



# IJRASET

International Journal For Research in  
Applied Science and Engineering Technology



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# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

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**Volume:** 10    **Issue:** V    **Month of publication:** May 2022

**DOI:** <https://doi.org/10.22214/ijraset.2022.42578>

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# Predictive Model for Type II Diabetes: Deep Learning with Probability Density Function

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**Abstract:** *Diabetes mellitus is a scientific ailment defined by hyperglycemia caused by a lack of absolute or relative insulin efficiency in the human body. Diabetes prediction is one of the newest and fastest-growing technologies in medical data analysis. The clustering method for grouping diabetes data based on cluster head properties is the focus of this study. This study proposes a new BG prediction method called RNN, which is based on recurrent neural networks (RNN). The probability of values of the variable is calculated using the probability density function (PDF). For pre-processing and missing value analysis, we used an enhanced Decision Tree and a weighted K-means method. The proposed method uses the weighted Binary Bat Optimization algorithm for feature selection. In terms of diabetic categorization, numerical findings reveal that when compared to other existing methods, the DP-RNN approach with PDF produces the way PDF-DPRNN produces the more accurate classification result.*

**Keywords:** PDF, RNN, Decision Tree, Bat Optimization, Diabetes mellitus.

## I. INTRODUCTION

Diabetes mellitus, or high blood sugar, is a progressive and permanent illness in which the body is unable to generate or use enough insulin. The blood glucose level is generally very high [1]. According to the Globe Health Organization (WHO), the number of diabetics in the world will rise to 333 million by 2025, up from 135 million in 1995 [3]. Uncontrolled and unmonitored diabetes can cause issues in different parts of the human body, including the skin, kidneys, heart, nerves, blood vessels, and healing of the feet [2].

Diabetes mellitus (DM) can cause coronary autonomic neuropathy as well as a slew of other problems [1]. If the condition progresses, specific blood vessels that supply the retina become blocked, preventing blood flow to select retinal regions [4].

In recent years, machine learning and deep learning have exploded in popularity. In a variety of domains, machine learning technologies such as medical prognostics and optical character recognition are being used [5]. Using modern computational approaches, such as a deep neural learning network [14] with probability density function, this research provides a high-precision model for diabetes prediction (PDF).

In this suggested framework, the PD-RNN classification result is compared to existing techniques. Type 2 diabetes develops when blood glucose levels are too high [7]. The most common type of diabetes is blood sugar, which is obtained from the food we eat. Insulin helps glucose travel from the bloodstream to the cells of our bodies, where it is converted into electricity. As a result, glucose does not reach type 2 diabetes cells and remains in the bloodstream.

The following sections make up this paper: Section II lists significant publications in this field, and Section III details the proposed technique, which involves dataset selection, pre-processing, and classification using PDF-RNN. Section IV provides the findings and evaluations of the results, which are reinforced by Section V, which contains the research's general conclusion.

## II. BACKGROUND STUDY

The blood glucose level diagnosis is a standard study field, and various studies are being conducted in this area. The goal of automatic screening detection is to diagnose the need for greater human life care.

The multimodal approach, developed by Bouallal, D. et al. [2], outperforms the thermal image-based process model, especially in complicated circumstances. A cross-sectional clinical investigation on 122 diabetes type 2 patients was done as part of this approach. A diagnostic examination was used to identify the three risk groups: low-risk (R0), medium-risk (R1), and high-risk (R2) (R2).

The diabetes prediction results show that the medium-risk (MR1) group had a higher average foot surface temperature than the low-risk (R0) group, with a  $p < 0.1$  difference. With  $p < 0.01$ , the temperature difference measured during a cold stress test differs dramatically from R0 to R1 on one side and R1 to R2 on the other. Finally, R1 to R2 ( $p < 0.1$ ) was the mean absolute deviation from the left to the right foot.

The hybridized patch approach was suggested by A. Chandran et al. [4] to identify proliferative diabetic retinopathy. Specialists can save time and effort by using electronic ophthalmology equipment, which can treat severe cases right away.

The author of this study, Kumar, S., and Kumar, B. [9], proposed a new method for detecting diabetic retinopathy by correctly estimating the number and size of micro aneurysms. The sensitivity and accuracy results show that the suggested diagnostic technique is more effective at detecting non-proliferative diabetes.

Vahidi, O. et al. [15] established a methodology for diagnosing cardiovascular deficits in a diabetic community of patients with type 2 diabetes. Using a particle filtering technique, the circumstances and glucose metabolic rates in several organs, as well as a pancreatic insulin secretion rate, were assessed. Hepatic abnormalities, pancreas, and peripheral diabetes type 2 patients can be diagnosed using nonlinear filtering system and mathematical model methods.

### III. SYSTEM MODEL

This section introduces the recommended RNN DP-RNN approach, which is often used in natural language processing, speech recognition, and other time series-related tasks due to its natural benefits for rapid capture. RNN can be used to process the BG data series.

#### A. Dataset

The Diabetes Dataset is available on the KagglePlat platforms used in this proposed work. The major goal is to diagnose the patient and determine whether or not the patient has diabetes. This medical record has a total of 17 features that can be used to predict disease.

#### B. System Architecture

The proposed framework is the architecture for predicting type 2 diabetes. The standard dataset received from Kaggle is used in this system. This dataset is further pre-processed such that it may be utilized to forecast disease outcomes effectively. The data is separated after the pre-processing is performed. The PDF-RNN is used to train this segregated data. We can get the procedure results after we've made the prediction. Many measures can be used to evaluate the model. We focused on accuracy, precision, and F-measure because these measures have a significant impact on the model's improvement.

#### C. Methods

Traditional computer approaches do not require the extraction, sorting, and classification of functions to be expressed explicitly in deep learning networks. In exchange, individuals become part of a larger learning network. The main mechanism is self-learning based on the data. RNN makes use of the probability density approach (PDF).

### IV. DISCUSSION

This section presents numerical results on the efficacy and benefits of the suggested PDF-RNN model for BG prediction. The ROC, where the X-axis represents the False Positive Rate and the Y-axis represents the True Positive Rate.  $ROC = TPR = TP / (TP + FN)$

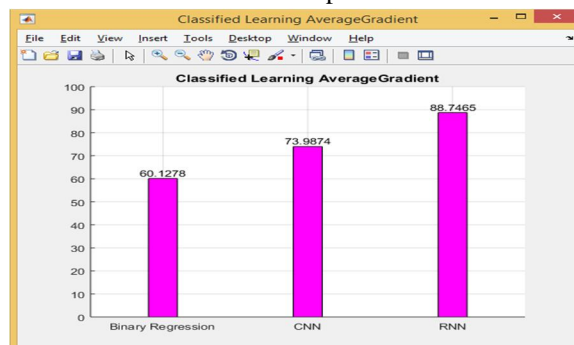


Figure 6: Learning Average Gradient Classification Result

The Average Gradient of Binary Regression is 60.1278, CNN is 73.9874, and PDF-RNN is 88.7465, as shown in Figure 6. Initial coefficient values, also known as feature coefficients, are the first step in the technique. This could be 0.0 or some other number. 0.0 is the coefficient. The cost of the coefficients is calculated by putting them in and measuring the cost. The expense derivative is calculated as  $\text{cost} = f(\text{coefficient})$ . The derivative is a calculus word that corresponds to the pitch of the equation at a specific step.

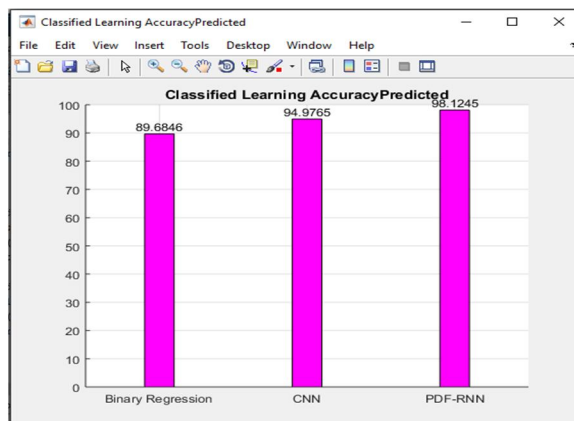


Figure 7: Learning Accuracy Predicted

100 percent accuracy = (properly predicted class/total tested class) with successful classifications, TPR and TNR can be as high as 100%. This is also true for precision and precision parameters. On the other hand, FPR and FNR might be as close to 0% as possible.

The Accuracy Predicted Binary Regression value for categorized learning is 89.6846, CNN is 94.9765, and PDF-RNN is 98.1245.

Table 1: Result Comparison Table

Method/ Measurement	BR	CNN	Proposed Method (PDF-RNN)
Accuracy	89.6846	94.9765	98.1245
Average Learning	60.1278	73.9874	88.2465
Classification with True data	85.3214	90.5213	94.5267
Sensitivity	86.2479	92.1236	97.8546
Specificity	40.3215	27.5645	12.5478
Precision	86.8566	94.3321	97.5499
Recall	12.6547	5.9874	2.8974
F Measure	8.6654	7.8846	3.5128

The overall comparison result table for Binary Regression, Convolution Neural Network, and PDF-Recurrent Neural Network is shown in Table 1.

### V CONCLUSION

We investigate machine learning methods for diabetes BG prediction in this proposed strategy. Many patients' data can be used in existing methods such as Logistic Regression, CNN, and PDF-RNN to improve prediction precision. When compared to the CNN and Logistic Regression approaches, the numerical results reveal that the suggested PDF-RNN solution has enhanced all diabetes types. The results for categorized accuracy are 98.1245. PDF-RNN can detect BG fluctuations, and the most significant effects are seen in terms of BG prediction precision. Instead of BG fluctuation, classification of additional factors or consequences will be done in the future.

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