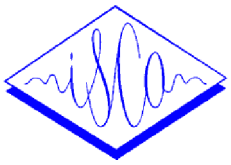

Models and Analysis of Vocal
Emissions for Biomedical Applications
(MAVEBA 1999)
Firenze, Italy, September 1-3, 1999

FROM SIGNAL PROSESSING TO SPEECH PROCESSING ANALYSIS BY NEUROFUZZY EXPERT SYSTEM FOR AUTOMATIC DIAGNOSIS.

Mariaisabella Colli-Roberto Mondino -Enrico Ozzano- Alfredo Sacchi

Department of Energetic, Polytechnic of Turin, Corso Duca degli Abruzzi 24-10129 Torino, Italy.e mail sacchi@polito.it

Abstract: An artificial method to analyse voice and speech, for automated diagnosis, is developed. Neuro-fuzzy expert system and a three-layer perceptron were used to classify phoniatric signals into four categories of disease. Simulation of the two different systems are referred, in order to show advantages and disadvantages of each system.

Keywords :speech processing, signal processing analysis, fuzzy expert system neural networks neural networks,

Introduction

Repetitively applied cognitive tasks of recognising and evaluating certain phenomena, called diagnostic tasks, are among the main applications for the Artificial Intelligence (AI). Most popular among Artificial Intelligence methods in medicine are:
knowledge based systems, modelling the diagnostic behaviour of experts.
neural networks, able to learn relationships between data sets by simply having sample data represented to their input and output layers.
fuzzy logic, dealing with the uncertainty of verbal expressions such as many, few or probably; the linguistic variables offered by fuzzy representations allow pseudo-verbal descriptions close to natural human expressions. This work deals with the analysis in two
categories es of phoniatric disease, by means of the methods listed above.:
voice
speech

Several methods of analysis of sets of data have been examined, by artificial intelligence instruments,. We have considered advantages and disadvantages of these methods, and we have chosen two different approaches at the problem.

First, we have used a simple multilayer perceptron, trained to recognise the voice and speech recordings and to classify them in one of the four categories we have chosen.
The second approach is a hybrid system, made up of different artificial intelligence techniques. The system we have planned is based upon the merging of neural networks, fuzzy representation of data and expert systems, in order to exploit the advantages of each technique and to avoid some of the disadvantages. Such a system is perhaps the most interesting, because of its user-friendly way of classifying data. In fact, while a neural network can be seen as a black box, our hybrid system uses a knowledge base, made up of rules in a linguistic forms. These rules can be easily understood and are modifiable by the users or the expert. Besides, other rules can be added to the system, such as rules that an expert usually uses in making a diagnosis.

For our research we have used a great number of sonogramm we have Hospital in Turin. normal and disphonie and disarthrie were much more then those in the other categories.

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Neural Network classifier

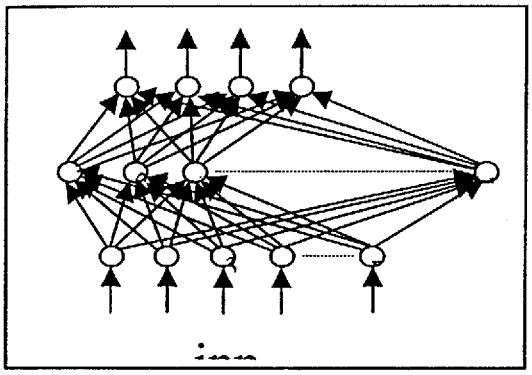

fig. 1 : multilayer perceptron with *m* input nodes, n hidden nodes and 4 outputs.

The structure of the human brain has a great degree of parallelism, has a great reliability even through if some elements are unreliable, and a learning ability, that is the ability to make rules from experience. With such a structure even animals with small and simple brains can perform complex actions, such as shape detection, motory control, learning and generalisation actions, that a computer cannot perform.
Artificial intelligence research tries to pass the architectural model of the actual computer, and tries to reproduce in some the features of the human brain , in a machine. Neural networks have been developed, in this field whose name is due to the fact they have the same logical structure of neurons and synapses. A neural network is, in fact, made up of simple elements, called neurons, and links which join these neurons. An artificial neuron is a simple element, which performs an activation function.
The first example of neural network wasby McCulloch and Pitts in 1943; it was a single element with threshold activation function, which could perform a simple logical function.
A neural network is a set of neurons linked to several methods. Modifying this structure means changing the weights of every connection; this causes some inputs to be more important than others.. By changing the weights of the connections, the network is givendifferent outputs, even ttrough the inputs do not change. The secret of neural networks is the method used to change the weights of the connections, A network, can be created that has the correct output when a particular input is given; the method used is called learning algorithm. The network,can be trained by simply giving the network several inputs and desired outputs as examples; the learning algorithm then changes the weights so that the network learns to give an intelligent answer to the inputs.
Neural network research has developed remarkably over the years; there are,at the present several kinds of neural networks, that are classifiable according to their architecture or their learning algorithm. As an example, there are supervised networks, such as the perceptron and the multilayer perceptron, recurrent networks, and unsupervised networks, such as Kohonen and ART, hybrid networks etc. The use one can make of these networks are numerous: pattern recognition, associative memory, character recognition, target recognition, speech recognition, pattern classification, associative memory, image recognition, etc.
An expert system is a rule based block, which is planned to be an 'expert' in a given field. An expert system is a programme planned by a human expert, in order to memorise an experience in a coded way.
An expert system is based on a knowledge base, containing sets of rules acquired by deductive and inductive learning, and on a block that makes a final diagnosis starting from the previous two knowledge blocks.
Rules resulting from a deductive learning are mostly given by an expert doctor.
An inductive learning is instead applied when the learning acquired deductively is incomplete; in this case, some examples are used to train an automatic block based on neural networks.
Deductive and inductive learning can give us the same rule, with different strengths (that is, different importance), or even contrasting rules. In this case, the system takes a decision on the basis of the strength of the rule or according to another rule.
It is important that such a system can give no response, that is the system can say 'not a classifiable track', when there is a strange

recording.
Fuzzy representation of data
A fuzzy representation of data is necessary, in order to discretize the input features, avoiding abrupt changies from one state to another.Furthermore, using the fuzzy sets, one can model, in a mathematical way, the vagueness and uncertainty of human expressions.
A fuzzy expert system is an expert system that uses a collection of fuzzy membership functions and rules, instead of Boolean logic, to reason on data. The rules in a fuzzy expert system are usually of a form similar to the following:

if x is low and y is high then z = medium

where x and y are input variables (names for known data values), z is an output variable (a name for a data value to be computed), low is a membership function (fuzzy subset) defined on x, high is a membership function defined on y, and medium is a membership function defined on z. The antecedent (the rule's premise) describes to what degree the rule applies, while the conclusion (the rule's consequece) assigns a membership function to each one or more output variables. Most tools used work with fuzzy expert systems allows more than one conclusion per rule. The set of rules in a fuzzy expert system is known as the rule base or knowledge base.

Presentation of the hybrid system and conclusion.

In order to extract the acquired knowledge, two types of fuzzy neural network have been used, FuNe I© and NEFCLASS©. The two networks perform differently, but the worst, NEFCLASS©, is, however, the one that has the simplest algorithm:
FuNe I©, is a three layer perceptron trained with a gradient descendent algorithm. There are three types of neurons in the middle layer grouped together topologically. One group of neurons can perform only the or function of multiple inputs while another group only performs the and function. There is a third group of neurons with single input and single output. The output neuron simply acts as an or function of all the middle neurons. In the initial state the fully interconnected network represents all possible logical functions of or premises, and premises, and unary premises. During learning, all connections below a certain threshold are eliminated. This pruning method is useful in order to increase the learning speed and to limit the number of the resulting rules.
Nefclass©, (which means NEeuro Fuzzy CLASSification) is a three layer perceptron. A NEFCLASS system can be created from an existing set of rules and then refined by the learning phase, or can be created entirely by the learning phase. The user must define the number of fuzzy sets, so that the domain of the inputs is correctly divided, then he must specify the maximum number of rules that can be created in the hidden layer. Every fuzzy set is labelled with a linguistic term, such as small, very small, medium, etc. A NEFCLASS system, without any initial rule, has no hidden neuron at the beginning. The hidden units are created during the first learning phase, by means of the set of examples. A rule is created by finding, for a given example, the combination of the fuzzy sets for each input, that have the largest membership value for that example. If this is a new combination, that is, there is not already an identical rule, a new rule is created. This way of finding fuzzy rules is reither simpler than the one used for FuNe; it is important that the patterns are randomly chosen and that every class has the same number of patterns as the others.

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