Neural Network Hidden Layer Number Determination Using Pattern Recognition Techniques

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Abstract: This article dwells on original method for determining the number of layers of neural network used in analyzing signal. In this article an original method is presented for determination of the numbers of layers of a neural network used in analyzing signal. The method consists in using a technique of grouping of entering forms, specific to the domain of recognizing forms, for establishing the optimal number of layers of a neural networks.

Keywords: neural network, hidden layer, backpropagation, P waves, QRS complex, T wave, pattern recognition, ECG

A major problem in designing a neural network is establishing the optimal number of layers and number of neurons on each of it.

Regarding the entering layer and out one, the problem is very easy, because for the entering one, the number of neurons will be equal with the numbers of classes[1], the problem being in establishing the number of hidden layers and the number of neurons on each layer.

Choosing the number of hidden layers and the number of neurons on this is difficult, because there are no generally acceptable theories, solutions being in the specific literature only for special cases. In present there are no formal ways of determining the size of a neural network, according to complexity of the problem to solve, the solutions being seared by means of empirical testing. Usually it is recommended to start with only one hidden layer, and if the results are not good, the number of hidden layers will grow up[2].

The number of neurons must be a little bit higher for generating a configuration of the decision areas, complex enough, for a given problem, but if the number of neurons is too big, then the number of connections becomes to big and there is the risk for the balance of these connections not to be calculated only using available examples, in this way it is possible that the network to generate noises[2]. So the

phenomenon of overfing the neural network. If the number of neurons from hidden layers is small the neural networks can't learn the entire information, so in this way the tolerance at technical hitch goes low through the available neural network [2].

A very easy method of determination the optimal architecture of a neural network for solving same problems would be the choosing of a great number of network with different architecture and learning them on a set of common data base, until the performance criteria is fulfilled and then the selection of that structure with minimal dimension. The disadvantage is that the results depend of the initial architecture selection and it takes a long time.

The proposed method for establishing the number of hidden layers of a multilayers neural network is based on the technical forms of entering some common characteristics, technique borrowed from the domain of pattern recognition. The idea is to build, for the entering forms a multidimensional cube, on which later, using the DBMiner program, these forms will be joined on the K-means algorithm, in this way the number of groups will be the number of hidden layers for obtaining a optimal neural network for analyzing a signal. With the support of DBMiner program we can group the entering forms in one group, equal with the number of forms, in a number of group between the two values. The idea is to find that number of group for which a t least 90% from the forms are grouped in groups having the same number of forms. The number of groups obtained will be considered as the optimal number of hidden layers for a neural network (not taking into account the clusters with too few forms).

As a practical example the EKG signal (which describes the heart's electrical electrical activity) has been used. The signal was divided in three separate waveforms, the P wave, the QRS complex and the T wave, each of these being characterized by a certain number of measurements (samples, according to the Nyquist theory).

A multidimensional cube was created using Microsoft SQL Server 2000, subsequently analyzed with DBMiner 2.0 program. As dimensions for the cube were considered the number of samples of the P wave and as measures the number of forms analyzed.

In the figures below the results only for the P wave are shown. The result for the QRS complex and the T wave are similar to those obtained for the T wave.

The clustering possibilities are shown in Figures 1, 2, 3, for P wave.
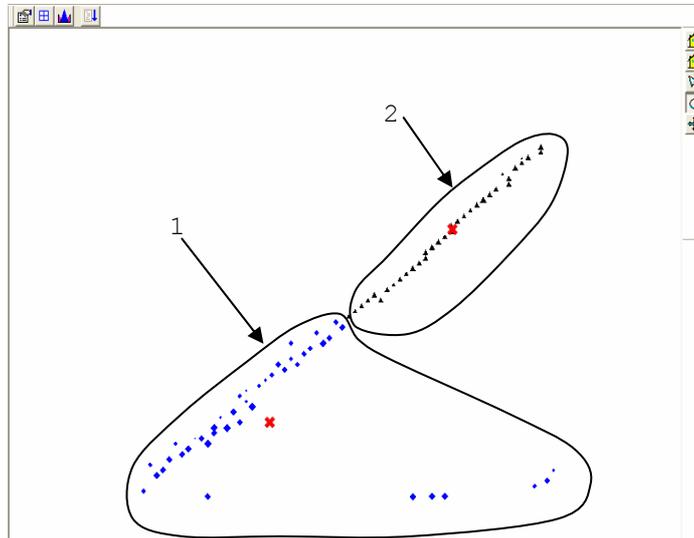
Figure 1
P wave grouped in two groups
Group 1 has a number of 45 forms
Group 2 has a number of 45 forms
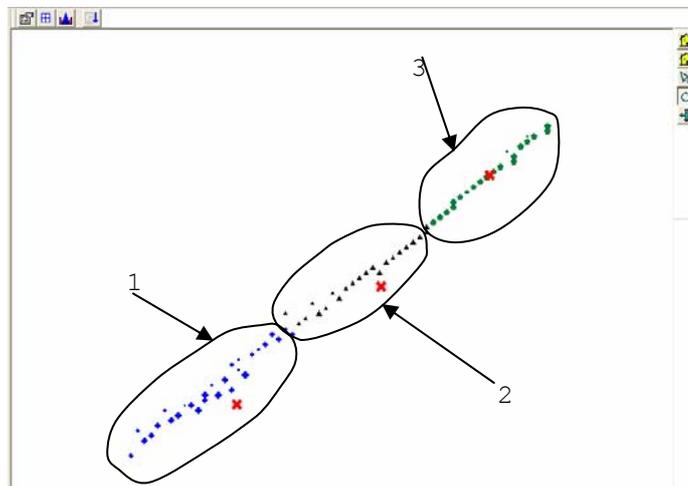
Figure 2
P wave grouped in three groups
Group 1 has a number of 45 forms
Group 2 has a number of 45 forms
Group 3 has a number of 45 forms
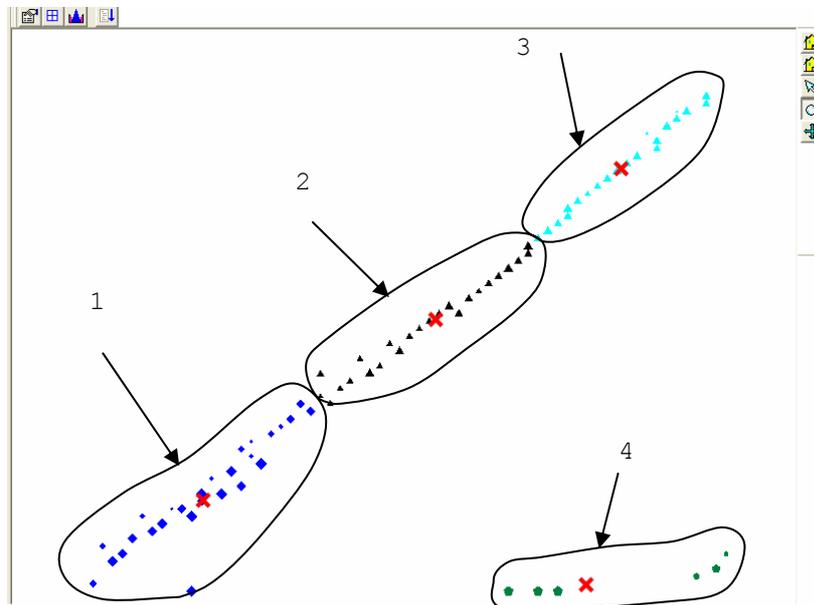
Figure 3
P wave grouped in four groups
Group 1 has a number of 45 forms
Group 2 has a number of 45 forms
Group 3 has a number of 45 forms
Group 4 has a number of 45 forms

Using the grouping technique, some common characteristics of input forms are emphasized on whom basis these can be grouped.

Taking into consideration the results obtained through specific technical methods of pattern recognition, it can be concluded that the optimal neural network for analyzing the ECG signal must have three hidden layers. Next we prove that the solution in this way is optimal from the point of view of performance in comparison with other architectural neural network.

The neural network was simulated with the program Neuroshell, using the backpropagation alghoritm for learning, the number of neurons of each hidden layers being calculated automatically by Neuroshell[4]. For the training we used 500 forms of entering for each three waves. In figures 4 and 5 the error of the neural network presented for different arhitectures(using the same criteria of error in the same time of training).
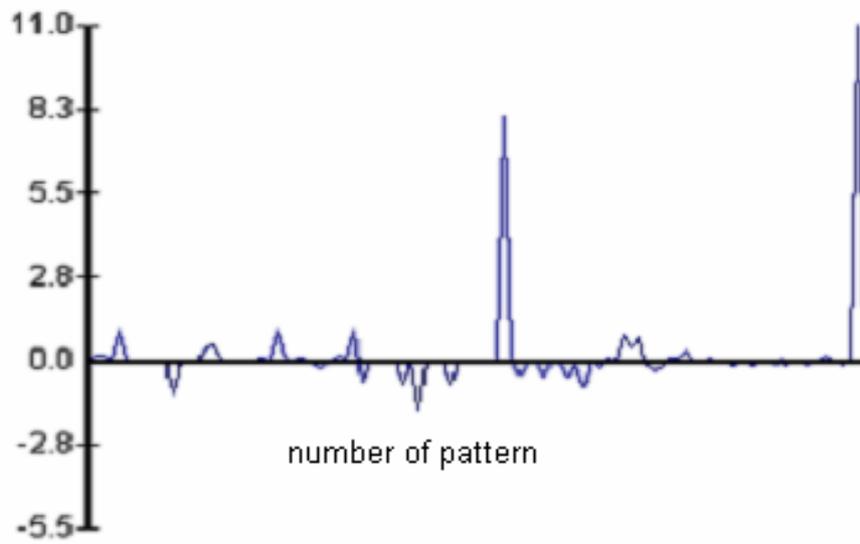
Figure 4
The error for the P wave using a neural network with two hidden layers
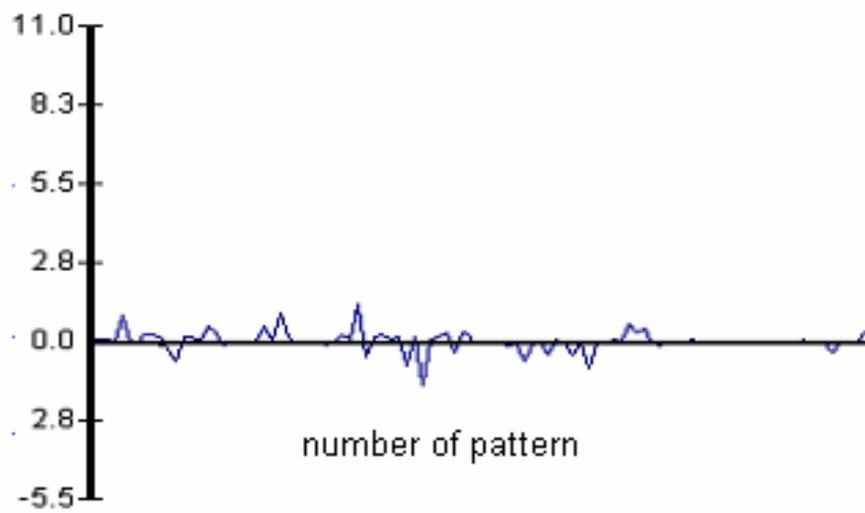
Figure 5
Error for P wave, for a neural network with three hidden layers
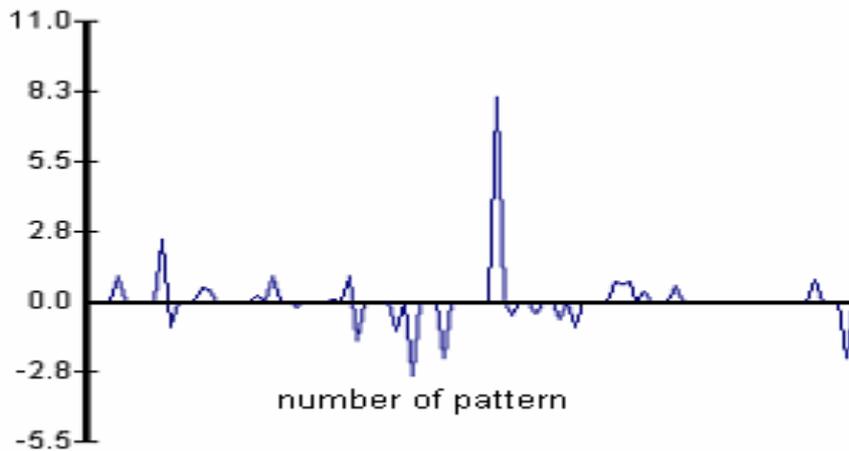
Figure 6
Error for P wave, for a neural network with four hidden layers

Making a comparison between these results we can say that the neural network with tree hidden layers is optimal, results being better (as final error).

On the basis of the obtained results we can conclude that the numbers of groups obtained (grouping being made on some criteria of similarities between characteristics), it can be considered as the optimal number of hidden layers for a neural network.

References

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