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Review Article

Detection of Breast Cancer using Neural Networks – A Review

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Abstract

Artificial neural network has been a widely used tool in various fields of medical and engineering applications as an intelligent tool, such as artificial intelligence, pattern recognition, medical diagnosis, machine learning and many more. Breast cancer classification is medical applications that possess great challenge for scientists and researchers. Neural network has become a very popular tool in diagnosis of breast cancer and classification of cancer datasets. Breast Cancer is one of the fatal diseases causing more number of deaths in women. For early and efficient diagnosis of breast cancer more and more techniques are being developed. Classical methods required cytopathologists or oncologists to examine the breast lesions for detection and classification of various stages of the cancer. Artificial neural network is a branch of artificial intelligence and has been widely accepted as a new technology in computer science. In carcinogenesis, artificial neural networks have been successfully applied to the problems in both pre-clinical and post-clinical diagnosis.

Key-words: Neural network, breast cancer diagnosis, medical decision making, back propagation, decision support system.

Introduction

Cancer detection and diagnosis is one of the most important areas of research in medical field. Neural networks have been used for same by many researchers.[1]-[5] for different classes of cancer. Different algorithms of neural networks have been used for cancer detection.[6] [7], [8]-[10] Next to skin cancer it is the most common disease the affects women in the world. .In terms of mortality, it is the leading cause of death among women aged between 35 and 64 years, and is the leading cancer-related cause of death in the female population as a whole. [11,12] Artificial intelligence based neural network is referred to as artificial neural network (ANN). ANN teaches the system to execute task, instead of programming computational system to do definite tasks. Many artificial neurons are correlated in accordance with explicit network architecture to make an artificial neural network. The objective of the neural network is to convert the inputs into significant outputs. The teaching mode can be supervised or unsupervised.

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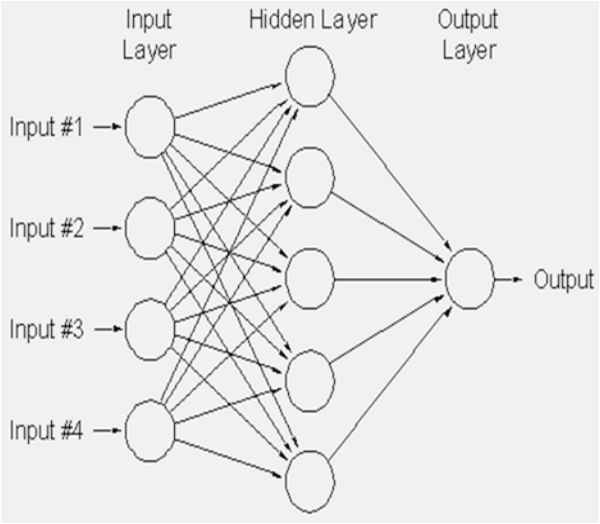

Fig 1. Artificial neural network

A brief breakup of different types of ANN architecture, which is done in the past by a number of researchers, is given in above table. The work done performed by researchers is good in many cases but there is always a scope to perform better. ANN tools have shown to be valuable in reducing the workloads on clinicians by detecting artefact and providing decision support. Table I provides information about different neural network algorithms studied by various researchers to detect and

Table 1. Research work on neural network architecture by medical imaging

ANN Types	Outcome	Image Type
Cellular Neural Network	Detect Boundary / area	X-ray
GA and CNN	Detect nodular shadows	X-ray
Hybrid Neural Digital CAD	Classify 3-15 mm size nodules	X-ray
ANN Feed Forward	Increase sensitivity & accuracy	X-ray
Artificial CNN & application	Detect False Positive & increase sensitivity	X-ray
Convolution Neural Network	Decrease False & Increase True Positive	X-ray
Two - level Convolution Neural Network	Reduce False Positive	X-ray
NN Ensembles	Reduce False Positive	X-ray
J-net	Improve sensitivity & accuracy	CT Image
Massive Training ANN (MTANN)	Enhancement of lung nodules	CT Image

classify case of Breast cancer, Brain cancer, Skin cancer etc. The methods mentioned in the table have not given enough importance to generalization aspect of neural network.

Artificial neural networks are computational systems whose concept is derived from biological neural networks. An ANN consists of a collection of processing elements that are highly interconnected and transform a set of inputs to a set of desired outputs. The result of transformation is determined by the characteristics of the elements and the weights associated with the interconnections among them. The construction of neural network involves three different layers with feed forward architecture. This is the most popular network architecture in use today. The input layer of this network is a set of input units, which accept the elements of input feature vectors.

The input units (neurons) are fully connected to the hidden layer with the hidden units. The hidden units (neurons) are also fully connected to the output layer. The output layer supplies the response of neural network to the activation pattern applied to the input layer. The information given to a neural net is propagated layer-by-layer from input layer to output layer through (none) one or more hidden layers. Artificial Neural Network model could perform "intelligent" tasks similar to those performed by the human brain. Artificial neural network models offer a completely different approach to problem solving and they are sometimes called the sixth generation of computing.

Detection of breast cancer

Wisconsin Breast Cancer Data (WBCD) is analysed by various researchers on medical diagnosis of breast cancer in neural network literature [13,14,15,16,17,18]. Breast cancer is diagnosed using feed forward neural networks by comparing the hidden neurons.[19] The performance comparison of the multi-layered perceptron networks using various back propagation algorithms for breast cancer diagnosis is discussed. The training algorithms used are gradient descent with momentum and adaptive learning, resilient back propagation, QuasiNewton and Levenberg-Marquardt. The performances of these four algorithms are compared with the standard steepest descent back propagation algorithm. The MLP network using the Levenberg-Marquardt algorithm displays the best performance. The seventh attribute called Bare Nuclei of WBCD has 16 missing values. In.[18] the 16 missing value instances have been left out while using WBCD for Breast Cancer diagnosis. The constructed feed forward neural network has been evaluated for breast cancer detection without replacing missing values.[20] Eliminating some instances will affect the diagnosis accuracy. The proposed work is available in UCI repository. It consists of 569 Fine Needle Aspirate biopsy samples of human breast tissues. There are 32 attributes computed for each cell sample. Radius, perimeter, texture, area, smoothness, compactness, concavity, concave points, symmetry and fractal dimension are the 10 most important features which have been used as the only inputs to the network as these are sufficient to obtain good results. This makes the network more concise and less complex.

Existing Techniques

3.1. Back propagation neural network

E. Hosseini Aria, J. Amini, M.R.Saradjian(2009) proposed a method for Classifying IRS-1D Satellite Images.[28]

Table 2. Existing methods of neural network algorithms for cancer diagnosis

Authors	Technique	Algorithms	Results
Sulochana Wadhwani, A.K Wadhwani, Monika Saraswat.[21]	Artificial Neural Network	Back propagation Algorithm	Classification of Breast cancer into malignant or benign with the accuracies of 94.11% and 100%
Pankaj Sapra, Rupinderpal Singh, Shivani Khurana.[22]	Computer Aided Detection System and Probabilistic Neural Network	Competitive Learning Algorithm	Detection of Brain Tumor, obtained 100% accuracy.
Yongjun WU, Na Wang, Hongsheng ZHANG, Lijuan Qin, Zhen YAN, Yiming WU.[23]	Artificial Neural Network	Back propagation Algorithm	Diagnosis of lung cancer. Provides accuracy of 96.6%.
Ayoub Arafi, Youssef Safi, Rkia Fajr and Abdelaziz Bouroumi.[24]	Image processing and Artificial Neural Network	Multilayer Perceptron Training Algorithm	Classification of mammographic images of breast cancer. Accuracy obtained is 95.49%.
Seema Singh, Sunita Saini, Mandeep Singh.[25]	Artificial Neural Network	Adaptive Resonance Theory	Detection of cancer using ART. Obtained accuracy 82.64%.
Ali Raad, Ali Kalakech, Mohammad Ayache.[26]	Artificial Neural Network	Back propagation Algorithm	Breast cancer detection and classification using ANN. provided an accuracy of 94%
Yuehui Chen, Yan Wang, Bo Yang.[27]	Artificial neural network	Hierarchical Radial Basis Function	Breast cancer detection using hierarchical RBF with the accuracy of 97.09%.

The fitness of Back Propagation Neural Network (BPNN) for classification of remote sensing images based on three steps is proposed. As an initial step, from the measures of first order histogram measures the features are extracted. In the second step, feature classification based on BPNN is done, and in the third step the outcomes are compared with the maximum likelihood classification (MLC) method. The statistical features in this paper depend on the first-order distribution measure such as mean, standard-deviation, skewness, kurtosis, energy, and entropy. The network contains 3 layers. The input layer is fed with extracted features which contains 18 neurons in the classification of IRS-1D satellite images six classes were used and the back ropagation neural network was trained on these classes. The whole image was classified using this trained network. The regions of Iran are taken for testing.

The IRS-1D satellite images uses artificial neural network for the classification of images. The major problem with the classification of IRS data is to choose a better method for training. TrainLM method has been implemented on using back propagation neural networks algorithm on IRS images.
There are various training algorithms for feed forward networks The gradient of the performance function is used by all the algorithms to find out how to fiddle with the weights to decrease the performance. The back propagation technique determines the gradient. This gradient performs computational backwards through the network. When the maximum likelihood method was compared with back propagation neural network method, the BPNN was more accurate than maximum likelihood method. The overall preciseness in MLC method is 75.00% whereas in BPNN method is 85.19%.

Helena Grip, Fredrik(2003) proposed Whiplash-Associated Disorders by classifying of neck movement patterns.[29] A novel method for the classification of neck movement patterns related to Whiplash-associated disorders (WAD) using a flexible back propagation neural network (BPNN) is studied. WAD is a common diagnosis after neck trauma, mainly caused by rear-ends car accidents. Since physical injuries cannot be detected with the current imaging techniques, the diagnosis can be complex to make. The dynamic range of the neck is often visually detected in patients with neck pain, but this is a biased measure, and a more intentional decision support system, that gives a consistent and more complete analysis of neck movement pattern, is needed. The estimation of the prognostic ability of a BPNN, using neck movement variables as input is

the main objective of the paper. The collection of three-dimensional (3-D) neck movement data from 59 subjects with WAD and 56 control subjects is made with a proReflex system. Rotation angle and angular velocity were measured using the direct helical axis method and motion variables and the results are extracted. To increase the performance of BPNN a principal component analysis was performed which reduces data. BPNNs with six hidden nodes had a yield of 0.89, a sensitivity of 0.90 and a specificity of 0.88, which are very hopeful results. The results were predicted from the neck movement analysis. The result was combined with a neural network where the origin of decision support system is constructed, which classifies the suspected WAD.

The flexible back propagation neural network (BPNN) resulted in a correct calculation for 84 percent of the control subjects and 89 percent of the WAD, showing that a BPNN could be appropriate for predicting motion characteristics. The presented method is very hopeful as an aid to determine whether a patient with suspected WAD has a neck movement pattern that deviates from that found in control subjects. A few perceptive variables seem to amplify the efficiency on abbreviating the results. A high predictive ability with stable and well functioning BPNN is presented using early stopping method. Yu-guo Wang, Hua-peng Li(2010) proposed classification of Remote sensing images using artificial neural network.[30]

Artificial neural network (ANN) is a significant part of artificial intelligence, It has been extensively used in the research field of remote sensing classification. The wetlands remote sensing classification based on ANN is complicated, because of the intricate feature of wetlands areas. The remote sensing image supervised classification is carried out on the training samples. The clarity is examined and it was found that it is hard to guarantee because it will have an effect on the classification results. This article proposed a method for sample purification to filter the training samples based on statistical analysis theory for enhanced wetlands remote sensing classification based on ANN. The BP ANN with a nonlinear mapping function gives better classification results for intricate areas. The TM image of Honghe Wetlands National Nature Reserve is chosen for classification. First, the statistical analysis theory to eradicate noise in training samples is used. Then the original samples and purified samples are used to train the BP ANN individually and created two classification maps of TM image based on two trained BP ANN. At last, the classification accuracy between the two maps is compared. The statistical analysis method for purifying training samples for remote sensing classification based on BP ANN is performed. The experiments showed that it was an efficient method to develop image classification.

Conclusion

ANNs help physicians in diagnosing acting as a powerful tool. It has been proven suitable for satisfactory diagnosis and medical decision making of various other medical conditions. Despite their wide application in medical diagnosis they must be considered as a final tool for decision making of the condition to the physician, who will be finally responsible for eventually interpreting the output of the artificial neural network. The neural networks based clinical support systems provide the medical experts with a second opinion thus removing the need for biopsy, excision and reduce the unnecessary expenditure.

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