A Clinical Decision Support System Using Multilayer Perceptron Neural Network to Assess Well Being in Diabetes


Abstract

Background: Diabetes mellitus is an increasingly common life-style disorder whose management outcomes are measured in symptomatic, biochemical as well as psychological areas. Well being as an outcome of treatment is being increasingly recognized as a crucial component of treatment. There is little published literature on psychosocial outcomes and the factors influencing them. Therefore we have developed a neural network system which is trained to predict the well being in diabetes, using data generated in real life.

Material and Methods: We developed a Multi Layer Perceptron Neural Network model, which had been trained by back propagation algorithm. Data was used from a cohort of 241 individuals with diabetes. We used age, gender, weight, fasting plasma glucose as a set of inputs and predicted measures of well-being (depression, anxiety, energy and positive well-being).

Results: It was observed that female patients report significantly higher levels of depression than their male counterparts. Some slight high or no significant differences are observed between males and females with regard to the number of persons with whom they share their anxieties and fears regarding diabetes. There is not much difference has been observed in energy levels of both males and females. Also, Males have higher pwb value when compared with the female counterparts. Also, this may be due to women tend to react more emotionally to disease and hence experience more difficulty in coping with it. The present sample of women being predominantly housewives may be worrying more about their health and its problems. Also, it is observed that, gender differences are significant with regard to total general well-being.

With five inputs (age, sex, weight, fasting plasma glucose, bias), four outputs are four (depression, anxiety, energy and positive well-being) the momentum rate was 0.9, the learning rate 0.7, using a sample of 50. the maximum individual error is 0.001 when the number of iterations were 500, number of hidden layers is 1 and the number of units in the hidden layer are 6, the normalized system error was 470.57. With input samples of 100, 150 and 200, keeping the other variables constant, the normalized system error was 419.61, 359.67 and 332.32 respectively. Similar values are found for the normalized system error when the number of units in the hidden layer have been increased to 7, 8 and 9 respectively. With two hidden layers, and with each hidden layer containing 6,7,8,9,10,11 units for the samples 50,100,150, and 200, the same values of normalized system error was found. Women having weight between 40kgs and 85kgs had higher levels of depression than men who had weight between 39kgs and 102kgs.

Conclusion: We have developed a prototype neural network model to predict the psychosocial well-being in diabetes, when biological or biographical variables are given as inputs. When greater data was fed to the system, the normalized system error can be reduced.

INTRODUCTION

Type 2 diabetes mellitus is a life style metabolic disorder that is becoming more common all over the world, particularly in resource poor developing countries. Being a chronic non-communicable disease it requires an interaction among the individual, the health-care team and family to participate in the multiple tasks in management. The aims of treatment are care rather than cure, and include various facets including symptomatic relief, metabolic control and psychological well being.

While the first two have been well known in the biophysical model of the disease, the importance of subjective well being is gaining importance more recently to expand the paradigm to a bio psychosocial model of managing diabetes.
Psychometrically validated disease-specific instrument for assessing well being is available. We have recently published psychosocial outcomes including well-being in persons with diabetes from South India. The terms are related to the field of psychology of diabetes and have been adequately defined in previous publications.

Neural network models were used to predict the diagnosis of diabetes. Here we developed a neural network model to predict four scales of diabetes well-being using biological or demographic variables.

**Material and Methods**

The input variables were either measured or were obtained from a psychometrically validated questionnaire on well being specifically used in diabetes, where the specific attributed of terms positive energy, stress and depression have been delineated. Method of Raghu was used to arrive at the four variables.

We used the multi layer perceptron (MLP) network models with back propagation in which weighted sum of inputs and bias term are passed to the activation level through the transfer function to produce the output. The learning algorithm we have used is a delta learning rule. The units are arranged in layered feed forward topology (feed forward neural networks (FFNN)). The schematic representation of feed forward, back propagated neural network with four inputs, 1 or more number of hidden layers with 6 neurons each and four output units in the output layer is given in Fig. 1. The sigmoid transfer function is chosen such that the algorithm requires a response function with a continuous, single valued with first derivative existence. These networks were trained in an iterative process. In this project one or more hidden layers are considered for the purpose. The data was taken from earlier published work on 241 subjects with diabetes mellitus, who were assessed for a variety of psychological and social parameters, including well being. The schematic representation of the neural network with an input layer, one or more number of hidden layers and an output layer is shown in Fig. 1.

The operation of the typical MLP with back propagation algorithm is as follows.

1. After presenting input data to the input layer, information propagates through the network to the output layer (forward propagation). During this time input and output states for each neuron will be set.

\[ x_j^{[s]} = f(I_j^{[s]}) = f(\sum (w_{ij}^{[s]} * x_{i}^{[s-1]})) \]

Where

- \( x_j^{[s]} \) - Denotes the current input state of the jth neuron in the current layer \([s]\) layer.
- \( I_j^{[s]} \) - Denotes the weighted sum of inputs to the jth neuron in the current layer \([s]\).
- \( f \) is conventionally the sigmoid function.

2. Global error is generated based on the summed difference of required and calculated output values of each neuron in the output layer.

\[ E(\text{glob}) = 0.5 * (r_k - o_k)^2 \]

Where \( r_k \) and \( o_k \) denote the difference of required and calculated output values.

3. Global error is back propagated through the network to calculate local error values and delta weights for each neuron. Delta weights are modified according to the delta rule that strictly controls the continuous decrease of synaptic strength of those neurons that are mainly responsible for the global error. In this manner the regular decrease of global error can be assured.

\[ E_j^{[s]} = x_j^{[s]} * (1.0 - x_j^{[s]}) * \sum (e_k^{[s+1]} * w_{kj}^{[s+1]}) \]

Where

- \( E_j^{[s]} \) is the scaled local error of the jth neuron in the current layer \([s]\) layer.
- \( \Delta w_{ji}^{[s]} = l_{coef} * e_j^{[s]} * x_{i}^{[s-1]} \)

Where

- \( \Delta w_{ji}^{[s]} \) - Denotes the delta weight of the connection between the current neuron and the joining neuron.

4. Synaptic weights are updated by adding delta weights to the current weights.

Neural network simulate neurotransmission by changing the strength of interneural connections. Positive synaptic weights provide amplified neural signal and stronger effect to the joining neuron. No modification in the information flow is modeled by zero weight. Negative weights mean negative effect to the joining neuron.
inhibition.11

The learning process of a neural network is similar to the learning function of the human brain. The learning takes place by providing data for both inputs and outputs. The calculated output value is compared to the required value that is also given in the training set. Depending on the difference between the required and the calculated output values, the network adjust the synaptic weights whose distribution constitutes the basis of the problem solving algorithm.11 The network processes the elements of the training set in cyclical order until the difference becomes lower than a given value.11

In the second part of the training process, the system is tested. The test set is fundamentally similar to the training set, but it contains different data. If testing fails network structure or the learning parameters are then modified.11

Numerical representation of the dataset

The four input units in constructing the MLP were age, gender, body weight and fasting plasma glucose levels. The four output units were depression, anxiety, energy and positive well being. These inputs and outputs were considered based on our earlier publications.4,12,6 There will be an interactive session between the network (MLP) and the user. During the interactive session, the user need to enter values for different parameters/variables like

1) selecting learning and output generation (L or O)
   • Press L or O and then press ‘ENTER’
2) Enter the name of the data file from where the network gets input and output data for training.
   • If the input file is ‘well being.dat’, just give the name as ‘well being’.
3) Number of inputs
   • Enter the number and press ‘ENTER’. Here, each input is a vector.
4) Number of outputs
   • Enter the number and press ‘ENTER’. Here, each output is a vector
5) Number of input samples
   • Give the number of input samples like 10,20,30,…..
6) Looking at data read by the network
   • Enter Y or N and press ‘ENTER’
7) Momentum rate of the network
   • Enter momentum rate like 0.07 etc… and press ‘ENTER’
8) Learning rate of the network
   • Enter rate 0.45 etc… and then press ‘ENTER’
9) Maximum total error of the network
   • Enter 0.01 etc… and then press ‘ENTER’
10) Maximum individual error of the network
    • Enter 0.01 etc… and then press ‘ENTER’
11) Maximum number of iterations (Default 1000)
    • Enter a number between 1 to 1000 and then press ‘ENTER’
12) Number of hidden layers (it can be set up to 1 to 5 layers dynamically)
    • Enter the number of layers and then press ‘ENTER’
13) Number of neurons in each hidden layer
    • Enter 4 or above for better performance
14) Create Error file (Enter 1 for yes and 0 for no)
    • Press ‘ENTER’
15) By pressing 1, the user will see the system output and the desired output for all the input samples as well as the Normalized System Error.
16) Lastly, if the user wants to continue again for learning and output generation, L/O letters need to be pressed. If you press L, the process continues right from the beginning ie from the step 1. If you press O, The system asks for the number of input vectors, and we have to enter the number of input vectors. After entering the values for the input vector, press ‘ENTER’. We get the corresponding output for the given input.

The Network will take input and output data from a notepad file which is saved as “.dat” file. Also, the bias is included in the input layer which is always set to +1. By seeing the error file, Along with the normalized system error the user comes to know the weights between neurons of individual layers. Also, all the weights corresponding to the entire network will be stored in suffix_w.dat file which is created by the system itself. The user can see these weights that are stored in suffix_w.dat in a note pad file.

The training of the network is continued till the normalized system error is reduced to a minimal value which is set during the interactive session. It is better to run the program using Microsoft visual studio, using VC++ under windows XP environment.

Implementing the MLP

Initially, The main function calls various methods and implements MLP model. It allocates sufficient space in memory to hold the activation values for each layer, the weights of connections between layers and the error of each unit in all layers. This component also handles both forward and backward passes in a single epoch. It initializes the network with initial random weights and uses sigmoid function in training the network. The sigmoid function is given by \( \frac{1}{1+e^{-x}} \), where \( x \) is the net value of each neuron.

Training of MLP network model
A training set of inputs and outputs were given to train the network. Initially, the weights were initialized with a set of random numbers generated through random function. The weights were calculated from input layer to hidden layer and from hidden layer to output layer.
These weights were adjusted (back propagation) from the required output values. In this way, the network was trained by providing both inputs and outputs. The training was performed repeatedly by changing the number of hidden units in each of the hidden layers which are set dynamically during the interactive session. Similarly the training has been performed repeatedly by changing learning rate and maximum error allowed and in each case a distinct outputs have been generated with this network. The transfer function implemented was a sigmoid transfer function. Once the training was performed with different samples, the network was tested by providing the input samples.

Formulation of network models for diabetes data

Data collected from 241 individuals with diabetes were used in whom well being was assessed. The well-being instrument gives information on four aspects are: energy, positive well-being, depression, anxiety. These four outputs indicate the extent to which a person experiences depression, Anxiety, Energy, Positive well-being.

- Some of the example items for Depression are:
  - I feel that I am useful and needed.
  - I feel downhearted and blue.

- Some of the example items for Anxiety are:
  - I feel nervous and anxious.
  - I get upset easily and feel panicky.

- Some of the example items for Energy are:
  - I feel Energetic, active or vigorous.
  - I have been waking up feeling fresh and rested.

- Some of the example items for Positive Well Being are:
  - I have been happy, satisfied or pleased with my personal life.
  - I have lived the kind of life I have wanted to.

A person who is in the state of well being can be considered as follows.

- Blood sugar levels need to be controlled and also be happy
- Physiologically and psychologically need to be balanced

For example, a person who maintains a Good FBS but still be depressed and he is not in well being state.

**RESULTS**

The following table indicates that, gender differences are significant with regard to depression, anxiety, energy and positive well-being. More specifically, female patients report significantly higher levels of depression than their male counterparts statistically and which is also evident from the NSE values of the neural networks.

Some slight high or no significant differences are observed between males and female patients with regard to the number of persons with whom they share their anxieties and fears regarding diabetes and this is evident from the given NSE values of the neural network. There is not much difference has been observed in energy levels of both males and females and which is very much clear from neural network as well as statistical point of view. Also, Males have higher positive well being value when compared with the female counterparts. Also, This is due to women tend to react more emotionally to disease and hence experience more difficulty in coping with it. The present sample of women being predominantly house wives may be worrying more about their health and its problems. It is observed that females who have weight between 40kgs and 85kgs have higher levels of depression than males who have weight between 39kgs and 102kgs. Also, it is observed that, gender differences are significant with regard to total general well-being. The total general well being includes depression, anxiety, energy and positive well-being (Table 1).

Table 2 provides descriptive statistics of the psychosocial correlates, compared to the absolute mean values.

Table 3 shows the difference of males and females with regard to weight versus depression. Here, number of hidden layers considered are three, number of units in hidden layer are seven, number of iterations are 5000.

Figure 2 shows the variation of depression levels, anxieties, energy and positive well being with regard to males and females. These variations have been found basing on the NSE values of the neural network. Here. Number of hidden layers considered are three, number of units in each hidden layer are 5 and number of iterations considered are 5000.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males (143)</th>
<th>Females (101)</th>
<th>NSE value for NN (For Males 143)</th>
<th>NSE value for NN (For females 101)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>Mean 7.88</td>
<td>8.71</td>
<td>17.02</td>
<td>26.12</td>
<td>2.93</td>
</tr>
<tr>
<td>SD 2.39</td>
<td>1.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>Mean 9.25</td>
<td>9.42</td>
<td>34.80</td>
<td>38.91</td>
<td>0.48</td>
</tr>
<tr>
<td>SD 2.76</td>
<td>2.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>Mean 6.20</td>
<td>6.00</td>
<td>15.93</td>
<td>13.90</td>
<td>0.96</td>
</tr>
<tr>
<td>SD 1.64</td>
<td>1.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWB</td>
<td>Mean 11.70</td>
<td>11.37</td>
<td>61.37</td>
<td>55.16</td>
<td>1.21</td>
</tr>
<tr>
<td>SD 2.13</td>
<td>2.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Here NI : Number of inputs, NOUT: Number of outputs, NIS: Number of input samples, MR: Momentum rate, LR: learning rate, MTE: Maximum Total Error, MIE: Maximum Individual Error, NIT: number of iterations, NHL: number of hidden layers, NUHL: number of units in the hidden layer, NSE : Normalized System Error.

Table 4 represents the output of neural network with one hidden layer, and the hidden layer contains 6,7,8,9 units each time and found the normalized system error gets decreased.

Table 5 represents the output of neural network with two hidden layers, and the first hidden layer contains 6,7,8,9 units, and the second hidden layer contains 6,7,8,9 units each time in the combination of (6,6), (7,7), (8,8) and (9,9) etc... found the normalized system error gets decreased in every time.

Similarly, it was observed that with the same values of number of inputs, number of outputs, number of input samples momentum rate, learning rate, maximum total error, maximum individual error, number of iterations, number of hidden layers, number of neurons in each hidden layer, normalized system error was calculated. It was found that, Similar NSE values was observed with the same input samples. Also, for your perusal, A table has been drawn with three hidden layers and each hidden layer contains 11 units respectively (Table 6).

From the above tables, it is observed that, the values of the NSE can be decreased with increasing number of input samples. Actually, the system was tested with only 241 patients data and the above NSE values were observed. The Normalized System Error (NSE) can be decreased by feeding more number of input samples.

Also, A graph has been drawn, showing that, with the increased number of input samples, The Normalized System Error can be reduced (Fig. 3).

Here, NI stands for number of input samples and NSE stands for normalized system error respectively. It is observed that, Males have better well being and quality of life and younger people report more enhanced quality of life and well being. Those, who experienced stress have more depression and better positive well being.

**DISCUSSION**

We describe the development of a prototype Multi Layer Perceptron Neural Network model, which had been trained by back propagation algorithm to predict the psychological well-being using biographical and biological variables. There has been little published literature on the psychosocial aspects of diabetes in India, which is the epicentre of the approaching diabetes epidemic.

Although in principle, similar results may be obtained using a variety of statistical methods such as logistic regression and are under the receiver operating characteristic

---

**Table 2 : Descriptive statistics of the psychosocial correlates**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well-being</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>0.00</td>
<td>12.00</td>
<td>8.22</td>
<td>2.22</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.00</td>
<td>16.00</td>
<td>9.32</td>
<td>2.75</td>
</tr>
<tr>
<td>Energy</td>
<td>0.00</td>
<td>12.00</td>
<td>6.12</td>
<td>1.67</td>
</tr>
<tr>
<td>Positive well being</td>
<td>5.00</td>
<td>18.00</td>
<td>11.58</td>
<td>2.10</td>
</tr>
</tbody>
</table>

**Table 3 : Gender difference (weight vs depression)**

<table>
<thead>
<tr>
<th></th>
<th>Least weight</th>
<th>Highest weight</th>
<th>NSE values of NN (Weight Vs Depression)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>39</td>
<td>102</td>
<td>24.33</td>
</tr>
<tr>
<td>Females</td>
<td>40</td>
<td>85</td>
<td>31.62</td>
</tr>
</tbody>
</table>

---

**Fig. 2 : Gender differences, depression levels, anxieties, energy and positive well being [4 panels]**

A. male depression vs female depression
B. male anxiety Vs Female anxiety
C. male energy vs female energy
D. male pwb vs female pwb
Table 4: Neural network output with one hidden layer, and variable units

<table>
<thead>
<tr>
<th>NI</th>
<th>NOUT</th>
<th>NIS</th>
<th>MR</th>
<th>LR</th>
<th>MTE</th>
<th>MIE</th>
<th>NIT</th>
<th>NHL</th>
<th>NUHL</th>
<th>NSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>6</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>6</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>150</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>6</td>
<td>359.67</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>200</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>7</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>7</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>7</td>
<td>359.67</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>120</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>7</td>
<td>332.32</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>8</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>8</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>150</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>8</td>
<td>359.67</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>200</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>1</td>
<td>8</td>
<td>332.32</td>
</tr>
</tbody>
</table>

Table 5: Neural network output with two hidden layers, and variable units

<table>
<thead>
<tr>
<th>NI</th>
<th>NOUT</th>
<th>NIS</th>
<th>MR</th>
<th>LR</th>
<th>MTE</th>
<th>MIE</th>
<th>NIT</th>
<th>NHL</th>
<th>NUHL</th>
<th>NSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>6,6</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>6,6</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>150</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>7,7</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>200</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>7,7</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>8,8</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>8,8</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>150</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>8,8</td>
<td>359.67</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>200</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>8,8</td>
<td>332.32</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>9,9</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>9,9</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>150</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>9,9</td>
<td>359.67</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>200</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>2</td>
<td>9,9</td>
<td>332.32</td>
</tr>
</tbody>
</table>

Table 6: Neural network output with three hidden layers, and variable units

<table>
<thead>
<tr>
<th>NI</th>
<th>NOUT</th>
<th>NIS</th>
<th>MR</th>
<th>LR</th>
<th>MTE</th>
<th>MIE</th>
<th>NIT</th>
<th>NHL</th>
<th>NUHL</th>
<th>NSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>50</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>3</td>
<td>11,11</td>
<td>470.57</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>100</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>3</td>
<td>11,11</td>
<td>419.61</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>150</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>3</td>
<td>11,11</td>
<td>359.67</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>200</td>
<td>0.9</td>
<td>0.7</td>
<td>0.01</td>
<td>0.001</td>
<td>500</td>
<td>3</td>
<td>11,11</td>
<td>332.32</td>
</tr>
</tbody>
</table>

curve, the current method has the advantage of giving dynamic output as more data is generated and fed to it. It also has the advantage of not requiring skills and insight needed to perform and analyze results from sophisticated statistical techniques.

This is the first step in developing such a neural network system which can be trained as more data is available.

Advantages of such a system include not requiring for the individual to visit a clinician often, being devoid any emotion or biases or prejudices, acting as a surrogate psychologist or endocrinologist for a patient, and ultimately assisting the patient and doctor in managing the diabetes with care. It can be extrapolated to large database and generalize the data to analyze the result. ie, it is more
dynamic in nature. But, this is not otherwise possible with the static statistical techniques.

**CONCLUSION**

In this work, we implemented a back propagating multi layer perceptron with multiple hidden layers to build a neural system. This system is able to measure the well being of a diabetic patient given the set of predefined values as input to the system. The idea as a whole is a decision making problem in which a group of previous observations for the patient state variable are used to approximate a decision value. This system has the potential to aid clinicians to tailor management based on the predicted outcome in terms of well-being. It has the potential to be developed further, incorporation more input variables and outcome measures. Thus this software tool can be ported into a wintel machine so that the patient or the doctor can use this tool to assess the well being in diabetes.

**REFERENCES**