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Prediction of Gum Disease Severity on the basis of Symptoms and Risk factors using Neural Network

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Abstract: *Keeping an eye on human health is always been a tedious task. As this process needs iterative Analysis of health factors. Dental diseases are born due to most primitive reasons that cannot be expected in most of the normal scenarios of day to day life. So task of identifying dental diseases with day to day data is again challenging task. Many systems are proposed to predict dental diseases like gum diseases but most of them are merely yield approximation for the prediction. so an urge of system for gum disease prediction is existed like never before. so proposed system puts forwards an idea of gum disease prediction based on the symptoms and risk factor of the disease. This involves clustering process through k-means algorithm, this clusters are feed to Baum Welch algorithm for the detection of the hidden state and this is been powered with dempster-shafer theory for the detection of gum disease.*

Keywords: *Gum Disease, Neural Network, Baum-Welth algorithm, Dampster-Shafer Theory, Clustering.*

I. INTRODUCTION

Gum is a area around the teeth and Gum disease is infection around teeth. Gum diseases range from simple gum inflammation to serious disease. The result of gum disease is a major damage to the soft tissue and bone that support the teeth. In the very serious case, teeth are lost. Our mouths are full of bacteria. These bacteria, along with mucus and other particles, constant form a sticky, colorless "plaque" on teeth. By daily brushing of teeth we can avoid gum disease. There are two main types of gum disease like periodontal and gingivitis. In this periodontal is very serious than gingivitis. Periodontal means around the teeth and it is very dangerous. Periodontal disease is spread because of bacterial infection in mouth. If there is early detection of gum disease is done then it may protect the teeth. While Gingivitis is the earliest stage of periodontal disease. If it is solved then next stage is not occurred. In gingivitis gum becomes red, swollen and bleed easily.

Neural Networks (NN) are important data mining tool used for classification and clustering and which is finally used for prediction. Working of Human brain neuron is used in prediction using basic neuron model. Structure of neuron model is exactly similar to the human neuron Structure. If NN is applied towards the different examples, at that time classification is done and finally the new trend of data is generated. Basic NN is made up of three layers input layer, hidden, layer and output layer. All these layers are connected to each other and output layer generates the result by adjusting the weights so prediction is easily done. Neural network has one of the best features that it can work on fuzzy and noisy data. From large amount of data, prediction is done by using Neural Network.

Neural network is nothing but the Artificial Neural Network (ANN).In medical science Artificial Neural Network is widely used. Mathematical representation of neural network is nothing but the Artificial Neural Network used for learning abilities. Different ANN models are proposed for prediction of different types of disease. Mainly the ANN is used for risk factor prediction.

In this paper we are proposing neural network model for prediction of gingivitis and periodontal gum diseases on the basis of their symptoms and risk factor. And in this paper we are also predicting the seriousness of the gum disease. Collected large amount of patient's data' symptoms and risk factor are used as input for multilayer neural network model and then neurons are created by using baum-Welth algorithm.

II. RELATED WORK

This section provides the existing work related to the prediction of gum disease and how the neural network is used for diagnosis of disease. In this section we are going to point out the difference between existing and proposed work. For explain this difference we mention the drawbacks of existing system.

Symptoms and risk factor based diagnosis of gum disease using neural network[1][6][10] in this paper only back propagation algorithm is used for prediction and there is small amount of dataset is used as input and so that accuracy of result is better in proposed system. Gingivitis is occur in different peoples and how it is categorized. For generation of inputs like symptoms and risk factor is important [3][12].Periodontal disease is generally spread in Us[4].and how it is spread in adults it is also very important thing[5][9].For diagnosis of gum disease[7], first we are familiar with what are the methods used for diagnosis of that particular disease[2].Risk factors are very for prediction of gum disease and smoking is one of the risk factor[8]

III.MATERIAL AND PROPOSED SYSTEM

This section explains the what is symptoms and risk factors of Gum Disease and how its generated and explains Proposed system architecture.

3.1 Symptoms and risk factors of Gum Disease

Gum disease is spread because of bacterial infection in mouth. Bacterial infection causes the teeth become reddish color, swollen and can bleed. When teeth become red and swollen this can be a Gingivitis and this is the first stage of Gum Disease. If this is not cleared properly then next stage of this is a Periodontal disease. At this stage there may be a loss of teeth.

Symptoms and risk factors of gum disease are nothing but the Bright red purplish gums ,Gums that feel tender when touched, Pus between teeth and gum, Exposure of root, Loose teeth, Bad taste in your mouth, Bad breathe Increase in size of gums ,Diabetes, Smoking Hormonal changes etc.

Symptoms and risk factors are taken as input to the neural network and depend upon that symptoms and risk factors prediction of seriousness of disease is done.

3.2 Proposed Neural Network Model for prediction of Gum Diseases

This section explains the overall architecture of proposed system.

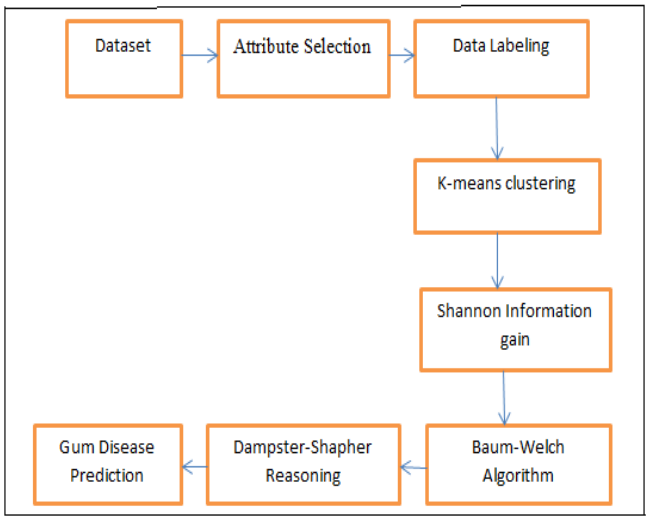
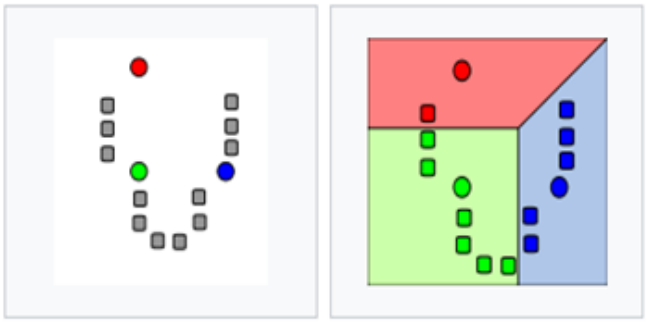


Figure 1: Proposed System Overview

Step 1: Attribute Selection: Here in this step system takes inputs as the dataset, which contains symptoms and factors related to the gum diseases. Then desired attributes are selected for the prediction of gum diseases.

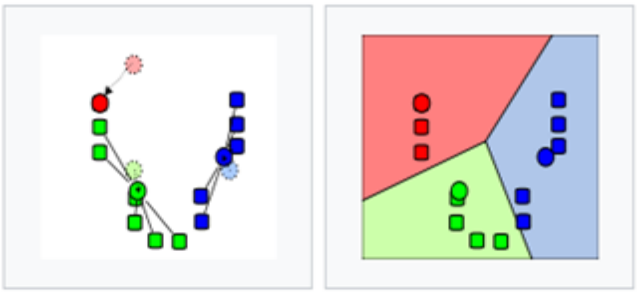
Step 2: Data Labeling: Here the data which is needed to be clustered based on the k-means algorithm is labeled so that any string form of data is eventually converted into numerical type**.**

Step 3: K-means Clustering: Here in this step the features which are labeled numerically are clustered using k-means algorithm.



(a) **(b)**

Figure 2 : Generation initial means(a) and partition of data(b)



(a) **(b)**

Figure 3: Finding out the centroid (a) and repeat steps followed in Figure 2(a)&2(b)

Step 4: Shannon Information Gain K-means clustering is used for generation clusters according to the parameters which is initially defined. After that Shannon-Information gain is used to find out the highest priority attributes which are essential for the prediction of gum disease and there seriousness. Here information gain is used to identify the most important and fluent attribute in the clusters which frequently affecting the gum disease features. This can be given with the following equations:

$IGR(C) = -\sum (|C_i| / |C|) \log (|C_i| / |C|)$

Where C_i is the frequency of the feature in Cluster C.

Step 5: Baum Welch algorithm

Baum–Welch algorithm is used to find the unknown parameters of a hidden Markov model (HMM). Here in this step the unknown parameters are identified from the clusters using Baum Welch algorithm as mentioned below. For creation of neurons Baum-Welch algorithm is used and after that Dampster-Shafer theory is used for further prediction.

I. Forward algorithm: The forward algorithm is mostly used in applications that need us to determine the probability of being in a specific state when we know about the sequence of observations. First calculate the probabilities over the previous observation and use them for the current observations, and then extend it out for the next step.

// Input: Data Set **D**,
Observed States $\mathbf{O_s}$ = { O_{s1} , O_{s2},O_{s3}}
Step 0: **Start**
Step 1: Identify the Observed state Attribute $\mathbf{O_{si}}$
Step 2: **FOR** i=0 to size of **D**
Step3: Identify Attribute $\mathbf{O_{si}}$ and put in separate List$\mathbf{O_{SL}}$
Step 4: END FOR
Step 5: FOR i=0 to size of $\mathbf{O_{SL}}$
Step 6: identify α using equation 1
Step 7: **END FOR**
Step 8: **Stop**

Equation1:

$$\alpha = O\ (t+1) \sum_{j=1}^{N} \mathrm{Osi(O1)}$$

Where α = Forward Probability
O(t+1) = For every next element of Observed state
N= Size of the Observed state List
$\mathrm{Osi(O1)}$ = For Every observed state

II. Backward algorithm: Backward algorithm is used for calculating the backward probabilities which is useful for prediction of disease.

// Input: Data Set **D**,
Observed States $\mathbf{O_s}$ = { O_{s1} , O_{s2},O_{s3}}
Step 0: **Start**
Step 1: Identify the Observed state Attribute $\mathbf{O_{si}}$
Step 2: **FOR** i=0 to size of **D**
Step3: Identify Attribute $\mathbf{O_{si}}$ and put in separateList$\mathbf{O_{SL}}$
Step 4: END FOR
Step 5: FOR i=0 to size of $\mathbf{O_{SL}}$
Step 6: identify β using equation2
Step 7: **END FOR**
Step 8: **Stop**

Equation 2:

$$\beta = \lambda O\ (t+1) \sum_{j=1}^{N} \mathrm{Osi(O1+1)}$$

Where α = Forward Probability
O(t+1) = For every next element of Observed state
N= Size of the Observed state List
$\mathrm{Osi(O1)}$ = For Every observed state
λ = Frequency of the occurred state

III. Baum-Weltch algorithm:

// Input : Data Set **D**,
Observed States $\mathbf{O_s}$ = { O_{s1} , O_{s2},O_{s3}}
Step 0: **Start**
Step 1: Identify the Observed state Attribute $\mathbf{O_{si}}$
Step 2: **FOR** i=0 to size of **D**
Step 3: Identify Attribute $\mathbf{O_{si}}$ and put in separateList$\mathbf{O_{SL}}$
Step 4: **END FOR**
Step 5: Transaction count $\mathbf{T_c}$=0
Step 6: **FOR** i=0 to size of $\mathbf{O_{SL}}$
Step 7: identify **α** and **β**
Step 8: Compute **γ** using Equation
Step 9:IF γ belongs to O_s
Step 10: **THEN** add H**s(Hidden State)** to list
Step 11: END FOR
Step 12: **Stop**

Equation :

$$\gamma = \sum_{j=1}^{N} \alpha(j)\beta(j)$$

Where γ=Probability of Being at the state
α=Forward Probability
β=Backward Probability

Step 6: Dempster-Shafer Theory It is a general framework for reasoning with uncertainty, with understood connections to other frameworks such as

probability, possibility and imprecise probability theories.

3.3 Three layer neural network model of proposed system

Input Layer: Input layer is used for providing the inputs to the hidden layers. For Diagnosis of gum disease uses 11 inputs which is combination of symptoms and risk factors. From different Hospitals and from websites we can take the dataset to generate an output.

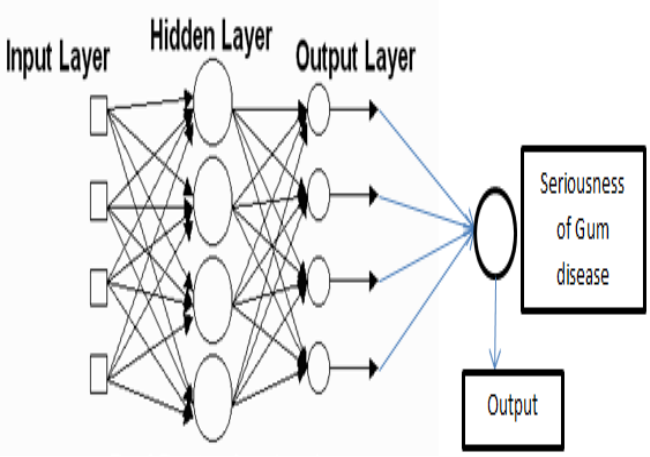


Figure 4: Three layer neural network model

First this dataset is selected and then data labeling is done according to parameters. These symptoms and risk factors are studied by taken the help of expert dentist.

Symptoms and risk factors to the neural network model as follows:

1 Bright red purplish gums
2 Gums that feel tender when touched
3 Pus between teeth and gum
4 Exposure of root
5 Loose teeth
6 Bad taste in your mouth
7 Bad breathe
8 Increase in size of gums
9 Diabetes
10 Smoking
11 Hormonal changes

Hidden Layer: Hidden layer is used to extract the features of inputs and likewise they perform there operation and then status to the output layer.

Output Layer: Output layer is used to generate an output according to our proposed methodology. Here in this system we are going to predict that gum disease is present or not. Gum disease is nothing but the periodontal disease or gingivitis. After predicting of the disease we are going to predict the seriousness of that disease or simply level of disease like high, medium and low.

IV. CONCLUSION

Soft computing based decision making model is a new era in the field of dentistry and for common people. Prognosis of early and accurate diagnosis of gum diseases and seriousness of disease using artificial neural network mode is helpful in clinical practice. It is also a time saving method. In proposed method we took symptoms and risk factors of gum diseases as input to the neural network model .Various training algorithms are used to train the neural network model. Baum-Weltch algorithm is very effective algorithms for prediction of gum disease. As neural network have the ability to approximately predict the uncertain data or missing data. So detection of gum diseases using artificial neural network method is robust solution in the field of dentistry.

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