning process is repeated until the output error value, for all patterns in the training set, are below a specified value.

In this implementation, supervised learning is used to train the back propagation neural network.

2.5.1 Neural nodes

As we explained earlier in our approach, we only need 2 nodes in the input layer where we need 2 distance values. The targeted output contain the classification number 1,..,4 so the output layer contains onle one node.

The hidden layer can contain dynamic values mostly lower than the number of input nodes. For the initial step, we take the number of nodes in the hidden layer as same as the input layer.

3.0 Conclusion

3.1 Problems Faced

In creating the neural network we faced no problems as it has been impleented in more generic way where even we can change the number of nodes in layers,

But the biggest problem we faced in detecting features where we need an efficient way to do this in time & space manner.

We use a number of iteartions where the weight matrix be solved in more accuarte manner. But we're still trying to produce the good results

3.2 Overall Picture

The combination of SUSAN edge detector, edge projection analysis and facial geometry distance measure is best combination to locate and extract the facial feature for gray scale images in constrained environments and feed forward back-propagation neural network is used to recognize the facial expression.

Proposed combination method for feature extraction does not extract exactly four features parameters properly if there are more than components than it's expected basically.