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An Comparative Analysis of Hybrid Ann With Logistic Regression Approach for Diabetic Prediction

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Data analysis, diabetic prediction, neural networks, prediction algorithms, classification, components.

Abstract

DIABETES IS ONE OF THE MOST SERIOUS ILLNESSES THAT AFFECTS A LOT OF PEOPLE. OBESITY, INACTIVITY, GENETIC DIABETES, A POOR LIFESTYLE, EATING UNHEALTHILY, HIGH BLOOD PRESSURE, ETC. CAN ALL ADD TO DIABETES MELLITUS. PATIENTS WITH DIABETES ARE MORE PRONE TO ILLNESSES INCLUDING HEART DISEASE, KIDNEY DISEASE, STROKE, VISUAL PROBLEMS, NERVE DAMAGE, ETC. A VARIETY OF TESTS ARE NOW ROUTINELY USED IN HOSPITALS TO ACQUIRE THE INFORMATION REQUIRED FOR A DIABETES DIAGNOSIS, AND THE DIAGNOSIS IS THEN USED TO DETERMINE THE APPROPRIATE COURSE OF TREATMENT. BIG DATA ANALYTICS IS ESSENTIAL IN THE HEALTHCARE INDUSTRY. THE HEALTHCARE INDUSTRY USES HUGE DATABASES. WITH THE USE OF BIG DATA ANALYTICS, IT IS POSSIBLE TO ANALYSE ENORMOUS DATASETS, UNEARTH CONCEALED INFORMATION, AND DISCOVER CONCEALED PATTERNS IN ORDER TO DERIVE KNOWLEDGE FROM THE DATA AND ACCURATELY FORESEE OUTCOMES. THE CURRENT STRATEGY HAS POOR CATEGORIZATION AND PREDICTION ACCURACY. IN THIS PROJECT, WE IDENTIFY DIABETICS USING A HYBRID MACHINE LEARNING METHOD CALLED HYBRID ANN WITH A LOGISTIC APPROACH. WE WERE ABLE TO ATTAIN HIGH ACCURACY OF OVER 90% WITH THIS STRATEGY THROUGHOUT TESTING AND TRAINING.

1. Introduction

It can be challenging to forecast events in real time today. When predicting the likelihood of a certain conclusion, such as whether or not a client would leave in 30 days, it represents the output of an algorithm after it has been trained on a prior dataset and applied on new data. Each record in the new data will have potential values for an unknown variable generated by the procedure, which will let the model's author choose the value that is most likely to be given to that variable.

Even the word "prediction" itself may be misleading. In other circumstances, such as when using machine learning to determine the optimal course of action for a marketing campaign, you are projecting future events. The "prediction" may, however, refer to an already occurring event, such as whether a transaction was fraudulent or not. In this case, the transaction is already over, but you're still trying to figure out whether it was legitimate so you may choose what to do next.

Predictions Important:

Machine learning model predictions allow firms to generate incredibly accurate estimations about the most likely results of a question based on prior data. These inferences can be made on a range of issues, such as the risk of client churn, potential fraud, and more. They provide knowledge to the business that actually affects its bottom line. For instance, the business can target a customer with personalised outreach and message if a model shows the customer is likely to quit.

A. Machine learning's explanation of predictions:

Machine learning predictions provide context for how or why an AI platform came to a conclusion. These models haven't always clarified the process by which decisions are made. This ambiguity leads to the "black box" syndrome, in which predictions are made but it is not evident which feature variables have an effect on the output of a model. Learning how to make judgements is based on the rules that machine learning models create while studying the training dataset. Prediction explanations make it easier for us to understand these rules, how they work with new data, and which factors are most crucial to consider when making predictions. The prediction explanation assigns a level of significance to each input value, and when all of those levels are added together, you get 100%. For decision

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tree models, the explanation of the prediction follows the prediction path. However, for other calculations, such as regression, the results of several projections that exploit arbitrary fluctuations in the input data are averaged.

B. Explanations for predictions Helpful:

Understanding how your AI systems analyze feature variables to make predictions is necessary for making data-driven decisions. By identifying the inputs that have the most influence on the results, you can gain insight into what influences factors like consumer trends or revenue growth. When machine learning algorithms are used in industries like finance, regulations demand explanations for the predictions made. In order to prove that a credit decision was fair, loan providers must explain why they denied a loan application and how they arrived at that conclusion. Since medical professionals must explain diagnoses, they are also crucial in healthcare.

C. Diabetics Prediction:

In 2017, there were 425 million diabetics globally, according to a survey by the International Diabetes Federation [1]. Its figure was projected to increase to 625 million by 2045 [2]. Reduced glucose absorption is a symptom of diabetes mellitus, a group of endocrine disorders brought on by absolute or relative insulin insufficiency. In addition to having a long history, the disease is defined by a disturbance of all types of metabolism. Type 1 diabetes, type 2 diabetes, gestational diabetes mellitus, and specialised kinds of diabetes resulting from different causes are the four primary groups into which diabetes is divided [3].Strokes, heart attacks, chronic renal failure, diabetic foot syndrome, antipathy, neuropathy, encephalopathy, hyperthyroidism, adrenal gland tumours, cirrhosis of the liver, glucagonoma, transient hyperglycemia, and many more are just a few of the potentially fatal complications from either type of the disease. Hence, for everyone who is at risk for developing the condition, diabetes prediction [4] and early identification [5] are crucial. Deep neural networks [6] function best when classifying issues, and many diseases are currently diagnosed using AI approaches. Recently, DNNs have been used to diagnose illnesses. Without diabetes, the pancreas functions normally and makes enough insulin. The entrance for the glucose molecule into the cell will open after insulin connects to receptors on the cell's surface. T1D prevents the pancreas from making insulin, which obstructs the process of transporting glucose to cells. The inability of the pancreas to generate insulin does not cause T2D. The insulin receptors that make it possible for the cells to receive enough glucose and insulin are no longer able to react to the insulin that is being given to the cells.

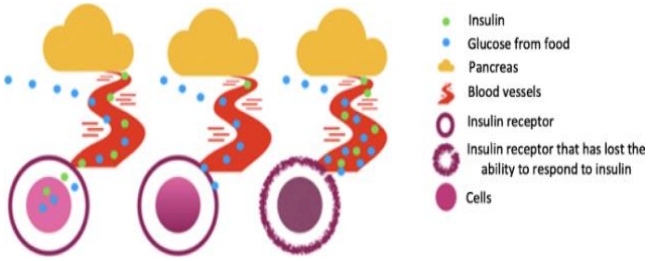

Fig.1 Processes of Glucose Entering Cells

Methods that allow glucose to enter cells. This picture illustrates three different ways that glucose enters cells. The first procedure is typical when a person does not have diabetes and his pancreas produces enough insulin. The second step takes place when a patient is diagnosed with type 1 diabetes. Type 1 diabetes affects the body's capacity to transport glucose to cells because the pancreas eventually quits producing insulin. The final procedure demonstrates type 2 diabetes's repercussions, which are not caused by the pancreas' failure to produce insulin. The insulin receptors that allow insulin to enter cells can no longer be activated by insulin, despite the organism getting adequate amounts of both insulin and glucose.Deep learning [7, 8] is a new innovation in machine learning that has made substantial progress in speech recognition and computer vision. The neural network was initially developed using machine perception. It differs from machine perception since it linked the several hidden levels [9]. As the network depth increases, the feature level increases, increasing the expressiveness of the model. Flexible applications of the approach include downscaling, grouping, regression, and classification. There may be numerous outputs on the output layer. The activation function of the perceptron is a sign (z), which is simple but has limited processing capability. Deep neural networks frequently include nonlinear variables and make use of activation functions like Sigmoid, Softmax, tax, ReLU, soft plus, and others to improve the model's capacity for self-expression.

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The multilayer perceptron is a development in artificial perception that is frequently referred to as the deep neural network [10, 11]. (MLP). Based on their locations, the layers of the DNN can be divided into three groups: the input layer, hidden layers, and output layer. In many cases, the first layer is the input layer, the last layer is the output layer, and the middle layers are the hidden layers. Depending on the problems in various industries, people have developed numerous deep neural networks, including the convolutional neural network (CNN) and the recurrent neural network. (RNN). The parameters' restrictions and the mining of the local structure make the CNN model suitable for voice and image recognition. The RNN can be used in both handwriting recognition and natural language processing since the chronological sequence in which samples are presented is important.

2. Related Works

A model to predict diabetes was developed by Huaping Zhou, Raushan Myrzashova, and Rui Zheng utilising an improved deep neural network. Diabetes is currently one of the most prevalent, deadly, and chronic diseases in the world because of its multiple complications. Early diabetes detection is essential for effective treatment since it can arrest the progression of the condition. The suggested method can be used to determine the type of disease a person has as well as predict if diabetes will develop in the future. Since type 1 diabetes and type 2 diabetes are handled in very different ways, this strategy will help provide the patient with the right care. The hidden layers of a deep neural network are principally used in the construction of our model, which transforms the task into a classification problem and uses dropout regularisation to prevent overfitting. We built a deep neural network prediction model with a high level of accuracy using the binary cross-entropy loss function and other parameter modifications. The developmental conclusions display how efficient and workable the DLPD(Deep Learning for Predicting Diabetes) miniature. The training accuracy for the diabetes data set for Pima Indians is 92.4112%, whereas the training accuracy for the diabetes data set for diabetes types is 90.02174%. Numerous studies have been conducted on the diabetes and variables associated with diabetes in Pima Indians. The experimental findings show the benefits of our proposed approach over cutting-edge methods. According to Francesco Mercaldoa, Vittoria Nardone, and Antonella Santone, medical studies revealed that the prevalence of diabetic pathology has been increasing over the past few decades and that this trend is not anticipated to change.

IMPLEMENTATION OF A SYSTEM

Blood glucose levels increase with diabetes, a chronic, widespread disorder brought on by the body's inability to produce adequate insulin. If untreated or undetected, diabetes has a number of negative health effects on adults. Despite the fact that this condition cannot be treated, early detection and fast treatment can lessen the dangers of the complaint's development and rigidity. In the proposed system, we mix a mongrel neural network with logistic retrogression. We were able to develop great delicacy because to the use of this technology; throughout testing and training, our delicacy was over 90%.

D. Obtaining Data

From the Kaggle website, we downloaded the dataset of diabetes complaints. Over 6000 case records make up this data, which includes characteristics like gravidity, glucose position, blood pressure position, skin consistency, body mass index, birth function for diabetes, age, and outgrowth.

E. Processing of Data Before Use

The data is preserved inside a Pandas data frame and was originally recovered using the Pandas library. Since our machine learning model cannot accept null values, we have removed all of the null values from the dataset.

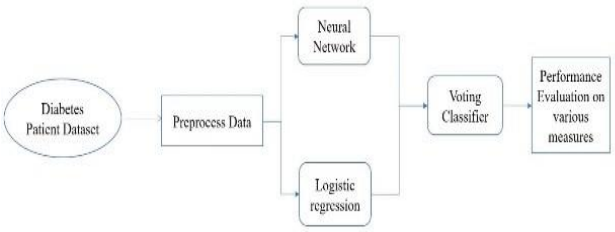

Fig.2 Proposed System Architecture

F. Description for Module

When utilising the input dataset from the Panda library, the diabetes values are accurate at first. Additionally, the null value is removed from the data before features are picked for input into the SVM, Naive Bayes, decision

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tree, and mongrel algorithm of the neural network with logistic retrogression. Finally, utilising a voting classifier to combine neural networks and logistic retrogression, we construct a mongrel ensemble machine learning style. The uprooted traits are eventually used to train the machine. We can prognosticate diabetes by incorporating test data into the mongrel model after training.

G. Learning from machines

The machine literacy field of artificial intelligence (AI) and computer wisdom focuses on using data and algorithms to simulate how individuals learn, gradually introducing the delicacy of the model. IBM has a lengthy history in artificial intelligence. With his research on the game of checkers, one of its own, Arthur Samuel, is credited with coining the term "machine literacy" (PDF, 481 KB). (link lives outside IBM). A tone-described checkers master named Robert Nealey challenged an IBM 7094 computer in 1962, but he lost.In light of what is currently feasible, this accomplishment almost seems small, but it is widely recognised as a pivotal moment in the evolution of artificial intelligence.

Machine literacy is a key component of data wisdom, a rapidly increasing field. Data mining activities use algorithms that have been taught to generate groupings or forecasts using statistical methods. The decisions made as a result of these perceptions have an excellent impact on key growth directions in operations and businesses. As big data evolves and expands, data scientists will be more in demand because they will be needed to help identify the most crucial business issues and the data to address them.

H. Logistic Regression

To read a data value based on prior data set compliances, a statistical analysis technique known as logistic retrogression is performed. In the area of machine literacy, logistic retrogression has become more significant. The technology makes it possible for an algorithm used in machine learning to classify new data based on old data. As more material data is supplied, the system should get more proficient at predicting classes within data sets. Logistic retrogression can also be employed in data medication operations by allowing data sets to be loaded into specific, designated pails during the excerpt, transfigure, cargo (ETL) process to carry the information for analysis.

I. Additionally, logistic regression can be used in,

- Medical attention to identify disease risk factors and develop preventive measures.
- Weather forecasting apps that can predict the weather and the amount of snowfall.
- Voting apps forecast the likelihood that a voter would back a particular candidate.
- Insurance that uses a number of variables, such as gender, age, and physical condition, to estimate the risk that a policyholder will pass away before the policy's term expires.
- Banking to calculate a borrower's risk of loan default based on annual income, past defaults, and current obligations.

J. Artificial Neural Networks

Artificial neurons, a group of connected units or bumps that roughly resemble the neurons in a healthy brain, are the foundation of an artificial neural network (ANN). Each link can send a signal to nearby neurons, just like synapses do in a living brain. An artificial neuron that has recycled a signal it has received can gesture neurons that are connected to it. Real numbers are used as the "signal" at each link, and each neuron's "affair" is decided by some non-linear function of the total of its inputs. Edges and connections are related. The weight of neurons and edges frequently changes while literacy takes place. The weight modifies the signal strength of a connection by increasing or decreasing it. Neurons might have a threshold that they will only cross in order to send a signal. Neurons continuously organise into layers.

Different inputs may be modified using colourful layers. The distance that signals travel through the layers from the first subcaste (the input subcaste) to the last subcaste may be longer than it was previously. (the affair subcaste). An artificial neural network (ANN) is a part of a computing system that mimics the evaluation and processing of information by the human brain. It acts as the cornerstone of artificial intelligence (AI) and solves problems that would be impossible or laborious

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according to statistical or mortal standards. As more data becomes available, ANNs can provide better answers since they are tone-literate.

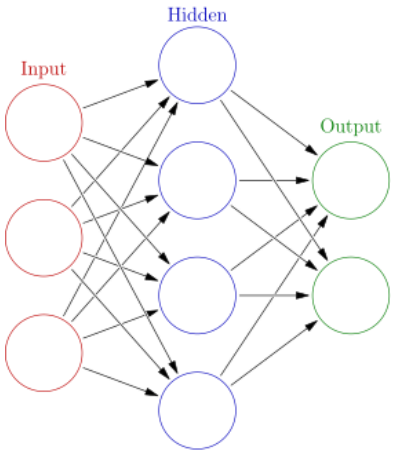

Fig.3 Structure of a Neural Network

ANNs were first created in an effort to exploit the architecture of the human brain to perform tasks that were challenging for conventional algorithms to effectively complete. They eventually gave up trying to be as biologically accurate as possible and instead refocused on improving empirical discoveries. Neurons are connected in a number of ways to allow the input of one neuron to become the output of another. A weighted, directed graph is produced by the system.

An artificial neural network is composed of a number of synthetic neurons. Each neuron has a node-like structure that connects to other nodes in a manner akin to the biological axon-synapse-dendrite connections. The strength with which one node affects another is determined by the weight of each link.

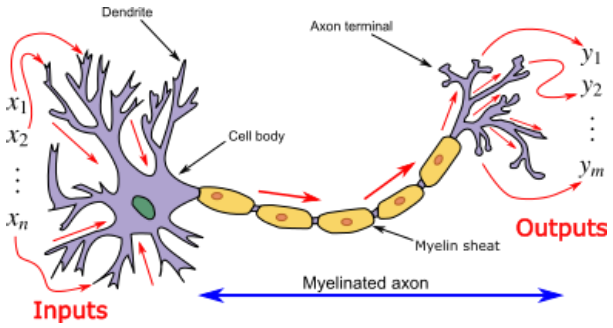

Fig.4 Signal flow in a neuron and myelinated axon with inputs at dendrites and outputs at axon terminals.

K. Components of an ANN

Conceptually, artificial neurons were conceptually developed from biological neurons to form ANNs. Each artificial neuron has inputs and a single output that can be shared by numerous other neurons. The inputs might be the results of other neurons or they could be a sample of feature values from outside sources, such images or papers. The outputs of the final output neurons of the neural network serve the purpose, such as identifying an object in a picture.

The output of the neuron is first determined from the weighted total of all the inputs, corrected for the weights of the connections from the inputs to the neuron. This weighted total is frequently referred to as activation. This weighted total is then sent through an activation function, which is frequently nonlinear, to produce the output. The initial inputs consist of external data like images and written documents. The purpose is successfully accomplished by the final outcomes, such as correctly identifying an object in an image.

L. Weights and Connections

The connections in the network allow the output of one neuron to act as the input for another. Each link is assigned a weight to represent its level of importance. For one neuron at a time, several input and output connections are available.

M. Function of Propagation

A weighted sum of a neuron's input is created by the propagation function from the connections and outputs of its predecessor neurons. The output of the propagation may be modified to include a bias term.

N. Artificial Neurons

An artificial neuron is a mathematical function created as a representation of biological neurons or a neural network. Artificial neurons are the fundamental constituents of an artificial neural network. The artificial neuron adds up one or more inputs, which stand in for excitatory and inhibitory postsynaptic potentials at neuronal dendrites, to create an output known as activation, which represents a cell's action potential as it travels along its axon. After each input is typically given a different weight, the sum is then passed using a non-

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linear function called an activation function or transfer function.

The transfer functions can be step functions, piecewise linear functions, or other non-linear functions even though they often have a sigmoid form. They are also commonly continuous, differentiable, bounded, and monotonically ascending. The thresholding function was the driving force behind the development of threshold logic gates that could be used to design logic circuits that mimicked brain processing. For instance, memristors, a type of contemporary hardware, have recently been extensively used to build such logic.

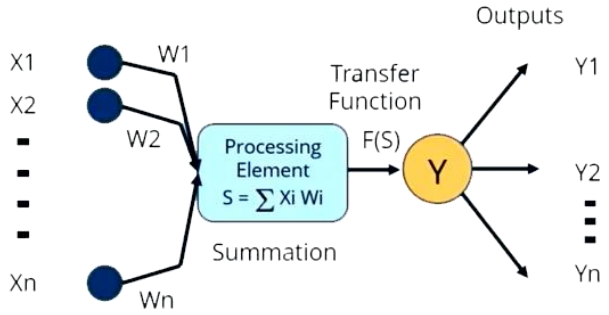

Fig. 5 Artificial Neurons

O. Mathematical Perceptron Model

A machine learning method for supervised learning of binary classifiers is the perceptron. An input, which is represented as a vector of integers, can be classified into one of several categories using a binary classifier function. It is a particular kind of linear classifier, or a data classification method, that bases its predictions on a linear predictor function that combines the feature vector with a number of weights.

$$f(x) = b_0 + \sum_{i=0}^{n} (b_i * w_i) \qquad (1)$$

$$b_i = Inputs \;\; w_i = Weights \;\; b_0 = Bias$$

P. Multilayer Perceptrons

Multilayer perceptron (MLP) artificial neural networks are a subclass of feed forward neural networks (ANN). MLP is a general term that can sometimes be used to describe any feedforward ANN and other times only to refer to networks with numerous layers of perception. (with threshold activation). Because they only contain one hidden layer, multilayer perceptions are frequently referred to as "vanilla" neural networks

An MLP has at least three layers of nodes, including an input layer, a hidden layer, and an output layer. Every node is a neuron that employs a nonlinear activation function, with the exception of the input nodes. During training, MLP employs the supervised learning technique known as backpropagation. Due to its multiple layers and non-linear activation, MLP differs from a linear perceptron. Data that cannot be separated linearly can be distinguished.

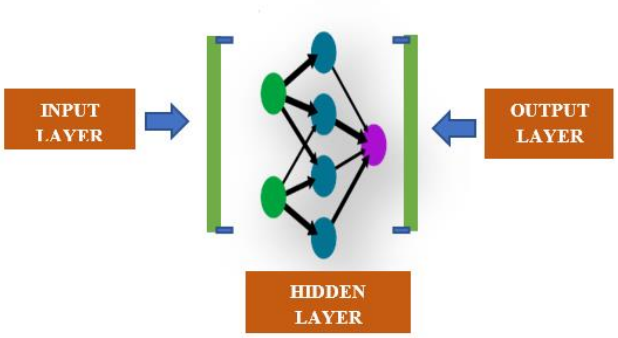

Fig. 6 Multiple Perceptron Network

Q. Gradient Descent

It is a method of cost-saving optimisation that seeks to identify the minimum value of a function.

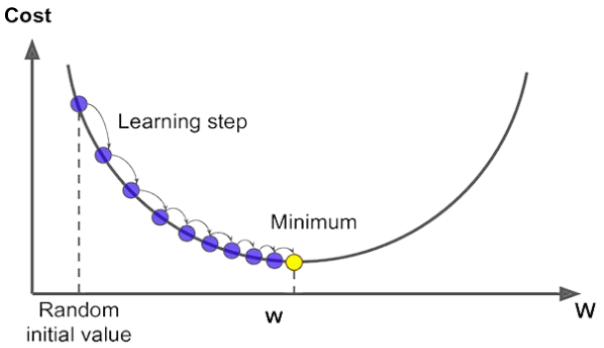

Fig. 7. Correlation among random value with cost

R. Back Propagation

A common method in machine learning for training feed-forward neural networks is back-propagation (back-prop, BP). Several artificial neural networks (ANNs) and generic functions have backpropagation generalisations. All of these collections of algorithms

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are referred to as backpropagation collectively. Backpropagation effectively calculates the gradient of the loss function corresponding to the network weights for a single input-output example while training a neural network, as opposed to a naive direct computation of the gradient for each weight individually.

Due to this efficiency, multilayer networks can be trained using gradient methods while having their weights updated to minimise loss. It is common to use gradient descent or one of its variations, such as stochastic gradient descent.The backpropagation algorithm operates by computing the gradient of the loss function to each weight using the chain rule, one layer at a time, then iterating backward from the last layer in order to prevent duplicating calculations of intermediate terms in the chain rule. Every node is a neuron that employs a nonlinear activation function, with the exception of the input nodes.

S. Proposed Ensemble Voting Classifier

The Ensemble Voting Classifier is a meta-classifier that combines machine learning classifiers with conceptual bases for majority or plurality voting that are similar or different. (For convenience, we will refer to both majority and plurality voting as "majority votes.")

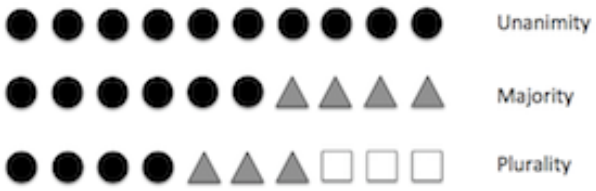

Fig. 8 Voting Classifier

Polling are implemented by the Ensemble Vote Classifier are both tough and tender. In hard voting, we select the final class label that the classification models have correctly predicted the majority of the time. We predict the class labels in soft voting by averaging the class probability.

T. Hard Voting

Hard voting is the most basic kind of majority voting.Here, we predict the class label yy using the majority (plurality) vote of each classifier CjCj:

y=modeC1(x),C2(x),...,Cm(x)

We employ a hard voting method.

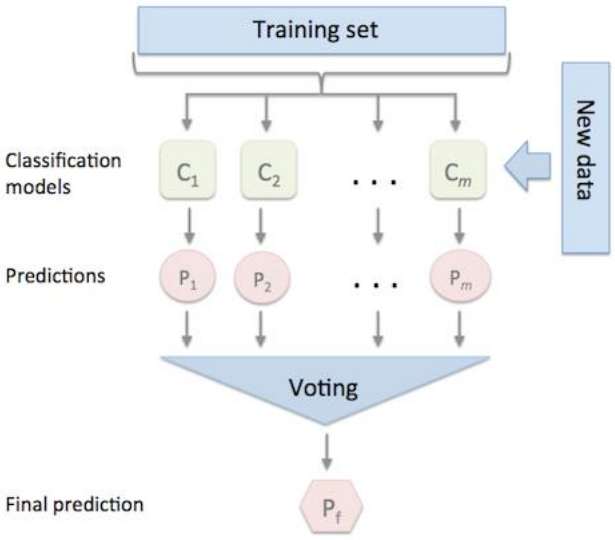

Fig. 9 Hard Voting Process

3. Result and Discussion

U. Input Dataset

- Over 6000 individuals' medical histories are included in the collection. The table has 9 columns and 6000 rows.
- On the Kaggle website, you can obtain this dataset.

Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
6	148	72	35	0	33.6	0.627	50	1
1	85	66	29	0	26.6	0.351	31	0
8	183	64	0	0	23.3	0.672	32	1
1	89	66	23	94	28.1	0.167	21	0
0	137	40	35	168	43.1	2.288	33	1
5	116	74	0	0	25.6	0.201	30	0
3	78	50	32	88	31	0.248	26	1
10	115	0	0	0	35.3	0.134	29	0
2	197	70	45	543	30.5	0.158	53	1
8	125	96	0	0	0	0.232	54	1
4	110	92	0	0	37.6	0.191	30	0
10	168	74	0	0	38	0.537	34	1
10	139	80	0	0	27.1	1.441	57	0
1	189	60	23	846	30.1	0.398	59	1
5	166	72	19	175	25.8	0.587	51	1
7	100	0	0	0	30	0.484	32	1
0	118	84	47	230	45.8	0.551	31	1
7	107	74	0	0	29.6	0.254	31	1
1	103	30	38	83	43.3	0.183	33	0
1	115	70	30	96	34.6	0.529	32	1
3	126	88	41	235	39.3	0.704	27	0
8	99	84	0	0	35.4	0.388	50	0
7	196	90	0	0	39.8	0.451	41	1

Fig. 10 Input dataset of patent history

V. ANN Training

- The diagram above illustrates the training of an artificial neural network. Over a thousand times have been spent training our ANN model.

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- During training, it shows certain characteristics like Training Accuracy and Training Loss.

Fig. 11 ANN Training Method

W. Trained Model

- The diagram above depicts the learned artificial neural network model.
- The machine saves its training memory in the.h5 format after training.

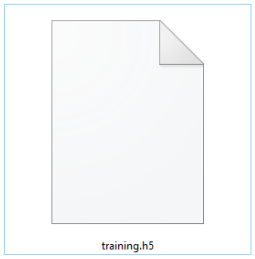

Fig. 12 ANN Trained Memory Format

X. Result of Hybrid ANN With LR

- The hybrid ANN and logistic regression approach's testing results are depicted in the top diagram.
- The accuracy of a hybrid algorithm is 92%.

```
Confussion Matrix for hybrid ANN + LR
[[961  41]
 [ 62 472]]
accuracy score of hybrid algorithm accuracy is
0.9329427083333334

Precision: 0.920078
Recall: 0.883895
F1 score: 0.901624
Cohens kappa: 0.850791
```

Fig. 13 Result of Hybrid ANN + LR

4. Conclusion

In this paper, we Examines the predicting of diabetes illness. Our hybrid approach predicts outcomes with accuracy and consistency, and its patterns match those in the available dataset. As a result, our algorithm is perfectly calibrated and able to predict the onset of diabetes with accuracy. We used the Diabetes disease dataset, which includes data on about 6000 patients, for training purposes. After training, we forecast diabetes disease using test data and a hybrid ANN with logistic regression. Our model archives have an accuracy rate of more than 90% throughout testing and training. In this method, hybrid ensemble ANN with logistic regression offers excellent accuracy. Future work will focus on applying more deep learning techniques to increase accuracy.

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