South Asian Journal of Engineering and Technology Research Article

Open Access Full Text Article 123(2022) 109-115 DOI: 10.26524/sajet.2022.12.46

INSULIN DOSAGE PREDICTION SYSTEM FOR DIABETIC PATIENTS

Neelam Sai Kiran [1], M. Keerthana [2], P. Bhavani [3], D. Revanth [4], P. Siva prasad [5]

Assistant Professor (IT), Dept. of Information Technology, Qis College of Engineering and Technology, Andhra Pradesh, India (1)

Final Year (B. Tech), Dept. of Information Technology, Qis College of Engineering and Technology, Andhra Pradesh, India (2,3,4,5)

Corresponding author.
Correspondence: Neelam Sai Kiran
E-mail: neelam@gmail.com

Article info
Received 3 th April 2022 Received in revised form 4 May 2022 Accepted 9 July 2022

Keywords
ANN,gender,fast blood

Abstract
Diabetes is a common chronic disease and poses a great threat to human health. Diabetes can lead to chronic damage and dysfunction of various tissues, especially eyes, kidneys, heart, blood vessels and nerves. To control the BGLs of diabetic patients the traditional prevention techniques such as eating healthy food and conducting physical exercise plays a major role and also taking the proper amount of insulin dosage has the crucial rule in the treatment process. The rapid development of machine learning has been applied to many aspects of medical health. We have proposed a model based on artificial neural network (ANN) to predict the proper amount of insulin needed for the diabetic patient. The proposed model was trained and tested using several patient's data containing many factors such as weight, fast blood sugar and gender.

1. INTRODUCTION

Diabetes mellitus is a chronic disease characterized by hyperglycemia. Normally, by adjusting of blood glucose levels (BGLs), diabetic patients could live a normal life without the risk of having serious complications. However, blood glucose levels of most diabetic patients are not well controlled for many reasons. The characteristic of diabetes is that the blood glucose is higher than the normal level, which is caused by defective insulin secretion or its impaired biological effects, or both. According to the growing morbidity in recent years, in 2040, the world's diabetic patients will reach 642 million, which means that one of the ten adults in the future is suffering from diabetes. Diabetes can be divided into two categories, type 1 diabetes (T1D) and type 2 diabetes (T2D). Patients with type 1 diabetes are normally younger, mostly less than 30 years old. Type 1 diabetes is an autoimmune disease in which the beta-cells of the body are destroyed, thus resulting in a lack of insulin production. The typical clinical symptoms are increased thirst and frequent urination, high blood glucose levels. This type of diabetes cannot be cured effectively with oral medications alone. Due to the lack of insulin production, type 1 diabetes patients are required to take insulin subcutaneously as their primary method of therapy. Type 2 diabetes occurs more commonly in the middle-aged and elderly people, which is often associated with the occurrence of obesity, hypertension, dyslipidemia, arteriosclerosis, and other diseases.

One of the essential components of a diabetes management system concerns the predictive modelling of the glucose metabolism. It is evident that the prediction of glucose concentrations could facilitate the appropriate patient reaction in crucial situations such as hypoglycaemia.

Thus, several recent studies have considered advanced data driven techniques for developing accurate predictive models of glucose metabolism.

2. OBJECTIVE

The aim of this project is to predict insulin dosage for diabetic patients. The main objective of this project is to predict whether the person has Diabetes or not based on various features like height, weight, fast blood sugar, gender. If the person is a diabetic patient, then using the Back Propagation (BP) Algorithm in Artificial Neural Network (ANN) model, we can predict the proper amount of insulin dosage required for that particular patient.

In addition to the general guidelines that the patient follows during his daily life, several diabetes management systems have been proposed to further assist the patient in the self-management of the disease. One of the essential components of a diabetes management system concerns the predictive modeling of the glucose metabolism.

3. EXISTING SYSTEM

In existing system KNN (K- Nearest Neighbors) Machine Learning model is used to predict the insulin dosage for diabetic patients. KNN algorithm can be used for both classification and regression problems. The KNN algorithm uses 'feature similarity' to predict the values of any new data points. A simple implementation of KNN regression is to calculate the average of the numerical target of the K nearest neighbours. Another approach uses an inverse distance weighted average of the K nearest neighbours. KNN regression uses the same distance functions as KNN classification.

The main disadvantage of this existing system is KNN is not efficient for large datasets, so that we go for ANN in proposed model.

4. PROPOSED SYSTEM

In the proposed system we are using Artificial Neural Network with Back Propagation algorithm to classify diabetic patients and predict the proper amount of insulin dosage required for the diabetic patient. To train and test the model we used a collection of Electronic Health Record (EHR) data. The input data for our model are: length for patient (cm), weight for patient (kg), fast blood sugar reading for patient (mmol/l) and gender of patient (female/male). So, we can build an ANN based model that is trained using backpropagation algorithm.

Length (cm)	Weight (kg)	Blood sugar (mmol/l)	Gender (f/m)

5. LITERATURE SURVEY

Robertson et al. demonstrated Elman's recurrent artificial neural network (ANN) based on meal and insulin intake. The data set originated from a free, artificial mathematical diabetes simulator called AIDA that modelled 28 days of measurements of a T1D patient. Regarding the meal intake, only carbohydrate quantities were considered, and the results are based on the quite limited food absorption modelling capabilities of AIDA.

Another, neural network-based solution is presented by Shanthi and Kumar [13]. The difference between their work and the previously mentioned ANN-based tests is that in this case, the validation data history included real patients in a hospital setting with different insulin therapies using Medtronic's CGMS.

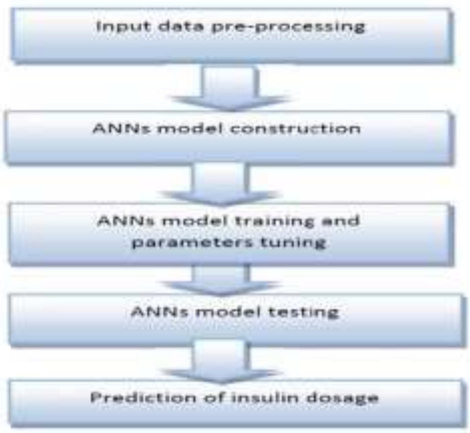
Deeraj Shetty et al. proposed diabetes disease prediction using data mining assemble Intelligent Diabetes Disease Prediction System that gives analysis of diabetes malady utilizing diabetes patient's database. In this system, they propose the use of algorithms like Bayesian and KNN (K-Nearest Neighbour) to apply on diabetes patient's database and analyse them by taking various attributes of diabetes for prediction of diabetes disease.

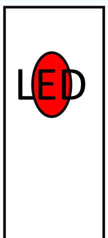
6. IMPLEMENTATION

6.1 MODULES

- Data Collection (EHR data)
- Data Processing
- Model Construction (ANN - Back propagation)
- Training and Testing the Model
- Model Evaluation (Insulin dosage Prediction)

6.2 SYSTEM DESIGN





6.3 METHODOLOGY

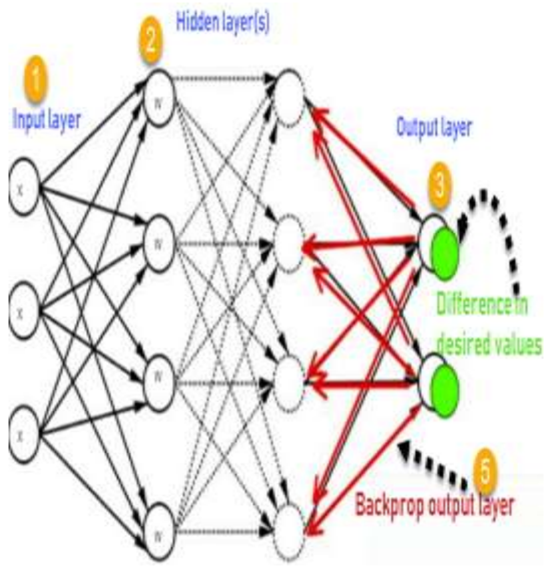
ARTIFICIAL NEURAL NETWORK:

A neural network is a group of connected I/O units where each connection has a weight associated with its computer programs. It helps you to build predictive models from large databases. This model builds upon the human nervous system. It helps you to conduct image understanding, human learning, computer speech, etc.

BACK PROPAGATION:

Back propagation is the essence of neural network training. In 1961, the basics concept of continuous backpropagation was derived in the context of control theory by J. Kelly, Henry Arthur, and E. Bryson. It is the method of fine-tuning the weights of a neural network based on the error rate obtained in the previous iteration. Proper tuning of the weights allows you to reduce error rates and make the model reliable by increasing its generalization.

6.4 ARCHITECTURE



The architecture of back propagation resembles a multi-layered Feed Forward network.

Input Layer: Accept the data (features) and pass it to the rest of the network. Hidden Layer: It is responsible for the excellent performance and complexity of neural networks. They perform multiple functions at the same time such as data transformation, automatic feature creation, etc.

Output Layer: The output layer holds the result or the output of the problem.

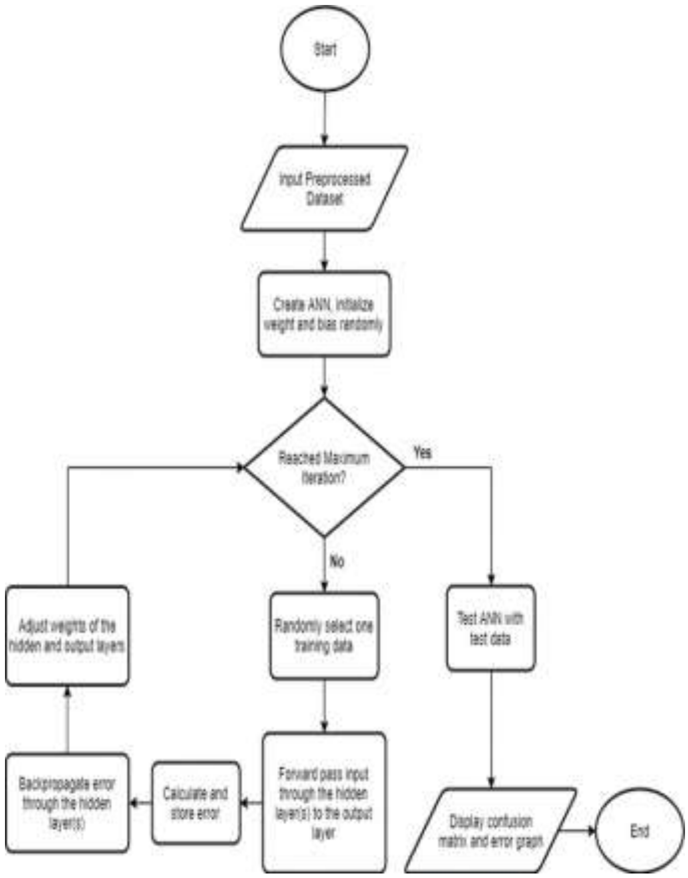
This method helps calculate the gradient of a loss function with respect to all the weights in the network. The Back propagation algorithm looks for the minimum value of the error function in weight space using a technique called the delta rule or gradient descent. The weights that minimize the error function is then considered to be a solution to the learning problem.

The Training algorithm of Back Propagation involves 4 stages:

1. Initialization of weights

2. Feed Forward
3. Back Propagation of errors
4. Updating of the weights and biases

6.5 ALGORITHM



6.6 WORKING

We collected our data for 180 patients. These data include: length for patient (cm), weight for patient (kg), fast blood sugar reading for patient (mmol/l), gender of patient (female/male) and the insulin dosage for that patient. The data was divided into two parts: the first part includes 120 reading and was used for training the ANN; the other part includes 60 reading and was used for testing the proposed model.

Step 1: Input data pre-processing: The input data for our model are: length for patient (cm), weight for patient (kg), fast blood sugar reading for patient (mmol/l) and gender of patient (female/male). The output is the suitable insulin dosage for the patient. All input data are normalized in the range (0.0 to 1.0).

Step 2: ANNs model construction: Two thirds of the data are selected to train the model and the other third is used to test it. The proposed prediction algorithm is constructed, it consists of 3 layers: an input layer, a single hidden layer and an output layer. The hidden and output layers use sigmoid activation function.

Step 3: ANNs model training and parameter tuning:
In the proposed 3-layer neural network, the number of nodes in the input layer is set to 4, the number of nodes in the hidden layer is varied from 5 to 10 and the learning rate is varied from 0.1 to 0.9. The number of neurons of the hidden layer is set to 7, the learning rate is set to 0.5, and the number of neurons in the output layer is set to 1, as a result, this proposed ANNs model achieves the best performance. The best ANNs model with the suitable number of nodes is selected accordance to the minimum prediction error.

Step 4: ANNs model testing: One third of the data are used to test the accuracy of the proposed prediction model.

Step 5: Prediction of insulin dosage: After training and tuning the proposed prediction algorithm, it can be used to predict new unknown insulin dosage suitable for the patients. MATLAB R2011software was used for the implementation of the proposed model.

Two performance measures related to the prediction errors (PE) were computed.

PE is calculated using the following error equation:

$$PE = |Arv - Prv|\ Arv \quad (1)$$

Where PE is the prediction error, Arv is the actual insulin dosage value, Prv is the predicted insulin dosage value, and | | is the absolute value.

Moreover, the prediction accuracy is defined as follows:

$$PA = (1 - PE) \times 100\% \quad (2)$$

Where PA is the prediction accuracy.

CONCLUSION

This project was aimed at modeling neural network for the prediction of amount of insulin dosage suitable for diabetic patients. A model based on ANN trained with Back Propagation Algorithm was used. The model uses four input information about each patient its length, weight, blood sugar, and gender. We are using Artificial Neural Networks to predict diabetes and applying Back Propagation Algorithm to predict proper amount of insulin dosage required for a diabetic patient.

FUTURE ENHANCEMENT

The results of the research conducted in this thesis are promising for a wide range of applications in T1D therapy. Nevertheless, the performance and safety of the predictions can be improved further by generating a set of interchangeable models that predict useful Blood Glucose values for control and therapy purposes based on the determination of individual specific dynamics, lifestyle, and other factors. An extension of this work will include testing personalized Blood Glucose prediction models in a more challenging situation involving real subjects.

REFERENCES

[1] American Diabetes Association. Diagnosis and Classification of Diabetes Mellitus. Diabetes Care, Vol. 31, No. 1, 2008, 55-60, 1935- 5548.

[2] I. Eleni Georga, C. Vasilios Protopappas and I. Dimitrios Fotiadi,. "Glucose Prediction in Type 1 and Type 2 Diabetic Patients Using Data Driven Techniques, “ Knowledge-Oriented Applications in Data Mining, InTech pp 277-296, 2011.
[3] V. Tresp, T. Briegel, and J. Moody, "Neural-network models for the blood glucose metabolism of a diabetic," IEEE Transactions on Neural Networks, Vol. 10, No. 5, 1999, 1204-1213, 1045-9227.
[4] C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006, New York
[5] S. Haykin, Neural networks and learning machines. Pearson 2008.
[6] W.D. Patterson, Artificial Neural Networks- Theory and Applications, Prentice Hall, Singapore. 1996.
[7] M. Pradhan and R. Sahu, "Predict the onset of diabetes disease using Artificial Neural Network (ANN)," International Journal of Computer Science & Emerging Technologies, 303 Volume2, Issue2, April2011.
[8] W, Sandham, D,Nikoletou, D.Hamilton, K, Paterson, A. Japp and C. MacGregor, "BLOOD Glucose Prediction for Diabetes THERAPY USING A RECURRENT Artificial Neural Networks ", EUSIPCO, Rhodes, 1998, PP. 673-676
[9] M, Divya, R. Chhabra, S. Kaur and S., "Diabetes Detection Using Artificial Neural Networks & Back-Propagation Algorithm", International Journal of Scientific & Technology Research". V 2, ISSUE 1, JANUARY 2013.
[10] G, Robertson, E. Lehmann, W. Sandham, and D. Hamilton Blood, "Glucose Prediction Using Artificial Neural Networks Trained with the AIDA Diabetes Simulator: A Proof-of-Concept Pilot Study". Journal of Electrical and Computer Engineering, V 2011 (2011), Article ID 681786, 11 pages.
[11] Van Cauter E, Shapiro E, Tillil H, Polonsky K. Circadian modulation of glucose and insulin responses to meals: relationship to cortisol rhythm. *Am J Phys.* 1992; 262: E467–E475.
[12] Gogou G, Maglaveras N, Ambrosiadou BV, Goulis D, Pappas C. A neural network approach in diabetes management by insulin administration. *J Med Syst.* 2001;25(2):119–131.
[13] Karim EJ. Neural network control of type I diabetes mellitus. *Bioprocess Biosyst Eng.* 2005;27(2):71–76. 23. Pender JE. *Modelling of blood glucose levels using artificial neural networks. Dissertation.* Glasgow, Scotland: University of Strathclyde; 1997.
[14] Sandham WA, Nikoletou D, Hamilton DJ, Patterson K, Japp A, Macgregor C. Blood glucose prediction for diabetes therapy using a recurrent artificial neural network. *Conf Proc EUSIPCO.* 1998;(11):673–676.
[15] Ibrahim, S. Jafar Ali, and M. Thangamani. "Enhanced singular value decomposition for prediction of drugs and diseases with hepatocellular carcinoma based on multi-source bat algorithm based random walk." *Measurement* 141 (2019): 176-183. https://doi.org/10.1016/j.measurement.2019.02.056
[16] Thangamani, M., and S. Jafar Ali Ibrahim. "Ensemble Based Fuzzy with Particle Swarm Optimization Based Weighted Clustering (Efpso-Wc) and Gene Ontology for Microarray Gene Expression." *In Proceedings of the 2018 International Conference on Digital Medicine and Image Processing, pp. 48-55. 2018. https://dl.acm.org/doi/abs/10.1145/3299852.3299866*