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Adaptive Neuro-Fuzzy System to Determine the Blood Glucose Level of Diabetic

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Abstract: Diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin. The main aim of this research work was to determine the blood glucose level of diabetic patient using adaptive Neuro-fuzzy. Data of 80 diabetic patients were collected from Federal Medical Centre Jalingo. It was used for training and testing the system, Gaussian Membership function was used, hybrid training algorithm was used for training and testing, the error obtain is 0.0008333 at epoch 4 which shows that the training performance is exactly 99.99% and testing performance of the system are 99.99% at epoch 4. This shows that adaptive Neuro-fuzzy system can be applied to medical diagnosis because of the error obtained.

Keywords: Diabetes, Neuro-Fuzzy, Gaussian, Hybrid

1. Introduction

Diabetes mellitus is a metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of some different organs in human, such as the eyes, kidneys, nerves, heart, and blood vessels. The major symptoms of diabetes are Polyphagia, Blurred vision, Polyuria, Polydipsia, Weight loss, Tiredness, High Blood Glucose, Very High Blood Glucose [1]. Basically there are two types of diabetes type I and type II. Type I is medically characterized by lack of insulin while type II is medically characterized by ineffective to utilize the insulin produce by the body [2].

Computational intelligence, Artificial intelligence and soft computing techniques which includes; Artificial Neural network, fuzzy logic, evolutionary algorithms and swarm intelligence, or any combination of these that is Neuro-fuzzy, Neuro-genetics among others are widely applied to medical diagnosis, prognosis, determining severity level, controlling and predicting of any disease in recent time. Medical diagnosis largely depends on experience of the medical expert together with the results from medical laboratory scientist and the symptoms exhibit by the patient before concluding or confirming the presence of the disease. However computational intelligence/soft computing techniques follow similar procedure as medical expertise thus; the symptoms exhibit by the patient, the results collected from lab and the experience of the medical expert are assign with weights or translate into a numeric values and formulate a matrix which would be used as an inputs parameters to confirm whether or not the presence of the disease.

Soft computing techniques was used to detect diabetes in it early stage [3], Artificial Neural network applied to diabetes control was implemented in [4], Fuzzy logic was used to diagnose diabetes in [5], Neural Network and fuzzy logic and Gaussian Kernel Methodologies was used in prognosis of diabetes in [6], Adaptive Neuro-fuzzy technique was used to predict type II diabetes in [7].

In recent years many disease are diagnosis using computational intelligence, Artificial intelligence and soft computing techniques, As in the research of [8] TB was detect using Artificial Immune recognition system, [9] TB detection using fuzzy based decision support system, [10] risk assessment of cardiovascular diseases using web based

fuzzy system, [11] combine Neural and Fuzzy logic to diagnoses hypertension, [12] diagnose malaria using ANFIS, [13] proposed neuro-fuzzy technique with online mode to medical diagnosis, [14] applied soft computing in predicting TB, [15] combine clustering and fuzzy ruled based to medical diagnosis from dental x-ray, [16] Presented Neuro-fuzzy model to predict the presence of mycobacterium TB, [17] applied ANFIS to determine the severity level of osteomyelitis [18] used Neuro-fuzzy technique in TB diagnosis.

2. Method of Data Collection

The primary data will be collected using interview to get in-depth knowledge about diabetes Mellitus from two Medical personnel while secondary data are collected from the laboratory technician's records about patients with Diabetes at Federal Medical Centre Jalingo.

2.1. Architecture of the Proposed Model

The proposed model will implement on a Takagi-Sugeno architecture which is a five layer architecture proposed by [19]. This architecture uses a rule structure with fuzzy antecedent and functional consequent part. The model will adopt the Gaussian membership function and the symptoms of diabetes will be analyzed and used as inputs parameters to the system. Figure 1 had shown architecture with it five layers

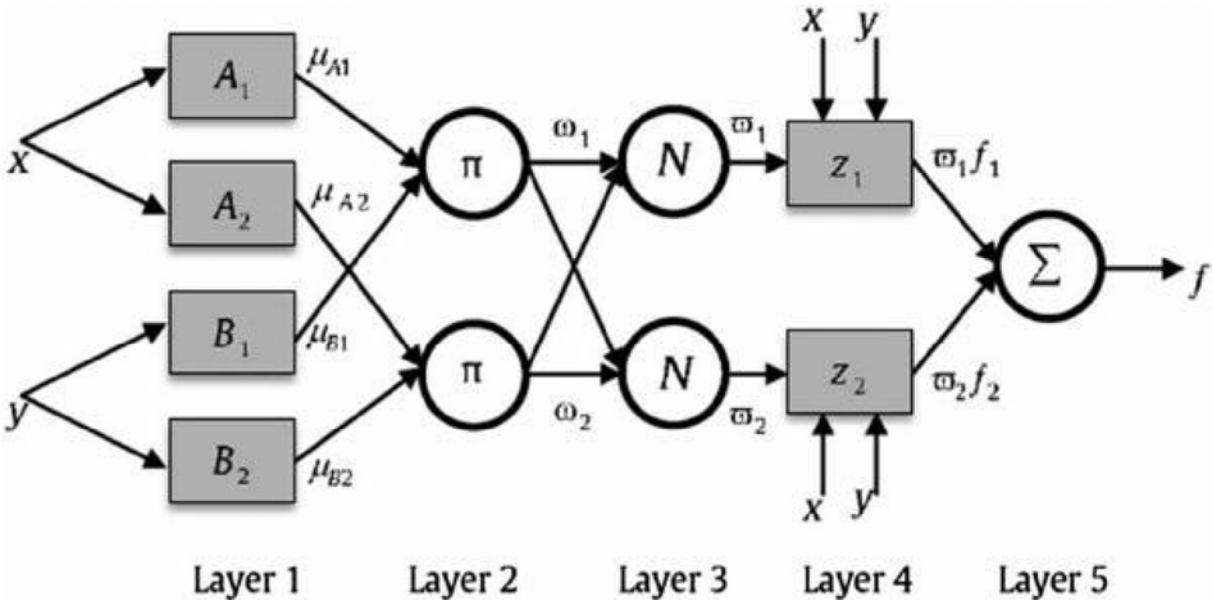

Figure 1. *Adaptive Neuro-fuzzy system [20].*

At the first layer is the fuzzification every node has membership function Ai and Bi and the output of the layer is given as;

$$O1i = \mu Ai(x) for\ i = 1, 2 \tag{1}$$

The second layer is called the product layer. Each neuron in this layer is non-adaptive and computes the product of incoming signals. Each node generates the firing strength of a rule.

$$wi = \mu(x)i \times \mu(x)i \tag{2}$$

The third layer is called the normalization layer. The nodes in this layer are non-adaptive and compute the normalized firing strength which is ratio of firing strength of a rule to the sum of the firing strength of all rules.

$$W_i = \frac{wi}{\sum wi} \tag{3}$$

After receiving the normalized power from layer three the next step is for every $i - th$ node to produce a function;

$$O^4_i = \overline{w}\,(p_i x + q_i y + r_i) \tag{4}$$

From the ANFIS architecture in figure 1 above the symbol (f), the single node in this layer is fixed labeled $\sum$ which calculate the overall output of the signals firing from layer one to four and can be express mathematically as;

$$f = \frac{w1}{w1+w2} f1 + \frac{w2}{w1+w2} f2 \tag{5}$$

3. Results

Adaptive Neuro-fuzzy system were applied to determine the blood glucose level of diabetic patient data were used to train and test the performance of the system, hybrid learning algorithm were used in this work. ANFIS depends on the sizes of the training and testing data. Training and testing data were formed by 80 data of diabetic patients which was used for training and testing. Based on this ANFIS structure was generated as shown in Figure 2.

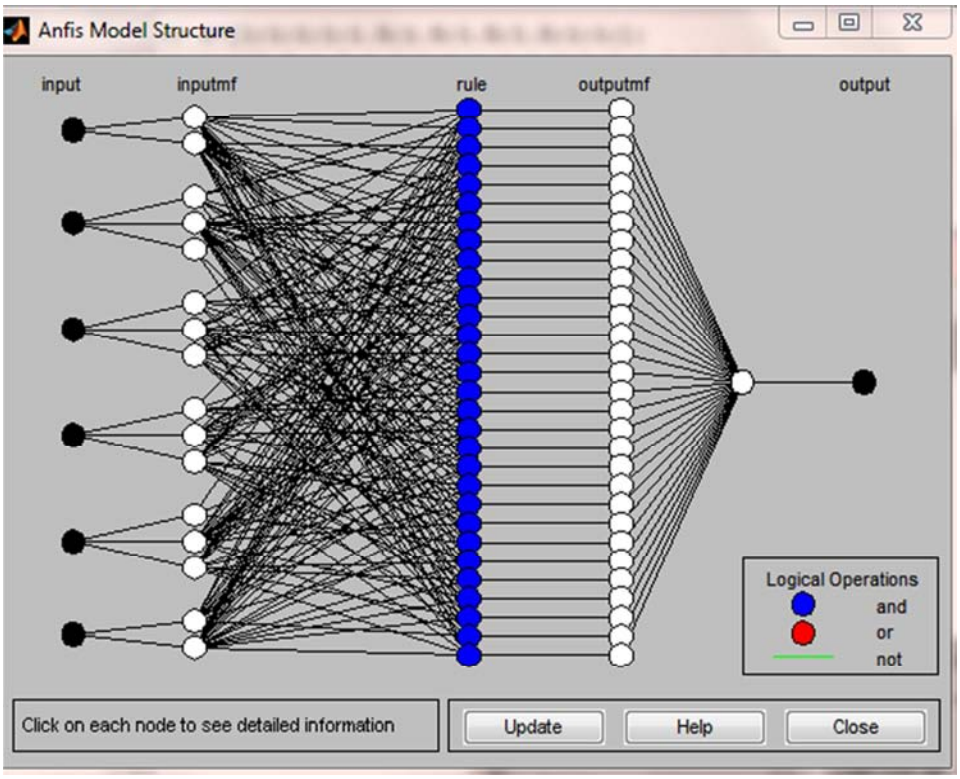

Figure 2. *ANFIS for diagnosing diabetes.*

The structure are obtained based on the six inputs with two linguistic terms in some inputs and three linguistic term in some were used and the rules are generated by the ANFIS and the target output is one. Figre 3 represent fuzzy logic control which is called rule viewer, the yellow color in the figure present the symptoms of the patient while the blue color indicate the diagnosis. The diagnostic output.

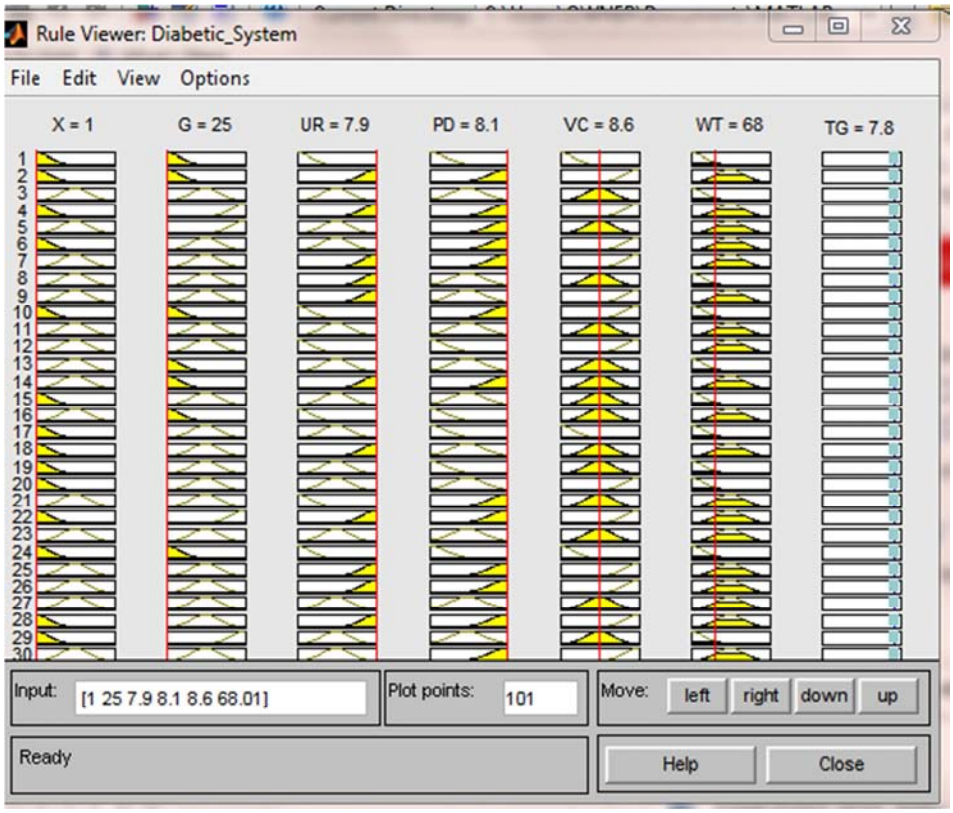

Figure 3. *Rule viewer.*

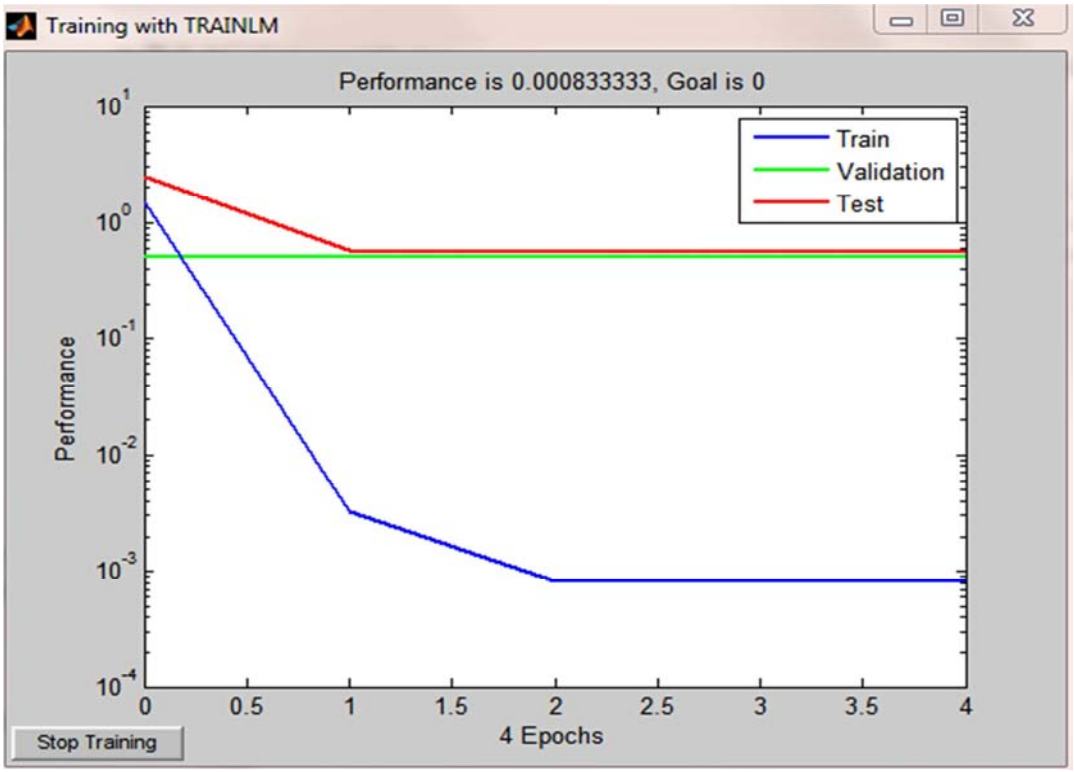

Figure 4. *Validation performance.*

4. Conclusion

In this research work ANFIS was used to implement diagnostic system for diabetic in which the 70 data was used for both the training and testing, hybrid training algorithm was used for both the training and testing of the system, ANFIS model are obtained based on these inputs, the error obtain are 0.0008333 during the training, testing and validation which shows that the training and testing performance is exactly 99.99% at epoch 4 and testing performance of the system is 99.99% at epoch 4. The performance of this system as well as the error obtain is acceptable in medical diagnosis.

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