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A Review on Role of Machine Learning Models on Coronary Heart Disease Detection Accuracy

Vikas Lamba
Chitkara University Institute of Engineering and Technology, Punjab

Tarun Agarwal
Vivekananda Global University, Jaipur

Ankesh Gupta
Vivekananda Institute of Technology, Jaipur

Jyoti Sharma
Vivekananda Institute of Technology, Jaipur

Abstract: It would be better if stats data on heart disease could be added here. For eg. According to WHO the number of people is reported to be suffering from heart disease, making it the most common disease worldwide. As we know that sometimes the lifestyle of human beings suffers from stress, anxiety, and depression, etc. The Detection of this disease is quite difficult in advance and it is challenging in medical science. The target of this paper is to understand certain machine learning models (MLMs) detection accuracy with classification techniques and limitations. Many researchers used certain machine learning models called classification techniques like naive bays (NB) decision tree (DT), Cooperative Neural-Network Ensembles (CNNEs) logistic regression (LR), Support Vector Machine (SVM), Least Square Twin Support Vector Machine (LSTSVM), k-Nearest Neighbor (KNN), Bays Net (BN), Artificial Neural Network (ANN) and Multi-Layer Perception (MLP).in general, we have a total of 50+ Features Attributes in the dataset. And we select the most appropriate features to detect the disease by using different features selection techniques to improve the accuracy. Maximum classification accuracy of 96.29% was achieved and we need to improve the accuracy with a minimum amount of time and try to develop single MLMs for detection and selection of precise features to improve the accuracy. Many researchers use hybrid approaches to combine two or more classification techniques (based on selected symptoms and features of a human being) in the layered form to improve the accuracy in terms of percentages. Sometimes it's not more effective and time-consuming. Hence, we need to develop flexible MLMs with feature selection and reduction techniques. Thus, the present study is focused on improving the accuracy. Also, include future perspectives or applications of your study.

Keywords: Multi-Layer Perception, naive bays, Support Vector Machine**, Artificial Neural Network, K-Nearest Neighbor, Cooperative Neural-Network Ensembles, The least Square Twin Support Vector Machine.**

I. *INTRODUCTION*

In medical science, a healthy heart is the sign of healthy fit life. Lots of people are suffering from this disease as per the medical industry data it's a common disease and several people die. So, the detection of this disease is on a priority basis for health care. A heart has four chambers, two superior atrium, and two inferior ventricles. The atriums are the receiving chambers and the ventricles are the discharging chambers of the heart. In general, the most common heart disease is Coronary heart disease (CHD) it is a condition in which plaque deposits block the coronary blood vessels leading to a reduced supply of blood and oxygen to the heart[XuWenxin (2020), LuxmiVerma & Sangeet Srivastava (2018), Hong, et al.,(2021), DivyaTomar, Sonali Agarwal, (2014), Durairaj M, Revathi V (2015), Kadam et al., (2019)]. As per health care, we have certain ways for heart disease which consider Sedentary lifestyle food habit, family history stress, Diabetes, lack of exercise, Excess weight, age, high blood pressure, smoking, alcohol, drug abuse, cholesterol, fast blood sugar etc., [Sachin Kamley, (2019), Vikas Lamba (2015), Abhishek Taneja (2013), Murthy and Meenakshi (2013), Tarun Kumar Agrawal (2017), Florence et al., (2014)].

Naive Bays (NB): The Naive Bayes algorithm employs a simplified version of the Bayes formula to decide which class a feature belongs to. The posterior probability of each feature, given the feature values, presents in the instance; the instance is assigned the class with the highest probability. According to the Bayesian theorem

$$P(X|Y) = P(X)*P(Y/X)/P(Y),$$

Where $P(Y|X) = P(X \cap Y)/P(X)$

P(X)= The probability of X happen P(Y)= The probability of Y happen P(X|Y) =The probability of X given Y P(Y|X) = The probability of Y given X $P(X \cap Y)$) = The probability of both X and Y happen

Simple and Effective for the prediction process: Based on the above formula, the Bayesian classifier calculates the conditional probability of an instance belonging to each class Can work with single and/or multiclass mode. Require fewer statistics for training the build model. Perform better from others when supposition of sovereignty holds. Attains high results with categorical input variables. Assumed normal distribution for the numerical variable. However, the Naïve Bayes technique has much more rewards over others but has its limitations which can be pointed out as: Unable to make a correct prediction in a case when novel statistics occur. Algorithm work on the base of assumption, independent predictors. An entirely autonomous set of predictors is almost impossible. Assign a 0 (zero) probability for the real data if data is not present at the training time of the model i.e., not present within the training dataset. This issue can be crack by using the Laplace estimation technique.

Cooperative Neural-Network Ensembles (CNNEs)the proposed methodology emphasizes disease diagnoses accuracy and diversity among individual Neural Network (NNs). The approach determines the number of hidden nodes in individual NNs by a constructive approach and uses Incremental training based on negative correlation to training individual NNs over training epochs. An experimental result shows that this methodology produces good generalization ability over individual NNs [Markos et al., (2008), Kadam et al., (2019)].

The least Square Twin Support Vector Machine (LSTSVM) is a machine learning method that achieved the highest accuracy to diagnose heart diseases with only eleven features set. However, authors of this approach have not been evaluated feature selection mechanisms with other accessible techniques. On the other hand, techniques have not been analyzed with different data sets hence there is a chance that this technique may produce low accuracy with other data sets so it is not a good solution for the classification of heart disease [XuWenxin, (2020), Akhil et al., (2013), Jabbar (2013), Florence et al., (2014), Sanagala et al., (2019)].

K-Nearest Neighbor (KNN) Based Approaches are one of the most widely used data mining techniques in classification problems. However, it showing good performance in classification problems with various datasets but the main disadvantage of KNN classifiers is the large memory requirement needed to store the whole sample. When the sample is large, the response time on a sequential computer is also large. Despite the memory requirement issue, hence use of a simple KNN algorithm is not a good choice and required an optimization process [Xiao et al., (2017), Latha et al., (2018), Vikas Lamba et al., (2014)].

Artificial Neural Network (ANN) This model was developed for the prediction of the degree of angiographic coronary heart disease, and subsequently, its performance is evaluated using a heart disease database obtained from Cleveland Clinic Foundation Database with all numeric-valued attributes. About 88 cases of different aged angiographic coronary heart disease subjects with 13 attributes have been tested in this model and the study exhibits that ANN-based prognosis of coronary heart disease improves the diagnostic accuracy to 95.5 % which is comparably higher with earlier works [XuWenxin, (2020), Namariq et. al., (2019), Jane & Subha (2020), Das et al., (2020), Vikas Lamba et al., (2021)].

Multi-Layer Perception (MLP) Multilayer perception (MLP) is a feed-forward neural network, a form of artificial neural network (ANN) which maps the sets of input data onto a set of appropriate outputs. The term feedforward means that data flows in one direction from the input to the output layer. It uses a backpropagation learning procedure for the training purpose of the designed network and is more capable to solve problems that are not linearly separable therefore used widely for pattern classification, recognition, prediction, and approximation. In simple terms, an MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function. MLP utilizes a supervised learning technique called backpropagation for training the network. MLP is a modification of the standard linear perception and can distinguish data that is not linearly separable [Mohammad etal., (2014), Sai et al., (2016), Tarun Kumar Agrawal (2017), Madhavi & Soujanya, (2021), Deepti & Sheetal (2013), Vikas Lamba et al. (2016)].
This technique has the following advantages:

- Neural Network is proficient in managing extensive troubles.
- Can outperform even in complicated domains.
- Efficiently handle both categorical and continuous data types.
- Designed to be parallelized.

Decision Tree (DT) is related to the information entropy principle, and it is a mostly used classification technique. it is used to find a significant feature by making and pruning trees. This information is developed in every node to construct the decision tree. In the all possible features are analyzed from the head node and maximum information features node will be considered for evaluation and less information node will be eliminated [XuWenxin, (2020),Namariq & Ziyad (2016),Das et al., (2020),LuxmiVerma, Sangeet Srivastava, (2018), Latha & Soujanya (2018)].

Gaps in Published Research: The researchers had presented many Techniques and Methodologies on Techniques for Diagnose Heart Disease. All the researchers had shown improvement. The gaps observed in total are: Most of the solution approaches in the literature review are based on the working concept of traditional prediction algorithms such used hybrid approach to predict the diseases with higher accuracy Some approaches are only showing the theoretical discussion rather than the proof. Numerous algorithms presented by different investigators use different concepts but still, no common approach is available which can outperform or maintain its accuracy with different datasets [Divya&Sonali , (2014),Tarun (2017)].

II. EVALUATION PARAMETERS USED TO ANALYZE DETECTION PERFORMANCE OF A PARTICULAR MODEL

Confusion Matrix

For analyzing the performance of the proposed model, a very popular methodology known as confusion matrix has been used in this work. It is also known by the name of coincidence matrix, classification matrix, or contingency table. Table 1 shows a confusion matrix for a two-class classification problem.

TABLE 1 Confusion Matrixes

		Predicted Class	
		Positive	**Negative**
Actual class	Positive	True Positive	False Negative
	Negative	False Positive	True negative

The left-most columns show values predicted by the models. The diagonal values show correct predictions. If the instance is positive and it is classified as positive, it is counted as a true positive (TP); if it is classified as negative, it is counted as a false negative (FN). If the instance is negative and it is classified as negative, it is counted as a true negative (TN); if it is classified as positive, it is counted as a false positive (FP). These terms are useful when analyzing a classifier's ability.

The prediction performance of the proposed scheme is calculated based on Accuracy, measured by the following equation

$$\textbf{Accuracy}(\%) = \frac{\text{TruePossitive} + \text{TrueNegative}}{\text{TruePossitive} + \text{TrueNegative} + \text{FalsePossitive} + \text{FalseNegative}}$$

Where, True Positive, True Negative, False Positive, and False Negative refer to the actual percentages that were predicted by the classification model. A classification algorithm may wrongly classify some instances because of the bias nature of the dataset but may appear to be accurate. As a result, to compare accuracy True Positive, True Negative, False Positive, and False Negative rates have been calculated to find out the main accuracy of a simulated classification algorithm.

1. True Positive (TP): Rate of Correctly Predicted data against to its class type.

2. True Negative (TN): A situation, data examined and has taken it correct position and no alarm is raised.

3. False Positive (FP): A state that data has not been associates to its relative class.

4. False Negative (FN): A state when a class data predict as another class type data [Tarun (2017),XuWenxin (2020),Sachin Kamley(2019), adithya et al., (2017)Namariq & Ziyad (2019),Das et al., (2020), LuxmiVerma & Sangeet Srivastava (2018)].

As shown in Figure 1.the Process flow diagram provides the details of experimental work carried out by researchers in the past. first of we get the data (optimum data sets) from the UCI library which provide the open-source data sets both testing and training data after that we select the optimal feature selection or reduction techniques for data processing and then create testing and training data sets and apply machine learning models (it may be hybrid or single approach) as per accuracy results and finally analyze the results with past information or data.

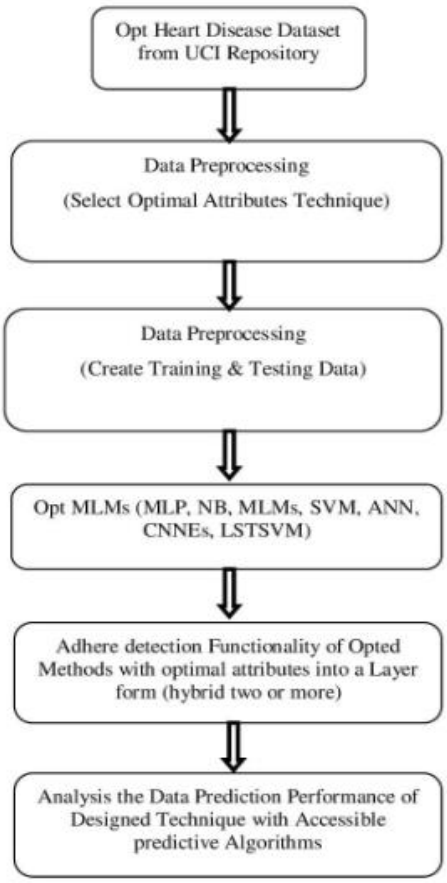

Figure1.work flow adopted by researchers

III. DISCUSSION

In this section we are discussing Table 2, Comparison of various MLMs, Feature Selection and Feature Reduction Techniques with results as well as Limitation/Weaknesses: The Coronary heart disease dataset is considered for study purposes, and different machine learning models are applied to detect heart disease with Feature selection/deduction techniques. The target or goal of this study is to compare the accuracy in the percentage of different classification MLMs and present the best one. Based on all the results, different techniques are performed better according to the researcher (with or without validation). However, every technique has intrinsic power to outperform other techniques depending on the situation.

In this review process, the performance of base MLMs and Features Select/Reduction Techniques (Table 1). However, SVM and MLP hybrid binary dragonfly algorithm (BDA). Mutual information (a filter method) Accuracy of 96.29% was achieved and mutual information is not effective for prediction because sometimes mutual information is not feasible to improve the accuracy.

On the other hand, the performance of Hybrid MLMS (DT, NB&RF) shows that probability based on closely related to the disease with 95% accuracy and sometimes diagnostic test is positive and technique is accurate in preventing and making an accurate prediction of heart disease [Sneha & Chetan (2020), Durairaj & Revathi (2015),]. Many MLMS with feature selection and reduction used by a researcher are not good in accuracy results sometimes hide the precise features related to disease at the time of the process and show the accuracy less than 95% after the removal or eliminate various disease-related features which are not effective. Moreover, the researchers are focusing on improving the accuracy results only which are not 100% so sometimes it is not considered in the medical industry. in medical science,

we notice and observe every feature in the duration of the entire disease treatment but NB, SVM, DT, AND MLP are very effective models for this disease in terms of detection.

Reference	MLMs	Feature selection techniques adopted by researcher in the past	Feature reduction techniques adopted by researcher in the past	Accuracy (in %)	Limitation/Weaknesses
Xiao Liu et al.	**K-NN+NB+ANN**	Feature space mapping (FSM), and separability split value (SSV) .	ReliefF and Rough Set (RFRS) method remove superfluous and redundant Features more effectively.	Accuracy of 92.59% was achieved	The number of the nearest neighbors and the weight threshold are not stable in the ReliefF algorithm
Tarun Kumar Agrawal et al.	**NB+MLP**	Correlation based feature selection (CFS) .	Best First Search (BFS)	Accuracy of **95.19%**was achieved	High rate of false prediction. And highly depend on performance of first technique
DivyaTomar et al.	**LSTSVM**	F-score feature selection technique this calculates the weight of every feature and higher weight is choosing as priority.	-	Accuracy of 94.63% was achieved	Totally depend on features weight and not effective (only 11 features set)
NamariqAyad Saeed et al.	**SVM+MLP**	Hybrid binary dragonfly algorithm (BDA).	mutual information (a filter method)	Accuracy of **96.29%** was achieved	mutual information is not effective for prediction
Xu Wenxin.	**SVM+ANN+DT**	Standard Scalar method (SSM), and ensure the numerical range of each feature is divided into zero to one .	-	Accuracy of **95%**was achieved	Useful for doctors but not effective and more time consuming.
Himansu Das et al.	**ANN+Neuro-Fuzzy**		Neuro-Fuzzy and Feature Reduction (NF-FR) model used feature-based class belongingness fuzzification process for all the patterns and expanded based on the number of classes available in the dataset. Its used to filter out the insignificant Features.	Accuracy of **95.15%**was achieved	Statistical analysis not for real-life problems.
SachinKamley et al.	**SVM+ Logistic Regression(LR)**	Best features Information gain is used to find the features.		Accuracy of not more than **85%** was achieved	Take five or six common Features only which are fixed
Chu-Hsing Lin et al.	**NN and CNN**	In NN variated the numbers of hidden layers, with the neuron number greater than 100 in each layer and in CNN variated the numbers of hidden layers in the fully connected network (FCNet) .		Accuracy of not more than **93.81%** was achieved	Its worked only Cleveland Heart Disease Data Set and compare the prediction accuracy of the two models Under different parameters settings.
SnehaGrampurohit et al.	**DT+ Random Forest (RF), and NB**	A dependent variable was composed of 41 Diseases. 95 of 132 independent variables (symptoms) closely related to diseases were selected and optimized.		Accuracy of not more than **95%** was achieved	comprehensive comparative study of three MLMs and The performance is analyzed Through confusion matrix and accuracy only.
Senthilkumar Mohan et al.	**RF+** Linear Method (LM)	hybrid random forest with a linear Model (HRFLM). is used combining the Characteristics.		Accuracy of not more than **88.7%** was achieved	new feature selection methods can be developed

Table 2: Comparison of various MLMs

IV. RESULTS

Table-I shows that Xiao Liu et al. used K-NN, NB, and ANN MLMs with feature space mapping (FSM), and separability split value (SSV) feature selection techniques, and ReliefF and Rough Set (RFRS) method remove superfluous and redundant Features more effectively. Accuracy of 92.59% was achieved which is low but effective for future perspectives. And the weakness is the number of the nearest neighbors and the weight threshold are not stable in the ReliefF algorithm [Xiao Liu e al., (2017)]. Tarun Kumar Agrawal et al. used NB and MLP with Correlation-based feature selection (CFS). Best First Search (BFS). Accuracy of 95.19%was achieved. And the weakness is The High rate of false prediction. And highly depend on the performance of the first technique and its select minimum features sometimes which is not considered in the medical industry [Tarun (2017)] And Reported higher accuracy with RF than CNN and NN as reported by other authors [Chu-Hsing &Po-Kai (2020), Senthil kumar et al., (2019)]. Divya Tomar et al., (2014) used the LSTSVM F-score feature selection technique this calculates the weight of every feature and a higher weight is chosen as a priority. Accuracy of 94.63% was achieved and it depends on features weight and is not effective (only 11 features set) [DivyaTomar&Sonali , (2014)]. NamariqAyadSaeed et al. used the SVM and MLP hybrid binary dragonfly algorithm (BDA). Mutual information (a filter method) Accuracy of 96.29% was achieved which is the highest accuracy in terms of prediction. And the limitation is that mutual information is not effective for prediction (Kamley 2019).

XuWenxin SVM+ANN+DT Standard Scalar method (SSM), and ensure the numerical range of each feature is divided from zero to one. Accuracy of 95%was achieved and it is Useful for doctors but not effective and more time-consuming 1 but it's batten than the MLP and NB hybrid approach [Tarun (2017)]. Himansu Das et al. used ANN, and Neuro-Fuzzy and apply Neuro-Fuzzy and Feature Reduction (NF-FR) model used a feature-based class belongingness fuzzification process for all the patterns and expanded based on the number of classes available in the dataset. It is used to filter out insignificant Features. Accuracy of 95.15%was achieved. Statistical analysis not for real-life problems 6 but batter than, SVM and LR, NN and CNN and LSTSVM MLMs used by the researchers [Kamley, (2019), Chu-Hsing&Po-Kai, (2020),DivyaTomar&Sonali , (2014)]. Kamley et al. (2019) used the SVM and Logistic Regression (LR) Best features Information gain is used to find the features. Accuracy of not more than 85% was achieved which is very less and not more effective in the medical industry and it Takes five or six common Features only which are fixed2. Chu-Hsing Lin et al. used the NN and CNNIn NN variated the numbers of hidden layers, with the neuron number greater than 100 in each layer and CNN variated the numbers of hidden layers in the fully connected network (FCNet). Accuracy of not more than 93.81% was achieved and It worked only Cleveland Heart Disease Data Set and compare the prediction accuracy of the two models Under different parameters settings 4 but its batter than the SVM and Logistic Regression (LR) hybrid approach used by the researcher [Kamley, (2019)]. Sneha & Chetan (2020) used the DT, Random Forest (RF), and NB and apply A dependent variable was composed of 41 Diseases. 95 of 132 independent variables(symptoms) closely related to diseases were selected and optimized. Accuracy of not more than 95% was achieved comprehensive comparative study of three MLMs and The performance is analyzed Through confusion matrix and accuracy only [9]. Senthil Kumar & Chandrasegar (2019) used the RF and Linear Method (LM) hybrid random forest with a linear Model (HRFLM). is used to combine the Characteristics. Accuracy of not more than 88.7% was achieved new feature selection methods can be developed 10. It's very little in terms of accuracy and considers in medical science.

V. CONCLUSION

The work carried out in this investigation has introduced certain novel hybrid data prediction techniques by incorporating the prediction functionality of MLMs s of data mining techniques into a single practice. The designed approach of this investigation has not simply integrated these algorithms for data prediction but has also considered an attributes selection process at the time of build technique. For the selection of only relative and efficient attributes feature selection technique has been used with the certain feature selection technique.

In this review process, the result has been analyzed results for features selection and reduction and covered almost best accuracy with MLMS and with certain features selection and reduction techniques which help up to take the decision and choosing a best suitable path to improve the accuracy of disease in the future. Reducing required data evaluation time may improve the performance of the presented approach in a new way. May inclusion of a more competent approach of picking up optimal features from elected datasets may improve prediction performance efficiently. Illustrate a single approach with combining two or more MLMs except for layered form rather than hybrid approaches in layered form for fast detection in an efficient way.

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