Artificial Neural Network in Medicine

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Abstract: One of the major problems in medical life is setting the diagnosis. A lot of applications tried to help human experts, offering a solution. This paper describes how artificial neural networks (compared with other systems from artificial intelligence) can improve this domain.

Keywords: artificial neural networks, expert systems, medical diagnosis

1 Introduction

The health of population, which is based primarily on the result of medical research, has a strong impact upon all human activities. Among the most important medical aspects are considered the good interpretation of data and setting the diagnosis. But medical decision making becomes a very hard activity because the human experts, who have to make decisions, can hardly process the huge amounts of data. So they need a tool that should be able to help them to make a good decision. They could use some expert systems or artificial neural networks, which are part of artificial intelligence.

2 Choosing between Expert Systems and Artificial Neural Networks

One of the most known modalities of setting the diagnosis consists in using an expert system (which is a branch artificial intelligence). These kinds of systems implement human reasoning and they use a set of decision rules, which test physical symptoms and laboratory analyses, making a suggestion for diagnosis.

Frequently is hard to express the rules for the system. The translation of implicit knowledge into explicit rules would lead to loss and distortion of information content [1]. In addition to these difficulties it can be said that to make such an

expert system need a good engineer who must understand the medical domain in which expert system is made.

On the other hand, the tree structure of rule-based relationships becomes too complex if new levels of knowledge are added.

An alternative to this kind of inference (which is called logical inference) is statistical inference. In this area, the most used method is Bayes theorem, which sets a probabilistic value for each considered output (disease, if the system is applied in medicine).

Such an expert system could be successfully used if it is developed for mutual exclusive diseases and independent symptoms. But sometimes these restrictions cannot be accomplished because there are situations when some symptoms have the same cause (being connected) and a patient can suffer of more than one disease. Because of these problems, Bayes theorem is not always a solution.

Therefor, there are a lot of cases when is not possible to implement the human intelligence with expert systems. This is the reason because artificial neural networks (a new branch of artificial intelligence) have been developed. These start with the idea that in order to reproduce intelligence, it would be necessary to build systems with a similar architecture [2].

3 What is a Neural Network

Artificial neural networks are developed based on brain structure. Like the brain, artificial neural networks can recognize patterns, manage data and learn [3]. They are made by artificial neurons (figure 1), which implement the essence of biological neurons.
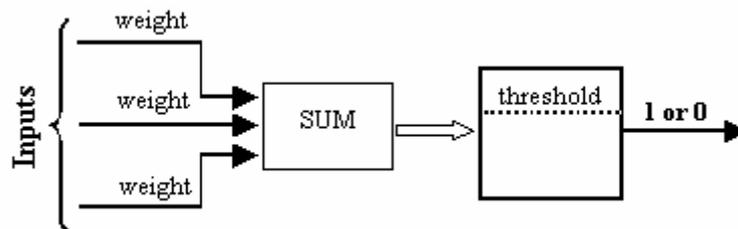

Figure 1
An artificial neuron

Such a neuron is defined as follows [2]:

— It receives a number of inputs (from original data or from output of other related neurons). Each input comes via a connection, which is called synapses and which has a weight (coefficient of connectivity [4]). A neuron also has a threshold value. If the sum of the weights is bigger than this value, than the neuron is activated.

— The activation signal produces the output of the neuron. This output can be the result of the problem or can be considered an input for another neuron.

To create an artificial neural network is necessary to put together a number of neurons. They are arranged on layers. A network has to have an input layer (which carries the values of outside variables) and an output layer (the predictions or the result). Inputs and outputs correspond to sensory and motor nerves from human body [2]. There also can be hidden layer(s) of neurons, which play an internal role in the network. All these neurons are connected together (like in figure 2).
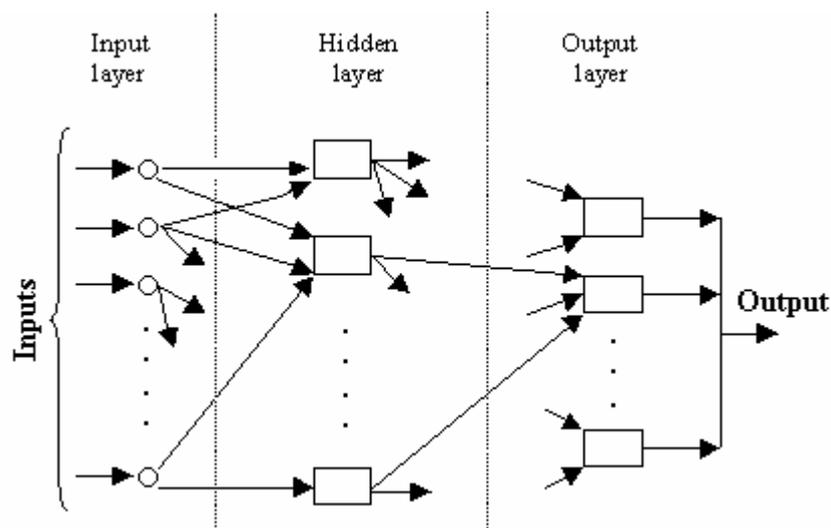

Figure 2
The architecture of an artificial neural network

4   How are Used Neural Networks in Medicine

Artificial neural networks could be used in every situation in which exists a relationship between some variables that can be considered inputs and other variables that can be predicted (outputs) [2]. The most important advantages using artificial neural networks is that this kind of system solves problems that are too complex for conventional technologies, do not have an algorithmic solution or the

solution is too complex to be used [3]. These characteristics have often appeared in medicine. Artificial neural networks have been successfully applied on various areas of medicine, such as: diagnostic systems, biomedical analysis, image analysis, drug development [5].

Using artificial neural networks, it can be monitored a lot of health indices (respiration rate, blood pressure, glucose level) or can be predicted the patient response to a therapy.

Artificial neural networks have a very important role in image analysis, too, being used together with processing of digital image in recognition and classification. They are used in pattern recognition because of their capacity to learn and to store knowledge [4], [5]. The medical image field is very important because it offers a lot of useful information for diagnosis and therapy.

There are also a lot of applications that use neural networks connected with Bayesian statistics (which can estimate the probability density of a model parameters given the available data [2]).

Conclusions

The artificial neural networks, with the ability of learning by example, are a very flexible and powerful tool in medical diagnosis and have a lot to offer to modern medicine.

References

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