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WALKTHROUGH ON NEURAL NETWORK AND FUZZY LOGIC FOR CLASSIFICATION OF MEDICAL IMAGE DIAGNOSIS

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ABSTRACT

Artificial Neural Network and fuzzy logic are the branch of Artificial intelligence, have been accepted as a new technology in computer science. Neural Networks and fuzzy logic has rapidly become one of the most successful of today's technologies especially in the field of medicine. 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. This Paper carried out to generate and evaluate both fuzzy and neural network models to predict malignancy of breast tumor, using Wisconsin Breast Cancer Database (WBCD).

KEYWORDS
artificial neural network, breast cancer, fuzzy logic

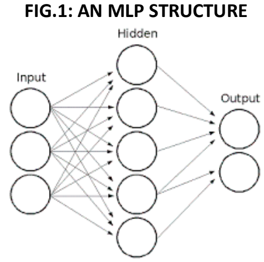
I. INTRODUCTION
Breast cancer is the second most fatal disease in women worldwide.Breast cancer affects not only women but also men and animals. Only 1% of all the cases are found in men. There are two types of breast lesions- malignant and benign. The Radiologists study various features to distinguish between the malignant tumor and benign tumor. 10%-30% of the breast cancer lesions are missed because of the limitations of the human observers Early and accurate diagnosis is essential for patient's timely recovery. Identifying the women at risk is an important strategy in reducing the number of women suffering from breast cancer. Detecting the probability of recurrence of the cancer can save a patient's life. When a number of tests are performed on a patient it becomes difficult for the medical experts to come to a correct conclusion and the screening methods produce false positive results. Thus smarter systems are required to decrease the instances of false positives and false negatives. This paper reviews the existing/popular methods which employ the soft computing techniques to the diagnosis of breast cancer.

II. NEURAL NETWORK TECHNIQUES FOR DIAGONOSIS OF BREAST CANCER
Various artificial intelligence techniques have been used to improve the diagnose procedures.

A MULTILAYER PERCEPTRON

MLP is a class of feed forward neural networks which is trained in a supervised manner to become capable of outcome prediction for new data [3]. The structure of MLP is shown in fig 1. An MLP consists of a set of interconnected artificial neurons connected only in a forward manner to form layers. One input, one or more hidden and one output layer are the layers forming an MLP [10]. Artificial neuron is basic processing element of a neural network. It receives signal from other neurons, multiplies each signal by the corresponding connection strength that is weight, sums up the weighted signals and passes them through an activation function and feeds the output to other neurons [4]. Neural classification of breast cancer data consists of two steps training and testing. The classification accuracy depends on training [5]. A mapping between the input and output data could be established by assigning weights to the input numerical data during training [6].. During the training, the network is repeatedly presented with the training data and the weights and thresholds in the network are adjusted from time to time till the desired input output mapping occurs [4].

FIG.1: AN MLP STRUCTURE



B. RADIAL BASIS FUNCTION NEURAL NETWORK

RBFNN is trained to perform a mapping from an m-dimensional input space to an n-dimensional output space. An RBFNN consists of the m-dimensional input x being passed directly to a hidden layer. Suppose there are c neurons in the hidden layer. Each of the c neurons in the hidden layer applies an activation function, which is a function of the Euclidean distance between the input and an m-dimensional prototype vector. Each hidden neuron contains its own prototype vector as a parameter. The output of each hidden neuron is then weighted and passed to the output layer. The outputs of the network consist of sums of the weighted hidden layer neurons [8]. The transformation from the input space to the hidden-unit space is nonlinear where as the transformation from the hidden-unit space to the output space is linear [7].The performance of an RBFNN network depends on the number and location (in the input space) of the centers, the shape of the RBFNN functions at the hidden neurons, and the method used for determining the network weights.

C. PROBABILISTIC NEURAL NETWORKS (PNN)

PNN is a kind of RBFNN suitable for classification problems. It has three layers. The network contains an input layer, which has as many elements as there are separable parameters needed to describe the objects to be classified. It has a pattern layer, summation layer, which has as many processing elements as there are classes to be recognized PNN used in [10] has a multilayer structures consisting of a single RBF hidden layer of locally tuned units which are fully interconnected to an output layer of two units. In this system, real valued input vector is feature's vector, and two outputs are index of two classes. All hidden units simultaneously receive the eight-dimensional real valued input vector. The input vector to the network is passed to the hidden layer nodes via unit connection weights. The hidden layer consists of a set of radial basis functions. PNN provides a general solution to pattern classification problems by following an approach developed in statistics, called Bayesian classifiers [11][12]. PNN combines the Bayes decision strategy with the Parzen non-parametric estimator of the probability density functions of different classes [13].

D. GENERALIZED REGRESSION NEURAL NETWORKS

GRNN is the paradigm of RBFNN, often used for function approximations [15]. GRNN consists of four layers: The first layer is responsible for reception of information, the input neurons present the data to the second layer , the output of the pattern neurons are forwarded to the third layer, summation neurons are sent to the fourth layer [16]. GRNN approximates the probability density function from the training vectors using Parzen windows estimation [17]. GRNNs do not require iterative training; It can be viewed as a normalized RBF network in which there is a hidden unit centered at every training case. These RBF units are called kernels and are usually probability density functions such as the Gaussians. The only weights that need to be learned are the widths of the RBF units h. These widths are called smoothing parameters or bandwidths and are usually chosen by cross validation [15].

E. FUZZY- NEURO SYSTEM

Fuzzy-Neuro system uses a learning procedure to find a set of fuzzy membership functions which can be expressed in the form of if-then rules[18-20]. A fuzzy inference system uses fuzzy logic, rather than Boolean logic, to reason about data [21]. Its basic structure includes four main components- a fuzzifier, an inference engine ; a defuzzifier, and a knowledge base. The decision-making process is performed by the inference engine using the rules contained in the rule base[22].

III. DESCRIPTION OF WISCONSIN BREAST CANCER DATABASE (WBCD)

The database used for detection of breast cancer by artificial neural networks is publicly available in the Internet . This database has 699 instances and 10 attributes including the class attribute. Each instance has one of two possible classes: benign or malignant. According to the class distribution 65.5% instances are Benign and 34.5% instances are Malignant. Table 1 provides the attribute information.

TABLE 1: ATTRIBUTES OF BREAST CANCER DATA

S.No	Attribute	Domain
1.	Clump thickness	1-10
2.	Uniformity of cell size	1-10
3.	Uniformity of cell shape	1-10
4.	Marginal adhesion	1-10
5.	Single epithelial cell size	1-10
6.	Bare nuclei	1-10
7.	Bland chromatin	1-10
8.	Normal nucleoli	1-10
9.	Mitosis	1-10
	Class	2 for benign, 4 for malignant

The original data can be presented in the form of analog values with values ranging from 0-10. Conversion of the given data sets into binary can be done based on certain ranges, which are defined for each attribute [31].

IV. COMPARISON TABLE

In [25] four different neural network structures, MLP, RBFNN, PNN and GRNN were applied to WBCD to show the performance of statistical neural networks on breast cancer data. According to results, RBF and PNN gives the best classification accuracy with 342 correct classifications while GRNN has the lowest accuracy with 330 correct classifications for the training set. MLP has 335 correct classifications. Accuracy comparison for popular neural network techniques with WBCD data for the diagnosis of breast cancer is shown by table 2.

TABLE 2: ACCURACY COMPARISON FOR TEST DATA CLASSIFICATION

Type of Network	Accuracy	References
Radial Basis Function Neural Network (RBFNN)	96.18%	[23]
Probabilistic Neural Network (PNN)	97.0%	[23]
Multilayer Perceptorn (MLP)	95.74%	[23]
Generalized Regression Neural Network (GRNN)	98.8%	[23]
Symbiotic Adapti ve Neuro-Evolution (SANE)	98.7%	[24]
Information Gain and Adaptive Neuro-Fuzzy Inference System (IGANIFS)	98.24%	[25]
Xcyct system using leave one out method	90 to 91%	[26]
Adaptive Neuro-Fuzzy Inference System (ANFIS)	59.90%	[27]
Fuzzy	96.71%	[28]
Shunting Inhibitory Artificial Neural Networks (SIANN)	100%	[29]

V. CONCLUSION

The last decade has witnessed that 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. This paper compares NN techniques for breast cancer diagnosis using WBCD. The MLP, RBFNN, PNN, GRNN, GA, Fuzzy- neuro -system, SANE, IGANIFS, Xcyct system, ANFIS, SIANN may be used for the classification problem. Almost all intelligent computational learning algorithms use supervised learning.

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