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Performance of ART1 Network in the Detection of Breast Cancer

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Abstract. Artificial Neural Network is a branch of Artificial intelligence, has been accepted as a new technology in computer science. Neural Networks are currently a 'hot' research area in medicine, particularly in the fields of radiology, urology, cardiology, oncology and etc. It has a huge application in many areas such as education, business; medical, engineering and manufacturing. The main aim of research in medical diagnostics is to develop more cost-effective and easy–to-use systems, procedures and methods for supporting clinicians. Here we discussed about ART1 network and its classification process .for breast cancer detection. It achieved the objective of classification of group in the given database by taking the input parameters and applied to the network basing on this we calculate the output with the desired output. With this we can get the 92% of accuracy is obtained by using this ART1 network.

Keywords: Classification, Diagnostics, Clinicians

1. Introduction

Breast cancer is cancer of breast tissue. Breast cancer is a malignant tumor that has developed from cells of the breast. Breast cancer has become a major cause of death among women in developed countries [4]. The most effective way to reduce breast cancer deaths is detect it earlier. However earlier treatment requires the ability to detect breast cancer in early stages. Early diagnosis requires an accurate and reliable diagnosis procedure that allows physicians to distinguish benign breast tumors from malignant ones. The automatic diagnosis of breast cancer is an important, real-world medical problem [6]. Thus, finding an accurate and effective diagnosis method is very important. The breast cancer diagnosis problem has attracted many researchers in computational intelligence, data mining, and statistical fields. Artificial neural networks (ANNs) [5] have been recently proposed as a very effective method for pattern recognition, machine learning. Between 1990 and 1997 applications of neural networks were introduced in near 2000 papers. Gives an overview of the main disciplines; Detailed description of one of the application oncology is discussed here. **Oncology:** 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.) [1].Baker et al. reported that they came to similar results by neural network evaluation of the parameters of the BI-RADS standardized code system [2]. 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 [3].

2. Neural Networks in Cancer Detection

Neural networks are important tools for cancer detection and monitoring. The ability of the physicians to effectively treat and cure cancer is directly dependent on their ability to detect cancers at their earliest stages. An initial diagnosis called early diagnosis is made based on the demographic and clinical data of the patient. More than 30% cancer deaths are preventable. Curing cancer has been a major goal of medical researchers for decades, but development of new treatment takes time and money. Science may yet find the root causes

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of all cancers and develop safer methods for shutting them down before they have a chance to grow or spread. Artificial neural networks offer a completely different approach to problem solving and they are sometimes called the sixth generation of computing. The aim of this research is to apply neural networks and their associated analysis techniques to Health care, specifically to the management of breast cancer patients. Artificial neural networks now are used in many fields. They have become well established as viable, multipurpose, robust computational methodologies with solid theoretic support and with strong potential to be effective in any discipline, especially medicine. Over the last two decades, a tremendous amount of research work has been conducted for automated cancer diagnosis. Chiou et al.(2003) designed an artificial neural network based hybrid breast cancer detection system named HLND, which improves the accuracy of diagnosis and the speed of breast cancerous pulmonary radiology. It includes the processing phases, such as pre-processing to enhance the figure background contrast, quick selection of nodule suspects based upon the most prominent feature of nodules and complete feature space determination and neural classification of nodules. Gutte, Henrik (2007) developed a completely automated method based on image processing techniques and artificial neural networks for the interpretation of combined fluorodeoxyglucose (FDG) positron emission tomography (PET) and computed tomography (CT) images for the diagnosis and staging of breast cancer. Kenji Suzuki (2003) investigated a pattern-recognition technique based on an artificial neural network (ANN). Penedo et al (1998) developed a system that employed an artificial neural network to detect suspicious regions in a low-resolution image and employed another artificial neural network to deal with the curvature peaks of the suspicious regions, which was used in the detection of breast nodules found on digitized chest radiographs. Bartfay (2006) proposed a neural network model.Utilizing data on patients from two National Cancer Institute of Canada clinical trials, he compared predictive accuracy of neural network models and logistic regression models on risk of death of limited-stage small-cell breast cancer patients.

3. Breast Cancer Detection using ART1 Network

ART1 networks are designed to allow the user to control the degree of similarity of patterns placed on the same cluster. Generally one of the simple tasks that neural nets can be trained to perform is pattern classification. Here each input vector belonging or does not belonging to a particular class or category is determined. For neural net approach a simplest case considering the membership in a single class the output unit represent membership in the class having a response of 1; a response of 0 is used to indicate that a pattern is not a member of class. This method of pattern of classification done by ART1 network.The ART1 classification process consists of three major phases - **recognition, comparison, and search phases** where the classification is determined.

3.1. Recognition phase

Initially no input vector is applied; hence all the components of input vector are zero. There by disabling all recognition layer neurons and causing their outputs to be zero. Because all the recognition layer neurons start out in the same state. The pattern to be classified is now applied for each neuron in the recognition layer. A dot product is formed between its associated weight vector and the input vector. The neuron with largest dot product has weights that best match the input vector. The ART1 network stores a set a pattern in the weights associated with the recognition layer neurons one for each classification category.

3.2. Comparison Phase

The single network firing in the recognition layer passed a back to the comparison layer on its output signal. Accordance to the two-third rule, the only comparison layer neurons that will fire are those that receives simultaneously from the input vector and the vector these are comparison layer excitation vector. If there is a substantial mismatch between these vectors, few neurons in the comparison layer with input vector over. This indicates that pattern being feedback is not the one sought and the neuron firing in the recognition layer should be inhibited. A comparison of the input vector to the inner layer vector is done and if degree of similarity is less than the vigilance parameter, the network causes reset. The effect of the reset is to force the output of the neuron in the recognition layer to zero, disabling it for the duration of the current classification.

3.3. Search Phase

If there is no reset signal generated, the match is adequate and the classification is finished. Otherwise the other stored pattern must be researched to seek a correct match. It is seen previously in the ART that once a pattern is found that has reset ratio less than vigilance parameter, that pattern is inhibited and a new pattern is fed to the comparison layer. This process repeats, until one of two events occurs.

1. A stored pattern is found that matches X above the vigilance parameter
2. All stored patterns have been tried, found to miss match the input vector and all recognition layer neurons are inhibited.

Data representation schemes: The original data is present in the form of analog values with values ranging from 0-10.Here the given data sets are converted to their equivalent digital form. Scaling has the advantages of mapping the desired range of variables ranging between minimum and maximum range of network input.

Digital Conversion: Here the conversion of the given data sets in to binary form is done based on certain ranges, which are defined for each attribute. There are total 10 attributes (1 class category and 9 numeric features). The 9 numerical attributes are in the analog form scaled in the range between 0 and 1.First from the given range of inputs, the minimum and maximum value is picked up and this scaling is done by the following formula.

New value (after scaling) = (current value – Min value) / (Max value – Min value)

The new values obtained after truncating are converted into binary from by the following scaling. The values which are in the range 0 to 5 are converted to 0 and 6 to 10 are converted to 1.

Data description: This database was obtained from the university of Wisconsin hospital, Madison from Dr. William H. Wolberg.[8].

Information:

- Number of instances: 699
- The 16 instances with missing attributes values are removed from the database, leaving 683 instances
- Number of attributes: 10 plus the class attributes
- Attributes 2 through 10 will be used to represent instances.
- Each instance has one of 2 possible classes: benign or malignant.

Class distribution: Benign: 458(65.5%), Malignant: 241(34.5%)

Table1:Attribute information

Attribute	Domain
Clump thickness	1-10
Uniformity of cell size	1-10
Uniformity of cell shape	1-10
Marginal adhesion	1-10
Single epithelial cell size	1-10
Bare nuclei	1-10
Bland chromatin	1-10
Normal nucleoli	1-10
Mitosis	1-10
Class	2 for benign, 4 for malignant

4. Proposed Algorithm

1. Load Data set.
2. Replace missing values by median missing values replacement method.
3. Normalize each variable of the data set, so that the values range from 0 to 1. We call this data set as normalized data set.
   op1= op1/2;
   % count i=1;

```
% coun j=1;
% for i =1 : r
%       if( sum ( ip1(i,:))~=0)
%               ip(count i, :)=ip1(i ,:);
%       target(count i)=op1(i);
%       count i =  count i +1;
%     else
%   asd( coun j)=op1( i );
%  counj=counj+1;
%  end
% end
```

4. Create a separate training set and testing set by randomly drawing out 80% of the data for training and 20% for testing.

```
reset  =  1;
        count  =  0;
        while(reset==1)
             count  =  count  +  1;
             [maxy    maxi]=  max(y);
             x=s.*t(  maxi,:);
        normx  =  sum (  x  );
        if  (  norms== 0)
            norms  =   0.1;
        end
        if (( normx/norms)>=row)
                reset  =  0;
        else
        reset  =  1;
        y(maxi)   =  -1;
        if(count > m)
        reset  =  2 ;
        end
      end
```

5. Create an initial ANN architecture consisting of three layers, an input, an output and a hidden layer. The number of nodes in the input layer is the same as the number of inputs of the problem. And the output layer contains 1 node. Increase the number of hidden nodes in hidden layer for every run. Randomly
6. Initialize all connection weights within a certain range.
7. Train the network on the training set by using Back propagation algorithm until the error is almost constant for a certain number of training epochs, this is specified by the user.

```
if  ( reset==2)
        cnc (pi)   =  1;
else
        cnc(pi)  =     0;
end
if  (reset ==  0)
        b( : , maxi)  =  (L *x/ ( 1 + sum(x) ) )' ;
        t ( maxi ,: )= x ;
        end
       end
```

8. Displays the test data to the trained network and evaluate the performance.

```
disp (per 1);
disp(t);
disp( count op);
disp( count tg);
disp(  count op/ count tg * 100);
```

Here we can test the data basing on the vigilance parameters and calculate the efficient of the network basing on the training and testing percentages.

Table2:The performance of vigilance parameter 0.6

Sl. No	Training vector %	testing vector %	Training time in seconds	Efficiency %
1.	10	90	1.459	92.3913
2.	20	80	2.890	92.9412
3.	30	70	4.230	93.6709
4.	40	60	5.688	93.0556
5.	50	50	7.098	94.2029
6.	60	40	8.455	95.0820
7.	70	30	9.656	95.4545
8.	80	20	11.344	96.5517
9.	90	10	11.750	100.00

Table3: The performance of vigilance parameter 0.8

Sl. No	Training vector %	Testing vector %	Training time in seconds	Efficiency %
1.	10	90	1.485	92.4731
2.	20	80	2.875	93.0233
3.	30	70	4.296	93.7500
4.	40	60	5.609	93.1507
5.	50	50	7.109	94.2857
6.	60	40	8.390	95.1613
7.	70	30	9.875	95.5556
8.	80	20	10.147	96.5899
9.	90	10	10.406	100.00

With the above results we can conclude that the performance of the vigilance parameter 0.8 is efficient when compare to the vigilance parameter 0.6,

5. Conclusion

ART1 network has achieved the objective classification of group in a given database of Breast cancer according to a high level of accuracy based on different train-test ratios. Thus for unsupervised input pattern, the output is obtained with a good level accuracy. Further development in the simulation can be obtained by increasing the level of accuracy and training time of network in seconds. By training more patterns, the simulated network for pattern classification of breast cancer data using the ART1 learning and testing algorithm, and about 92% accuracy is obtained. It can be safely concluded that ART1 is the best-suited network for pattern classification as of today. This work also indicates that neural networks can be effectively used for breast cancer diagnosis to help oncologists.

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