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Diagnosis of Anemia in Children via Artificial Neural Network

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Abstract: In this paper, a neural network algorithm, which diagnosis of anemia for children under 18 years of age, is presented. The network is trained by using data from hemogram test results from 30 patients and an expert doctor. The network has 5 inputs (HGB, HCT, MCV, MCH, MCHC) and an output. Simulations on 20 different patients show that the artificial neural network detects disease with high accuracy. In this paper, it is shown that anemia diagnosis can be made via neural network methods.

Keywords: *Anemia, Diagnose, Artificial neural network.*

1. Introduction

Anemia is a decrease in number of red blood cells (RBCs) or less than the normal quantity of hemoglobin in the blood. The most common anemia type is iron deficiency anemia among various types [1], [2]. Iron-deficiency affects people at all age but mostly women and children. Iron-deficiency caused by insufficient dietary intake and absorption of iron [1]. Fast growing of children, high iron demand during pregnancy, and menstruation are some physiological reasons that lead to iron-deficiency. Iron-deficiency is a widespread diet problem all over the world. Prevalence of iron-deficiency anemia is higher in low developed and developing countries [2, 3, 4]. Prevalence of anemia is also high in Turkey [2, 4, 5]. As premature and preterm birth increases in recent years, iron-deficiency age decreases [6]. In that manner, hematology includes the study of etiology, diagnosis, treatment, prognosis, and prevention of blood diseases [7].

Anemia diagnosis is being made by a doctor using the data obtained from hemogram blood test results in today's applications. The parameters considered for the detection of disease is listed below.

Table 1. Parameters

HGB: Hemoglobin
HCT: Hematogrit
MCV: Mean Corpuscular Volume
MCH: Mean Corpuscular Hemoglobin
MCHC: Mean Corpuscular Hemoglobin Concentration [8]

There is vast literature about the diagnosis of iron-deficiency anemia. In [9], diagnosis of women's iron- deficiency anemia is investigated by several neural network techniques using Red Blood Cells (RBC), HGB, HCT, MCV, MCH, MCHC datum. These techniques are Feedforward Networks (FFN), Cascade Forward Networks (CFN), Distributed Delay Networks (DDN), Time Delay Networks (TDN), Probabilistic Neural Network (PNN), and Learning Vector Quantization (LVQ). Furthermore, comparative results are presented. In [10], two different neural network model, whose inputs are zinc protoporphyrin (ZPP), Hb, RBC, and MCV, is used to diagnose anemia and the performances of these neural networks are compared.

In this paper, a neural network model, which diagnose anemia for children under 18, is developed. The network architecture is designed to have 3 layers which are input, hidden, and output layers. In this network there 5 inputs and 1 output. Inputs are HGB, HCT, MCV, MCH, MCHC values. In order to train the network real data from 30 different patients are used. Data obtained from another 20 patients are used to verify the trained network. Among total 50 patients, there are 18 female and 32 male. These data is taken from a private hospital. Results are discussed in conclusions section.

2. Materials and Method

2.1. Network Architecture

The network is developed in feedforward multilayer perceptron with 3 layers architecture. Number of neurons in the hidden layer is 100. Tangent sigmoid (TANSIG) is used as activation functions. The results showed that the network is able to diagnose the disease with high accuracy. Network architecture is illustrated in Figure 1.

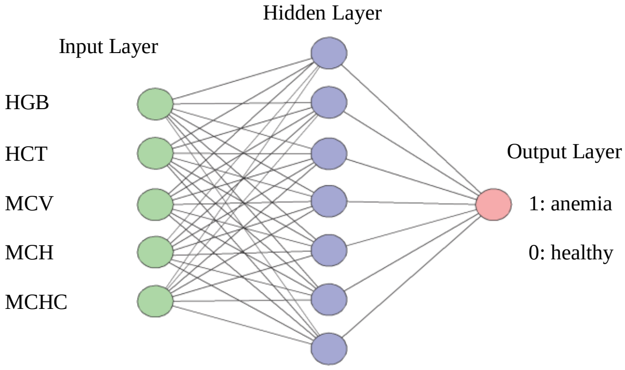

Figure 1. Architecture of the developed artificial neural network

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The values to be used as inputs are determined after discussing with experts. According to these discussions 5 inputs are HGB, HCT, MCV, MCH, MCHC. The output is a logical value which is either 0 (healthy) or 1 (anemia). Inputs and outputs of 50 different patients are saved to a computer database. 30 of these 50 data are used to train the artificial neural network. Whereas, the remaining 20 is used to test the network. It is tried to distribute the data such that equal number of healthy and diseased patients are available in each groups. Examples of the training data and test data can be seen in Table 2 and Table 3, respectively.

2.2. Training ANN

The neural network toolbox of Matlab© R2010a environment is used to create, train and test the network. At first, train and test data is normalized between -1 and 1. Corresponding code is,

[norm_train, ps1] = mapminmax(train) (1)

[norm_test, ps2] = mapminmax(test) (2)

Table 2. Sample train data

HGB g/dl	*HCT %*	*MCV fL*	*MCH pg*	*MCHC %*	*0: healthy 1: anemia*
7.27	22.50	84.10	27.10	32.30	1
11.70	35.30	73.10	24.30	33.30	0
7.71	23.40	85.00	28.10	33.00	1
10.90	33.90	76.90	24.80	32.30	0

Table 3. Sample test data

HGB g/dl	*HCT %*	*MCV fL*	*MCH pg*	*MCHC %*	*0: healthy 1: anemia*
9.79	31.30	56.70	17.80	31.30	0
12.70	40.30	91.20	28.80	31.50	1
6.47	20.20	68.10	21.80	32.00	1
11.20	33.00	80.00	27.10	33.80	0

Then, training, test, and output data is assigned to variables, so they are ready to be used. Neural Network Toolbox interface can be seen in Figure 2.

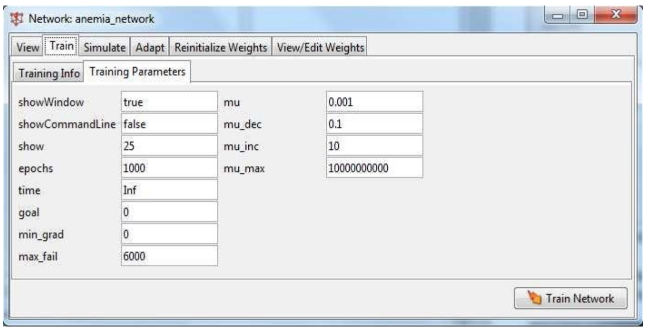

Figure 2. Neural Network Toolbox interface

Training and test data is transferred as input data, and the output of training data is transferred as target data, and the network is created. By using ”Create Network or Data” interface, network type, training function, number of layers, number of neurons, and transfer functions values are determined. ”Create Network or Data” interface is shown in Figure 3.

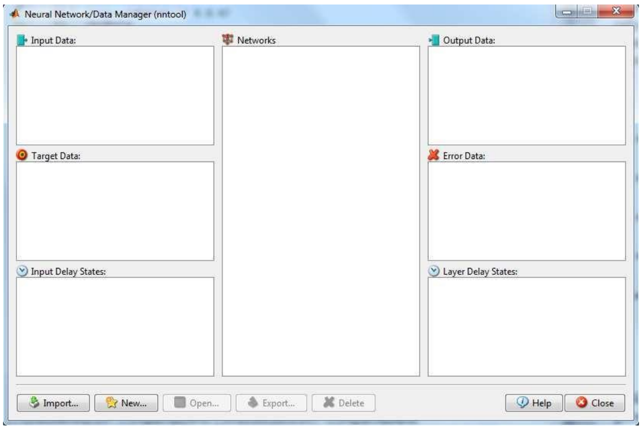

Figure 3. Create Network or Data interface

Once the network is created, the next step is the training. Training parameters are shown in Figure 4.

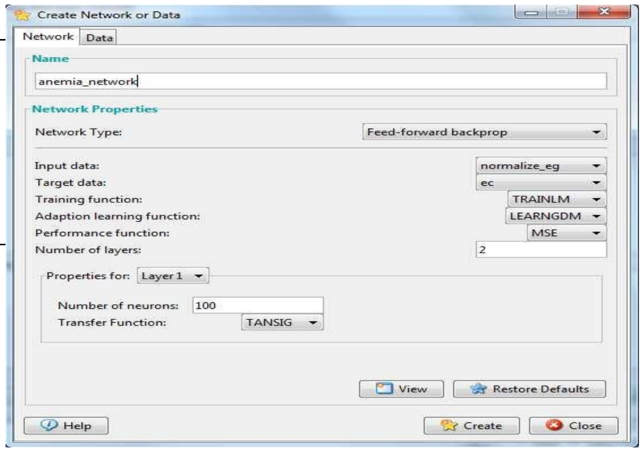

Figure 4. Training parameters

The training of the network is made by backpropagation method after setting the network properties and the training parameters. Performance of the network, regression, and training state plots are shown in Figure 5, Figure 6, and Figure 7, respectively.

Mean square error is between 10^{-23} and 10^{-26} according to network learning performance plot in Figure 5. We can say that it is a successful training.

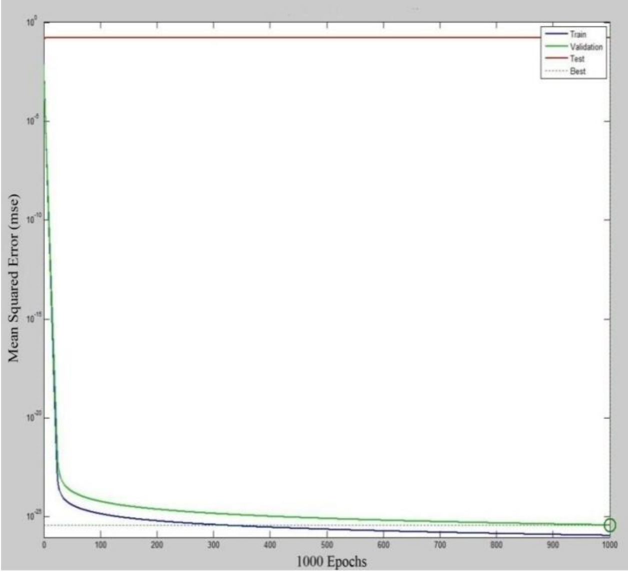

Figure 5. Learning performance of the network

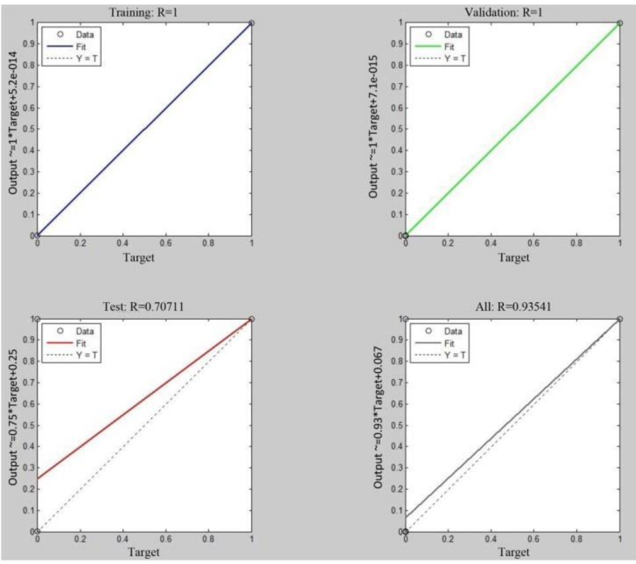

Figure 6. Regressions result

2.3. Testing ANN

The network is tested with 20 data from patients. Once the outputs of the network is compared with hemogram test results, there is only 1 fault detection. Comparison of the network's output with the real diagnosis of patients can be seen in Table 4. The logic 1 means the patient is diseased by anemia and 0 denotes corresponding person is healthy.

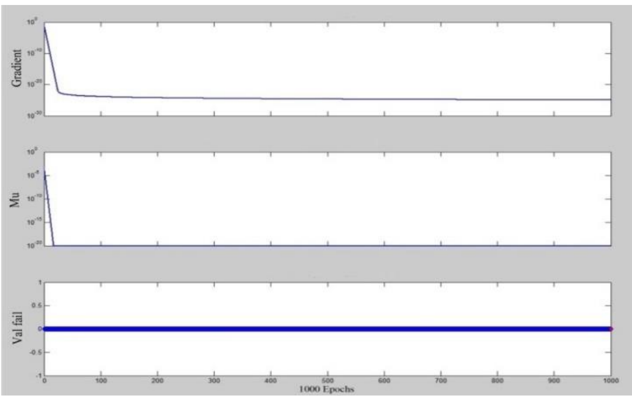

Figure 7. Training state results

Table 4. Test results

Patient	Output	Network Output	Accuracy (%)
P01	1	1	100
P02	0	0	100
P03	0	0	100
P04	0	0	100
P05	1	0	0
P06	0	0	100
P07	1	1	100
P08	1	1	100
P09	1	1	100
P10	0	0	100
P11	1	1	100
P12	1	1	100
P13	1	1	100
P14	1	1	100
P15	0	0	100
P16	0	0	100
P17	0	0	100
P18	1	1	100
P19	0	0	100
P20	0	0	100

3. Conclusions

In present paper, an artificial neural network which diagnose anemia in children under 18 is developed. Some of the data of healthy/diseased decisions made by an expert doctor according to the blood parameters obtained from a hospital are used to train the neural network, while some of them are used to test the performance of the network. In this test process, outputs of the network and the diagnosis of the doctor are compared. For 19 of 20 cases, outputs of the network and the diagnosis of the doctor are matched. Hence, accuracy of the network is %90.909. The developed network architecture is adequate to be used to help doctors in real-life applications.

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