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by Subham Sinha

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DIABETES PREDICTION USING MACHINE LEARNING

SUBHAM SINHA, SUYASH PRATAP SINGH and SHASHANK PRATAP SINGH

ABESEC, Ghaziabad
Dr. A.P.J Abdul Kalam Technical University, Lucknow, India
E-mail : subham8084@gmail.com

ABSTRACT

Low insulin levels and high blood glucose levels in the body are the causes of diabetes. The symptoms of this raised blood sugar level include increased thirst, appetite, and frequency of urinating. Diabetes shouldn't be neglected since, if left untreated, it can have serious effects for a person, such as damage to the kidneys, heart, eyes, blood pressure, and other bodily organs. Diabetes may be controlled if it is discovered early. At a specific time, our pancreas is designed to release insulin. Our cells may be unlocked by insulin, allowing glucose to enter and be utilized by us as fuel.

However, diabetes makes this procedure inefficient. The most prevalent types of diabetes are type 1 and type 2, but there are other varieties as well, including gestational diabetes, which appears during pregnancy. For a higher degree of accuracy, we will use a variety of machine learning techniques to predict early onset diabetes in a human body or patient. Machine learning techniques build models using patient datasets to improve the accuracy of predictions.

A recent branch of data science called "machine learning" studies how computers pick up knowledge via knowledge.

The goal of this effort is to create a system that can more accurately identify early diabetes in a patient by merging the findings of different machine learning approaches. K-Nearest Neighbor, Decision Tree, Random Forest, Support Vector Machine, and Logistic Regression are some of the methodologies employed. The model's and each method's accuracy are calculated. The diabetes prediction model with the highest accuracy is then chosen.

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INTRODUCTION

Medical experts and other healthcare providers typically refer to diabetes, a chronic illness, as diabetes mellitus. Insufficient insulin synthesis, inappropriate insulin cell response, or a combination of the two can all lead to high blood sugar levels, which is what this word refers to as a set of metabolic illnesses. As a result, the level of glucose in the blood will increase. Although certain cases of diabetes are difficult to classify, type 1 and type 2 cases of the disease may be loosely classified into two groups. If diabetes is not treated, it causes several negative side effects.

As a result, not only does it harm individuals, but it also causes heart failure, kidney difficulties, and blindness. Due to inadequate pancreatic insulin synthesis or a body's inability to use the insulin that is produced, diabetes develops when blood glucose levels rise. Elevated amounts of glucose (sugar) in the blood and urine are signs of diabetes mellitus.

Types of Diabetes

Type 1 : Type 1 diabetes patients have a weakened immune system and decreased insulin synthesis in their cells. There are presently no proven preventative measures or therapies for type 1 diabetes, nor is it known with certainty what the causes are.

Type 2 : Either inadequate insulin production by cells or incorrect insulin usage by the body are characteristics of diabetes. 90% of people with diabetes have this kind, making it the most common type. Genetics and dietary habits both have a role in its occurrence.

Gestational Diabetes: High fasting blood sugar levels in pregnant women are a risk factor for gestational diabetes. In two-thirds of the cases, it will return during subsequent pregnancies. There is a considerable chance that type 1 or type 2 diabetes will manifest after a pregnancy in which gestational diabetes was present.

Symptoms of Diabetes.

- Frequently Urination
- Increased thirst
- Tired / Sleepiness
- Weight loss
- Blurred vision
- Confusion and difficulty concentrating
- Mood Swings

Causes of Diabetes

Genetics is primarily to blame for diabetes. It is caused by at least two chromosome 6 genes that are faulty and change how the body responds to certain antigens. Viral infection has the ability to influence the development of type 1 and type 2 diabetes. According to studies, carrying viruses such the CMV, mumps, rubella, or hepatitis B virus increases the likelihood of acquiring diabetes.

Diabetes is now one of the leading causes of illness and death in the vast majority of countries. This number is expected to approach 642 million by 2040, according to the International Diabetes Federation; as a

result, early screening and identification of diabetes patients is essential for early detection and effective treatment. Due to the nonlinear, atypical, correlation-structured, and complex character of the majority of medical data, analysing diabetic data can be difficult.

MOTIVATION

By 2020, 463 million people globally, including 88 million in Southeast Asia, are expected to get diabetes, according to the International Diabetes Federation (IDF). These 88 million individuals include 77 million Indians. According to the IDF, 8.9% of people have diabetes. In terms of the prevalence of type 1 diabetes among children, India is second only to the United States, according to IDF estimates. In the SEA region, type 1 diabetes in children is also more common there than everywhere else. Diabetes is said to be the cause of 2% of all fatalities in India, according to the WHO.

India now has 65 million diabetics, up from 26 million in 1990. The prevalence was determined to be 11.8% among those over 50, according to the Ministry of Health and Family Welfare's report on the 2019 National Diabetes and Diabetic Retinopathy Survey. According to the DHS study, 6.5% of those under 50 have diabetes, and 5.7% have prediabetes. Both the male (12%) and female (11.7%) groupings were equally frequent.

It was higher in cities. Testing revealed that the sight-threatening condition diabetic retinopathy was present in 16.9% of diabetics up to the age of 50. According to the survey, people aged 60 to 69, 70 to 79, and those beyond the age of 80 were most likely to have diabetic retinopathy (18.6%, 18.3%, and 18.4%, respectively). For people aged 50 to 59, the incidence was 14.3% lower.

In India, type 2 diabetes patients fall into four subgroups or clusters, of which two are peculiar to that nation. These categories may face varying levels of problem risk and require different treatments.

Women are the ones who are most affected, however children and young people account for the bulk of instances that have been reported. We have decided to work on a machine learning-based diabetes detection tool in view of these worrying figures.

PROJECT OBJECTIVE

The objective is to transform the desired outcome into a measurable and manageable goal.
Find answers by coming up with machine learning concepts (how to address the issue and accomplish the desired result). First comes divergent reasoning, then follows convergent reasoning.

The main goal is to develop and test many machine learning models, assess their precision, and choose the best and most precise one among them to recognize diabetes in a person based on particular traits and attributes.

SCOPE OF THE PROJECT

The process of scoping involves detailing a project and choosing the resources that will be utilized to finish it. There is more to planning than just that, though. Additionally, you must formulate the right queries, determine the objectives of your business, and then match those objectives with machine learning solutions. The first and generally regarded as the most important stage of a machine learning project's overall process is scoping.

Around 350 million people will have diabetes globally by 2030, and 642 million will by 2040, predicts the World Health Organization (WHO).

In order to minimize the diabetes pandemic that has befallen humanity, the scope involves creating machine learning models and testing them to see which ones are the most accurate to utilize in real-world circumstances.

RELATED PREVIOUS WORK

A great deal of research has been conducted on the non-invasive automated detection of diabetes using machine learning approaches. Utilizing the procedures of feature extraction, feature selection, and classification, machine learning was put into practise. There were various studies that differed in the classifiers used and the extracted characteristics. Additionally, it was shown that standard machine learning algorithms performed poorly on important AI tasks like speech recognition and object identification, mostly due to the amount of the data they had to handle.

The inadequacies of machine learning encouraged the development of deep learning research. Deep learning has further uses in the medical field. A considerable number of new studies have been published recently, particularly in the field of healthcare anomaly detection. Deep learning methods were used to make the diabetes diagnosis, and the accuracy level that resulted was about equivalent to the highest level of automated diabetes detection accuracy at the time. In the aforementioned study, we classified diabetes with a 95.7% accuracy rate. The most significant studies on the automated, noninvasive diagnosis of diabetes using HRV as compiled in Table 1.

Table 1: Works on the automated non-invasive detection of diabetes using HRV.

Methods	Accuracy obtained (in %)
Nonlinear	86.0
Higher order spectrum	90.5
Higher order spectrum	79.93
Nonlinear	90.0
Discrete wavelet transform	92.02
Empirical mode decomposition	95.63
Deep learning (CNN - LSTM)	95.1
Deep learning	95.7

LITERATURE REVIEW

K. Vijiya Kumar [1] To more precisely predict a patient's risk of acquiring diabetes

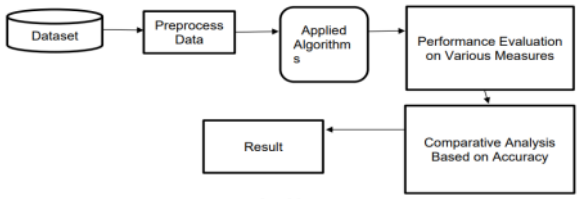
early on, K. developed a machine learning system that makes use of the Random Forest algorithm. The results demonstrated the prediction system's ability to accurately, quickly, and most importantly, efficiently anticipate the diabetes condition. The suggested approach produces the most accurate results for diabetes prediction. Nonso Nnamoko offered an approach to ensemble supervised learning for predicting the onset of diabetes. Following the usage of five commonly utilised classifiers for the ensembles, the findings were integrated using a meta-classifier. The outcomes are displayed and contrasted with findings from earlier studies that made use of the same dataset. It has been demonstrated that the proposed method can more precisely predict when diabetes would begin.

Aishwarya [2] attempts to create techniques to diagnose diabetes by researching and analysing the patterns that appear in the data through classification analysis using Decision Tree and Naive Bayes algorithms.. The study's goal is to develop a faster and more accurate means of disease diagnosis, which will aid in patients' quick treatment. Using a 70:30 split, the PIMA dataset, and a cross validation procedure, the study revealed that the J48 method achieves an accuracy rate of 74.8%, while the naive Bayes method achieves an accuracy rate of 79.5%.

Lee et al. [3] Focus on using the CART decision tree algorithm on the diabetes dataset after the data has been processed using the resample filter. The author emphasises the need of fixing the class imbalance problem before using any technique to increase accuracy rates. Class imbalance is more common in datasets with dichotomous values, which demonstrate the existence of a class variable with two alternative outcomes. If this imbalance is identified earlier during the data pre-processing stage, the prediction model's accuracy will increase.

SYSTEM DESIGN AND METHODOLOGY

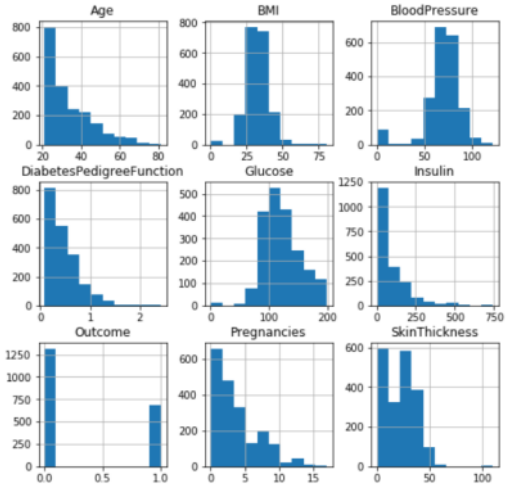
System Design



Proposed Model Diagram

IV. RESULT & DISCUSSION

Histogram



Dataset Description

The data was discovered in the UCI Pima Indian Diabetes Dataset repository. There is a lot of data in the collection regarding 768 patients.

The ninth characteristic for each data point is the class variable. This class variable indicates if the result is positive or negative for diabetes by showing the result for diabetics (0 or 1).

Distribution of Diabetic Patients: Despite the fact that we developed a model to predict diabetes, the dataset had 268 classes that had the label "1 indicates positive" and 268 classes that had the label "2 means negative."

Table 2 : Description of the Dataset

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	2	138	62	35	0	33.6	0.127	47	1
1	0	84	82	31	125	38.2	0.233	23	0
2	0	145	0	0	0	44.2	0.630	31	1
3	0	135	68	42	250	42.3	0.365	24	1
4	1	139	62	41	480	40.7	0.536	21	0

There are 2000 data points in the diabetes data collection, each with nine attributes..

We will forecast a characteristic called "Outcome," where 0 indicates no diabetes and 1 indicates diabetes.

ALGORITHM

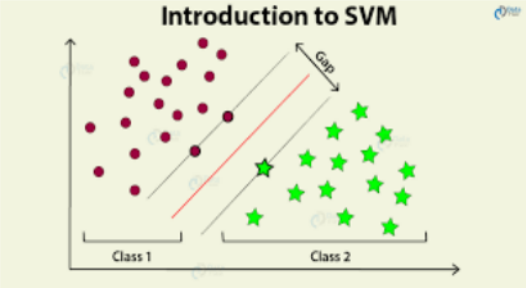
When the data is ready, the machine learning technique is used. To forecast diabetes, we employ a variety of ensemble and classification algorithms. the processes used to analyse the diabetes dataset among Pima Indians. The main goal is to use ML techniques to analyse the effectiveness of various approaches, evaluate their accuracy, and identify the critical variable that influences prediction.

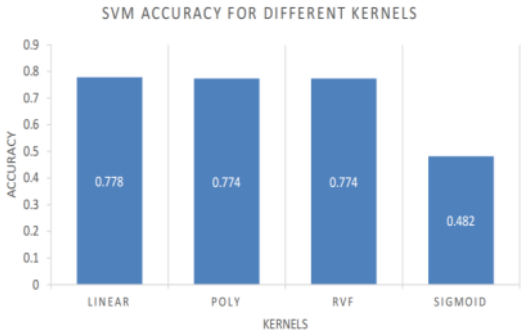
The Techniques are follows

1. **Support Vector Machine** - SVM stands for support vector machine, which is a method of supervised machine learning. The most used classification approach is SVM. SVM creates a hyperplane that divides two classes. It can result in a hyperplane or collection of hyperplanes in high-dimensional space. Regression or classification may both be performed using this hyperplane. SVM can distinguish between samples in particular classes and categorise objects for which no supporting data is available. A hyperplane is used to locate the nearest training site for each class for separation.

Algorithm-

- Choose the hyperplane that best divides the class.
- To determine the best hyperplane, you must compute the Margin, which is the distance between the planes and the data.
- Likelihood of miscarriage is higher and vice versa depending on how far the classes are from one another. As a result, we must
- Choose the class with the highest margin. Margin equals the distance between the positive and negative points.

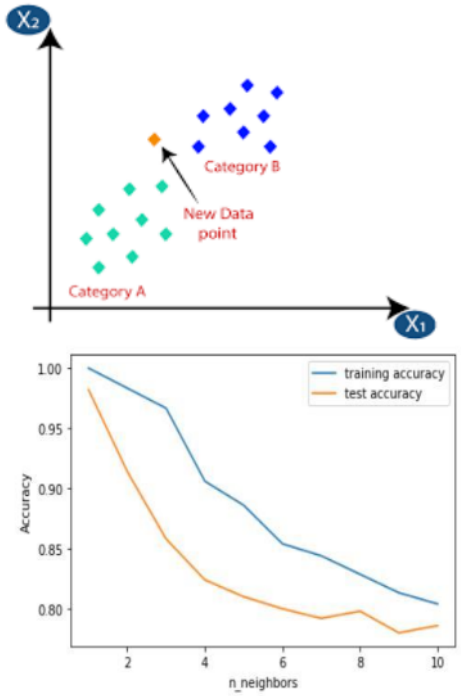




2. **K - Nearest Neighbor-** KNN is a supervised machine learning method that is distinct from others. KNN aids in the resolution of classification and regression difficulties. KNN is a slack prediction approach. According to KNN, similar objects should be found near to one another. Close proximity between similar data points is commonly seen. KNN provides assistance in categorizing new work using a similarity metric. Every record is collected and categorized using the KNN algorithm according to how similar they are. The distance between the places is calculated using a tree-like structure. To predict a new data point, the approach determines the closest training data points. K stands for "number of near neighbours," is always a positive integer in this context. A class value is selected for neighbours from a list of class values.

Algorithm-

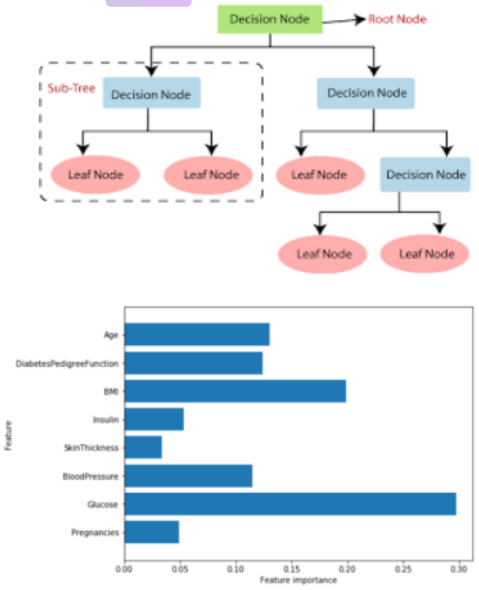
- Check out the Pima Indian Diabetes data collection, an example dataset with rows and columns.
- Think of a test dataset that has characteristics and rows.
- Determine the Euclidean distance by using the formula.
- The number of closest neighbours, K, should then be chosen at random.
- Then, using these minimal distances and Euclidean distance, each is calculated to the nth column.
- Discover the identical output values.
- The patient is diabetic if the levels are the same; otherwise, the patient is not.



3. **Decision Tree** - A significant categorising tool is the decision tree. It is a method of supervised learning. When the response variable is categorical, a decision tree is utilised. A decision tree is a tree-like architecture that selects categorisation depending on input characteristics. Input variables might be text, discrete, continuous, or graph.

Steps for Decision Tree Algorithm-

- Build a tree using nodes as input features.
- Choose the feature with the best information gain to forecast the output from the input feature.
- For each characteristic in each tree node, the greatest information gain is determined.
- Repeat step 2 to create a sub-tree utilising the feature that was not utilised in the previous node.

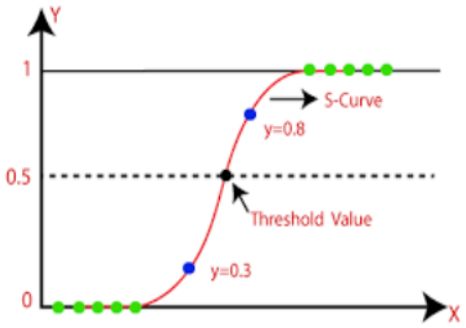


4. **Logistic Regression** -Logistic regression is yet another classification approach used in supervised learning. A binary response's propensity to be influenced by one or more predictors is assessed using this method. Discrete and continuous ones are both feasible. We utilise logistic regression to categorise or divide particular data points into groups.

Only the numbers 0 and 1 are used to classify the data in binary form, indicating whether or not a patient has diabetes.Logistic regression's main goal is to get the optimal fit, which best reflects the connection between the target and predictor variables. On top of the model for linear regression, logistic regression is constructed. To forecast the probability of the positive and negative classes, the logistic regression model uses the sigmoid function.

P = 1/1+e - (a+bx) Sigmoid function P denotes probability, a and b denotes Model parameters.

Ensembling - A machine learning strategy is being developed. Numerous learning algorithms are blended in an ensemble to accomplish a certain goal. It is utilised because it predicts more accurately than any other model. Noise bias and variation are the primary drivers of inaccuracy, and ensemble techniques assist in minimising or reducing these errors. Two popular ensemble algorithms include voting, averaging, ada-boosting, bagging, and gradient boosting. In this work, we employed the Gradient Boosting Ensemble and Bagging (Random forest) approaches to detect diabetes.



5. **Random Forest** - It is an ensemble learning approach that is used in classification and regression applications. It is more accurate than previous models. This method can easily handle large datasets. Leo Bremen created Random Forest. It is a well-liked technique for group learning. By lowering variation, Random Forest enhances Decision Tree performance. The class that reflects the average of all classes, classifications, or average predictions (regressions) of all trees is formed after a large number of decision trees have been built during training.

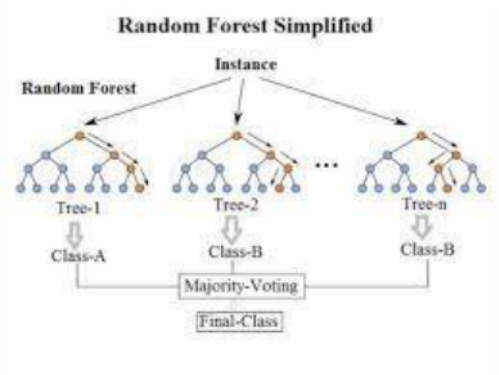
Algorithm-

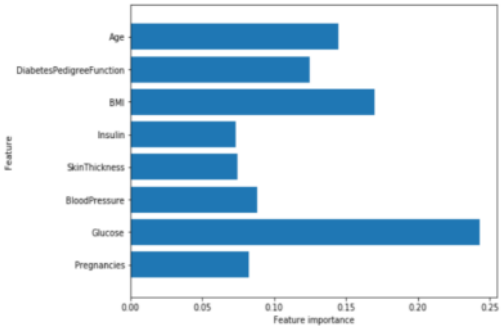
- Picking the R features where R>M from the total set of features is the first step.
- The node utilising the optimal split point among the R characteristics.
- Using the best split, divide the node into sub nodes.
- Repeat steps a through c until the l th node is reached..

Repetition of steps a through d n times produced the n trees that made up the forest.

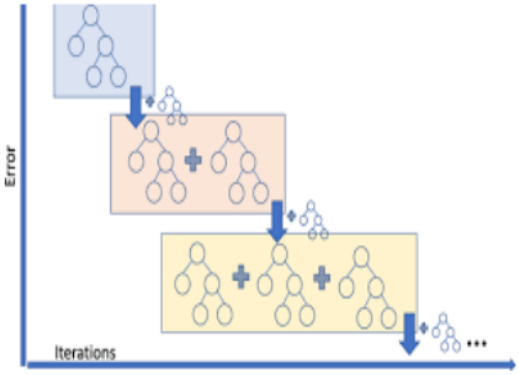
The Gin-Index Cost Function is used by the random forest to determine the best split and is made available via:

Options are thought about, results are projected using the bases of each decision tree that was produced at random, and the projected outcomes are stored at intervals around the desired location in the first step. Votes should be counted for each projected goal, and the projected goal with the most support should be used as the result of the final random forest technique prediction. For a number of applications, Random Forest provides a wide range of techniques that deliver precise forecasts.





- Calculate the target value error.
- To decrease mistake M, update and change the weights.
- P[x] = alpha M[x] + p[x]
- The loss function F analyses and calculates model learners.
- Repeat steps until desired and target result P is obtained..



6. **Gradient Boosting** – The most effective ensemble method for prediction and classification is gradient boosting.. Weak learners are combined to produce effective learning models for prediction. It is decided to employ the decision tree model. It is a popular and commonly used method for categorising huge, complex data sets. Gradient boosting models improve with iteration.

Algorithm-

- Consider the following sample of target values: P.

IMPLEMENTATION AND RESULTS

Software and Hardware Requirements

The major software and hardware requirements include :

Python

A high-level, all-purpose programming language is Python. Code readability is prioritised in its design philosophy, which typically employs indentation.

Both dynamic typing and garbage collection are supported by Python. Procedural, structured, object-oriented, and functional programming are just a few of the

programming paradigms that it supports (especially this). This language's vast standard library has given it the nickname "batteries included."

Python was developed by Guido van Rossum in the late 1980s to replace the ABC programming language. Python 0.9.0 was made public in 1991. New features including list comprehensions, reference counting, cycle-detecting garbage collection, and support for Unicode were included in Python 2.0 when it was released in 2000. 2008 saw the release of Python 3.0, a substantial change that was not entirely backwards compatible with earlier iterations. 2020 saw the end of Python 2 with version 2.7.18.

NumPy

NumPy is a Python open source project that aims to make numerical computation easier. The Numeric and Numarray libraries' initial work served as the foundation for its creation in 2005. Free, fully open source, and in line with the permissive provisions of the modified BSD licence, NumPy will always be made available.

According to the NumPy and larger science Python communities, NumPy is maintained publicly on GitHub.

Pandas

Pandas is a collection of data analysis and manipulation tools made especially for the Python programming language. It provides detailed instructions for utilising mathematical tables and time series data. It is free software that is released in accordance with the license's three clauses.

An econometrics term for data sets that include observations for the same people over several time periods is panel data. The name of Python data analysis is punny. In his time from 2007 to 2010 as a researcher at AQR Capital, Wes McKinney started developing the pandas that would later become well-known.

Matplot Lib

Python's NumPy extension for numerical mathematics, along with Matplotlib, are graphing libraries. It provides an object-oriented API for adding charts to applications that make use of a general-purpose GUI toolkit like Tkinter, wxPython, Qt, or GTK. The state machine-based procedural "pylab" interface, designed to closely resemble the MATLAB interface, should not be used (similar to OpenGL). In SciPy, Matplotlib is utilised.

Matplotlib is ascribed to its creator, John D. Hunter. Since then, a healthy development community has developed around it, and it is presently available under a BSD-like licence. Michael Droettboom and Thomas Caswell were both suggested as matplotlib's primary developers before John Hunter passed away in August 2012. The Matplotlib project receives financial support from NumFOCUS. Python 2.7 to 3.10 are compatible with Matplotlib 2.0.x. Python 3 was initially supported by Matplotlib 1.2, whereas Python 2.6 was last supported by Matplotlib 1.4. By committing to discontinue Python 2 support after 2020, Matplotlib made a commitment to the Python 3 Statement.

Seaborn

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Pimas Indian database

This dataset was originally stored by the National Institute of Diabetes and Digestive and Kidney Diseases. Based on key diagnostic indications that are available in the data, the dataset attempts to diagnose diabetes. Based on a number of factors, these examples were picked from a larger database. Particularly, Pima Indian women who are at least 21 years old make up the majority of the clinic's clientele.

MODEL BUILDING

The stage that involves creating a model for predicting diabetes is the most crucial. This took use of the previously stated machine learning algorithms for diabetes prediction.The proposed methodology's process-

Step 1: Import the diabetic dataset along with the necessary libraries.

Step 2: To fill in any gaps, Pre-process the data.

Step 3: Divide the dataset in half, 80% for training and 20% for testing.

Step 4: Choose from the following machine learning methods: K-Nearest Neighbor, Support Vector Machine, Gradient Boosting, Logistic Regression, Random Forest, and Decision Tree.

Step 5: For the aforementioned machine learning technique, create the classifier model based on the training set.

Step 6: To assess the Classifier model for the previously described machine learning technique, use a test set.

Step 7: Compare the experimental performance outcomes of each classifier.

Step 8: After analysing various metrics, select the best performing algorithm.

CONCLUSION

The early diagnosis of diabetes is one of the most significant medical issues today. This strategy consciously works to create a diabetes prediction system. Six machine learning categorization techniques are looked into and assessed in this study based on a number of different factors. Experiments are being carried out on the Pima Indian database.

Algorithms	Training Accuracy	Testing Accuracy
k-Nearest Neighbors	81%	78%
Logistic Regression	78%	78%
Decision Tree	98%	99%
Random Forest	94%	97%
SVM	76%	77%

Table-5

Future Directions

Future research may predict or diagnose new ailments using the developed approach and ML classification techniques. The approach might be enhanced and broadened for diabetes analysis automation by including new machine learning methods.

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Possessive This word may be a plural noun and may not need an apostrophe.

PAGE 2

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Prep. You may be using the wrong preposition.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

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P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

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Article Error You may need to use an article before this word. Consider using the article **the**.

Wrong Form You may have used the wrong form of this word.

PAGE 3

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Article Error You may need to remove this article.

Article Error You may need to use an article before this word.

Missing "," You may need to place a comma after this word.

PAGE 5

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PAGE 6

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Verb This verb may be incorrect. Proofread the sentence to make sure you have used the correct form of the verb.

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S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

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Run-on This sentence may be a run-on sentence. Proofread it to see if it contains too many independent clauses or contains independent clauses that have been combined without conjunctions or punctuation. Look at the "Writer's Handbook" for advice about correcting run-on sentences.

S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

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Proofread This part of the sentence contains a grammatical error or misspelled word that makes your meaning unclear.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Missing "," You have a spelling or typing mistake that makes the sentence appear to have a comma error.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

Proper Noun If this word is a proper noun, you need to capitalize it.

Possessive This word may be a plural noun and may not need an apostrophe.

Confused You have used **a** in this sentence. You may need to use **an** instead.

Confused You have a spelling mistake near the word **a** that makes **a** appear to be a confused-word error.

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Dup. You have typed two **articles** in a row. You may need to delete one of them.

Article Error You may need to use an article before this word. Consider using the article **a**.

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Article Error You may need to use an article before this word.

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