Breast Cancer Diagnosis Using MLP Back Propagation

Pachipala Yellamma[1], Ch Smitha Chowdary[2], G Karunakar[3], B.V Subba Rao[4], Vithya Ganesan[5]

[1,2] Associate Professor, Department of Computer Science and Engineering, Koneru Lakshmaiah Education

Foundation, Vaddeswaram, AP, India, pachipala.yamuna@gmail.com

[3]Assistant Professor, Department of Computer Science and Engineering, Koneru Lakshmaiah Education
Foundation, Vaddeswaram, AP, India

[4] Professor, Department of Information Technology, P.V.P Siddhartha Institute of Technology, Vijayawada, A.P,
India,

[5]Professor, Department of Computer Science and Engineering, Koneru Lakshmaiah Education Foundation,
Vaddeswaram, AP, India
Corresponding author: pachipala.yamuna@gmail.com

ABSTRACT

Breast Cancer (BC) is one of the most prevalent forms of Cancer among women. Premature diagnosis of BC is crucial to the survival of the patient. Here we implement an algorithm designed to diagnose and forecast breast cancer using a multi-layer perceptron (MLP) back-propagation technique that will help doctors diagnose the disease (benign, malignant). The proposed MLP includes an input layer, and, has inputs linked to the ten attributes of the data set. It has a hidden layer with five nodes (neurons). It leads to the pair outcomes: benign and malignant. The objective of our projected algorithm is to diagnose and classify the disease. MLP can help timely recognition of the cancer, and, therefore, can help to go for proper medication at early stage of cancerous development. This approach is tested on the (WBC) Wisconsin Breast Cancer dataset, resulted in 98.9 percent accuracy of classification using MLP back propagation.

Key words: Neural-Network, Tumour, Prediction, Features, Training, Analysis, Multi-layer Perceptron
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1. INTRODUCTION

As per the reports, one of each eight women in the United States build ups breast cancer in their life span. It is one of the most critical diseases among women leading to their death. Premature identification needs an exact and consistent diagnosis system that allows physician to differentiate benign breast tumours from malignant ones without departing for surgical biopsy. Marcano-Cedeno et al. (2011) Breast cancer originates with an unrestrained partition of one cell and consequences in an observable mass called tumour [1]. The tumour can be benign or malignant. Katsis et at (2013) Breast Cancer causes several of the risk factors such as genetic, obesity, family history, having a first child after the age thirty, not having children, aging, menstrual periods, not having children, smoking, drinking, that raise a women possibility of developing breast cancer [2]. Anil Arora et al. (2016) the precise diagnosis of the breast cancer is one of the critical problems in the medical field [3]. NN based MLP back propagation technique seems to be an efficient method for classification of breast cancer. This approach is pedestal on the WBC (Wisconsin Breast Cancer) and the taxonomy of dissimilar category of breast cancer datasets. The MLP back propagation is used to reduce the error rate of breast cancer and increase accuracy.

II. MATERIALS AND METHOD

Related work discloses that different methods employed for diagnosis of Breast Cancer by using NN approaches particularly in medical applications. It is intended for assessment; this procedure is extremely complicated to obtain a result as of which schema is better one as it depends on numerous factors similar to number of occurrences to be inspected, kind of abnormalities and dataset being used.
Alaa Rateb Mahmoud Al-shamasneh et al. 2017; Ali Abd Elgader et al. 2011 Described the various NN model for categorize WBC datasets are MLP, Generalized Regression Neural Network (GRNN) and Probabilistic Neural Networks (PNN) [4][5]. The overall results examining that MLP and GRNN are best appropriate for NN model for classifying WBC dataset. Azar et al. (2011) Used the MLP an obtained an accuracy of 96.18 percent [6]. Basavaraj hiremath et al.

(2015) Proposed an Automated Evaluation of Breast Cancer Detection on image processing morphological algorithm produced an accuracy of 88.33 percent [7]. Bichen et al. (2014) proposed a new K-SVM (K-Means and Support Vector Machine) algorithm was performed the accuracy of 97.3 percent, when tested on the WBC [8]. Chandra Prasetyo Utomo et al. (2014) a result showed that Extreme Learning Machine Neural Networks has better performances in term of sensitivity and accuracy in all experiments and with accuracy of more than 95percent[9][10]. Hui-Ling Chen et al. (2011) projected a rough set based supporting vector machine classifier [11]. The Rough set reduction algorithm used for features selection followed by support vector machine in order to achieve the highest classification accuracy 99.4 percent, 100 percent, and 100 percent for partition of training and test (50:50) percent of training and test partition (70:30), and percent of training and test partitions (80:20) respectively, for a subset that restricted five features. Janghel et al. (2010) used MLP with Gradient Descent (GD) function to get a low accuracy of 51.9 percent [12]. Jung et al. (2015) used MLP with back propagation training algorithm on ultrasound images, experimental studies obtained high accuracy for detection and classification of breast cancer on 96 percent, 95 percent [13]. Kasra et al. (2015) used a new algorithm based on C4.5 on WBC which is based on entropy of the attribute and a comparison made with weka tool and results having an accuracy of 97.9 percent [14][15]. Raad, et al, (2012) employed the MLP back propagation function achieved an accuracy of 88 percent [16]. Sarvestan Soltani et al. 2010; Smaranda Belciug 2010 Discussed different NN techniques such as Probabilistic Neural Network, Radial Basis Function (RBF) Self Organizing Map and MLP are used to classify the WBC dataset and then compared all the networks according to their accuracy[17]. According to his results RBF and PNN are shown as the good classifiers in the training set [18][19].Seema Singh et al. (2014) employed MLP algorithm obtained accuracy of more than 95 percent [20]. Usha et al. (2010) the investigational outcomes were based on single and multi layer NN models [21][22]. BP algorithm and MLP was adopted to produce an accuracy of 92 percent. Y. Wu et al. (2006) explain the Multilayer Perceptron architecture based on parameter regularization and cross-validation [23][24]. This gets the least absolute error and qualified error ratio.

The main cause of breast cancer is when a single cell or group of cells escapes from the usual controls, that regulate cellular growth and begins to multiply and spread. Some tumours are malignant that means the abnormal growth invades the surrounding tissues and that may metastasize or spread to remote areas of the body. The benign masses may lead to complications whereas malignant tumors are serious cancer. The dataset used in this paper is publicly available and was created by Dr. William H. Wolberg, physician at the University of Wisconsin Hospital at Madison, Wisconsin, USA[25][26]. Health records may include a range of data such as general medical records, patient examinations, patient treatments, medical history, allergies, immunization status, laboratory results, radiology images, and some useful information for examination. This rich information may help researchers in examining and diagnosing diseases using computer techniques. Features are computed from a digitized image of a fine needle aspirate (FNA) of a breast mass. They describe characteristics of the cell nuclei present in the image. Number of instances: 569, Number of attributes: 32 (ID, diagnosis, 30 real-valued input features). This has 699 instances (Benign: 458 Malignant: 241) of which 16 instances has missing attribute values removing that we have 683 instances of which 444 benign and 239 are malignant. Features are computed from a digitized image of a Fine Needle Aspiration (FNA) of a breast mass. Table 1 and Table 2 show the dataset description and the sample dataset representation for Breast Cancer stage and Table 3 shows the sample dataset for experimentation respectively.

Table 1: Breast Cancer dataset attribute description

S.NO	Attribute name	Attribute description
1	Clump Thickness	Malignant cells are multi layered while benign cells are layered in a single band
2	Uniformity of cell size	Cancer cells tend to vary in size. That is why this feature is valuable in saying whether the cells are cancerous or not
3	Uniformity of cell shape	Cancer cells tend to vary in shape. That is why this feature helps to know if the cell is cancerous or not.
4	Marginal Adhesion	Normal blood cells adhere to each other. In cancer cell this ability diminishes. So loss of adhesion is a sign of malignancy
5	Single epithelial cell size	Epithelial cells that are enlarged significantly t out to be malignant
6	Bare nuclei	Term for nuclei not surrounded by cytoplasm. They are typically seen in harmless tumors
7	Bland Chromatin	In malignant cells the chromatin is found to be rough in texture, while the nucleuses of noncancerous cells have an unvarying texture.
8	Normal Nucleoli	In malignant cells the nucleoli are largely visible, and are sometimes

		present in a greater quantity. In contrast, benign cells have Microscopic nucleoli.
9	Mitosis	Mitosis is a process that is inherently managed by the genes inside every cell. If this control fails, a single cell can multiply to make new Cells that can lose control and are cancerous.

Table 2: Dataset Attribute description

| S.N O	Attribute Description	Representation
1	Clump Thickness: 1 – 10	A
2	Uniformity of Cell Size: 1 – 10	B
3	Uniformity of Cell Shape: 1 - 10	C
4	Marginal Adhesion: 1 – 10	D
5	Single Epithelial Cell Size: 1 – 10	E
6	Bare Nuclei: 1 – 10	F
7	Bland Chromatin: 1 – 10	G
8	Normal Nucleoli: 1 – 10	H
9	Mitoses: 1 – 10	I
10	Class benign, malignant	Class

Table 3: Sample dataset

A	B	C	D	E	F	G	H	I	CLASS
7	3	2	10	5	10	5	4	4	Malignant
6	1	1	1	2	1	3	1	1	Benign
10	7	7	6	4	10	4	1	2	Malignant
4	1	1	1	2	1	2	1	1	Benign
4	1	1	1	2	1	2	1	1	Benign
7	4	6	4	6	1	4	3	1	Malignant
8	7	6	4	5	1	4	2	1	Malignant
1	1	1	1	2	2	1	3	2	Benign
9	5	6	10	4	2	4	1	2	Malignant
2	1	1	1	2	1	2	1	2	Benign
4	2	1	2	1	2	2	3	1	Benign
1	1	1	1	2	9	1	2	1	Benign
8	9	10	5	6	4	4	1	3	Malignant
5	4	4	2	3	4	3	2	3	Benign
4	3	2	2	1	2	3	1	2	Benign
4	3	2	4	2	5	6	2	3	Malignant
1	2	3	4	5	4	5	1	2	Malignant
1	2	3	8	9	4	1	2	2	Benign
4	5	2	3	1	2	2	3	4	Benign
1	2	3	4	5	1	2	2	1	Benign

In this paper MLP back propagation algorithm having three layers such input layer, a hidden layer and an output layer. The proposed network processing time can be compact on each layer in the network; as a result the overall training period reduces. The proposed breast cancer schema prediction and diagnosis is depends on ten features, normalization, leaning rate and activation function is applied throughout the training process.

This work proposes a technique to predict the existence of Breast-Cancer with women using a Neural Network (NN) technique with efficient algorithm using 10 attributes as an input of WBC dataset consisting of samples of 699 patients. The main reason for using back propagation algorithm is to achieve high accuracy of prediction, and, thereby, minimizing the error rate. The proposed algorithm tries to minimize the error on a given weights space by the means of GD. The objective of our proposed MLP is to make a model that exactly applies the input data to the output data by using a past dataset. Because of that, the model can be used to generate the output when the desired output is unidentified. In Figure 1 shown the proposed MLP neural network model has been represented in Figure 1. The algorithm corresponding Breast cancer disease prediction has been given by Algorithm 1.
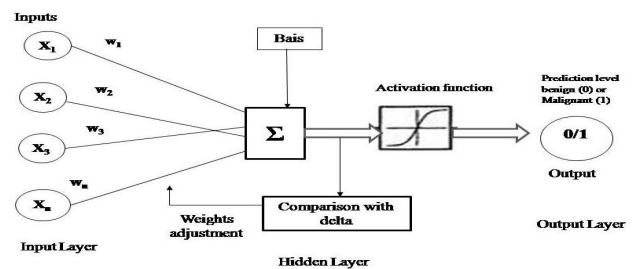
Figure 1: Multi Layer Perceptron NN model
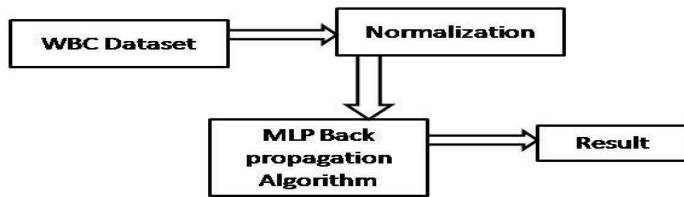Breast cancer Disease Prediction: Analysis flow

Datasets for Breast Cancer has been taken from the WBC neural network repository as the concerned data set has already been pre-processed. The concerned algorithm makes use of the ten features shown in the Table 4.

Table 4: Features information

#	Features	Domain
1	Sample code number	0.1 to 1
2	Bare Nuclei	0.1 to 1
3	Bland Chromatin	0.1 to 1
4	clump thickness	0.1 to 1
5	Marginal Adhesion	0.1 to 1
6	Single Epithelial Cell Size	0.1 to 1
7	Uniformity of Cell Size	0.1 to 1
8	Uniformity of Cell Shape	0.1 to 1
9	Normal nucleoli	0.1 to 1
10	mitosis	0.1 to 1

Next, data clean up procedure is applied and the outcome is utilized as key to the NNBP (Neural-Network-Back-Propagation) algorithm for predicting the cost function (sigmoid function). In Figure 2

shown the breast cancer prediction analysis flow is exposed clearly. The output is shown after predetermined iterations.

Figure 2: Breast cancer Disease Prediction analysis flow

Data Normalization

In neural networks the most significant pre-processing step is data normalization. In order to get better performance of a MLP neural network, we normalize the data in the first phase. After the processing the data set using given algorithm, we get output in the interval [0 1].An imaginative appearance of the input data was offered in proposed study was in the analog form, the range starting from 0.1 to 1. Translating the input data into digital form, and employs it as input to NN. Scaling or normalization must be recognized for each and every feature. The ten features in the analog appearance are scale in the range of 0 to 1.New value (After normalization) is equal to current value minus minimum value divided by maximum minus minimum value. Breast cancer prediction is analyzed by using MLP back propagation algorithm.

Algorithm 1: breast cancer disease prediction

Function model = ExtentedMLP (InputAttribute, Target, rate, NoIter, visualize)
Input: All 10 attributes
Output: learned model [(Benign (non-cancerous) or Malignant (cancerous))]
Step 1: Initialization
 [p, q] =size (InputAttribute);
Bais =ones (p, 1);
No_Of_Input_Nodes=q+1;
No_Of_HiddenLayer_Nodes= No_Of_Input_Nodes;
Step2: Generate Random Weights
Weights_Input_Hidden = (randn (No_Of_Input_Nodes, No_Of_HiddenLayer_Nodes) - 0.5)/10;
Weights_Hidden_Output = (randn (1, No_Of_HiddenLayer_Nodes) - 0.5)/10;
Step 3: Execution
Hidden layer size = 1;
For iter = 1: NoIter
   rand_Input = rand_perm (p, p);
   For i = 1: p;
Step4: Setting perceptron Parameters
      Input = InputAttribute (rand_Input (i), :);

      Target = Target_vector (rand_Input (i), 1);
      HiddenInput = tanh (Input * Weights_Input_Hidden);
      HiddenOutput = HiddenInput *
Weights_Hidden_Output'
      Error = HiddenOutput - Target;
      Options= maxIter=10
      Delta=0.001
Step 5: calculate error function
 Delta = error * rate * HiddenInput;
      Weights_Hidden_Output = Weights_Hidden_Output - delta;
      Delta= (rate/10) * error * Weights_Hidden_Output ' * (1-(HiddenInput'^2)) * Input;
      Weights_Input_Hidden = Weights_Input_Hidden - delta';   End
Step 6: Predict Level of breast cancer disease
Pred = Weights_Hidden_Output * tanh (InputAttribute * Weights_Input_Hidden)';
    Err (iter) = (sum ((pred' - Target) ^2)) ^0.5;
If err (iter) < 0.001 end
Step 7: Display
Training Set Accuracy, error

III. RESULTS AND DISCUSSION

Our scheme categorizes a tumour as benign or malignant based on WBC dataset, it contain samples of 699 patients having 10 features as has been given in the table 1, and, one class feature. The class allocation is 65.5 percent (458 samples) for benign and 34.5 percent (241 samples) for malignant.

Training and Classification

Our proposed Multi Layer perceptron uses an algorithm called back-propagation for training. Breast cancer is forecasted using the NN technique using the proposed algorithm using 10 parameters as input from WBC data set (consisting of samples of 699 patients). Here, the input data is repetitively offered to the NN. With each appearance a hidden layer result of the neural network compared with the target result and then, error is calculated. The resultant error is back propagated to the NN and then, used to normalize the weights, so that the error gets reduced after the end of each of the iterations. This training technique is capable to solve nonlinearly separable problems. The solution to the learning problem is considered as a combination of various weights leading to the minimization of the error rate function. As the gradient method needs to perform a number of procedures for the error function at each and every execution step, there is a

need to guarantee differentiability for error function and its continuance in each of the iteration. The key reason intended for using back-propagation algorithm is to reach high accuracy of prediction by minimizing the error rate. The algorithm tries to minimize the error function in a given weight space by means of the gradient descent.

Performance of MLP Back Propagation Algorithm

Analysis, construction and learning, three various phases are used in categorization of the disease. Three layers are present in the network of back propagation, input layer consisting of ten features, hidden layer possessing five neurons and output layer having a single class (benign or malignant). The significance of neurons of the output layer specifies, if the output corresponds to a Cancer case or not. Weights of the network connections are positioned arbitrarily in learning stage. The input layer attributes standardized values between zero (0) and one (1). Table 5 represents classification result of Breast Cancer using MLP.

Table 5: Experimental result on Breast Cancer using Multilayer Perceptron Back propagation

TRAINING SET SAMPLES	TEST SET SAMPLES	CLASSIFICATION EFFICIENCY OF MLP
378	120	98.9%
180	100	95.1%
150	178	92.0%
120	378	89.4%

Here eighty nine percent of patients have been classified properly, in this case, in which the training set samples (120) are less than the test set samples (378). In this case the error is twelve percent. Input to the Breast cancer diagnosis is a 10x699 matrix describing 10 features of the samples consisting of the 699 patients. The breast cancer goal is a 2x699 matrix where every column specifies an accurate class attribute with a one in either benign or malignant. Among these circumstances, the input and target matrix will be arbitrarily divided into two datasets.

Table 6: Description of WBC database

S.No	Features	Number of attributes
1	Number of samples	699
2	Number of features	10
3	Attributes 2 through 10	Samples
4	Classes	1.benign with value 0 2.malignant with value 1
5	Class Distribution	Benign is 458 samples (65.5%) Malignant is 241 samples (34.5%)

Description of WBC data attributes has been represented in the Table 6. The input and target matrix will be arbitrarily

divided into two datasets. Those are training and testing set. Eighty percent of samples are used for the training and remaining twenty percent of samples are used for the testing. In the beginning of the training, all the weights are place randomly in NN. The hidden layer assigns 5 neurons. The output layer gives two outputs. The training carries on for 10 iterations. All the computations have been executed by using MATLAB 9.0 neural network toolbox.

IV.CONCLUSION

In this investigation, the performance of MLP has been studied on a real life women breast cancer problem. The investigational outcomes in Wisconsin breast cancer dataset show that MLP back propagation is an efficient classification algorithm for training and testing. MLP gives the accurate classification and analysis when the dataset is measured. This model has specified a good breast cancer diagnosis performance of 98.9 percent.

V.FUTURE SCOPE

In real life, medical inspections and reports will take a lot of time consuming process scheduled by specialized doctors. In this report, time spending procedure is made by in a few minutes and details will generate in a short span of time afterwards patient's treatment will make further and quicker.

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