University of Waterloo

Winter 2015 – ECE457B Computational Intelligence

ECE Dept, University of Waterloo

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Facial Expression Recognition System

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Abstract and Overview:

The goal of this project is to explore and evaluate facial expression detection for the purposes of improving human-machine interfacing through enabling artificial intelligence to perceive non-verbal cues. Since the desired application involves analyzing human faces while they are speaking, the detection and tracking of metrics regarding the mouth may not be precise. This project will explore whether a reliable facial expression classification system can be created without the use of mouth metrics.

Problem Formulation:

The application should be able to classify four facial expressions using facial data and metrics. The four emotions are happiness, sadness, surprise, and anger. The source of facial data is not within the scope of this project, however the source should be able to provide a large set of data for training and testing. The classification should be accurate, correctly identifying 70% of the emotions. The research should also attempt to maximise the accuracy where possible.

Proposed Solution:

The proposed solution is to use facial landmark data provided by the Cohn-Kanade (CK and CK+) database. Some of the data will then be used to train a neural network which will be implemented in MATLAB. The remaining unused data will then be used to validate the accuracy of the implementation. In order to improve the accuracy of the system, the code will be run with varying parameters in order to determine an optimal range of parameters.

Tools, Algorithms:

Database: Cohn-Kanade AU-Coded Expression

Method 1: Matlab Neural Network Library (nnstart)

Method 2: Code Implemented of Back Propagation Neural Network with
- Offline Learning (Cumulative Error)
- Momentum
- Batch Learning (Updating Weights)

Experiments, Analysis:

Experiment Setup

Input: Face Landmarks (136: x_1, …, x_{68}, y_1, …, y_{68})

Output: 4 Classes of Emotions Happy, Surprise, Anger and Sadness

Exemplars: 225

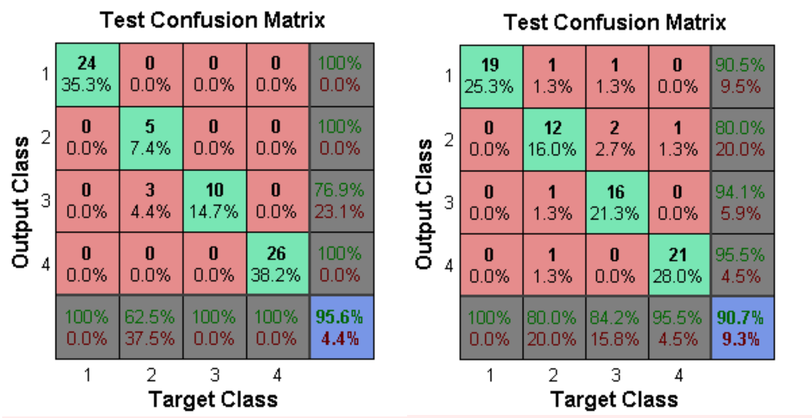
Training: 65% of Exemplars
Testing: 30% of Exemplars

Evaluation Metrics

- Classification Accuracy vs Neurons, Layers, Input Size

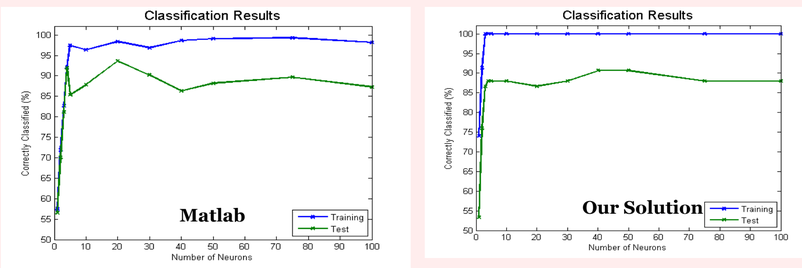
Analysis

Best Result



Matlab – 20 Neurons (95.6%) | **Our Solution – 50 Neurons (90.7%)**

Effect of Number of Neurons



Effect of Number of Hidden Layers

Number of Hidden Layers \ Neurons per layer	5 Neurons		20 Neurons		50 Neurons	
	Train	Test	Train	Test	Train	Test
1	**100 %**	**88 %**	100 %	87 %	**100 %**	**91 %**
2	91 %	76 %	**100 %**	**89 %**	100 %	88 %
3	91 %	75 %	100 %	83 %	100 %	87 %

Effect of Size of Input

	!( )	!(Jaw)	!(Eye Brows)	!(Eyes)	!(Nose)	!(Mouth)
Training	100	100	100	100	100	97.9
Testing	88.6	**91.1**	89.9	89.9	86.1	**70.9**

	!(Jaw, Eye Brows)	!(Jaw, Eye Brows, Eyes)	!(Jaw, Eye Brows, Eyes, Nose)
Training	100	100	100
Testing	91.1	92.4	93.7

	Jaw	Mouth	Eye Brows	Eyes	Nose
Training	96.6	100	97.3	87.7	76.7
Testing	50.6	93.7	43	59.5	43

Conclusion:

The team was able to achieve a fairly high overall classification rate of over 90% for the 4 emotions. A single hidden layer with 50 neurons provided the best classification results.

Facial landmarks that most reduces classification accuracy are situated on the mouth. Using only the mouth as input actually happens to provide the best classification accuracy of 93.7 %. Over fitting occurs with reduced landmarks.