PRE-DIAGNOSIS OF LUNG CANCER USING FEED FORWARD NEURAL NETWORK AND BACK PROPAGATION ALGORITHM

Mr. Abhinav Vishwa

Information Technology
Under Graduate from Indian Institute of Information Technology
Allahabad, India
e-mail: avishwa21@gmail.com

Ms. Alka Vishwa

Computer Science and Engineering
International Institute of Management, Engineering and Technology
Jaipur,, India
e-mail: alkavishwa09@gmail.com

Prof. Archana Sharma

Computer Science and Engineering
International Institute of Management, Engineering and Technology
Jaipur,, India
e-mail: adi_arch73@yahoo.co.in

Abstract

Cancer is the most important cause of death for both men and women. The early detection of cancer can be helpful in curing the disease completely. So the requirement of techniques to detect the occurrence of cancer nodule in early stage is increasing. A disease that is commonly misdiagnosed is lung cancer. Artificial Neural Networks (ANNs) play a vital role in the medical field in solving various health problems like acute diseases and even other mild diseases. Earlier diagnosis of Lung Cancer saves enormous lives, failing which may lead to other severe problems causing sudden fatal end. Its cure rate and prognosis depends mainly on the early detection and diagnosis of the disease. This paper provides a Feed Forward Artificial Neural Network Model for early detection of lung cancer. The model consists of an input layer, a hidden layer and an output layer. The network is trained with one hidden layer and one output layer by giving twelve inputs. One of the most common forms of medical malpractices globally is an error in diagnosis. The paper provides a formula for Error Detection and on the basis of error weights are adjusted and system is improved.

Aim of the paper is to propose a model for early detection and correct diagnosis of the disease which will help the doctor in saving the life of the patient.

Keywords: - ANN, Back propagation algorithm, sigmoid function, input layer, hidden layer, output layer.

1. Introduction

Lung cancer is a disease that occurs because of uncontrolled cell growth in tissues of the lung. This growth may lead to metastasis, which is the invasion of adjacent tissue and infiltration beyond the lungs. Treatment and prognosis depend on the histological type of cancer, the stage (degree of spread), and the patient's performance status. Possible treatments include surgery, chemotherapy, and radiotherapy. Survival depends on stage, overall health, and other factors, but overall only 14% of people diagnosed with lung cancer survive five years after the diagnosis. Symptoms that may suggest lung cancer include:

- dyspnea (shortness of breath with activity),

- hemoptysis (coughing up blood),
- chronic coughing or change in regular coughing pattern,
- wheezing,
- chest pain or pain in the abdomen,
- cachexia (weight loss, fatigue, and loss of appetite),
- dysphonia (hoarse voice),
- clubbing of the fingernails(uncommon),
- dysphasia(difficulty swallowing),
- Pain in shoulder ,chest , arm,
- Bronchitis or pneumonia,
- Decline in Health and unexplained weight loss.

If the cancer grows in the airway, it may obstruct airflow, causing breathing difficulties. The obstruction can lead to accumulation of secretions behind the blockage, and predispose to pneumonia. Many lung cancers have a rich blood supply. The surface of the cancer may be fragile, leading to bleeding from the cancer into the airway. This blood may subsequently be coughed up.

The main causes of any cancer include carcinogens (such as those in tobacco smoke), ionizing radiation, and viral infection. This exposure causes cumulative changes to the DNA in the tissue lining the bronchi of the lungs (the bronchial epithelium). As more tissue becomes damaged, eventually a cancer develops.

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. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. 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 paper proposes a model based on multi-layer neural network for early detection and correct diagnosis of lung cancer.

2. Review of Literature

Karayiannis et.al(1993) presented several efficient learning algorithms for neural networks (ELEANNE). Invariant pattern recognition was the problem facing neural networks for some time, and the challenge was to overcome the limitation of Hamming distance generalization and for this Wang(1993) reviewed four representative architectures, the back propagation network, the ART architecture, the dynamic link architecture, and associate memories. Bishop et.al(1993) derived a smoothing regularizer for dynamic network models by requiring robustness in prediction performance to perturbations of the training data. Hagan et.al(1994) presented the Marquardt algorithm for nonlinear least squares and is incorporated into the backpropagation algorithm for training feedforward neural networks. Takeda et.al(1995) proposed a new technique to improve the recognition ability and the transaction speed to classify the Japanese and U.S. paper currency. Castro et.al(1997) provided an interpretation of neural networks so that they will no longer be seen as black boxes. Zhang(1997) presented the complex domain generalized Hebbian algorithm (CGHA) for complex principal component extraction. It extends the real domain generalized Hebbian algorithm (GHA) proposed by Sanger. Halgamuge et.al(1997), discussed two training algorithms for self-evolving neural networks for rule-based data analysis. Rowley et.al(1998) presented a neural network-based upright frontal face detection system. A retinally connected neural network examines small windows of an image, and decides whether each window contains a face. Park et.al(1998) developed two different methods, which are the slope adjustment and bias adjustment methods, in order to speed up the convergence of the Hopfield neural network system. Ota et.al(1999) presents a compact architecture for analog CMOS hardware implementation of voltage-mode pulse-coupled neural networks (PCNN). The hardware implementation methods shows inherent fault tolerance specialties and high speed, which is usually more than an order of magnitude over the software counterpart. A new machine learning concept-self-organizing learning array (SOLAR)-is presented in their paper. Xin Yao(1999) showed, through a considerably large literature review, that combinations between ANN’s and EA’s can lead to significantly better intelligent systems than relying on ANN’s or EA’s alone. Ciesielski et.al(2000) gave a constructive proof of a formula for the upper bound of the approximation error in (supremum norm) of multidimensional functions by feedforward networks with one hidden layer of sigmoidal units and a linear output. Zeng et.al.(2001) proposed a parametric approach, which starts with an estimate of the local distribution and efficiently avoids pre-assuming the cluster number. A theory was proposed by Back et.al(2002) that provides a possible mechanism by which the multiple modeling phenomenon can occur. Zhang et.al.(2003), describes fundamental concepts in teaching RF/microwave engineers what neural networks are, why they are useful, when they can be used, and how to use them. Bashah et.al.(2005) proposed a dynamic model Intelligent Intrusion Detection System based on specific AI approach for intrusion detection. Starzyk et.al(2006), introduced a feedback-based associative learning in self-organized learning arrays (SOLAR). In 2007 Ravichandran et.al proposed a methodology in which the neural network is applied to the investor's financial decision making to invest all type of shares irrespective of the high / low index value of the scripts, in a continuous time frame work and further it is further extended to obtain the expected return on investment through the Neural Networks and finally it is compared with the actual value. Starzyk et.al.(2007) proposed a novel hierarchical structure for complex temporal sequence learning. Shetty et.al(2008) implemented an artificial neural network (ANN) approach for audio data mining. Mishra et.al(2009), presented an alternate ANN structure called functional link ANN (FLANN) for image denoising. Thakare et.al(2010) presented a new method of calculation of patch dimensions of a rectangular microstrip patch antennas using Artificial Neural Network (ANN).

3. Methodology

Inputs are taken as the major symptoms of the lung cancer in the form of 1 and 0. Thus, If the patient has the particular symptom than the input is taken as 1 otherwise 0. Weights on connections are chosen as random initially. Then a transfer function (Sigmoid function) is applied on the weighted sum of inputs, which transfers the output to next layer, which now is hidden layer. Then at all neurons of hidden layer, input value is compared to threshold value and result is compared to original one which were found, if the results do not match then back propagation algorithm is applied by which weights of previous connections are adjusted. The neurons in hidden layer represent those diseases which mimic lung cancer. Therefore in above check we insure from original database that if the patient is suffering from that disease or not. The back-propagation algorithm ensures that when we are at a particular connection, then weights of all previous connections have already been adjusted. The same procedure is applied for transfer from hidden layer to output layer.

Therefore the objective of paper is insured in the way that hidden layer contains neurons which represents the diseases which mimic lung cancer, thus effectively we are checking that if a patient is suffering from any of these diseases, then how many possibilities exist for that patient to be suffering from lung cancer also. Thus, in effect reducing the cases of wrong diagnosis.

4. Model for Lung Cancer

4.1. *FeedForward ANN Architecture*

Feed-forward ANN 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.

The behavior of an FeedForward ANN (Artificial Neural Network) depends on both the weights and the input-output function (transfer function) that is specified for the units. This function typically falls into one of three categories:

- linear (or ramp),
- threshold,
- sigmoid.

For **linear units**, the output activity is proportional to the total weighted output.

For **threshold units**, the output is set at one of two levels, depending on whether the total input is greater than or less than some threshold value.

For **sigmoid units**, the output varies continuously but not linearly as the input changes. Sigmoid units bear a greater resemblance to real neurons than do linear or threshold units, but all three must be considered rough approximations. The total input I is given by the formula

$$I = \sum_{i=0}^{n} w_i x_i \qquad (1)$$

Where $X_1, X_2, X_3, ..., X_n$ are the n Inputs to the Artificial Neuron and W_1 , W_2, W_3 … W_i are the weights associated to these input links.

For sigmoid units, the output varies continuously but not linearly as the input changes. This unit calculates the activity Xi using the function of total weighted input and this is called activation function used in the sigmoid unit and it is defined as:

$$Sigmoid(X_i) = {}^{1}/_{(1+e^{-x})} \qquad (2)$$

Where x is the sum of total weighted inputs to the particular node and e=2.732

4.2. ***The Back-Propagation Algorithm***

In order to train a neural network to perform some task, we must adjust the weights of each unit in such a way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the error derivative E of the weights. The back propagation algorithm is the most widely used method for determining the Error E.

$$E = \sum_{k=1}^{m} ((E_k - O_k)^2) \qquad (3)$$

Where E_k is the expected output and O_k is the original output of the model.

5. Construction of FeedForward ANN Model for Lung Cancer

A FeedForward ANN consists of an input layer, an output layer, and a variable number of hidden layers. The input layer is not counted normally, because it is only formally present, in the sense that it does not do any processing: for example, a two-layer net- work consists of the input, hidden, and output layers. All connections between the layers are allowed. Connections between the nodes of the same layer, as well as the auto-connections (loops), are prohibited. By using Back Propagation algorithm the weights in the networks are adjusted in each iteration so as to reduce the error.

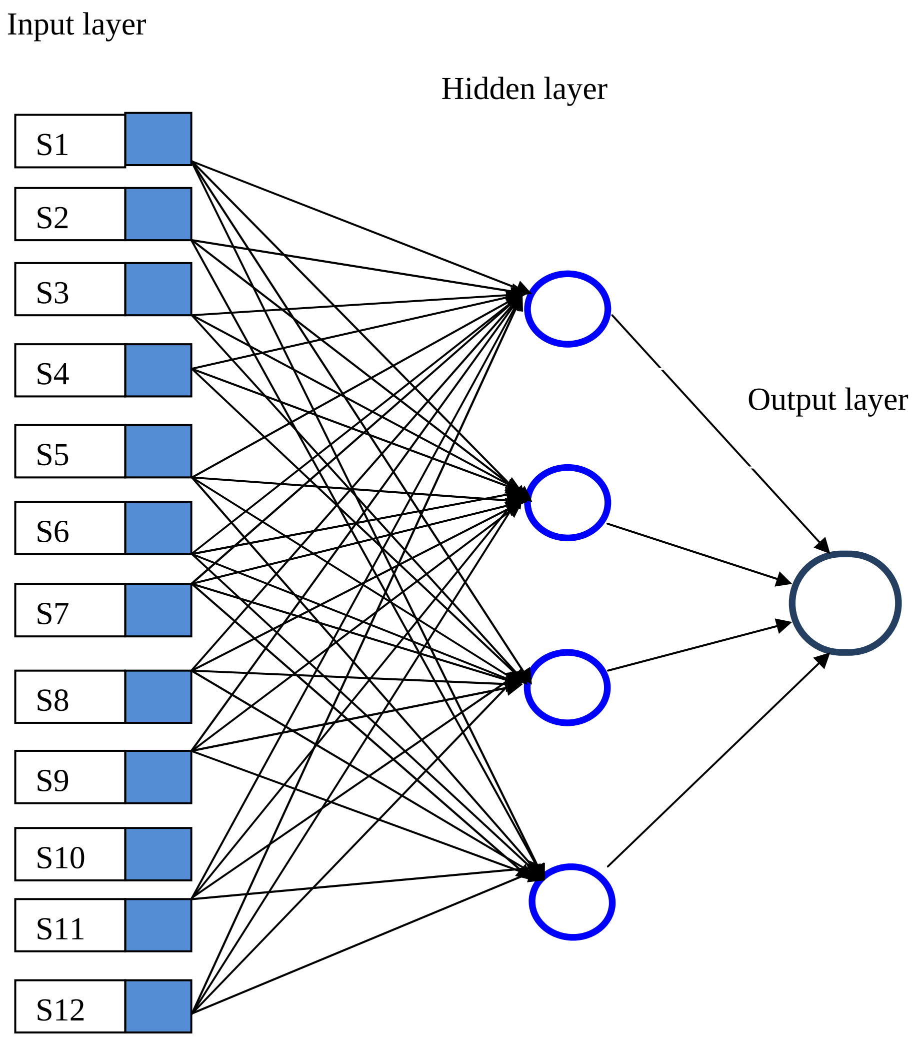

Fig.1. Feedforward back-propagation neural network

The network created in this paper is a Back propagation neural network consists of 12 input neurons in the input layer which are the symptoms of Lung Cancer, 4 hidden neurons in the hidden layer represent the diseases that mimic Lung Cancer, 1 output neuron in the output layer. It classifies that one is having Lung Cancer or not. The ANN used in this study is a standard feedforward back-propagation neural network with three layers: input layer, a hidden layer and an output layer as shown in Figure . Each neuron or node in the input layer contains known information. The number of neurons in the input layer is equal to the number of elements existing in one transaction in the database. The input layer of a neural network is determined from the characteristics of the application input. For diagnosis of Lung Cancer 12 variables are used as the inputs to the network. The sample data are prepared on the basis of symptoms and risk factors. Line represent weights which connect the input layer to the hidden layer. The hidden layer is also made up of neurons which represents some diseases that mimic Lung Cancer, The output layer consists of one neuron which represents Lung Cancer(if Sigmoid(X_i)> θ_i) or no Lung Cancer. The activation of the neuron is computed by applying a sigmoid function. Each neuron receives a signal from the neurons in the previous layer, and each of those signals are multiplied by a separate weight value. The weighted inputs are summed, and passed through a limiting function which scales the output to a fixed range of values. At the output layer which decides whether the patient is suffering from lung cancer or any other disease.

If the result of model doesn't match with the original one then back propagation algorithm comes in play which goes back to connections in between current layer and previous layer and redefines the weights, and then again weighted sum is calculated, thus it is ensured that while working on a particular connection, weights of all previous connections are correct and already have been adjusted.

6. Proposed Pseudocode

```
I ← weighted sum of input
tmp ← sigmoid(I)
for  I ← 1 to element_second_layer
        if   tmp is greater than θi
                yi ← tmp
                flag ← check_with_expected()
                if   flag is equal to false
                        adjust_weight()
                        return false
        else
                yi  ← 0
I ← weighted sum of y
tmp ← sigmoid(I)
if   tmp > θi
        flag ← check_with_expected()
        if   flag is equal to false
                adjust_weight()
                return false
        else
                return confirm
else
        return negative
```

7. RESULTS AND DISSCUSSION

- As we proposed a model for the pre-diagnosis of lung cancer using feedforward ANN by using this model one can input his symptoms in the form of 0 and 1 and can come to the decision whether he is suffering from lung cancer or any other mimic diseases.
- This model can analyze and improved by using back propogation algorithm and learning.
- On the basis of learning weights at the hidden layer can be adjusted and the model become more effective.

8. CONCLUSION AND FUTURE ENHANCEMENT

This model prevents the cases of wrong diagnosis and in turn delay in proper diagnosis, this feature enhances its usability given that lung cancer is kind of disease which can only be cured if an early diagnosis is available to patient. Prognosis of early diagnosis of Lung cancer with ANN models has the best performance in large data sets.

We can get a fixed value of threshold(θ_i) by using large data set, thus it is a process of learning which makes model more authenticated. Thus it is a proposed model which threshold values can be made stable by using simulated learning.

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