Comparative Study of Machine Learning Approaches in Diabetes Prediction

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ABSTRACT

Diabetes is a common illness that scares people around the world about their health. Biomedical research effort helps in preventing diabetics and treat it in an efficient way. There are lot of traditional systems, but it cannot handle large amount of data and it leads to problems with high levels of complexity and often it was very tedious. This research helps to design a model that can predict the risk of diabetes in patients with acceptable accuracy. Therefore, to identify diabetes in initial stage, this experiment uses machine learning algorithms, namely Random Forest, J48 as well as Multilayer Perceptron. Experiments are carried out on data collected from the UCI machine learning repository that has been gathered from patients. The impacts of all three algorithms are calculated on many scales, such as Accuracy, Precision, Recall and F-Measure. Accuracy is calculated against instances predicted correctly and incorrectly. The results obtained indicates Random forest performs well with the highest precision of 97.5 percent compared to other algorithms but J48 algorithm took minimum time to build the model.

KEY WORDS: DIABETES, RANDOM FOREST, J48, MULTILAYER PERCEPTRON, MACHINE LEARNING.

INTRODUCTION

Machine learning algorithms can learn from data and evolve from experience, without involving human beings. Learning tasks can include learning the features that map input to output, learning the hidden structure in unlabeled data, also known as example-based learning, where a class label is created from training data by comparing the new instance to memory-stored instances (Goyal et al, 2018). There are three kinds of machine learning algorithms, like Supervised Learning, Unsupervised Learning and Reinforcement Learning. To study a mapping function that converts input variables

into output variables, Supervised Learning utilizes labelled training data (Priyanka et al, 2020a & 2020b). Instance -based learning does not create an abstraction from specific instances. Two ways of classification and regression are available for Supervised Learning. Classification is used in the form of categories to predict the result of a given sample data (Parameswari et al, 2015a & 2015. b). Unsupervised learning models are used where there are input variables and no corresponding output variables to model the basic structure of the data and are used in unlabeled training data. The reinforcement learning algorithm allows agent to decide the best next step by learning patterns that maximize a reward based on its present state (Sriram et al, 2020).

Diabetes occur when the body is not capable to produce insulin properly, which enables the body to absorb glucose as a cellular fuel and use it. This leads to a persistent increase in blood glucose levels and other abnormalities, leading in turn to the development of complications of the disease. Type I diabetes and type 2 diabetics are the common forms of diabetes. In type

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I, the immune system initiated a misguided attack and destroyed the pancreas beta cells (Rehman et al, 2020). Approximately 5% of people with diagnosed diabetes are affected and it develops mostly during childhood. The body becomes immune to insulin and destroys the development of insulin in type II diabetes, which affects most organs. It is very important to predict diabetics at an early stage. There are many computer intelligence methods available that help with the available data sets to carry out analysis.

Related Works: The combination of fuzzy logic along with artificial neural networks and case-based reasoning for information engineering techniques has been proposed. Modified co-occurrence and cluster-based mean mode technique was implemented to manage mixed data types that can be used for any type of system (Sokolovska et al, 2018). Optimization of the updated fuzzy ant-miner designed for medical diagnostic efficacy. There are a variety of methods used to produce rules from the medical domain database (Priyanka et al, 2020c). In order to perform a diabetic prediction process, a modified and improved form of artificial bee colony algorithm have been used with an evolutionary algorithm to construct a classification system that allows doctors to make decisions. It is proposed to apply an approach that generates association rules on numeric data to medical data. Predictive Apriori diabetic prediction algorithms have been suggested by generate association rules.

In addition, there is also a greater risk of infection in people with diabetes. In most of the developed nations, diabetes is a leading cause of cardiovascular disease, blindness, kidney failure and lower levels of diabetes (Sierra-Sosa et al, 2019). Development of predictive models in predicting diabetics using risk factors is very significant. Traditional approaches have been proposed by several studies as predictors. Algorithms like Naive Bayes, Logistic Regression and Random Forest assessed the dataset and Random Forest was found to have the highest accuracy on this dataset which we used for this research. Many research come out with prediction of disease by generating rules by using Enhanced Apriori (EA) algorithm with minimum execution time and with better results comparing to the traditional algorithm.

Proposed Methodology: For the healthcare field, the Machine Learning Algorithm has tremendous potential as it allows health systems to use medical data for research and improve healthcare at reduced costs. Data mining techniques are useful in the prediction and diagnosis of different health issues, such as heart disease, diabetes, cancer, skin disease and so many more, when applied to health care (Parameswari & Manikantan 2017). A more detailed way in which the information was used to predict diabetics at an early stage was discussed in this part. The proposed system forecasts the diabetics of a

individual based on questions and answers provided to the prediction system. The impacts of all three algorithms are calculated on many scales, like Precision, Accuracy, F-Measure, and Recall. Accuracy is calculated against correct and incorrectly predicted instances (Priyanka & Thangavel, 2020).

Random Forest Algorithm: Random Forest is a supervised learning algorithm used for both classification and regression. But it is, however, primarily used for problems with classification. As inferred, a forest is made up of trees, and more trees make the forest stronger. Similarly, the random forest algorithm produces decision trees on data samples and then gets the prediction from every one of them and picks the best solution by polling. It is an ensemble strategy that is stronger than a single decision (Parameswari et al, 2015c).

1. Begin by selecting random samples from a specific dataset.
2. For every sample, this algorithm will create a decision tree. Then, from any decision tree, it will get the prediction result.
3. For each predicted outcome, voting will be carried out at this point.
4. Eventually, as the final prediction outcome, pick the most voted prediction result.

J48 Algorithm: In order to construct a trimmed C4.5 decision tree, Quinlan's C4.5 algorithm updates J48. All aspects of the data are divided into minor subsets based on a decision. J48 looks at the structured data that really results in the information being broken by selecting an attribute. The attributes are used to obtain extremely structured knowledge. By the algorithm, the minor subsets are returned (Nagata et al, 2018). When a subset has a position with a similar class, the split strategies end.

It functions as follows.

1. If the instances belong to a similar class, the leaf is labelled with a similar class.
2. The possible data will be measured for each attribute, and the benefit in the data will be taken from the attribute test.
3. Eventually, based on the current selection criteria, the best attribute will be picked.

Multilayer Perceptron: In Artificial Neural Network (ANN), feed forward neural network class is the Multilayer Perceptron (MLP). The term MLP is applied ambiguously, for any feed-forward ANN, often specifically to mention networks made up of multiple perceptron layers. Multilayer Perceptron is often referred to colloquially as vanilla neural networks, particularly when they have a single hidden layer. The MLP consists of three main layers that is, input layer, hidden layer, and the output

layer (Mir and Dhagae 2018). Every node is a neuron that utilizes a nonlinear activation function, except for the input nodes. MLP uses a supervised learning approach to back-propagation training. MLP is distinguished from a linear perceptron by its several layers and non-linear activation. It can discern data which cannot be separated linearly.

RESULTS AND DISCUSSION

The Weka tool is used in this research work to complete the experiment. Weka is a software tool that includes a collection of different machine learning methods for data classification, clustering, regression and visualization. One of the key advantages of using Weka is that it can be customized to suit the requirements. The main objective of this research is to predict diabetes-affected patients. We have used the algorithm J48 with modified Weka. Updated Weka offers various types of data file classification test choices, such as user training set, test set given and cross-validation. The 10-fold cross-validation data is chosen.

Table 1. Data Set Description

S.No	Attribute	Description
1.	Age	Patient Age
2.	Gender	Male/Female
3.	Polyuria	Sign of diabetics
4.	Polydipsia	Increase in Thirst
5.	Weight loss	Patient having sudden weight loss
6.	Weakness	Happens if cells don't have an adequate amount of glucose
7.	Polyphagia	Extreme hunger
8.	Genital thrush	Yeast infection
9.	Visual blurring	Temporary blurred vision
10.	Itching	Skin itching
11.	Irritability	Disturbance in patient mood.
12.	Delayed healing	Delay in wound healing
13.	Partial paresis	Weakness in muscles
14.	Muscle stiffness	Feeling tightness in muscles.
15.	Alopecia	Disorder that is the reason for hair fall.
16.	Obesity	Unnecessary body fat

Data Set Description: Data was obtained using direct surveys from patients at Sylhet Diabetes Hospital in Sylhet, Bangladesh, donated to the UCI repository. The suggested approach that is taken from the UCI Repository is evaluated. This dataset contains medical descriptions of male and female patients in 520 instances. In the dataset, there are 16 attributes where the value of one class 0 is viewed as diabetes negative and the value of

another class 1 is viewed as diabetes positive. Dataset in this research work has 520 instances and sixteen attributes namely and all the 16 attributes are described in the Table 1.

Table 2. Accuracy Measures

Algorithm	Correct Predictions	Incorrect Predictions
Random Forest	507	13
Multilayer perceptron	501	19
J48	499	21

Table 3. Prediction Results

Algorithm	Accuracy	Time (Model Building)
Random Forest	97.5	0.14
Multilayer perceptron	96.3	0.78
J48	95.9	0.01

Figure 1: Accuracy Measures of different algorithm in manipulations

In Figures 1, 2 and 3, the pictorial representations of the prediction results and the time taken to construct the computational model of the three algorithms were given and the results are discussed in Table 2, 3, and 4. Where the difference in time between all three algorithms can be seen. The impacts of all three algorithms were evaluated on different scales such as Precision, Accuracy,

F-Measure, and Recall. Precision is measured against exact and wrongly calculated events. The results obtained indicate that Random Forest performs well with the highest accuracy of 97.5 percent compared to other algorithms, but the J48 algorithm took limited time to create the model.

Figure 2: Prediction Results of different algorithms during manipulations

Table 4. Performance of Machine Learning Algorithms for Different Measures

Algorithm	TPR	FPR	Precision	Recall	F-Measure
Random Forest					
Forest	0.975	0.027	0.975	0.975	0.975
Multilayer perceptron	0.963	0.038	0.964	0.963	0.964
J48	0.960	0.035	0.961	0.960	0.960

Figure 3: Performance of Machine Learning Algorithms for Different Measures

CONCLUSION

Any intelligence systems for the management of diabetics should be established with regard to the high incidence of diabetics and their impact on mortality. So the suggested system may support individuals with their symptoms to

predict diabetics at an early stage. This research results in disease prediction through the use of machine learning algorithms that provide diabetic patients with knowledge. The proposed method shows that the impacts of all three algorithms are calculated by different measures such as Precision, Accuracy, F-Measure, and Recall. Compared to other algorithms, the results obtained indicate that Random forest performs well with the highest accuracy of 97.5%, but the J48 algorithm took limited time to construct the model.

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