SELF MEDICAL DIAGNOSIS USING ARTIFICIAL NEURAL NETWORK

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Abstract:
The major problem in medical field is to diagnose diseases. Human beings always make mistake and because of their limitation, diagnosis would give the major issue of human expertise. One of the most important problems of medical diagnosis, in general, is the subjectivity of the specialist. It can be noted, in particular in pattern recognition activities, that the experience of the professional is closely related to the final diagnosis. This is due to the fact that the result does not depend on a systematized solution but on the interpretation of the patient's signal. The basis for a valid diagnosis, a sufficient number of experienced cases, is reached only in the middle of a physician's career and is therefore not yet present at the end of the academic formation. This is especially true for rare or new diseases where also experienced physicians are in the same situation as newcomers. Principally, humans do not resemble statistic computers but pattern recognition systems. Humans can recognize patterns or objects very easily but fail when probabilities have to be assigned to observations. This paper is basically a medical diagnosis system which tells the user about the disease he/she is having on the basis of symptoms.

Keywords: ANN, KMP, SOM algorithm

I. INTRODUCTION
An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well.

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II. Related Work
One of the major problems in medical life is setting the diagnosis. A lot of applications tried to help human experts, offering a solution. Artificial Neural Networks (ANN) is currently a hot research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years [1]. At the moment, the research is mostly on modelling parts of the human body and
recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).

Neural networks are ideal in recognizing diseases using scans since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognize the disease are not needed. What is needed is a set of examples that are representative of all the variations of the disease. The quantity of examples is not as important as the 'quantity'. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

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. 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 [5] is not always a solution.

Artificial neural networks are designed to simulate the behaviour of biological neural networks for several purposes. According to DKlerfors (1998), Artificial Neural Network is a system loosely modelled on the human brain. The field goes by many names, such as connectionism, parallel distributed processing, neuro-computing, natural intelligent systems, machine learning algorithms, and artificial neural networks. It is an attempt to simulate within specialized hardware or sophisticated software, the multiple layers of simple processing elements called neurons. Each neuron is linked to certain of its neighbours with varying coefficients of connectivity that represent the strengths of these connections. Learning is accomplished by adjusting these strengths to cause the overall network to output appropriate results.

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques.

A. Medical Diagnosis

The major problem in medical field is to diagnose disease. Human being always make mistake and because of their limitation, diagnosis would give the major issue of human expertise. One of the most important problems of medical diagnosis, in general, is the subjectivity of the specialist. It can be noted, in particular in pattern recognition activities, that the experience of the professional is closely related to the final diagnosis. This is due to the fact that the result does not depend on a systematized solution but on the interpretation of the patient's signal (Lanzarini and Giusti, 1999). Brause (2001) highlighted that almost all the physicians are confronted during their formation by the task of learning to diagnose. Here, they have to solve the problem of deducing
certain diseases or formulating a treatment based on more or less specified observations and knowledge. For this task, certain basic difficulties have to be taken into account.

The basis for a valid diagnosis, a sufficient number of experienced cases, is reached only in the middle of a physician’s career and is therefore not yet present at the end of the academic formation. This is especially true for rare or new diseases where also experienced physicians are in the same situation as newcomers. Principally, humans do not resemble statistic computers but pattern recognition systems. Humans can recognize patterns or objects very easily but fail when probabilities have to be assigned to observations. Brause(2001) also give an example of a study in the year 1971 showed these basic facts in the medical area. This study had shown that human have many limitations in diagnosis. The results of this experiment were as follows:-

Best human diagnosis (most experienced physician): 79.7%
Computer with expert data base: 82.2%
Computer with 600 patient data: 91.1%

From this result we can see that humans cannot ad hoc analyse complex data without errors.

B. Neural Network Capabilities

Breast Cancer:

Breast cancer is the second largest cause of cancer deaths among women. The automatic diagnosis of breast cancer is an important, real-world medical problem. A major class of problems in medical science involves the diagnosis of disease, based upon various tests performed upon the patient. When several tests are involved, the ultimate diagnosis may be difficult to obtain, even for a medical expert. This has given rise, over the past few decades, to computerized diagnostic tools, intended to aid the physician in making sense out of the confusion of data (Kiyan and Yildirim, 2003). Neural network have been applied to breast cancer diagnosis (Kiyan and Yildirim, 2003) employed Radial Basis Function, General Regression Neural Network and Probabilistic Neural Network in order to get the suitable results. From overall results, it is seen that the most suitable neural network model for classifying Wisconsin Breast Cancer data is General Regression Neural Network. This work also indicates that statistical neural networks can be effectively used for breast cancer diagnosis to help oncologists.

C. Diagnose heart failure

Making prognosis for patients with congestive heart failure is difficult due to the complex nature of this multisystem disease. No single criterion helps to identify patients at risk, and a combination of several prognostic parameters is recommended (Cowburn et al., 1998). Neural networks are associative self learning techniques with the ability to identify multidimensional relationships and perform pattern recognition in non-linear domains. Atieza et al., (2003) identified that classification is the best result for this cases.

D. Diagnose by Medical Images

Neural networks are extremely useful, since not only are they capable of recognizing patterns with the aid of the expert, but also of generalizing the information contained in the input data, thus showing relations which are a priori complex. (Laura and Armando, 1999) combined the processing of digital image and neural network to carry out the required recognition and classification. As a result, the solution to the problem can be divided in two parts: the segmentation of different elements, and their subsequent classification. In this case good results have been obtained. Thanks to the definition of a new clustering algorithm based on re-definition of the input image. As for the classification stage, different
solutions using neural networks have been compared, the results obtained being correct, with an error smaller than 10%.

Neural Networks are used in pattern recognition because of their ability to learn and to store knowledge. Because of their 'parallel' nature can achieve, Neural network can achieve very high computation rates which is vital in application like telemedicine (Siganos, 1995).

**E. Diagnose Acidosis Diseases**

Ultsch et al. (1995) used the capability of neural network to diagnose acidosis diseases by using knowledge based system in their hybrid system. The data set consists of 11 attributes originating from the blood analysis. Several classification methods according to (Deichsel and Trampisch, 1985) were used to explain these data. The Neural Network together with the UMatrix method was able to classify the data into the subcategories healthy, lacacidemia, metabolical acidosis, respiritory acidosis and one patient with cerebral deficiency. They used rule generation module to extracted rules out of the Neural Network, which were described by 4 or 5 attributes resembling more closely the decisions made by medical experts (Ultsch and Li, 1993).

**E. Diagnose Lung Cancer**

Lung cancer is another diseases that commonly known as a deadly disease in the world. Many patients suffer from this disease. Early detection of this disease is very important to prevent this disease. Expertise have to measures for early stage lung cancer diagnosis mainly includes those utilizing X-ray chest films, CT, MRI, isotope, bronchoscopy, and needle biopsies. According to Zhou et al. (2001) at present, the specimens of needle biopsies are usually analysed by experienced athologists. Since senior pathologists are rare, reliable pathological diagnosis is not always available.

**III. Proposed Work**

An artificial neural network (ANN), usually called "neural network" (NN) is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks [6]. It consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation. They are usually used to model complex relationships between inputs and outputs or to find patterns in data.

Our approach is to generate an appropriate diagnosis report, which will let the user know about the disease he is suffering from, what precautions he should take, which tests he should undergo and where these tests are available based on the input provided by the user. The appropriate diagnosis report will be generated using SOM (Self Organizing Map) algorithm, provided the user input is correct.

A medical diagnosis is an attempt at classification. Just as chemists attempt to classify naturally occurring elements into a periodic table and biologists attempt to classify plants and animals into species and genii so too do physicians attempt to classify disease into separate and distinct categories that allow medical decisions about treatment and prognosis to be made.

Physicians usually begin the diagnostic process by observing the patient for specific signs and symptoms and by taking a specific history. For example, how did these signs and symptoms come about? Specific signs, symptoms and historical clues allow the physician to perform a specific physical examination and order specific diagnostic imaging. The provider usually formulates a "short list" of likely diagnoses and may obtain further testing to confirm or rule-out competing diagnoses before providing treatment.
Artificial neural networks are made up of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Artificial neural networks may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real, biological nervous system is highly complex and includes some features that may seem superfluous based on an understanding of artificial networks.

Self-Organizing Maps (SOM), a specific kind of ANN, is a tool that may be used for the purpose of automatic document categorization.

The SOM is an unsupervised competitive ANN, which transforms highly dimensional data into a two-dimensional grid, while keeping the data topology by mapping similar data items to the same cell on the grid (or to neighbouring cells). A typical SOM is made of a vector of nodes for the Input, an array of nodes as the Output map, and a matrix of connections between each Output unit and all the Input units. Thus each vector of the Input dimension can be mapped to a specific unit on a two-dimensional map. In our case each vector represents a document, while the output unit represents the category that the document is assigned to.

Neural networks provide significant benefits in medical research. They are actively being used for such applications as locating previously undetected patterns in mountains of research data, controlling medical devices based on biofeedback, and detecting characteristics in medical imagery.

A. Background

Neural network simulations appear to be a recent development [1, 2]. However, this field was established before the advent of computers, and has survived at least one major setback and several eras.

Many important advances have been boosted by the use of inexpensive computer emulations. Following an initial period of enthusiasm, the field survived a period of frustration and disrepute. During this period when funding and professional support was minimal, important advances were made by relatively few researchers. These pioneers were able to develop convincing technology which surpassed the limitations identified by Minsky and Papert. Minsky and Papert, published a book (in 1969) in which they summed up a general feeling of frustration (against neural networks) among researchers, and was thus accepted by most without further analysis. Currently, the neural network field enjoys a resurgence of interest and a corresponding increase in funding.

The first artificial neuron was produced in 1943 by the neurophysiologist Warren McCulloch and the logician Walter Pits. But the technology available at that time did not allow them to do too much.

Neural networks, also known as connectionist systems or parallel distributed processing models, are computer-based, self-adaptive models that were first developed in the 1960s, but they reached great popularity only in the mid-1980s after the development of the back propagation algorithm by Rumelhart et al. [1986]. Initially derived from neuroscientists models of human neurons, neural networks now encompass a wide variety of systems (many of which are in no way intended to mimic the functions of the human brain).

Neural network research has its origins in the work developed by McCulloch and Pitts [1943], who developed mathematical models based on observational studies of real neurons.
Figure (a). Real and artificial neural networks.

The neural body is represented in artificial neural networks as a circle, and is called a node. The synapses are represented as lines connecting nodes, and are called weights. In artificial neural networks, the connections are called weights and are represented by real numbers.

B. Algorithms

1. KMP (Knuth Morris Pratt) algorithm:

The Knuth–Morris–Pratt string searching algorithm (or KMP algorithm) searches for occurrences of a "word" W within a main "text string" S by employing the observation that when a mismatch occurs, the word itself embodies sufficient information to determine where the next match could begin, thus bypassing re-examination of previously matched characters. In our project we are using this algorithm for pattern matching.

Algorithm:

**Input:**
An array of characters, S (the text to be searched)

An array of characters, W (the word sought)

**Output:**

n integer (the zero-based position in S at which W is found)

**Defined variables:**

- an integer, m ← 0 (the beginning of the current match in S)
- an integer, i ← 0 (the position of the current character in W)
- an array of integers, T (the table, computed elsewhere)

while m is less than the length of S, do: // while starts

if W[i] = S[m - i],

if i equals the (length of W)-1,

return m

let i ← i + 1

otherwise,

let m ← m - i - T[i], // end of while

if T[i] is greater than -1,

let i ← T[i]

else

let i ← 0

(if we reach here, we have searched all of S unsuccessfully)

return the length of S

2. SOM (Self Organizing Map) algorithm:

A self-organizing map (SOM) or self-organizing feature map (SOFM) [7,9] is a type of artificial neural network that is trained using unsupervised learning to produce a low-dimensional (typically two-dimensional), discretized representation of the input space of the training samples, called a map. Self-organizing maps are different from other artificial neural networks in the sense that they use a
neighborhood function to preserve the topological properties of the input space.

This makes SOM useful for visualizing low-dimensional views of high-dimensional data, akin to multidimensional scaling. The model was first described as an artificial neural network by the Finnish professor Teuvo Kohonen, and is sometimes called a Kohonen map [8].

Assumptions & Terminology

- \( t = \text{current iteration} \)
- \( \lambda = \text{limit on time iteration} \)
- \( W_v = \text{current weight vector} \)
- \( D = \text{target input} \)
- \( \Theta(t) = \text{restraint due to distance from BMU} - \text{usually called the neighbourhood function} \)
- \( \alpha(t) = \text{learning restraint due to time} \)

Algorithm:

1. Randomize the map's nodes' weight vectors
2. Grab an input vector
3. Traverse each node in the map
   1. Use Euclidean distance formula to find similarity between the input vector and the map's node's weight vector
   2. Track the node that produces the smallest distance (this node is the best matching unit, BMU)
4. Update the nodes in the neighborhood of BMU by pulling them closer to the input vector
   1. \( W_v(t + 1) = W_v(t) + \Theta(t)\alpha(t)(D(t) - W_v(t)) \)
5. Increment \( t \) and repeat from 2 while \( t < \lambda \)

IV. Approaches & Benefits

The various approaches can be used for implementing medical diagnosis:

1. Expert or Knowledge Based Systems
2. Artificial Neural Networks

An expert system is software that uses a knowledge base of human expertise for problem solving, or clarifies uncertainties where normally one or more human experts would need to be consulted. Expert systems are most common in a specific problem domain, and are a traditional application and/or subfield of artificial intelligence (AI). This approach has following drawbacks.

- A system that uses expert-system technology provides no guarantee about the quality of the rules on which it operates. All self-designated "experts" are not necessarily so, and one notable challenge in expert system design is in getting a system to recognize the limits to its knowledge.
- Expert systems are notoriously narrow in their domain of knowledge — as an amusing example, a researcher used the "skin disease" expert system to diagnose his rust bucket car as likely to have developed measles — and the systems are thus prone to making errors that humans would easily spot. Therefore, some of the techniques of expert systems can now be found in most complex programs without drawing much recognition.
- An expert system or rule-based approach is not optimal for all problems, and considerable knowledge is required so as to not misapply the systems.
Ease of rule creation and rule modification can be double-edged. A system can be sabotaged by a non-knowledgeable user who can easily add worthless rules or rules that conflict with existing ones.

Because of the above mentioned drawbacks of the expert systems we have used ANN for the medical diagnosis. Given below are the benefits of using ANN.

- **Adaptive learning:** An ability to learn how to do tasks based on the data given for training or initial experience.
- **Self-Organization:** An ANN can create its own organization or representation of the information it receives during learning time.
- **Real Time Operation:** ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
- **Fault Tolerance via Redundant Information Coding:** Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

V. References


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