

Classification of Raman Spectrum of Coronary Tissue using Neural Networks

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Keywords: neural networks, Raman spectra, cardiac tissue, arteriosclerosis.

Cardiovascular diseases are the largest cause of death in industrialized countries, and arteriosclerosis is considered the worst among them. Hence, early diagnostic of bad conditions in patients can increase their chance of survival. One way of performing the detection is using an optical catheter that is introduced into the patient's coronary to excite its inner walls using a laser radiation and acquire the resulting radiation to a Raman spectrometer. With the spectra obtained it is then possible to automatically diagnose the condition of the coronary [Oliveira, 2002].

Artificial Neural networks has been shown efficient and of the great importance in the classification of Raman spectra of coronary tissues. The noise generated by the detector has about the same level that the Raman spectrum of the tissues, making hard the analysis. The objective of this work is to find a topology of a neural network adjusted for this kind of problem, as well as the selection of an algorithm with a good performance to classify the Raman Spectra [Paula, 2002].

In this work we evaluate multilayer perceptrons (MLP) trained using the backpropagation algorithm with descendent gradient method and with the Levenberg-Marquardt method that are the most utilized algorithms nowadays to solve this problem. We also analyse the Adaline algorithm, in order to verify whether to separate the three different kinds of tissue can be considered a linear problem.

According to Oliveira (2002), two or three neurons are required for the neural output layers in order to separate the groups. The desired classification outputs are selected according in Table 1.

Table 1 Net's output

Tissue	2 neurons	3 neurons
Normal	-1 1	-1 1 -1
Atheromatous	-1 -1	1 -1 -1
Calcified	1 -1	-1 -1 1

We find that the problem could not be considered as linear, because the Adaline algorithm have the good response to the training spectrum set, but did not classify satisfactorily the validation set. The MLP solved the problem using both the Levenberg-Marquardt and the Standard Backpropagation algorithm. The performance of the Standard Backpropagation was better than the Levenberg-Marquardt, considering the error and the computational cost (time of processing and memory space).

The number of neurons in the output layer (two or three neurons) was not important; both topologies had good performance in separate the groups. One difference is that with two neurons in the output, two hidden layers were required to this problem, but with three neurons, only one hidden layer is enough for the classification.

In Figure 1 presented the formation of the three clusters, representing the three different kinds of tissue. We find that the best topology of net was 32-16-2, but the net 16-16-2 can also be considered to this problem, as a minor net, with little computational cost.

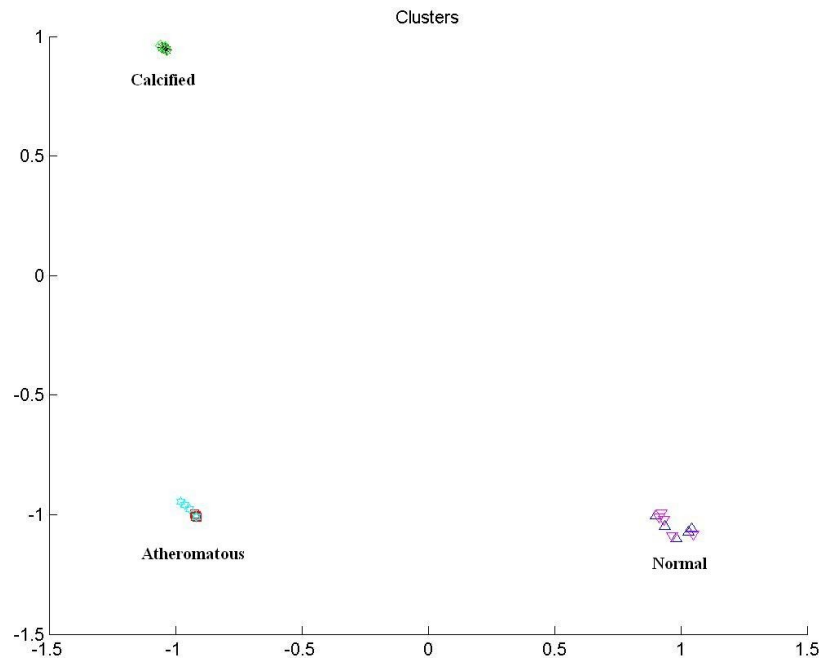


Figure 1 Formation of three different groups corresponding to normal, atheromatous and calcified tissue, for training and validation.

We conclude that neural networks are efficient to the classification of Raman specters of the different kinds of cardiac tissue, once it could separate the data in three distinct groups, each one associated to one type of coronary tissues.

We observed that this problem was not linear, and needs one algorithm more powerful than the Adaline to separate the groups.

The comparison between the training algorithm shows that the Standard Backpropagation had a best performance in classify the Raman spectra of coronary tissues. It had the smallest error to both training and validation, and required smaller processing time to training the net.

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