ENT Bacteria classification using a neural network based Cyranose 320 electronic nose

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Summary

An electronic nose (e-nose), the Cyrano Sciences' Cyranose 320 (see Fig.1), comprising an array of thirty-two polymer carbon black composite sensors has been used to identify 3 species of bacteria responsible for ear nose and throat (ENT) infections when present in standard agar solution. Swab samples were collected from the infected areas of the ENT patients' ear, nose and throat regions. Gathered data were a very complex mixture of different chemical compounds. An innovative data clustering approach was investigated for these bacteria data by combining the Principal Component Analysis (PCA) based 3-dimensional scatter plot, Fuzzy C Means (FCM) and Self Organizing Map (SOM) network. Using these three data clustering algorithms simultaneously better 'classification' of three ENT bacteria classes were represented. Then three supervised classifiers, namely Multi Layer Perceptron (MLP), Probabilistic Neural network (PNN) and Radial basis function network (RBF), were used to classify the three bacteria classes. A comparative evaluation of the classifiers was conducted for this application.

Motivation

This type of bacteria data analysis and feature extraction is very difficult. We can conclude that this combined use of three nonlinear methods (PCA based 3D-Scatter plot, SOM, FCM) can solve the feature extraction problem with very complex data and enhance the performance of Cyranose 320. So from these results we can conclude that in future we can create a 'knowledge base of extracted features' by applying three nonlinear methods like PCA based 3D-Scatter plot, SOM and FCM for each bacteria class. So in future if we have an input dataset from unknown bacteria, by applying these three methods in a combined manner we can extract some feature for that unknown class of bacteria; later on we can match with the existing knowledge base of classes of bacteria features to predict the bacteria class. For this matching purpose, supervised ANN classifiers like PNN or RBF can be used with very high accuracy. See (Fig. 2, Fig. 3, Fig. 4 and Fig. 5).

Results

Later on two supervised ANN classifiers, PNN and RBF were able to predict the four different ENT bacteria classes with 95% and 98% accuracy respectively.
Finally, we can conclude that this combined use of three nonlinear methods along with RBF neural network can solve the feature extraction problem with very complex data and enhance the performance of Cyranose 320.

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Figure 1: Typical Cyranose 320 e-nose

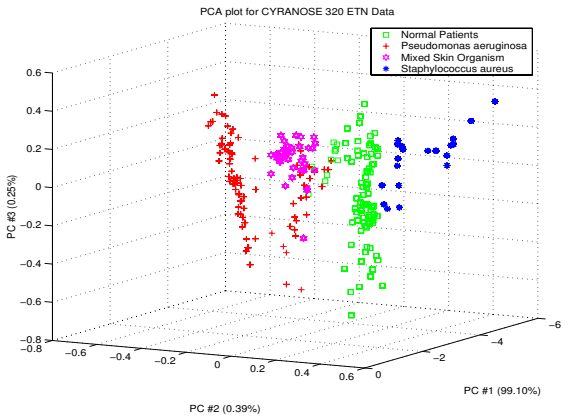

Figure 2: 3D view of the PCA plot for the e-nose data sets from four different ENT bacteria swab samples.

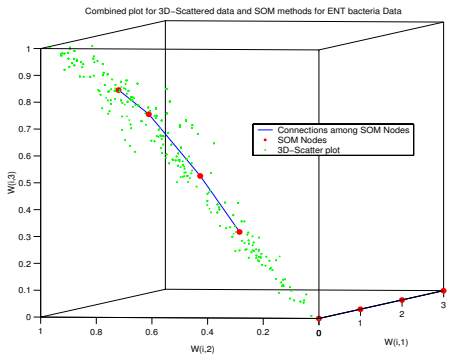

Figure 3: 3D view of the unsupervised SOM analysis for four types of ENT bacteria data from polymer based e-nose.

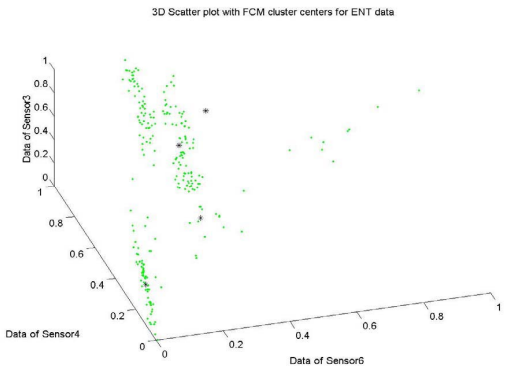

Figure 4: 3D view of the unsupervised FCM from non-conducting polymer sensor based Cyrano's e-nose.

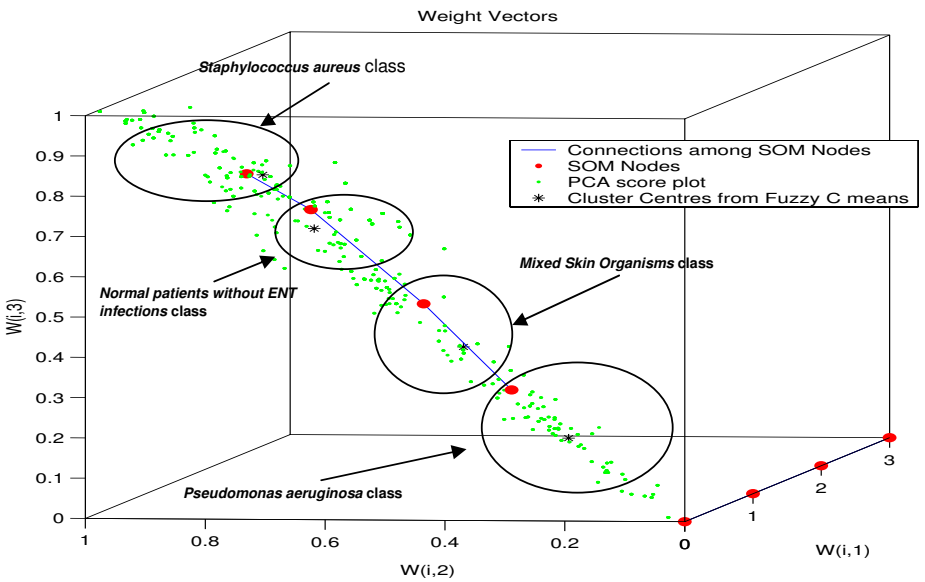

Figure 5: Combined plot for the four types of ENT bacteria data, based on the extracted knowledge from the main data processing techniques, PCA, FCM and SOM, for the ENT bacteria class.