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Diabetic disease prediction using deep learning paradigm

Nazar Abdulameer Hussain [1,*]

[1] Al kunooze University College, Iraq

[*]nazar.abd@kunoozu.edu.iq

ABSTRACT

Diabetic patients are dominating large population of today's world. Young citizens as well as senior citizens are suffered from this chronic disease. After technology revolution and internet expansion, more flexibility is granted to fields alike medical applications in terms of disease diagnosis and treatment. Individual developers and companies are now granted accesses to data where intelligent systems can be developed. This paper is detailing the process of neural network based diabetic diseases diagnosis depending on historical diabetic data analysis. The problem of machine learning reliability in health care services was realized in this project and was addressed. Ordinary feed forward neural network is used as corner stone for classifying the diabetic data. The proposed modification using artificial bee colony (ABC) for neural network optimization has yielded best prediction result of 95.2% accuracy. Results are compared by using other algorithms such as principle component analysis (PCA), k-nearest neighbour (KNN), support vector machine (SVM) and Bagging Classification.

Keywords: FFNN, ANN, prediction, PCA, SVM, machine learning

INTRODUCTION

The last two decades witnessed too many researches works for developing of various techniques in health care enchantment. Due to the present lifestyle and pollution, humans have faced a new era of challenging illness such as liver fails, brain strokes, cardiac arrests, etc. Amongst all, heart diseases are more popular [1]. It was reported by the million human per year. The major percentage of death due to diseases are strokes and cardiac arrest. The cost of treatment of those cases is majorly large approaching 316 billion dollar every year [2]. Intelligent systems were developed for diabetic diseases diagnosis such that using advanced machine learning approaches for analyzing the data of blood test and other body tests. The approaches of machine learning basically depend on taking the data of diabetic diseases diagnosis to be analyzed by computer vision process in order to monitor the so-called signal disorder. The monitoring process of liver disorder is performed by matching the health liver data or data of health candidate with the test one that to be examined. Hence, computer tool may decide whether the being examined signal is normal or not. Literature of artificial inelegance technology included many other applications alike heart monitoring and brain monitoring. In [3] proposed the wavelet-based denoising technique for suppressing EMG noise and motion artifact in ECG which has advantages that this approach does not require a reference as required in adaptive filtering techniques and also it does not require multi-channel signals as required by ICA-based techniques. As well as no need identification of R-peaks as required in the cubic spline and EMD techniques. The discrete Meyer wavelet is the selected wavelet basis function. Combining the features of hard and soft thresholding EMG noise was reduced with limiting the wavelet coefficients. At [4] proposed an approach for baseline wander correction and denoising that is based on discrete wavelet transform. The wavelet shrinkage method was used to reduce the high-frequency noise by implementing Symlet wavelet with order 8 and decomposition level up to 6. At [5] stated about the importance of filters in various applications of signal processing; filters can be used for removing the noisy frequencies from the signal according to the shape of their frequency responses. This study involves comparing performances of Butterworth and Chebyshev filters and results revealed the Butterworth is outperformed. The experiment was conducted by applying signals alike EEG into the both filters. At [6] proposed an adaptive Kalman filter for the real time removal of baseline wandering. The Kalman filter has the ability to simultaneously model both the ECG signal and the baseline wandering. The comparison of the proposed approach is made with moving averaging and cubic spline baseline removal techniques which shows that distortion is minimum in case of the proposed approach. Due to adaptability and convergence factor of Kalman filter, the approach fails to remove baseline wander under high frequency changes. At [7] used wearable devices for monitoring the individual health by detecting the heart ECG signals and uploading it into prediction on cloud server. The Patient is provided with wearable ECG sensors (portable device) to be sent to remote server (wirelessly) where on- cloud system was established. Alarm is provided upon any abnormal indication of heart electrical activates. At [8] deployed artificial neural network for performing classification of heart rhythms. The Authors mentioned that data obtained from the standard diabetic data was diagnosed for missing information

***Corresponding author**
Nazar Abdulameer Hussain,
Al kunooze University College, Iraq
e-mail: nazar.abd@kunoozu.edu.iq

before the classification. Missing information is none preventable for the diabetic data. The accuracy obtained from the proposed model was close to 80 percent. At [9] mentioned that heart diseases can be clearly predicted upon accurate classification of diabetic data. This study was relied on two types of features namely: time domain features and frequency domain features. Subsequently, none linear classification algorithms were used for classifying the data obtained from both domains. The Authors mentioned that recurrent neural network and long or short term memory neural network were used for the same and the accuracy were found approaching to 80 percent.

DATA PRE-PROCESSING

Most of real-life signals are continuous which are considered as analog containing of alternating voltage. Hence, signal processing is based firstly on signal sampling which involves converting the continuous signal into a discrete signal. Mainly, sampling is performed by selecting the suitable sampling frequency. The Nyquist rate or sample frequency is representing the period on the waveform that samples are taking place. Assuming that t_m the time of the continues signal and $f_m=1/t_m$ is representing the frequency of the signal [39]. Sampling frequency can be given by the following equation (1) and Figure (1) represents the sampled signal.

$$f_s \geq 2 \times f_m \quad (1)$$

Sampling can be performed by passing the continues time signal into the sampler which can be represented in the real life as a switch that open and close within the period of sampling frequency. Figure (2) is demonstrating the sampler module used for converting the continuous signals into discreet samples. Sampling operation can be summarized as selecting points on the continuous signal envelope for using it in signal processing tasks. The sampling period should be selected properly in order to recover the signal information when it is required to convert the signal samples into the previous continue signal.

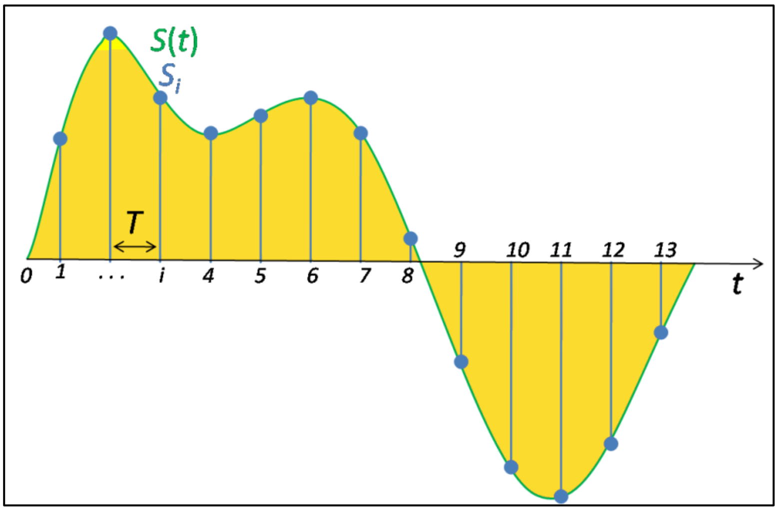

Figure 1: Waveform of the continues time signal with its samples

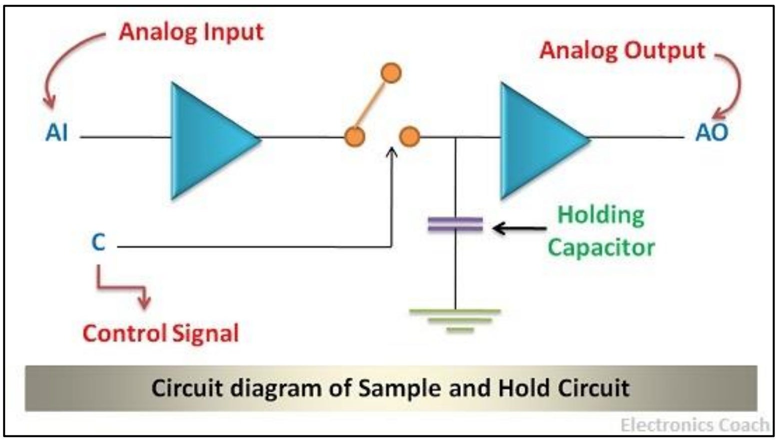

Figure 2: Sampler (switch) circuit diagram

***Corresponding author**
Nazar Abdulameer Hussain,
Al kunooze University College, Iraq
e-mail: nazar.abd@kunoozu.edu.iq

NEURAL NETWORK

The model of the artificial neural network (ANN) is one of the artificial intelligence applications that used for classification, prediction and clustering tasks in engineering and science applications. The feed forward neural network (FFNN) is one of popular types of ANN which can be used for classification of diabetic data. FFNN is consisting of a similar structure of the human neural system which consists of nerves for transmission of the signals amongst the brain cells. In ANN, the model is firstly trained for performing particular tasks and thereafter model can be used for performing the prediction task depending on the application nature [10]. Training process is performed in this project for the model of FFNN so that the model can predict whether the ECG signal is infected or not. The predictor is termed for the FFNN which consists of three essential layers namely: input layer, hidden layer and output layer. Each layer is connected to the other layer using the neurons which are called as weights in the context to the neural network [11]. Figure (3) is demonstrating the structure of the FFNN

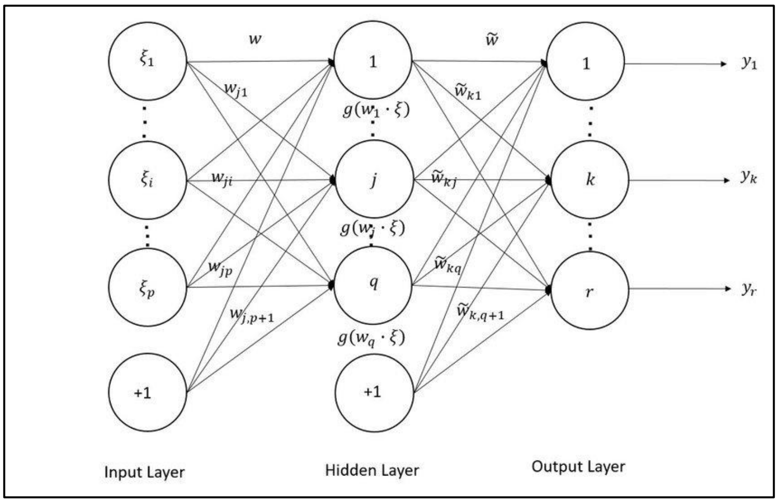

Figure 3: Feed forward neural network structure overview

Let X_n to be the input vector at the input layer of F_{net} the FFNN model; training process is termed as all the modifications i.e. scaling up/down, weighting, biasing, etc. that taking place on the input vector X_n to produce an output Y_n as showing by Equations below

$$Y_n = net(X_n) \quad (2)$$

$$Y_n = X_n \times W + B \quad (3)$$

where W is the weights coefficients and B is the bias coefficients, Eq. (4 & 5) can be deconstructed to prescribe the training operations on an input vector of this elements.

$$Y = \sum_{n=1}^{3} X_n \times W_n + B_n \quad (4)$$

$$Y = (X_1 \times W_1 + B_1) + (X_2 \times W_2 + B_2) + (X_3 \times W_3 + B_3) \quad (5)$$

where B_n is representing the training bias which is used to bias the scaling (weighting) operation at one specific node over the other nodes. Data passing at the input of the neural network may propagate through the so-called hidden layers and finally the output layer. In each layer, data is to be scaled in order to meet the required fitness according the error reduction function. The scaling factors in each layer are known as weight coefficients that are responsible to pass the data between the layers after applying the scale/bias operations. In this thesis, FFNN is being used for providing the most accurate diagnosis of diabetic Process of the neural network is beginning by training the model using the data of the diabetes data obtained from an open source dataset repertory. The neural network is being trained using the aforementioned data and mean square error a fitness function. Standard Levenberg–Marquardt (LM) hence after freezing model is used by freezing the weight values of the model into those yielding the best performance. The last stage of optimization is performed using ABC algorithm in place of LM algorithm where the best results are achieved.

PERFORMANCE METRICS

In order to examine the models during each experiment, the following performance metrics are used: (MSE): which stands for the mean of the squared error elements that obtained from of subtraction the optimum results and actual results, this can be given in the following equation

*Corresponding author
Nazar Abdulameer Hussain,
Al kunooze University College, Iraq
e-mail: nazar.abd@kunoozu.edu.iq

$$MSE = \sum_{n=1}^{N} E[n]^2/N \quad (6)$$

(MAE): which stands for the mean of the absolute error elements that obtained from subtraction the optimum results and actual results, this can be given in the following equation

$$MAE = \sum_{n=1}^{N} |E[n]|/N \quad (7)$$

Time (T): the amount of time taken by the model to finalize the results and produce the predictions vectors. It is represented by positive real number only.

(RMSE): represents the root square of the mean square error

$$RMSE = \sqrt{\sum_{n=1}^{N} |E[n]|/N} \quad (8)$$

Accuracy: represent the rate of number of correct predictions to all outputs numbers.

$$Acc. = \frac{Number\ of\ correct\ classes}{Total\ number\ of\ classes} \quad (9)$$

Data is obtained from open source platform of medical records for Pima Indians diabetic dataset. Data is contained of 768 rows and eight columns. Data labels (target) is made on the column number nine of the same data.

RESULTS AND DISCUSSIONS

Results are made after testing of seven algorithms on the same data where disease need to be discovered. The same was made according to the performance metrics as mentioned in the previous section. Results shown that best accuracy is yielded after ABC-FFNN algorithm which dominated 99.8553 percent. Data preprocessing such as missing values evaluation and data normalization is made prior to use of any of the mentioned algorithms.

Table 1: performance evaluation of the proposed algorithms

Algorithm	ACCUR	MSE	MAE	RMSE
P-FFNN	75.3247	0.2468	0.2468	0.4967
ABC-FFNN	80.5195	0.1948	0.1948	0.4414
F-FFNN	99.8553	0.0014	0.0014	0.038
PCA	77.9220779	0.22077922	0.31077922	0.46987149
KNN	75.974026	0.24025974	0.33025974	0.49016297
SVM	74.025974	0.25974026	0.34974026	0.50964719
Bagging Classification	77.2727273	0.22727273	0.31727273	0.47673129

Table 1: The performance metrics results of the model (Pixel-SNR).

CONCLUSION

In this paper, a diabetic disease smart diagnosis approach was performed for implementing a computer vision health care application. Data from 768 volunteers are used for the development of intelligent diabetic diagnosing model based on deep learning approach namely feed forward neural network. With the intension of achieving maximum possible accuracy of diabetic diagnosis, optimization approaches were performed on the ordinary neural network. However, an experimental model is performed in three stages such that Stage A: ordinary FFNN neural network, Stage B: model freeze FFNN neural network and

***Corresponding author**
Nazar Abdulameer Hussain,
Al kunooze University College, Iraq
e-mail: nazar.abd@kunoozu.edu.iq

eventually model C: artificial bee colony (ABC) based FFNN neural network. All mentioned models are used for learning the data of diabetic and then for diagnosing the diabetic cases during the test phase. Performance of each model is evaluated using results statistical analysis as performance metrics; from those metrics, accuracy, MSE, MAE, time and RMSE are determined. The results found that optimum accuracy of diagnosis was achieved after using the ABC based approach with the neural network. Accuracy of our stat of the art was found 99.855.

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***Corresponding author**
Nazar Abdulameer Hussain,
Al kunooze University College, Iraq
e-mail: nazar.abd@kunoozu.edu.iq