Diabetes Prediction using Data Mining Techniques

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Abstract:- Diabetes is a chronic disease with the potential to cause a worldwide health care crisis. According to International Diabetes Federation 382 million people are living with diabetes across the whole world. By 2035, this will be doubled as 592 million. Diabetes is a disease caused due to the increase level of blood glucose. This high blood glucose produces the symptoms of frequent urination, increased thirst, and increased hunger. Diabetes is a one of the leading cause of blindness, kidney failure, amputations, heart failure and stroke. When we eat, our body turns food into sugars, or glucose. At that point, our pancreas is supposed to release insulin. Insulin serves as a key to open our cells, to allow the glucose to enter and allow us to use the glucose for energy. But with diabetes, this system does not work. Type 1 and type 2 diabetes are the most common forms of the disease, but there are also other kinds, such as gestational diabetes, which occurs during pregnancy, as well as other forms. Machine learning is an emerging scientific field in data science dealing with the ways in which machines learn from experience. The aim of this project is to develop a system which can perform early prediction of diabetes for a patient with a higher accuracy by combining the results of different machine learning techniques. The algorithms like K nearest neighbour, Logistic Regression, Random forest, Support vector machine and Decision tree are used. The accuracy of the model using each of the algorithms is calculated. Then the one with a good accuracy is taken as the model for predicting the diabetes.

Keywords: *Diabetes, Machine, Learning, Prediction, Dataset, Ensemble*

I. INTRODUCTION

The term "diabetes" is a disease that occurs when the blood glucose in the body, also called blood sugar, is too high. Blood glucose is the main source of energy and comes from the food we eat. According to doctors, diabetes occurs when a gland known as the pancreas does not release a hormone called insulin in sufficient quantity. Insulin is a hormone that carries sugar from the bloodstream to various cells to be used as energy. Lack of insulin disrupts the body's natural ability to produce and use insulin accurately. As a result of this, high levels of glucose are released in urine. In the long-term, diabetes when not properly managed can lead to organ failure, and cardiovascular diseases and disrupts other functions of the body. Diabetes usually known as Diabetes Mellitus. It is a type of metabolic disorder in which diabetics experience blood glucose difficulties as a result of irregular ulin production and release. It's also a long-term condition marked by hyperglycemia. It is one of the world's most serious diseases, and it can lead to a variety of consequences. According to recent rises in morbidity, the global number of diabetic patients will reach 642 million by 2040, suggesting

that one out of ery 10 people will have the disease. This alarming figure, without a doubt, requires quick attention.

Type 1 and Type 2 diabetes are the two most common forms. Type 1 diabetes can strike anyone at any age, although it strikes teenagers and children the most commonly. The body of a person with type 1 diabetes generates very little or no insulin, requiring daily insulin injections to keep blood glucose levels under control. Type 2 diabetes can strike anyone at any age, but it is more frequent in adults, accounting for over 90% of all diabetes occurrences. The body of a person with type 2 diabetes does not make good use of the insulin it produces. The cornerstone of type 2 diabetes care is a healthy lifestyle that includes increased physical activity and a balanced diet. The majority of people with type 2 diabetes, on the other hand, will eventually need medicines or insulin to keep their blood glucose levels in check.

II. LITERATURE REVIEW

K.VijiyaKumar et al. [11] proposed random Forest algorithm for the Prediction of diabetes develop a system which can perform early prediction of diabetes for a patient with a higher accuracy by using Random Forest algorithm in machine learning technique. The proposed model gives the best results for diabetic prediction and the result showed that the prediction system is capable of predicting the diabetes disease effectively, efficiently and most importantly, instantly. Nonso Nnamoko et al. [13] presented predicting diabetes onset: an ensemble supervised learning approach they used five widely used classifiers are employed for the ensembles and a meta-classifier is used to aggregate their outputs. The results are presented and compared with similar studies that used the same dataset within the literature. It is shown that by using the proposed method, diabetes onset prediction can be done with higher accuracy. Tejas N. Joshi et al. [12] presented Diabetes Prediction Using Machine Learning Techniques aims to predict diabetes via three different supervised machine learning methods including: SVM, Logistic regression, ANN. This project proposes an effective technique for earlier detection of the diabetes disease. Deeraj Shetty et al. [15] 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 Neighbor) to apply on diabetes patient's database and analyze them by taking various attributes of diabetes for prediction of diabetes disease. Muhammad Azeem Sarwar et al. [10] proposed study on prediction of diabetes using machine learning algorithms in healthcare they applied six different machine learning algorithms Performance and accuracy of the applied algorithms is discussed and compared. Comparison of the different machine learning techniques used in this study

reveals which algorithm is best suited for prediction of diabetes. Diabetes Prediction is becoming the area of interest for researchers in order to train the program to identify the patient are diabetic or not by applying proper classifier on the dataset. Based on previous research work, it has been observed that the classification process is not much improved. Hence a system is required as Diabetes Prediction is important area in computers, to handle the issues identified based on previous research.

III. PROPOSED METHODOLOGY

Goal of the paper is to investigate for model to predict diabetes with better accuracy. We experimented with different classification and ensemble algorithms to predict diabetes. In the following, we briefly discuss the phase.

A. Dataset Description- the data is gathered from UCI repository which is named as Pima Indian Diabetes Dataset. The dataset have many attributes of 768 patients.

Table 1: Dataset Description

S No.	Attributes
1	No Of Pregnancy
2	Glucose Levels
3	Blood Pressure
4	Skin thickness
5	Insulin
6	BMI(Body Mass Index)
7	Diabetes Pedigree Function
8	Age

The 9th attribute is class variable of each data points. This class variable shows the outcome 0 and 1 for diabetics which indicates positive or negative for diabetics.

Distribution of Diabetic patient- We made a model to predict diabetes however the dataset was slightly imbalanced having around 500 classes labeled as 0 means negative means no diabetes and 268 labeled as 1 means positive means diabetic.
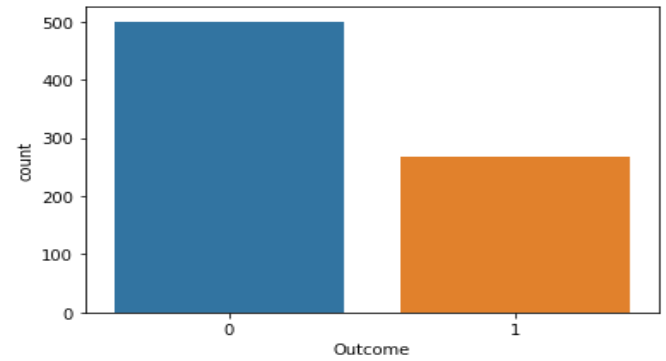

Figure 1: Ratio of Diabetic and Non Diabetic Patient

B.   Data Preprocessing- Data preprocessing is most important process. Mostly healthcare related data contains missing vale and other impurities that can cause effectiveness of data. To improve quality and effectiveness obtained after mining process, Data preprocessing is done. To use Machine Learning Techniques on the dataset effectively this process is essential for accurate result and successful prediction. For Pima Indian diabetes dataset we need to perform pre processing in two steps.

1). Missing Values removal- Remove all the instances that have zero (0) as worth. Having zero as worth is not possible. Therefore this instance is eliminated. Through eliminating irrelevant features/instances we make feature subset and this process is called features subset selection, which reduces diamentonality of data and help to work faster. **2). Splitting of data-** After cleaning the data, data is normalized in training and testing the model. When data is spitted then we train algorithm on the training data set and keep test data set aside. This training process will produce the training model based on logic and algorithms and values of the feature in training data. Basically aim of normalization is to bring all the attributes under same scale.

C.   Apply Machine Learning- When data has been ready we apply Machine Learning Technique. We use different classification and ensemble techniques, to predict diabetes. The methods applied on Pima Indians diabetes dataset. Main objective to apply Machine Learning Techniques to analyze the performance of these methods and find accuracy of them, and also been able to figure out the responsible/important feature which play a major role in prediction. The Techniques are follows-

1) Support Vector Machine- Support Vector Machine also known as svm is a supervised machine learning algorithm. Svm is most popular classification technique. Svm creates a hyperplane that separate two classes. It can create a hyperplane or set of hyperplane in high dimensional space. This hyper plane can be used for classification or regression also. Svm differentiates instances in specific classes and can also classify the entities which are not supported by data. Separation is done by through hyperplane performs the separation to the closest training point of any class.

Algorithm-
- Select the hyper plane which divides the class better.
- To find the better hyper plane you have to calculate the distance between the planes and the data which is called Margin.
- If the distance between the classes is low then the chance of miss conception is high and vice versa. So we need to
- Select the class which has the high margin. Margin = distance to positive point + Distance to negative point.

2) K-Nearest Neighbor - KNN is also a supervised machine learning algorithm. KNN helps to solve both the classification and regression problems. KNN is lazy prediction technique.KNN assumes that similar things are near to each other. Many times data points which are similar are very near to each other.KNN helps to group new work based on similarity measure.KNN algorithm record all the records and classify them according to their similarity measure. For finding the distance between the points uses tree like structure. To make a prediction for a new data point, the algorithm finds the closest data points in the training data set — it's nearest neighbors. Here **K**= Number of nearby neighbors, it's always a positive integer. Neighbor's value is chosen from set of class. Closeness is mainly defined in terms of Euclidean distance. The Euclidean distance between two points P and Q i.e. P (p1,p2, …. Pn) and

Q (q1, q2,..qn) is defined by the following equation:-

$$d(P,Q) = \sum_{i=1}^{n} (P_{i} - Q_{i})^2$$

- Take a sample dataset of columns and rows named as Pima Indian Diabetes data set.
- Take a test dataset of attributes and rows.
- Find the Euclidean distance by the help of formula-

$$EculideanDistance = \sqrt{\sum_{i=1}^{y} \sum_{j=1}^{m} \sum_{l=1}^{n-1} (R_{(j,l)} - P_{(i,l)})^2}$$

- Then, Decide a random value of K. is the no. of nearest neighbors
- Then with the help of these minimum distance and Euclidean distance find out the nth column of each.
- Find out the same output values.

If the values are same, then the patient is diabetic, otherwise not.

3)   Decision Tree- Decision tree is a basic classification method. It is supervised learning method. Decision tree used when response variable is categorical. Decision tree has tree like structure based model which describes classification process based on input feature. Input variables are any types like graph, text, discrete, continuous etc.

Steps for Decision Tree **Algorithm-**
- Construct tree with nodes as input feature.
- Select feature to predict the output from input feature whose information gain is highest.
- The highest information gain is calculated for each attribute in each node of tree.
- Repeat step 2 to form a subtree using the feature which is not used in above node.

4)   Logistic Regression- Logistic regression is also a supervised learning classification algorithm. It is used to estimate the probability of a binary response based on one or more predictors. They can be continuous or discrete. Logistic regression used when we want to classify or distinguish some data items into categories.

It classify the data in binary form means only in 0 and 1 which refer case to classify patient that is positive or negative for diabetes.

Main aim of logistic regression is to best fit which is responsible for describing the relationship between target and predictor variable. Logistic regression is a based on Linear regression model. Logistic regression model uses sigmoid function to predict probability of positive and negative class. Sigmoid function P = 1/1+e - (a+bx) Here P = probability, a and b = parameter of Model.

Ensembling- Ensembling is a machine learning technique Ensemble means using multiple learning algorithms together for some task. It provides better prediction than any other individual model that's why it is used. The main cause of error is noise bias and variance, ensemble methods help to reduce or minimize these errors. There are two popular ensemble methods such as – Bagging, Boosting, ada-boosting, Gradient boosting, voting, averaging etc. Here In these work we have used Bagging (Random forest) and Gradient boosting ensemble methods for predicting diabetes.

5) Random Forest – It is type of ensemble learning method and also used for classification and regression tasks. The accuracy it gives is grater then compared to other models. This method can easily handle large datasets. Random Forest is developed by Leo Bremen. It is popular ensemble Learning Method. Random Forest Improve Performance of Decision Tree by reducing variance. It operates by constructing a multitude of decision trees at training time and outputs the class that is the mode of the classes or classification or mean prediction (regression) of the individual trees.

Algorithm-
- The first step is to select the "R" features from the total features "m" where R<<M. • Among the "R" features, the node using the best split point.
- Split the node into sub nodes using the best split.
- Repeat a to c steps until "l" number of nodes has been reached.
- Built forest by repeating steps a to d for "a" number of times to create "n" number of trees.

The random forest finds the best split using the Gin-Index Cost Function which is given by:

$$Gini = \sum_{k=1}^{n} p_k * (1 - p_k) \; Where \; k = Each \; class \; and \\ p = proption \; of \; training \; instances$$

The first step is to need the take a glance at choices and use the foundations of each indiscriminately created decision tree to predict the result and stores the anticipated outcome at intervals the target place. Secondly, calculate the votes for each predicted target and ultimately, admit the high voted predicted target as a result of the ultimate prediction from the random forest formula. Some of the options of Random Forest does correct predictions result for a spread of applications are offered.

6) Gradient Boosting - Gradient Boosting is most powerful ensemble technique used for prediction and it is a classification technique. It combine week learner together to make strong learner models for prediction. It uses Decision Tree model. it classify complex data sets and it is very effective and popular method. In gradient boosting model performance improve over iterations.

Algorithm-

- Consider a sample of target values as P
- Estimate the error in target values.
- Update and adjust the weights to reduce error M.
- P[x] =p[x] +alpha M[x]
- Model Learners are analyzed and calculated by loss function F
- Repeat steps till desired & target result P.

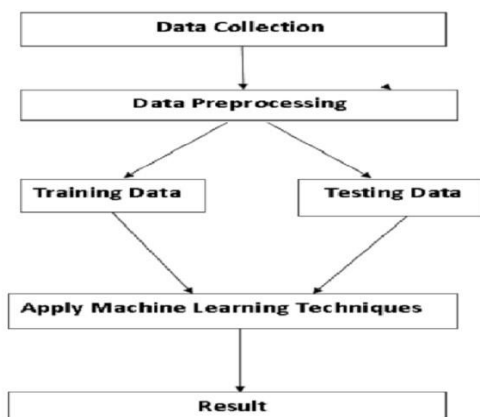Figure 2: Overview of the Process

IV. MODEL BUILDING

This is most important phase which includes model building for prediction of diabetes. In this we have implemented various machine learning algorithms which are discussed above for diabetes prediction.
Procedure of Proposed Methodology-
Step1: Import required libraries, Import diabetes dataset.

Step2: Pre-process data to remove missing data. **Step3:** Perform percentage split of 80% to divide dataset as Training set and 20% to Test set.
Step4: Select the machine learning algorithm i.e. KNearest Neighbor, Support Vector Machine, Decision Tree, Logistic regression, Random Forest and Gradient boosting algorithm.
Step5: Build the classifier model for the mentioned machine learning algorithm based on training set. **Step6:** Test the Classifier model for the mentioned machine learning algorithm based on test set.
Step7: Perform Comparison Evaluation of the experimental performance results obtained for each classifier.
Step8: After analyzing based on various measures conclude the best performing algorithm.

V. EXPERIMENTAL RESULTS

In this work different steps were taken. The proposed approach uses different classification and ensemble methods and implemented using python. These methods are standard Machine Learning methods used to obtain the best accuracy from data. In this work we see that random forest classifier achieves better compared to others. Overall we have used best Machine Learning techniques for prediction and to achieve high performance accuracy. Figure shows the result of these Machine Learning methods.
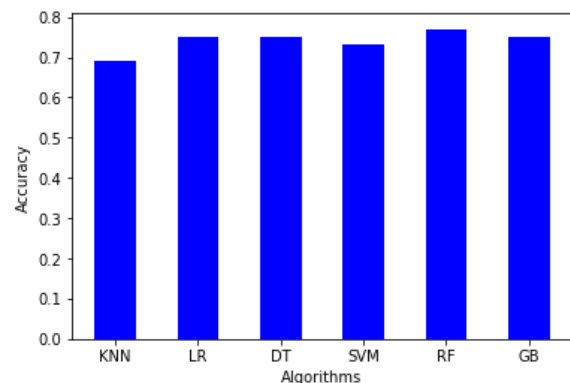

Figure3: Accuracy Result of Machine learning methods

Here feature played important role in prediction is presented for random forest algorithm. The sum of the importance of each feature playing major role for diabetes have been plotted, where X-axis represents the importance of each feature and Y-Axis the names of the features.
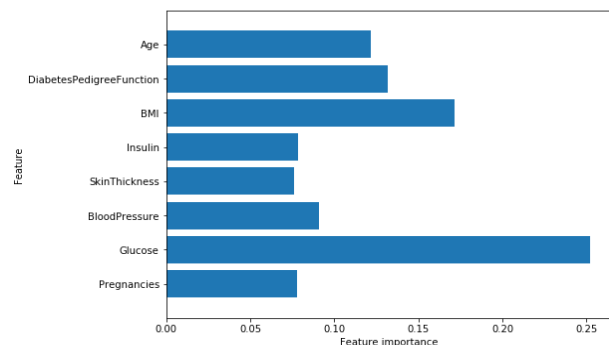

Figure 4: Feature Importance Plot for Random Forest

VI. CONCLUSION

The main aim of this project was to design and implement Diabetes Prediction Using Machine Learning Methods and Performance Analysis of that methods and it has been achieved successfully. The proposed approach uses various classification and ensemble learning method in which SVM, Knn, Random Forest, Decision Tree, Logistic Regression and Gradient Boosting classifiers are used. And 77% classification accuracy has been achieved. The Experimental results can be asst health care to take early prediction and make early decision to cure diabetes and save humans life.

VII.DEPLOYMENT

We have deployed all our models using the flask-web framework in the local host environment. The final prediction will be the majority vote on predicted labels of top-3 performed classifiers
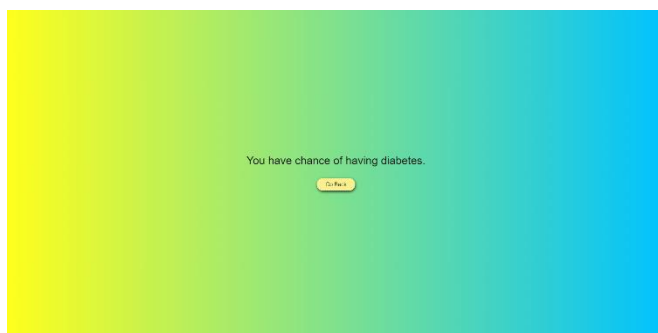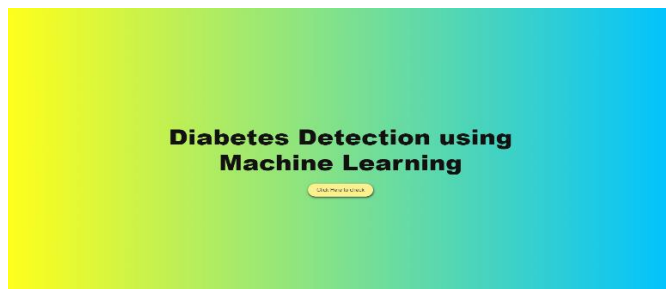
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