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NEURAL NETWORKS TOWARDS MEDICAL

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ABSTRACT

The Neural Networks are best at identifying patterns or trends in data and they are well suited for predicting or forecasting. Hence neural networks are extensively applied to biomedical systems. An analysis is carried out to motivate neural network applications in medical diagnosis. A special note is made on neural network effort on cancer diagnosis. This paper focuses on the importance of application of neural networks in the medical world, particularly in the diagnosis of various diseases. Technical concepts like MLP, SVM, RBF, CANFIS, TLRN, PCA, SOM, and SNNS are applied for diagnosing various diseases using neural networks.

Keywords - **ANN, MLP, TLRN, RBF, CANFIS, SNNS.**

I. INTRODUCTION

The term neural network was traditionally refers to a network of biological neurons. The modern usage of the term refers to artificial neural networks, which are composed of artificial neurons. Thus the term has two distinct usages, Biological neural networks and Artificial Neural Networks. Biological neural networks are made up of real biological neurons that are connected in the peripheral nervous system or central nervous system. In the field of neuroscience, they are identified as a group of neurons that performs a specific physiological function in the laboratory analysis. Artificial neural networks are composed of interconnecting artificial neurons. This network may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems.

Fig.1 Neural Networks

The neural networks exhibit mapping capability, they can map input pattern to their associated output patterns. They can learn by examples. Neural network architectures can be trained with known examples of a problem before they are tested for their inference capacity on unknown instances of the problem. They can identify new objects previously untrained. They possess the capacity to generalize. Thus, they can predict new outcomes from past trends. They are robust systems and fault tolerant. They can recall full patterns from incomplete, partial or noisy patterns. They can also process information in parallel, at high speed and in a distributed manner.

II. ARCHITECTURE OF NEURAL NETWORKS

1. Feed-forward networks:

Feed-forward ANNs allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down.

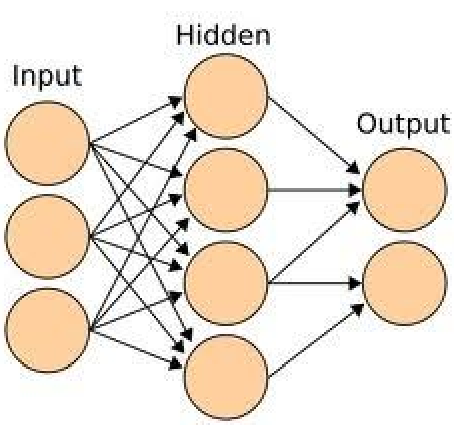

Fig.2 Feed-Forward Networks

2. Feedback networks:

Feedback networks can have signals travelling in both directions by introducing loops in the network. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic; their 'state' is changing continuously until they reach an equilibrium point. They remain at the equilibrium point until the input changes and a new equilibrium needs to be found. Feedback architectures are also referred to as interactive or recurrent, although the latter term is often used to denote feedback connections in single-layer organizations.

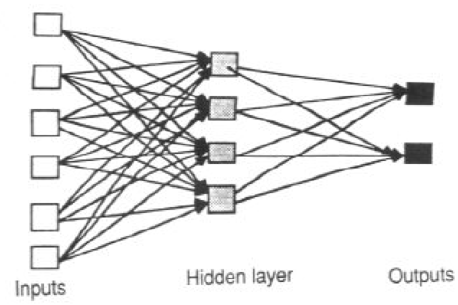

Fig.3 Feedback Networks

III. NEURAL NETWORKS LAYER

The common type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units. The activity of the input units represents the raw information that is fed into the network. The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units. The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

This simple type of network is interesting because the hidden units are free to construct their own representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents. We can also distinguish single-layer and multi-layer architectures. The single-layer organization, in which all units are connected to one another, constitutes the most general case and is of more potential computational power than hierarchically structured multi-layer organizations. In multi-layer networks, units are often numbered by layer, instead of following a global numbering.

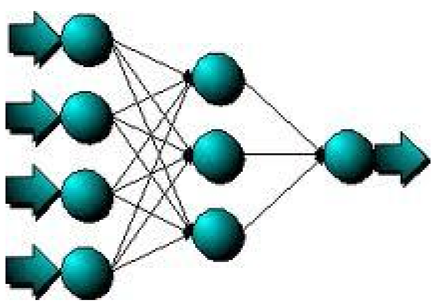

Fig.4 Neural Networks Layer

IV. APPLICATIONS OF NEURAL NETWORKS

Neural Networks have broad applications to the real world business problems. They have already been successfully applied in many industries. Since neural networks are best at identifying patterns or trends in data, they are well suited for prediction or forecasting. These include Sales forecasting, Industrial process control, Customer research, Data validation, Risk management, Target marketing.

V. NEURAL NETWORKS IN MEDICINE

The Artificial Neural Networks (ANN) receives extensive application to biomedical systems in the next few decades. The research is focusing on modelling parts of the human body and recognising diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc).

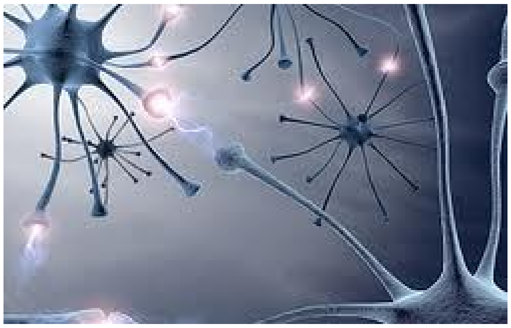

Fig.5 Neural Networks in Medicine

Neural Networks are ideal in recognising diseases using scans there is no need to provide a specific algorithm on how to identify the diseases. Neural Networks learn by example so the details of how to identify the diseases are not needed. What is needed is a set of examples that are reprehensive of all the variations of the diseases. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

1. Modelling and Diagnosing the Cardiovascular System:

Neural Networks are used experimentally to model the human cardiovascular system. Diagnosis can be achieved by building a model of the cardiovascular system of an individual and comparing it with the real time physiological measurements taken from the patient. If this routine is carried out regularly, potential harmful medical conditions can be detected at an early stage and thus make the process of combating the disease much easier.

Fig.6 Cardio Vascular System

A model of an individual's cardiovascular system must mimic the relationship among physiological variables (i.e., heart rate, systolic and diastolic blood pressures, and breathing rate) at different physical activity levels. If a model is adapted to an individual, then it becomes a model of the physical condition of that individual. The simulator will have to be able to adapt to the features of any individual without the supervision of an expert. This calls for a neural network.

Another reason that justifies the use of ANN technology is the ability of ANNs to provide sensor fusion which is the combining of values from several different sensors. Sensor fusion enables the ANNs to learn complex relationships among the individual sensor values, which would otherwise be lost if the values were individually analyzed. In medical modelling and diagnosis, this implies that even though each sensor in a set may be sensitive only to a specific physiological variable, ANNs are capable of detecting complex medical conditions by fusing the data from the individual biomedical sensors.

2. Electronic Noses:

ANNs are used experimentally to implement electronic noses. Electronic noses have several potential applications in telemedicine. Telemedicine is the practice of medicine over long distances via a communication link. The electronic nose would identify odours in the remote surgical environment. These identified odours would then be electronically transmitted to another site where an door generation system would recreate them. Because the sense of smell can be an important sense to the surgeon, telesmell would enhance telepresent surgery.

Fig.7 Electronic Nose

3. Instant Physician:

An application developed in the mid-1980s called the "instant physician" trained an auto associative memory neural network to store a large number of medical records, each of which includes information on symptoms, diagnosis, and treatment for a particular case. After training, the net can be presented with input consisting of a set of symptoms; it will then find the full stored pattern that represents the "best" diagnosis and treatment.

Fig.8 Instant Physician

VI. ADVANCEMENT OF NEURAL NETWORKS IN MEDICAL SCIENCE

1. Examine common characteristics in large volume of data:

Locating common characteristics in large amounts of data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks.

Examples of classification applications in medicine include dividing research populations or data into groups for further study. For example, data from studies of body movement could be classified into different patterns to aid with physical therapy.

2. Predicting results based on existing data:

Forecasting results based on existing data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks.

Examples of function approximation applications in medicine include the prediction of patient recovery and automated changes to device settings. For example, data from studies of potential recovery level of patients can provide realistic estimates to patients while helping facilities cut costs by better allocating resources.

3. Predict the progression of medical data over time:

Predicting the progression of medical data over time is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRN) type network.

Examples of time-series predictions in medicine include the prediction of cell growth and disease dispersion. For example, data from studies of muscle stimulation patterns of arm movements can be used to control mouse movements on a computer screen.

4. Identify specific characteristics in medical imagery:

Identifying specific characteristics in medical imagery is a type of image processing problem. Neural networks can be used to solve image processing problems, typically through Principal Component Analysis (PCA) type network.

Examples of image processing in medicine include the detection of characteristics in ultrasound and x-ray features. For example, image data from studies of mammograms can be used for the detection of breast cancer.

5. Group medical data based on key characteristics:

Grouping of medical data based on key characteristics is a type of clustering problem. Neural networks can be used to solve clustering problems, typically through Self-Organizing Map (SOM) type network.

Examples of clustering in medicine include the detection of key characteristics in demographics or pre-existing conditions. For example, data from studies combined with sensitivity analysis can reverse engineer a biologically plausible relationship from real world data.

VII. CANCER

Cancer is primarily an environmental disease, though genetics influence the risk of some cancers. Common environmental factors leading to cancer include: tobacco use, poor diet and obesity, infection, radiation, lack of physical activity, and environmental pollutants. These environmental factors cause or enhance abnormalities in the genetic material of cells. Cell reproduction is an extremely complex process that is normally tightly regulated by several classes of genes, including oncogenes and tumor suppressor genes. Hereditary or acquired abnormalities in these regulatory genes can lead to the development of cancer. A small percentage of cancers, approximately five to ten percent, are entirely hereditary.

The presence of cancer can be suspected on the basis of clinical signs and symptoms, or findings after medical imaging. Definitive diagnosis of cancer, however, requires the microscopic examination of a biopsy specimen. Most cancers can be treated, with the most important modalities being chemotherapy, radiotherapy and surgery. The prognosis in cancer cases can be greatly influenced by the type and location of the cancer and the extent of disease. While cancer can affect people of all ages, and a few types of cancer are more common in children than in adults, the overall risk of developing cancer generally increases with age, at least up to age 80-85 yr. In 2007, cancer caused about 13% of all human deaths worldwide (7.9 million). Rates are rising as more people live to an old age and as mass lifestyles changes occur in the developing world.

1. Origin of Cancer:

The organs in our body are made up of cells. Cells divide and multiply as the body needs them. When these cells continue multiplying when the body doesn't need them, the result is a mass or growth, also called a tumor. These growths are considered either benign or malignant. Benign is considered non-cancerous and malignant is cancerous. Benign tumors rarely are life threatening and do not spread to other parts of the body. They can often be removed. Malignant tumors, however, often invade nearby tissue and organs, spreading the disease.

2. Spreading of Cancer:

The cells within malignant tumors have the ability to invade neighboring tissues and organs, thus spreading the disease. It is also possible for cancerous cells to break free from the tumor site and enter the bloodstream, spreading the disease to other organs. This process of spreading is called metastasis. When cancer has metastasized and has affected other areas of the body, the disease is still referred to the organ of origination. For example, if cervical cancer spreads to the lungs, it is still called cervical cancer, not lung cancer. Although most cancers develop and spread this way -- via an organ - blood cancer like leukemia do not. They affect the blood and the organs that form blood and then invade nearby tissues.

Fig.9 Spreading of Cancer Cells

VIII. DIAGNOSING CANCER USING NEURAL NETWORKS

There are several systems available for the diagnosis and selection of therapeutic strategies in breast cancer. A neural network judged the possible recurrence rate of tumors correctly in 960 of 1008 cases by using data from lymphatic node positive patients (tumor size, number of palpable lymphatic nodules, tumor hormone receptor status, etc.). Baker et al. reported that they came to similar results by neural network evaluation of the parameters of the BI-RADS standardized code system. Fogel stated in his paper on neural network recognition of breast cancer that evaluation of mammographic, cytological and epidemiological findings in an integrated system are thought to be useful in the diagnostic process.

IX. CONCLUSION

In this article efforts are taken to analyse the application of Artificial Neural Network towards medical diagnosis. Step by step analysis is carried out and emphasis is made on diagnosis of cancer. Identifying diseases helps Doctors to save human to a major extent. Mathematical modelling of neural networks in analyzing their medical diagnosis using allowable range of parameters is taken as future work.

FURTHER ENHANCEMENT

The field of Bio-Medical Engineering is an emerging branch where attentions are called for every individual. The present world which is adversely affected by Tsunami and Earthquakes faces the terrific attack of diseases and it is of immense need for protecting against as well as getting cured from threatening diseases.

Care is taken to apply neural networks in diagnosing recent diseases like Swine Flu, Chicken Guinea, Brain tumor, and Brain fever and so on.

Mathematical modeling of neural networks will be focused on and various parameters will be engaged so as to get the required result to desired degree of accuracy.

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