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DDPIS: Diabetes Disease Prediction by Improvising SVM

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ABSTRACT

An illness that lasts longer and has continual repercussions is known as a chronic illness. Adults all across the world die as a result of chronic sickness. Diabetes disease prediction by improvising support vector machine is a platform that predicts diabetes based on the data entered into the system and offers reliable results based on that data. Earlier, the dataset consisted of a smaller number of features comprising the patients' medical details that were useful in determining the patient's health condition and was mainly focused on gestational diabetes, which only deals with pregnant women. In this work, the authors build a system that is more efficient than the previous system because of these reasons. It provides more accurate results by improvising the support vector machine, which includes more datasets and can predict the possibility of diabetes disease in both males and females.

KEYWORDS

Accuracy, Diabetes Disease Prediction, Machine Learning, Support Vector Machine

INTRODUCTION

Diabetes is one of the most widespread and fatal chronic diseases that harm the entire body system. The body of a diabetic patient has a high level of blood sugar (Lyngdoh et al., 2021). A person with a chronic illness has a condition that lasts longer and has ongoing consequences. One of the most significant disadvantages of chronic disorders is that they have a detrimental impact on people's standard of living. It is one of the most dangerous infections that may be discovered worldwide. This chronic illness costs the lives of adults all over the world.(Ahmed et al., 2021; Lai et al., 2019). Chronic diseases have a monetary burden attached to them and cost a lot of money for governments and people. As we all know, the operation cost is high and not every family can afford it. Two factors

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can cause diabetes: (1) the pancreas produces insufficient insulin, or (2) the body produces insufficient insulin. Only 5–10% of people with diabetes have this type of disease (Type-1) or (2). The produced insulin does not affect the cells (Type-2). Insulin is the hormone that controls the uptake of glucose from the bloodstream into most cells (muscles and fat cells). If there isn't enough insulin, glucose won't have the same effect as it usually does, and glucose won't be absorbed by the body cells that need it (Deberneh & Kim, 2021).

Diabetes mellitus is one of the leading causes of death in the United States. It requires detection and diagnosis at an early stage. Diagnosis of diabetes and interpretation of diabetes data is a significant categorization issue (Deberneh & Kim, 2021; Saeedi et al., 2019). Diabetes also afflicted approximately 463 million people aged 20 to 79 in 2019. (International Diabetes Federation-IDF) (Gulshan et al., 2016). Seventy-nine percent of the adult population live in low- and middle-income countries. According to estimates (IDF), approximately 700 million people will have diabetes by 2045 (Soni & Varma, n.d.). Every year, the number of instances grows, and the number of active cases continues to rise. Diabetes has become one of the most severe and rapid diseases to claim many people's lives worldwide, so it is essential to be concerned (Nayak & Pandi, 2021; Perveen et al., 2016). According to research, 70% of people in India suffer from this widespread disease, and 25% die due to early ignorance. The primary motivation for developing this project is so that a user can sit at their convenience and check their health (Vizhi & Dash, 2020; Zhou et al., 2020).

We developed the platform diabetes disease prediction by improvising a support vector machine to overcome diabetes disease in earlier stages. As we all know, in the competitive economic development environment, people are so busy making money and improving their lifestyle and future that they are not concerned about their health. The leading causes of ignorance are that they do not have time. They are so busy with their work that they neglect their health and do not go for regular body check-ups, which are essential for monitoring an individual's health to be free from any disease harmful to their body that may cost their life. People have become so preoccupied with their daily lives that they have no time to schedule appointments and consult a doctor, resulting in fatal conditions. Our diabetes prediction system helps individuals to predict the possibility of diabetes without taking more of their time. Whenever they are free from work, they can immediately check the likelihood of diabetes. They can consult the doctor for further treatment or assistance if the results are positive.

Machine learning is a kind of artificial intelligence (AI) that lets software applications become more accurate and efficient in predicting outcomes. ML algorithm uses historical data to anticipate improved output values (Kaur, 2019; Kumar et al., 2022).

Support Vector Machine, i.e., SVM, is a machine learning algorithm based on supervised learning. SVM can be used for classification and regression complications but mainly for classification problems. The main aim of the support vector machine is to find a hyperplane in n-dimensional space (where n is the total number of attributes). The dimension in the hyperplane depends on the number of attributes used (Pranto et al., 2020; Rani, 2020)

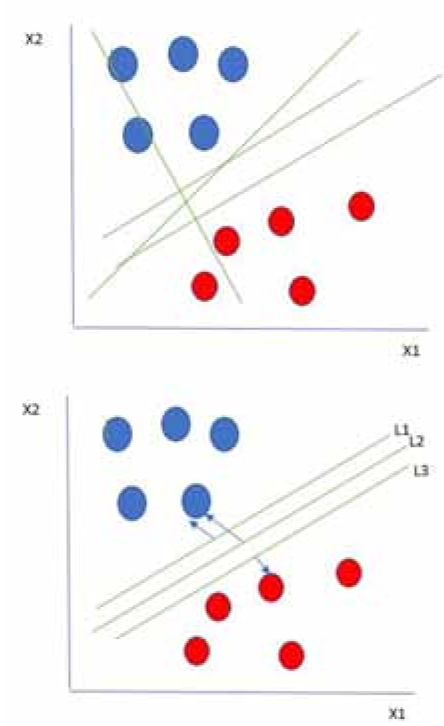
Let's consider an example where we have two independent variables x1, x2 and one of them is dependent on either the blue or red. From the first figure, we now have to choose the best line to segregate our data points.(Shafi & Ansari, 2021)

We choose the hyperplane whose distance from it to the nearest data point on each side is maximized. If such a hyperplane exists, it is known as the maximum-margin hyperplane/hard margin. So, from the above figure, we choose L2.

LITERATURE REVIEW

Arwatki Chen Lyngdoh et al. (2021) compared machine learning algorithms such as KNN, SVM, DT, RF, and Naive Bayes. They compared all the classifiers and obtained the highest accuracy of

Figure 1. SVM before finding hyperplane and after finding hyperplane. (Lyngdoh et al., 2021)



76% with KNN, and with the other remaining classifiers, they got above 70% accuracy(Lyngdoh et al., 2021).

Hang Lai et al. (2019) used machine learning techniques such as LR and Gradient Boosting Machine (GBM) to predict the occurrence of diabetes mellitus. They obtained the Area under the Receiver Operating Characteristic Curve (AROC) for the GBM was 84.07%, and for the LR model, it was 84%. They also compared these models with other techniques, such as DT (80.5%) and RF (83.04%) and found that the GBM and LG were more efficient (Lai et al., 2019).

Henock M. Deberneh et al. (2021) proposed a system that can predict Type 2 diabetes. For this study, they collected the dataset from the private medical institute as electronic health records from 2013 to 2018. They used SVM, XG Boost, RF, LR, and ensemble classifiers and got an accuracy of 73%, 72%, 73%, and 71%, respectively (Deberneh & Kim, 2021).

Mitushi Soni et al. (2019) used different machine learning classifications to predict diabetes disease. They use SVM, LR, KNN, Gradient Boosting Classifiers, DT, and RF to improve the performance, which helps them increase the prediction model's accuracy. The technique which provided the highest accuracy compared to other machine learning techniques was Random Forest (RF), with 77% accuracy.

N. Sneha et al. (2019) focused on analyzing diabetes using optimal feature selection. They use various algorithms such as SVM, RF, NB, DT and KNN and get an accuracy of 77.73, 75.39, 73.48, 73.18, and 63.04%, respectively (Sneha & Gangil, 2019). Lomani Nayak et al. (2021) applied three algorithms to the Pima Indian Diabetes dataset, KNN, SVM, and Decision Tree, to predict early diabetes. They also compared the SVM with the other two algorithms and got the highest accuracy of 73.95%, whereas KNN provided 71.35% and DT provided 72%.

Sajida et al. (2016) evaluated data mining classification techniques and their performance for analysis. The Canadian Primary Care Sentinel Surveillance Network (CCPCSSN) was the dataset used in this paper. They used AdaBoost, a bagging ensemble technique using the J48 decision tree, to classify diabetic patients across three age groups, which were 18–35, 36–55, and older than 55. They found that the AdaBoost ensemble method is better than bagging and the J48 decision tree (Perveen et al., 2016)

Hauping Zhou et al. (2020) proposed a system that can predict diabetes by using DNN. This system can also determine the type of diabetes. They achieved 94.02% accuracy with the diabetes type dataset and 99.41% accuracy with the Pima Indian Diabetes Dataset.

Kayal Vizhi et al. (2020) used different machine learning techniques such as KNN, SVM, LR, DT, GNB, RF, and XG Boost to predict diabetes disease. They used the PIMA dataset and achieved the highest accuracy of 77.64% with the LR.

Talha Mahboob Alam et al. (2019) aimed to predict the early prediction of diabetes. They used ANN, RF, and K-means clustering techniques. The dataset they used was taken from the National Institute of Diabetes and Digestive and Kidney Diseases. The K-means clustering achieved an accuracy of 73.6%, RF completed 74.7%, and the highest, 75.7%, was achieved by ANN.

Kannadasan et al. (2021) focused on deep neural network (DNN) classifiers to predict diabetes. They categorized diabetes using the SoftMax layer to extract the excellent features. They used stacked autoencoders. The dataset that they used was the PID dataset, and they achieved an accuracy of 86.26%. (Butt et al., 2021)

Anuja Kumari et al. (?) classified diabetes from a high dimensional dataset using SVM and obtained an accuracy of 75% (Jegan et al., n.d.).

Jobeda et al.(2021) compared the seven ML algorithms to predict diabetes, also built a NN model, and found out two hidden layers in NN give the best accuracy of 88.6%. (Khanam & Foo, 2021) Bharath et al. used the PIMA dataset on convolutional long short-term memory (CLSTM) Deep Learning Technique to detect the occurrence of diabetes disease (Bharath et al., n.d.).

Yazan Jian et al. (2021) used a dataset from the Rashid Center for Diabetes and Research, which is situated in UAE and applied ML to predict diabetes disease. (Jian et al., 2021)

Finally, Xue et al. (2020) used SVM, NB and Light GBM, collected datasets from UCI ML Repository, and achieved the best accuracy with SVM. (Xue et al., 2020)

In our work, we found that most diabetes disease predictions are based on gestational diabetes, which is present in pregnant ladies. The database used to train this system was the PIMA dataset, which only contains attributes regarding female patients. The accuracy of SVM obtained by the PIMA dataset was less.

METHODOLOGY

Data Collection

The dataset was collected from the UCI ML repository, which contains 16 attributes of 520 patients. This dataset includes information on both female and male patients. Further, we've converted string values such as YES or NO to binary values 0 and 1, where 0 means NO or Negative and 1 means YES or Positive. Also, the gender binary value is 0 for Males and Females is 1.

Data Pre-processing

We used data pre-processing to make the dataset serviceable and obtain an understanding. We analyzed the dataset for uncommon entries and fixed them manually to deal with erroneous records (Sharma et al., 2022). To make a helpful dataset, we've used Pandas and NumPy library to deal with the dataset efficaciously (Bano et al., 2021). We've converted string values such as YES or NO to binary values 0 and 1 where 0 means NO or Negative and 1 means YES or Positive. Also, the gender binary value is 0 for Males and Females is 1.

Table 1. List of attributes

S No.	Attributes
1	Gender
2	Visual Blurring
3	Polydipsia
4	Delayed Healing
5	Genital Thrush
6	Partial Paresis:
7	Muscle Stiffness
8	Alopecia
9	Irritability
10	Itching
11	Sudden Weight Loss
12	Obesity
13	Weakness
14	Polyphagia
15	Polyuria
16	Age

Setting Classification Metrics

To categorize the disease and get a final result, we need to set a few metrics to help us predict diabetes. Since we used the Sk-learn machine learning library (Jakka & Vakula Rani, 2019) for our experiment, we've used the confusion matrix as the classification measure metrics. In our analysis, the used metric, i.e., accuracy is listed below (Sahoo et al., 2020).

Accuracy (A) is defined as follows.

$$A = \frac{Tp + Tn}{Tp + Tn + Fp + Fn} \tag{1}$$

Precision represents the number of true positives correctly identified as diabetic patients over the total number of positive predictions.

Precision (P) is defined as follows.

$$P = \frac{Tp}{Tp + Tn} \tag{2}$$

Architecture Diagram

An architecture diagram is used to describe the dynamic aspects of the system. The activity can be described as an operation of the system. In this diagram, the activity starts from the user, where the user registers into the system, logs in using the credentials and then the credentials are matched into the system. If true, the user proceeds to the input phase, where the user enters input, and then moves to the prediction phase, where the input is analyzed. Finally, after processing the data from the datasets, the analysis will happen, and the correct result will be displayed, which is nothing but the Output.

The system will detect whether the user or the person has diabetes disease or not. It gives the Output in the form of YES or NO. When using the SVM algorithm for predicting the disease, the user enters his credentials and answers some questions in yes or no terms. After that, the values are processed using the SVM algorithm, and after this process, the Output is predicted in terms of Yes or NO.

Dataset Collection: The data is collected from the UCI dataset. The dataset has 16 attributes of 520 patients.

Data Pre-processing: This is the most critical process. It is used to improve the efficiency and quality of data. Data pre-processing is done in two steps which are as follows:

Missing Value Removal: As our dataset does not contain any missing values, the process for removing missing values will be skipped.

Splitting The Data: When data cleaning is done, the data will get normalized in the training and testing model.

After splitting the data, it is trained using logic and an algorithm.

Applying the SVM Algorithm: We use the SVM algorithm after the data is pre-processed. The algorithm is applied to UCI datasets and analyzes the algorithm's accuracy.

On the User end, the following activity will take place:

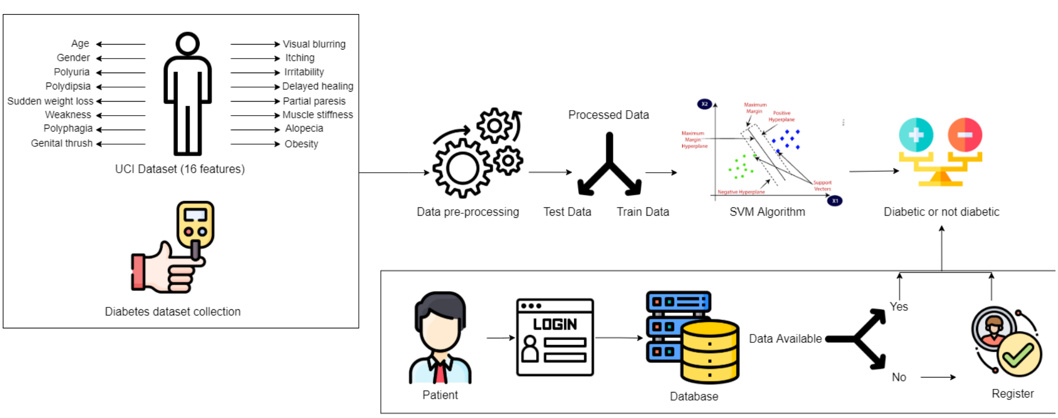
Login and Registration: The user or patient will log into the system, enter their details, and register themselves.

Enter The Details: The user will enter the details such as age and gender and the symptoms in terms of yes or no.

Match Values: The values the user enters are now matched with the database by applying the SVM algorithm.

Output Is Generated: After matching the values and applying the SVM algorithm, the Output is generated, and the result is displayed to the user. The Output is presented in terms of YES or NO.

Figure 2. Architecture diagram



Workflow

A Workflow is a type of diagram representing a system's process. It can be defined as a diagrammatic representation of a diabetes disease prediction system, a step-by-step approach to predicting the possibility of diabetes.

Initially, the data collection of diabetic patients is done. After that, the collected data moves to the pre-processing stage, and irreverent features are removed from the datasets. After that, it turns to the testing and training phase. When data testing and training are done, SVM algorithms are applied to the data, and the predicted outcome is generated using SVM algorithms.

The workflow diagram defines various steps such as data collection, pre-processing, testing, analysis and prediction. The data of diabetic patients is collected here from the UCI (University of California Irvine) Machine Learning Repository, which is available for males and females. The UCI dataset has 16 attributes, which will further help improve the system's accuracy. The next step is Data Pre-processing, where the raw data is manipulated and converted into efficient and valuable data, increasing the system's performance. That is preparing the raw data and making it suitable for a machine-learning model. When data pre-processing is complete, we move to the next step, training and testing the data. In the training model, the UCI Dataset is fed to the SVM algorithm to train the model. It helps the program to understand the dataset for predicting the Output. Training datasets are provided to machine learning algorithms to teach them how to make predictions or perform a desired task. Now, the test data are the data which will determine whether our system returns the expected result or not. Data testing measures performance, such as the algorithm's accuracy. As the training and testing of the data are done, we apply the SVM algorithm to the available data, which will help predict diabetes. The SVM algorithm is used to help predict the possibility of diabetes and provide the user with an output.

IMPLEMENTATION AND RESULTS

1. Import the dependencies
2. Load the diabetes dataset to a pandas DataFrame.
3. Standardize the data using the function scaler.transform()
4. Split the dataset by using train_test_split()
5. Use function SVC(kernel = 'linear')
6. Use Classifier. fit() function to train the model.
7. Perform prediction on the test set using Classifier. predict()

We've made a model to predict diabetes with 520 classes and 16 attributes; among them, 320 are marked as 1, i.e., Positive and 200 are marked as 0, i.e., Negative.

Heatmap can be defined as the graphical representation of data using various colors to create the value of the matrix. The darker colors represent the higher values, whereas the brighter one represents the low value of multiple attributes in the below figure.

Figure 3. Workflow diagram

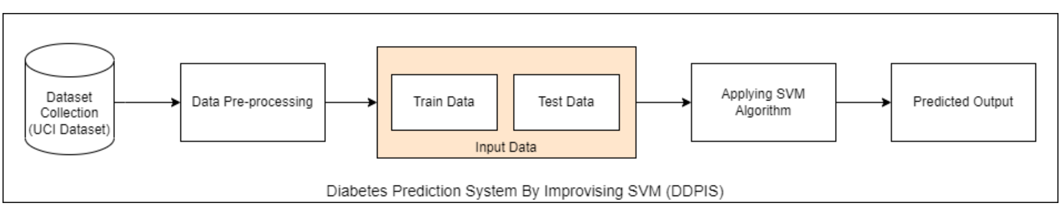


Figure 4. Outcome count

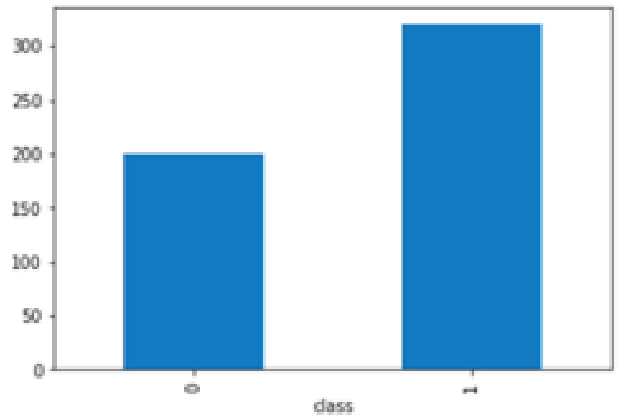
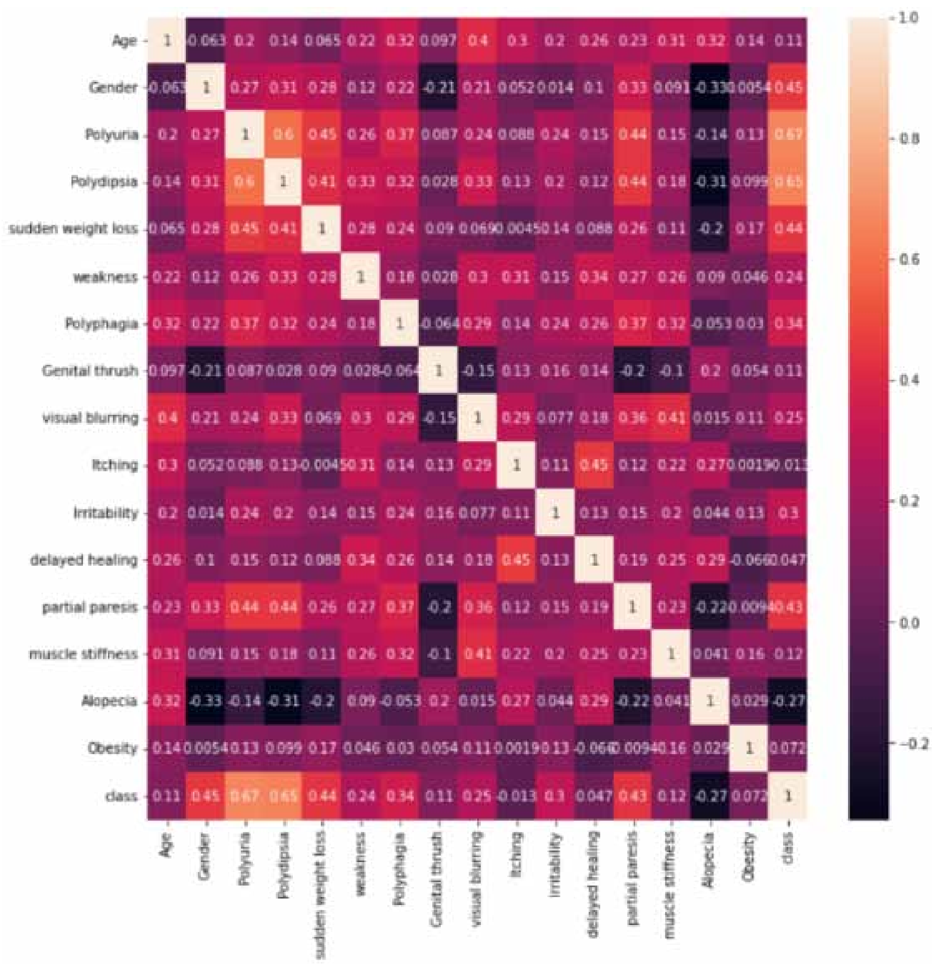


Figure 5. Heat map



Accuracy Score

The accuracy we got from our Diabetes Disease Prediction by Improvising SVM is 93.26%. We have used 16 attributes to improvise the performance of SVM, including the attributes of both females and males.

CONCLUSION

Diabetes is a fatal chronic disease that harms the entire body system. The body of a diabetic patient has a high level of blood sugar. Various machine learning techniques could be utilized to forecast the presence of disease, such as SVM, Logistic regression, KNN, XGBoost, etc. In our research paper, we propose a diabetes occurrence prediction system that can predict the occurrence of diabetes disease using SVM. Earlier, the dataset consisted of a smaller number of features comprising the patients' medical details that were useful in determining the patient's health condition. It was mainly focused on gestational diabetes. In this implementation, we used a dataset comprising more features, which helped us increase the accuracy of SVM to 93.26%. The dataset included females and males, and it was built to help patients assess the risk of diabetes.

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Competing Interests

All authors of this article declare there are no competing interest.

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