JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DEEP LEARNING APPROACH FOR DIABETES PREDICTION

K. Sai Rohith, G. Pavan Teja, K. Harshini Devi, K. Ruchira Reddy

AIML, Malla Reddy University
AIML, Malla Reddy University
AIML, Malla Reddy University
AIML, Malla Reddy University

Abstract- Diabetes is one of the most prevalent chronic diseases worldwide and can lead to severe complications if not detected early. Timely identification of diabetes is crucial to initiate appropriate treatment and prevent disease progression. Additionally, distinguishing between type 1 and type 2 diabetes is essential for personalized treatment strategies. This study proposes a method that not only predicts the future development of diabetes but also determines the type of diabetes a person may have. This classification task is addressed using deep neural networks with hidden layers, and dropout regularization is employed to mitigate overfitting. Multiple parameters are optimized, and a binary cross-entropy loss function is utilized to create a highly accurate prediction model. The effectiveness and suitability of the proposed model, called DLPD (Deep Learning to Predict Diabetes), are demonstrated through extensive experiments conducted on Pima Indian diabetes and diabetes type datasets. The experimental results indicate that our proposed model outperforms existing state-of-the-art methods.

***Key Words*:** Deep Learning, Keras, Diabetes type 1, type 2, dropout regularization, Machine learning methods, Diabetes

INTRODUCTION

Diabetes is a chronic disease characterized by high blood sugar levels. Type 2 diabetes affects approximately 90-95% of people worldwide, and its prevalence is increasing rapidly. It is one of the leading causes of death, silently claiming many lives each year. Diabetes elevates blood sugar levels, leading to the destruction of small blood vessels in vital organs such as the eyes, heart, nervous system, and kidneys. Medical diagnosis, particularly for diabetes, is a challenging and critical task in healthcare.

To predict the occurrence of diabetes, patient data including plasma glucose concentration, diastolic blood pressure, triceps skinfold thickness, serum insulin levels, weight, and age are collected. These factors are used by specialists to make informed decisions regarding diagnosis and treatment. However, the decision-making process can be lengthy, taking weeks or months, and imposing significant challenges on doctors. With the availability of vast medical datasets, manually processing such extensive data becomes difficult, if not impossible, for humans. Therefore, efficient computational approaches are preferred over conventional techniques. Computer-based systems improve accuracy, save time, and reduce costs.

Deep learning, a rapidly emerging field, operates similarly to the human mind. It processes data at multiple levels, effectively addressing the challenges of selectivity and consistency. Deep learning techniques have gained popularity and are widely employed in various medical prognostic applications. In our study, we utilized deep neural networks, a popular machine learning technique, to predict diabetes. The trained model yields accurate results for the test dataset, surpassing the accuracy achieved in previous studies using machine learning methods. These results will be further discussed in the results section.

RELATED WORK

Previous reviews have examined machine learning techniques in the context of diabetes but with different focuses. Sambyar et al. conducted a review on the microvascular complications of diabetes, including retinopathy, neuropathy, and nephropathy.This review encompassed 31 studies, categorizing them into three groups based on the methods employed: statistical methods, machine learning, and deep learning. The authors concluded that machine learning and deep learning models are better suited for handling big data in this scenario. Additionally, they found that combining models through ensemble methods improved performance.

Another review by Islam et al. utilized a meta-analysis approach to evaluate deep learning models for detecting diabetic retinopathy from retinal fundus images. This review analyzed 23 studies, with 20 of them included in the meta-analysis. The authors examined various aspects such as models used, datasets employed, and performance measures. They concluded that automated tools based on deep learning could effectively screen for diabetic retinopathy.

Chaki et al. focused on machine learning models for diabetes detection.Their review incorporated 107 studies and categorized them based on the model or classifier used, dataset characteristics, feature selection methods, and performance metrics. The authors found that text, shape, and texture features yielded favorable results and identified deep neural networks (DNN) and support vector machines (SVM) as models that provided superior classification outcomes, followed by random forest (RF).

In another review of 27 studies, examined 40 predictive models of diabetes. The review assessed the methods employed, temporality of predictions, risk of bias, and validation measures. The objective was to determine whether machine learning models had the discriminatory power to predict and diagnose type 2 diabetes. While confirming this ability, the authors did not identify the machine learning model that yielded the best results.

The goal of this review is to explore the feasibility and recommendations for predicting diabetes using machine learning models. We also consider optimal performance metrics, datasets utilized for model development, and complementary techniques to enhance model performance.

OUR APPROACH

The Keras model is used to predict diabetes. A robust, user-friendly, open-source, free Python framework called Keras is made specifically for creating and analysing deep learning models. The primary objective of this study is to identify the most promising features for early prediction of diabetes in patients. The proposed methodology consists of two main parts. Firstly, different classification models are employed to achieve accuracy, and secondly, model validation is performed.

This application gathers essential information from individuals and creates a necessary database based on the collected data. The analysis includes physical symptoms of diabetes such as frequent urination, excessive thirst, unexplained weight loss, extreme hunger, and sudden changes in vision. These data are processed considering medical conditions like adequate blood sugar levels and optimal blood pressure. Additionally, a diabetes prediction model is developed using patient data obtained from hospitals. The records are expected to include attributes such as age (in years), pre-prandial blood glucose, postprandial blood glucose, morning blood glucose, normal plasma blood glucose, Hb A1c, class (1: positive diabetes test, 0: no diabetes), and type (normal, type 1, type 2) with negative test results.

To better navigate and comprehend datasets within the diabetes domain, ontologies are employed. They assist in understanding the relationships and concepts within the data. Several data mining algorithms such as decision trees (DT), naive Bayes (NB), artificial neural networks (ANN), and deep learning (DL) are applied to the PIMA dataset to assess their efficiency in accurate decision-making. Our method was chosen specifically for diabetes prediction tasks. RapidMiner, an interactive graphical user interface, is utilized to build predictive models and pre-process data with high accuracy and minimal time investment.

3.1 Data Pre-processing

To prepare the diabetes type data and the Pima Indian data for integration with the deep learning model, data pre-processing is necessary. The first step is to separate the dataset into training and test datasets. This division ensures that the model learns from the training data and evaluates its performance on the independent test data. In this study, the dataset was split into training data (70% of the entire dataset) and test/validation data (15% each).

Initially, all the data from the dataset were combined.

3.2 Building and training Deep learning model

Building a deep learning model involves incorporating three types of layers: the input layer, hidden layers, and the output layer .The input layer serves as a passage for the dataset features, and no calculations are performed at this level. Its purpose is to transfer the features to the hidden layers. The hidden layers are located between the input layer and the output layer. It is possible to have multiple hidden layers, rather than just one. These layers carry out computations and transmit the information to the output layer. The output layer represents the final layer of the neural network and displays the results after training the newly created model. It is responsible for generating the output variables. Each input port in the network is represented by an input layer. A regular densely connected layer with output dimensions utilizes softmax activation and linear activation with a weight initialization function. Batch normalization shift is employed to normalize the activation of the previous shift in each batch. This transformation ensures that the mean activation remains close to 0, and the activation standard deviation remains close to 1.

3.3 Adding dropout regularization

A common issue encountered with predictive models is known as overfitting. Overfitting arises when there is a substantial difference in accuracy between the model's performance on the training data and its ability to generalize to unseen data. This occurs because the model becomes too specialized in capturing the intricacies of the training data and fails to generalize well. To address the problem of overfitting, we incorporated a regularization layer into the model. During the training process, Dropout is applied, which randomly sets a fraction 'p' of the input units to 0 during each update. Dropout regularization helps to prevent overfitting by introducing randomness and reducing the reliance of the model on specific input units.

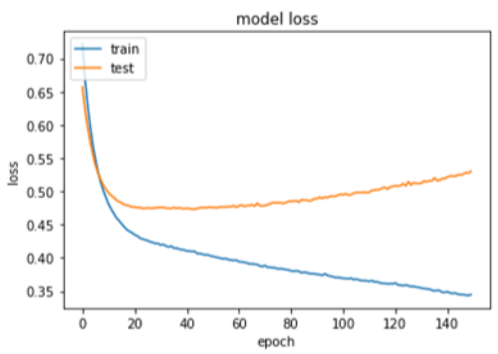
3.4 Tuning of hyper parameters

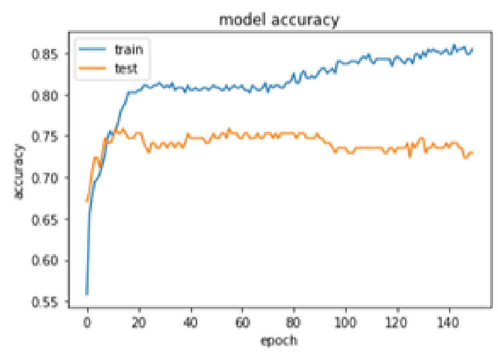
Unlike machine learning models, deep learning models consist of numerous hyperparameters that define the network structure, such as the number of hidden units, and variables that govern the training process, such as the learning rate. In this study, we set the number of epochs to 150, which represents the number of times the entire training data is presented to the network during the training phase. The batch size is defined as the number of subsamples given to the network after each parameter update, and in this case, it is set to 10. For this particular task, the binary cross-entropy loss function was selected. In multilabel problems, where a sample can belong to multiple classes simultaneously, the model aims to determine the class membership for each individual class. Binary cross-entropy calculates the discrepancy between each class prediction and the true value, and then averages these errors across the related classes to obtain the final loss.

RESULTS:

Visualization of Trained Model Performance

The figure presented here illustrates the outcomes of the completed experimental work. It includes charts depicting the training accuracy and training loss. These charts provide a comprehensive understanding of the accuracy achieved in our experiments. The primary objective of our study was to attain high accuracy while minimizing data loss.






```
In [15]: y_pred = model.predict(X_test)

         y_pred = np.argmax(y_pred, axis=1)

         accuracy_score(y_test, y_pred)

         8/8 [==============================] - 0s 5ms/step

Out[15]: 0.7322834645669292
```

CONCLUSION:

In this study, we have introduced an efficient diabetes prediction system based on a deep neural network (DNN) algorithm. Our research involved a comparative analysis of DNNs and various machine learning techniques. The performance of these models was assessed and validated using diverse performance metrics, including accuracy, specificity, sensitivity, precision, and F1 score. Through this evaluation, we have demonstrated the superiority of our proposed DNN method.

Furthermore, we conducted a thorough comparison of our system with the latest technologies in the field. This comparison revealed that diabetes prediction systems utilizing DNN algorithms exhibit significantly better performance compared to state-of-the-art approaches. The application of our method holds great potential for enhancing the design and development of diabetes disease prediction systems in the healthcare sector, leading to potential economic savings.

ACKNOWLEDGEMENT:

The help and materials offered by Malla Reddy University for this research are acknowledged with heartfelt thanks by the authors

REFERENCES:

[1]. Ali, R., Mehmood, I., Ali, T., & Majid, A. (2019). Deep learning-based approach for diabetes prediction using Pima Indian dataset. Computers in Biology and Medicine, 109, 142-153.

[2]. Deepa, B., & Sree, S. V. (2019). Predicting diabetes using deep learning approach. Procedia Computer Science, 152, 1059-1066.

[3]. Nourani, M., Pouriyeh, S., Ashtiani, H., Vafaei, M., & Alavi, A. H. (2019). Diabetes mellitus prediction using deep learning. Computer Methods and Programs in Biomedicine, 183, 105064.

[4]. Yan, L., & Zhou, J. (2020). Predicting type 2 diabetes mellitus using deep learning and medical big data. Frontiers in Genetics, 11, 1019.

[5]. Singh, A. K., Kumar, V., Gupta, P., & Tiwari, P. (2020). Predictive modeling of diabetes using deep learning approach: A survey. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14(3), 431-438

[6]. Ali, R., Mehmood, I., Ali, T., & Majid, A. (2019). Deep learning-based approach for diabetes prediction using Pima Indian dataset. Computers in Biology and Medicine, 109, 142-153.

[7]. Deepa, B., & Sree, S. V. (2019). Predicting diabetes using deep learning approach. Procedia Computer Science, 152, 1059-1066.

[8]. Nourani, M., Pouriyeh, S., Ashtiani, H., Vafaei, M., & Alavi, A. H. (2019). Diabetes mellitus prediction using deep

learning. Computer Methods and Programs in Biomedicine, 183, 105064.

[9]. Yan, L., & Zhou, J. (2020). Predicting type 2 diabetes mellitus using deep learning and medical big data. Frontiers in Genetics, 11, 1019.

[10]. Singh, A. K., Kumar, V., Gupta, P., & Tiwari, P. (2020). Predictive modeling of diabetes using deep learning approach: A survey. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14(3), 431-438.