EDITORIAL

ARTIFICIAL NEURAL NETWORKS IN MEDICINE

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By the turn of the century, it became evident that the most important features of the last decade were the information revolution and the impact of computer on all disciplines of medicine. It is well known now that computers make performance of computational tasks faster, more accurate and easier.

Evolving from neurobiological insight, neural network technology was developed. The neural network mimics the human brain in terms of architecture, design and functioning. It can be used to recognize pattern and images, construct a design tree to image a problem, classify data, predict outcomes and study thematic evolution of a process.

Neural network gives a computer system an amazing capacity to actually learn from input data. Artificial neural net works (ANN) have provided solution to problems normally requiring human observation and thought process.

Artificial neural network are software construction designed to mimic the way human brain learn. The brain is made up of billions of interconnected neurons. Similarly, artificial network are made of virtual interconnected node. Computer scientists have developed many classes of artificial neural networks with a variety of architecture and training a logarithm. The most basic and commonly used neural networks architecture is the “Multilayer Perception (MLP)” with a back-propagation training a logarithm. The input layer nodes accept input variables (analogous to independent variables). One or more hidden layers of nodes do the majority of processing. Values from the hidden layer are processed and presented as an output value at one or more output nodes (analogous to dependent variables).

Each generic hidden node has multiple connections. Each connection has a weight or coefficient associated with it (W1, W2, W3 ......). These weights serve as multipliers for the value passing to the nodes through each connection from the previous layer (the values coming from the input layer are usually represented by X1, X2, X3 .....). When numbers are entered into the input layer, they are multiplied by the weights at each connection and then summed at the hidden nodes. The resulting sum is passed to the next layer of nodes. Finally, a number emerges at the output node with a value that depends on the input values and weights assigned to each interconnection.

The above description forms the basis of the use of artificial neural networks in medicine and clinical practice. Almost all clinical decisions that doctor make are based on more than one item of data because it is very rare for a single symptom or sign, or measurement to be path gnomonic with no overlap with other diseases. Doctors make such decisions by assigning, usually unconsciously, different weights to the items of data and then choosing the most probable prediction. They will have learned the relative importance and specificity of the items of the data from the past experience of seeing patients, collecting data from them, making a diagnostic prediction, and then comparing this with the actual outcome. A physician attending a patient presenting with chest pain in an admission unit will ask about site and character of the pain, whether the patient is short of breath, is nauseous, or smokes; what is the age and sex of the patient; and will assess whether there is new ST elevation or pathological Q wave on the ECG, will elucidate other data items, and a clinical decision will evolve.

In developing an artificial neural network, data are collected from real patients. These data are compiled and studied to determine their characteristics. Then an artificial neural network is created to model the data.

Artificial neural networks are not programmed like conventional computer programs, but learn from experience. The artificial neural network learns during a training phase in which cases

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with known inputs and outputs are shown to the artificial neural network sequentially and repeatedly. A training algorithm adjust the weights at each connection with the goal of reducing the error between the known output values and the actual values the artificial neural network generate with the weights it has at the moment. At first, the outputs produced by the artificial neural network are somewhat arbitrary. But, over time, as cases are reintroduced repeatedly hundreds or thousands of times, the artificial neural network begins to get some of the answers right. The training algorithm continues to change the weights until most of the answers are correct and training is then stopped. The next phase is to test or validate the artificial neural network. This is done with a set of cases that the artificial neural network has never seen. Based on the artificial neural network performance on this test, called validation set, it is determined whether the artificial neural network has learned appropriately.

Several research groups and investigators are currently working to develop artificial neural networks for clinical application. Ian Cather of the University of Sydney is using artificial neural networks in assisted cardiac auscultation and clinical identification of murmurs. Silipo and his group from the University of California at Berkeley use artificial neural networks in classification of arrhythmic events in ambulatory ECG. The group at Aston University, Birmingham is interested in artificial neural network techniques in the analysis of electroencephalogram. One of the well known programs is the Prostatic Cancer Calculator which is under investigation by Josephine Ford Cancer Center and Department of Urology, Detroit.

Several links to people and organizations working with medical application of artificial neural networks and related technologies can be found on the net at:

"Artificial Neural Networks in Medicine World Map.htm".