Convolutional Neural Network for Periodontal Disease

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Abstract- Artificial intelligence is widely used in medical field. It is helpful in diagnoses, risk management, patient monitoring, robotic handling of surgeries and predicting effect of new medicines. This paper proposes convolutional neural network with information gain for periodontal disease. Risk factors viz. Monocytes, Neutrophils, Lymphocytes, Blood sugar level; Pregnancy is taken as inputs to the system. The results of proposed system have been compared with Multilayer perceptron and other techniques in terms of Accuracy, precision, Recall and F-measure is found better.

Index Terms- Periodontitis; Multilayer perceptron; Logistic regression; Random forest; Information gain; Convolutional neural network

I. INTRODUCTION

Periodontitis is a chronic inflammatory disease of supporting tissues of the teeth. The tooth is supported by these tissues which is called dental root. Periodontal disease propagates through different stage. In very first stage plaque deposit and gingival affect by infection which is known as gingivitis. Gingivitis is inflammation of gingival. In next pockets are form which is filling with plaque and then deeper pockets are form as more tissues are lost. At last tissues have been lost and teeth may lose. Currently two types of periodontitis are there: Chronic periodontits and Aggressive periodontitis.

(a)Chronic Periodontitis: It is chronic inflammation of the periodontal tissues that is caused by plaque. The disease may be modified with systemic diseases. For example Blood sugar level and Pregnancy.

(b)Aggressive periodontitis: The involvement of multiple teeth and periodontal tissue loss; a high rate of disease progression.

There are some important risk factors in periodontitis like Monocytes, Neutrophils, Lymphocytes, blood sugar level and Pregnancy. Classification of periodontitis can be done on the behalf of these risk factors. Blood sugar level and Pregnancy are indirectly involved in this disease.

Researchers have been proposing Multilayer perceptron in order to evaluate periodontal disease using different input factors. This study proved that convolution neural network judgments are better than Multilayer perceptron and others. **Figure1** shows the block diagram of multilayer perceptron. It has some inputs and outputs. And number of hidden layers. This paper presents convolution neural network which has five input risk factors. Convolution neural network is a type of feed-forward artificial neural network. It has been discussed in detail in the proceeding section.

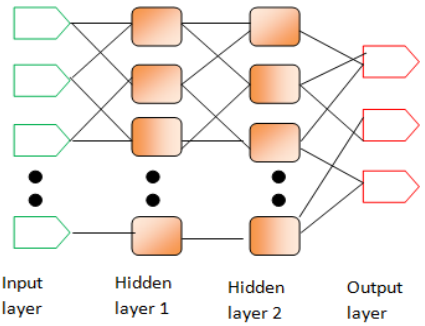

Fig.1. MULTILAYERPERCEPTRON

In previous work various techniques used for periodontal disease like Multilayer perceptron, Logistic regression and Random Forest.
Logistic Regression is the appropriate regression analysis to conduct when the dependent variable is binary. Like all regression analyses, it is a predictive analysis. It is used to describe data and to explain the relationship between one dependent binary variable and one or more metric independent variables.
Random Forest is used for classification, regression and other tasks that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of

the classification or mean prediction of the individual trees. Random decision forests used for decision trees' habit of overfitting to their training set

This paper arranged as follows: Section 2 shows the related work. Section 3 presents the proposed work. Section 4 gives the Result and discussion. Section 5 presents the conclusion and then references.

II. RELATED WORK

This section deals with data set and tool used in this work. It includes the detail description of dataset and tool used.

DATASET

The data set of periodontal disease is purely real data set. The data set used in this work collected from medical laboratories. In this work 437 patients data has been used i.e. 437 instances and has 5 attributes. These attributes are actually risk factors of periodontal disease on the behalf of convolutional neural Network trained. The attribute taken for classification are neutrophils, monocytes, lymphocytes, blood sugar level and pregnancy. The dataset is divided into two classes i.e. Agp and CP. These features are helpful in the classification of periodontal disease. These features in table1 specify their range through which classification is done.

Table 1: Sample of dataset for periodontal disease

S.No.	Features	Normal Range
1	Neutrophils	50-80%
2	Monocytes	2-10%
3	Lymphocytes	25-50%
4	Blood sugar level	70-130 mg/dl
5	Pregnancy	1-9 months

2.2 TOOLUSED

The tool used in this work is Matlab version 2013a. Matlab is a programming language which is developed by Math Works. The coding of this system has been performed using two different toolboxes of Matlab i.e. *neural tool box* and *Convolution neural tool box.*

III. PROPOSED WORK

All paragraphs must be justified, i.e. both left-justified and right-justified. The proposed system consist of two steps i.e. feature selection and convolutional neural network. This section presents the detail description of methodology. The above data set is used as input in this work. There are two labels i.e. Agp and CP in the sample data. Agp and CP consider as "1" and "0" respectively for input. This process is supervised that's why labels are also considered as an input with attributes value.

3.1 FEATURE SELECTION

Feature selection is done for effective features. In this attribute reduction is done which is the key process for knowledge acquisition. Some data set is larger in size. If that data set is used for classification it may occupy more resources especially in terms of time. Most of the features present are redundant and inconsistent and affect the classification [5]. In order to improve the efficiency of classification these redundancy and inconsistency features must be eliminated by feature selection. It has been done by following method:

3.1.1 INFORMATION GAIN: Information gain (IG) is the amount of information in bits about the class prediction, if the only information available is the presence of a feature and corresponding class distribution. It measures the expected reduction in entropy [29]. Information gain is that in which an Attribute has a high information gain, because it will uniquely identify.

In this work,there are some values which are genratting from features. That value will predict the label i.e. Agp or CP, if this can be done effecently it means it has more information. Otherwise it will show entropy, if this is fail to predict. In this work information gain is done with following formula:

*logVal(ithEle)=(subLen/totLen)*log2(subLen/totLen);*

3.2 CONVOLUTIONAL NEURAL NETWORK: Convolutional neural network is a type of feed-forward artificial neural network. It helps us train deep. It is many-layer networks, which is very good at classification. It is a neural network with specialized connectivity structure. In this, Classification layer at the end. **Figure2** shows the single layer architecture of CNN.

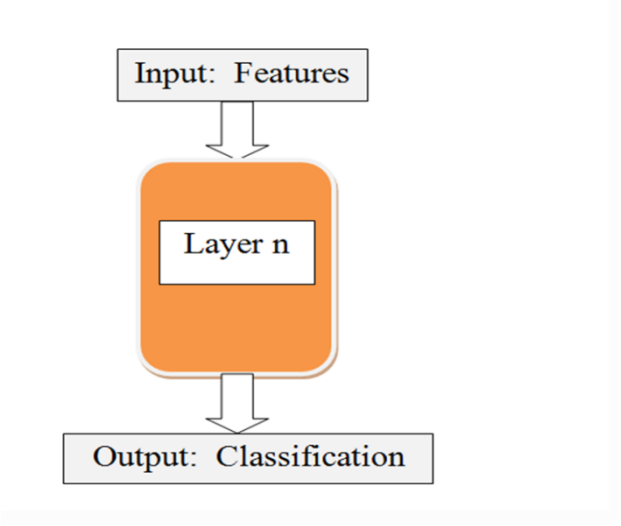

Fig.2: Single layer Architecture of CNN

In this work, if we see features label on the behalf of 2D it will overlap. To remove overlapping CNN separate it by given weights.CNN selects the weight with the help of overlapping. In CNN, weights are given according to feature's values and

reduce overlapping between the features. In the next step, input is given to neural network. At last neural network trained.
CNN selects the adaptive weights where as Multilayer perceptron (MLP) selects the random weights. In the CNN training error and testing error reduced on the behalf of overlapping weights. CNN with information gain shows better results as compare with multilayer perceptron and other techniques.

IV. RESULTS AND DISCCUSION

In this section, feature selection and convolutional neural network is implemented and shown the four parameters i.e. Accuracy, Precision, Recall and F-measure.

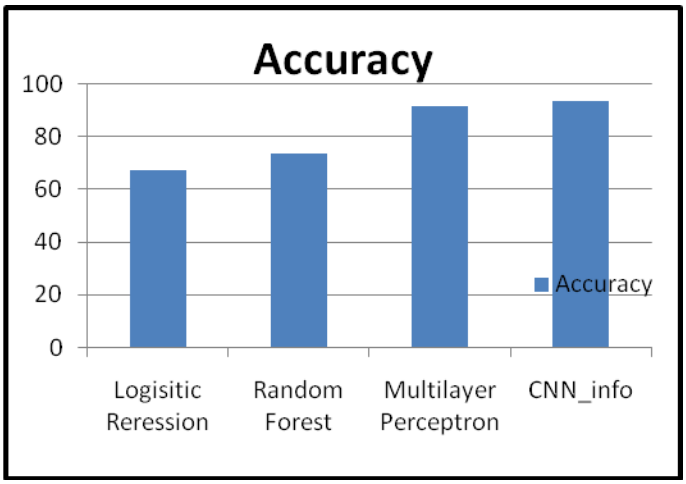

Fig.3: Result graph for Accuracy

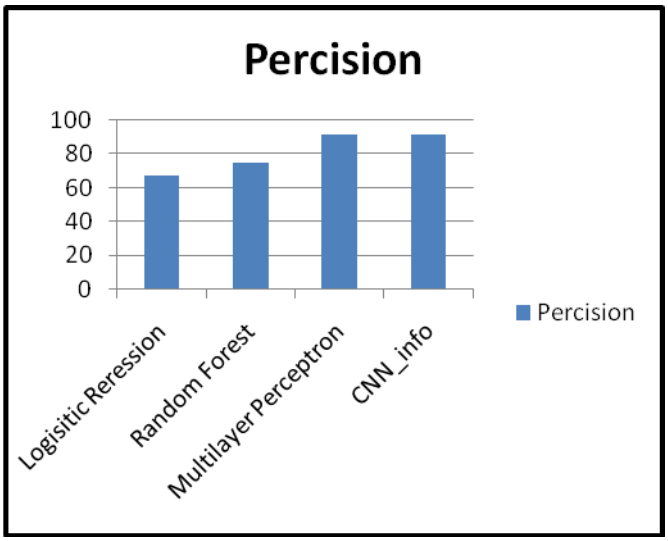

Fig.4: Result graph for Precision

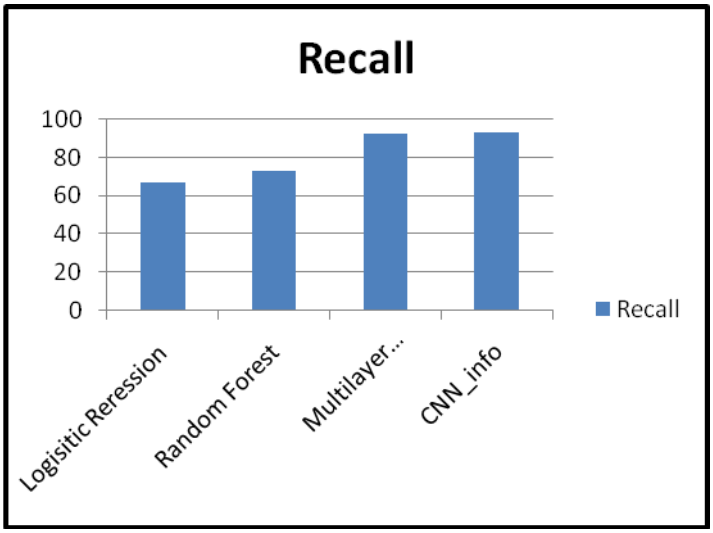

Fig.5: Result graph for Recall

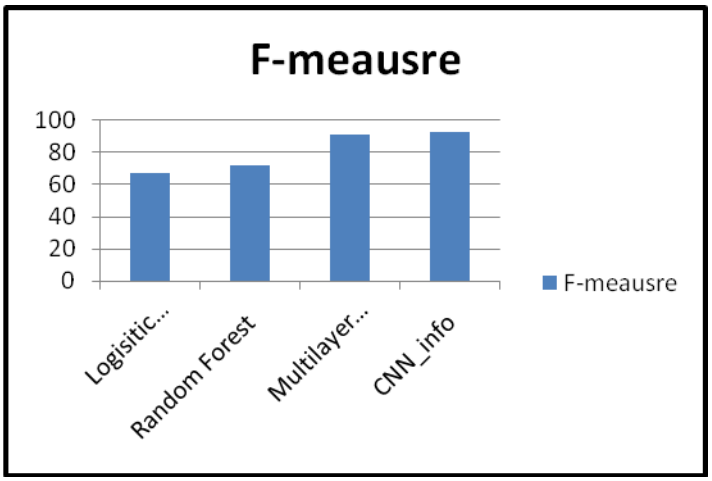

Fig.6: Result graph for F-measure

In **Table 2** shows the four classifiers with four different parameters. In last comparison graph is shown with classifiers and parameters.

Table 2: Results of classification after Training and Testing

Classifiers	Accuracy	Precision	Recall	F-measure
Logisitic Reression	67.24	67.2	67.2	67
Random Forest	73.77	74.8	73.4	72
Multilayer	91.8	91.87	92.3	91

Perceptron				
CNN_info	93.5714	91.46	93.429	92.448

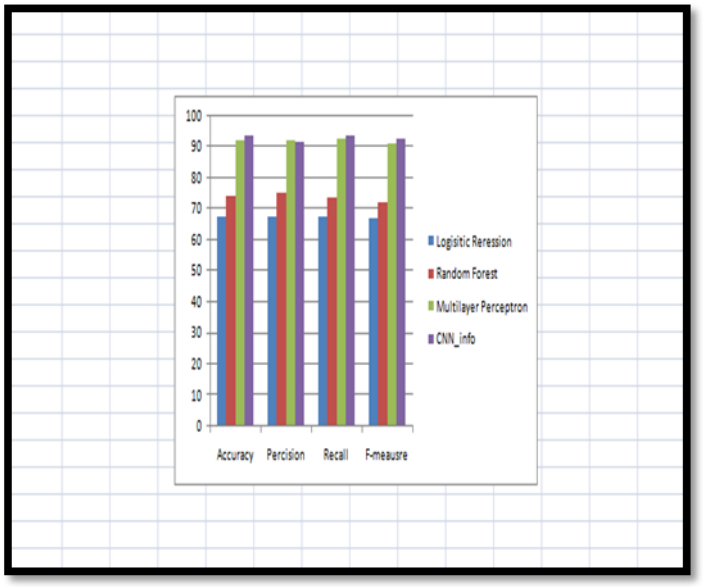

Fig.7: Comparison Result Graph

V. CONCOLUSION

In the Work Presented Here, four classifiers have been investigated for periodontal disease. From the above results we achieve our objective to find the best model for periodontal disease. That efficient model is convolutional neural network with information gain. For data set five risk factors are used i.e. Monocytes, Neutrophils, Lymphocytes, Blood sugar level and Pregnancy. The proposed system achieved highest accuracy i.e. 93.5714% as compared to others. Thus it may be concluded that the results of the system are reliable for the system to be substitute to the medical experts.

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