Analysis and Comparison of Naive Bayes Algorithm for Prediction of Cardiovascular Disease over Support Vector Machine Algorithm with Improved Precision

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ABSTRACT

Aim: To find the best algorithm for the prediction of Novel Cardiovascular Disease Detection accurately, with fewer errors between Novel Naive Bayes and Support Vector Machine classifiers. **Materials and Methods:** Data collection containing various data points for predicting Novel Cardiovascular Disease Detection from UCI machine learning repository. Classification is performed by Naive Bayes classifier (N=20) over Support Vector Machine (N=20) total sample size calculation is done through clinical.com. The accuracy was calculated using Matlab software and the outputs are graphed using SPSS software. **Results:** Comparison of accuracy rate is done by independent sample test using SPSS software. There is a statistical indifference between the Naive Bayes algorithm and Support Vector Machine algorithm. Support Vector Machine algorithm (87.38%) showed better results in comparison to Novel Naive Bayes algorithm (75.13%). **Conclusion:** Support Vector Machine algorithm appears to give better accuracy than Naive Bayes algorithm for the prediction of Novel Cardiovascular Disease Detection.

INTRODUCTION

These days, the death rate due to cardiovascular diseases are increasing day by day every year. It is observed that 17.9 million deaths are being recorded as per the surveys made by WHO (Bharti et al. 2021). The way of living, new food habits and lack of physical exercise has been a major contributor for the increased cardiovascular disease. For instance, smoking, high blood pressure, having high amounts of body fat, and consumption of junk are the main risk factors for Novel Cardiovascular Disease Detection mainly these can be suppressed in the early stages by changing the lifestyle, being more physically active, and taking medication in some complex cases (Das, Turkoglu, and Sengur 2009). The main goal of this work is to apply machine learning algorithms to predict cardiovascular diseases in this the comparison is done between Naive Bayes algorithm and Support Vector Machine algorithm and finding the best accuracy obtaining algorithm (Al'Aref et al. 2019). The prediction of cardiovascular disease should be done by the evaluation of certain features given by the user (Ishaq et al. 2021). If the accuracy of this prediction is high enough it will be helping to save a lot of human resources by avoiding incorrect diagnoses (Shouman, Turner, and Stocker 2012).

About 150 Science direct and 47 IEEE Xplore articles were found similar to this work in the last 5 years and has a clear report of developed algorithms and models using machine learning algorithms such as Naive Bayes algorithm, Support Vector Machine algorithm, Logistic Regression, Neural Network, Random Forest algorithms to predict and evaluate the performance of each algorithm in terms of accuracy, sensitivity, precision in the prediction of Novel Cardiovascular Disease Detection (Lai et al. 2019). In this paper, the major aim is to evaluate the validity of every algorithm in terms of accuracy, sensitivity, precision, and specificity and to find the best accuracy obtaining algorithm for the prediction of cardiovascular disease (Al'Aref et al. 2019). Accuracy comparison is done over different classifiers Novel Naive Bayes, Neural Network, Logistic Regression, Random Forest, diagnoses, and Support Vector Machine algorithm on UCI Machine Learning Repository data set (Nikam et al.

2020). All these classifiers are executed in simulated environments using Matlab data mining tools. The executed results depict high accuracy by the Support Vector Machine algorithm with an accuracy of 87.38% and with the least error rate whereas Naive Bayes got 75.13%. The precision values of Support Vector Machine algorithm and Naive Bayes also are 90.85% and 77.45% respectively, followed by recall and F1 values are also ruled out by Support vector Machine classifiers with higher values than the Naive Bayes. Research work proposed a machine learning algorithm comparison of various classifiers to predict and reduce deaths due to cardiovascular diseases (Dube et al. 2020). The hyperplanes are selected by the Support Vector Machine algorithm (Jayadeva, Khemchandani, and Chandra 2016). The Naive Bayes algorithm is a probabilistic machine learning algorithm that is used for decision – making tasks (AhmedMedjahed, Saadi, and Benyettou 2013). Naive Bayes will approximate the independence between the features of the dataset rules. Applying Bayes Theorem we can build a Naive Bayes Algorithm model. All the characteristics in the Naive Bayes and this method is based on the conditional probabilities.Our team has extensive knowledge and research experience that has translate into high quality publications (Chellapa et al. 2020; Lavanya, Kannan, and Arivalagan 2021; Raj R, D, and S 2020; Shilpa-Jain et al. 2021; S, R, and P 2021; Ramadoss, Padmanaban, and Subramanian 2022; Wu et al. 2020; Kalidoss, Umapathy, and Rani Thirunavukkarasu 2021; Kaja et al. 2020; Antink et al. 2020; Paul et al. 2020; Malaikolundhan et al. 2020)

Inefficient predictions by the algorithms, more data redundancies, and human error in the early detection of Novel Cardiovascular Disease Detection by conventional methods are giving errors this motivated me to do the research work improving the accuracy of the classifiers for the better prediction of cardiovascular diseases. The major drawback of the existing research is having poor accuracy in the prediction algorithms. The authors are experts in machine learning and deep learning algorithms technologies. The main aim is to analyze and compare the breast cancer detection techniques using the best innovative machine learning algorithms namely the Naive Bayes and Support Vector Machine.

MATERIALS AND METHODS

The study was carried out at the University simulation laboratory, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai. In the current paper, the dataset was taken from UCI Machine Learning Repository cardiovascular disease dataset. This data set consists of various features of the patients and different parameters of the patients in the given data set using the description of the various features in the form of columnar attributes. There is visualization and analysis for support.

The data was donated by the UCI Machine Learning Repository and this includes all the parameters and the features which are required for the prediction, analysis, and evaluation of cardiovascular diseases such as age and various heart parameters. This data is divided into two different groups. The sample size calculation was done using previous study results (yangguang He et al. 2019) by clinicalc.com by keeping alpha error-threshold by 0.05, confidence interval at 95%, enrollment ratio as 0:1, and G-power at 80%. Sample preparation is carried out for Naive Bayes and Support Vector Machine classifiers for the data collected from the UCI Machine Learning Repository dataset.. But the Support Vector Machine algorithm is the higher accuracy giving algorithm which uses supervised learning and has excellent accuracy and classification performance. Support vector machine uses non-linear mapping to vary the training data to a greater dimension.

Group 1 is Naive Bayes and with N value 20 and group 2 is Support Vector Machine with N value 20, the total sample size is 40. A sample dataset of both Naive Bayes and Support Vector Machine are exported to the Microsoft Excel Sheet for importing to the Matlab as input. Matlab 2021a software has to be installed on the PC for training the source dataset. Both Naive Bayes and Support Vector Machine algorithms are used to train the sample groups. A confusion matrix is obtained and true positive, true negative, false positive, and false negative values are noted. Accuracy (%), sensitivity (%) and precision (%) values are calculated from the resulting confusion matrix.

Statistical Analysis

The software used here for the statistical analysis is IBM SPSS V28.0.0.0 (190). Accuracy, precision, recall, and f1 Comparison of Naive Bayes with Support Vector Machine algorithm were done in this software. As the variables are independent of each other an in-

dependent sample T-test was carried out to find the mean values of accuracy, precision, recall, and F1 between two groups, and performance comparison between the two groups is performed.

RESULTS

In this research work of cardiovascular diseases prediction by Naive Bayes and Support Vector Machine on UCI Machine Learning Repository, the results depict to produce the same variable results with the accuracy of 75.13% and 87.38%, precision 77.45% and 90.85%, recall 74.29% and 84.52% and F1 75.80% and 87.55% respectively.

Table 2 shows the comparison of mean accuracy, mean sensitivity, and mean precision values of Naive Bayes (NB) and Support Vector Machine (SVM) algorithm. Support Vector Machine shows the higher values in terms of accuracy, sensitivity, and precision. Variable results with an accuracy rate of 87.38%, precision of 90.85%, recall value of 84.52%, and F1 value of 87.55%. The results of Novel Naive Bayes are with an accuracy of 75.13%, precision of 77.45%, recall value of 74.29%, and F1 value of 75.80%. The Naive Bayes algorithm had less accuracy, precision, recall and F1

Table 1b

Cardiovascular Disease samples using Support Vector Machine Algorithm

Sample	Accuracy	Precision	Recall	F1
1	0.85	0.894737	0.809524	0.85
2	0.9	0.947368	0.857143	0.9
3	0.825	0.85	0.809524	0.829268
4	0.9	0.947368	0.857143	0.9
5	0.85	0.894737	0.809524	0.85
6	0.9	0.947368	0.857143	0.9
7	0.85	0.894737	0.809524	0.85
8	0.9	0.947368	0.857143	0.9
9	0.875	0.9	0.857143	0.878049
10	0.85	0.857143	0.857143	0.857143
11	0.85	0.894737	0.809524	0.85
12	0.9	0.947368	0.857143	0.9
13	0.875	0.9	0.857143	0.878049
14	0.875	0.9	0.857143	0.878049
15	0.9	0.947368	0.857143	0.9
16	0.875	0.9	0.857143	0.878049
17	0.875	0.9	0.857143	0.878049
18	0.875	0.9	0.857143	0.878049
19	0.875	0.9	0.857143	0.878049
20	0.875	0.9	0.857143	0.878049

Table 1a

Cardiovascular Disease samples using Naive Bayes Algorithm

Sample	Accuracy	Precision	Recall	F1
1	0.75	0.761905	0.761905	0.761905
2	0.725	0.777778	0.666667	0.717949
3	0.8	0.842105	0.761905	0.8
4	0.725	0.75	0.714286	0.731707
5	0.75	0.761905	0.761905	0.761905
6	0.75	0.761905	0.761905	0.761905
7	0.75	0.789474	0.714286	0.75
8	0.725	0.75	0.714286	0.731707
9	0.725	0.75	0.714286	0.731707
10	0.775	0.8	0.761905	0.780488
11	0.75	0.789474	0.714286	0.75
12	0.8	0.809524	0.809524	0.809524
13	0.725	0.75	0.714286	0.731707
14	0.75	0.761905	0.761905	0.761905
15	0.775	0.8	0.761905	0.780488
16	0.725	0.75	0.714286	0.731707
17	0.725	0.75	0.714286	0.731707
18	0.8	0.809524	0.809524	0.809524
19	0.75	0.761905	0.761905	0.761905
20	0.75	0.761905	0.761905	0.761905

Table 2

Comparison of Mean Accuracy, mean precision, mean recall, and mean F1 between Naive Bayes and Support Vector Machine.

Group Statistics					
	Group	N	Mean	Std.Deviation	Std.Error Mean
Accuracy	Naive Bayes	20	.7513	.2625	.00587
	Support Vector Machine	20	.8738	.02218	.00496
Precision	Naive Bayes	20	.7745	.02649	.00592
	Support Vector Machine	20	.9085	.02943	.00658
Recall	Naive Bayes	20	.7429	.03590	.00803
	Support Vector Machine	20	.8452	.02116	.00473
F1	Naive Bayes	20	.7580	.02720	.00608
	Support Vector Machine	20	.8755	.02143	.00479

when compared to the Support Vector Machine algorithm as shown in Table 1a and Table 1b. The descriptive statistics of table 2 shows that the Support Vector Machine algorithm had less error when compared to the Naive Bayes algorithm.

Table. 3

Independent sample T-test in predicting the accuracy, precision, recall, and F1 of cardiovascular disease prediction using Naive Bayes and Support Vector Machine classifiers. There appears to be a statistically insignificant difference (p<0.001) in both the classifiers.

		INDEPENDENT SAMPLE TEST							
		LEVENE'S TEST FOR EQUALITY OF VARIANCES				T-TEST FOR EQUALITY OF MEANS			
						SIGNIFI-CANCE		95% CONFIDENCE INTER-VAL OF THE DIFFERENCE	
		F	SIG	T	DF	ONE-SID-ED P	STD.ERROR DIFFERENCE	LOWER	UPPER
Accuracy	Equal Variance Assumed	.28	.599	-15.94	38	<.001	.00768	-.13806	-.0694
	Equal Variance is not As-sumed			-15.94	36.96	<.001	.00768	-.13807	-.10693
Precision	Equal Variance Assumed	.05	.823	-15.13	38	<.001	.00886	-.15198	-.11612
	Equal Variance is not As-sumed			-15.13	37.58	<.001	.00886	-.15198	-.11612
Recall	Equal Variance Assumed	7.52	.009	-10.98	38	<.001	.00932	-.12124	-.08352
	Equal Variance is not As-sumed			-10.98	30.75	<.001	.00932	-.12139	-.08337
F1	Equal Variance Assumed	1.03	.317	-15.18	38	<.001	.00774	-.13323	-.10188
	Equal Variance is not As-sumed			-15.18	36.03	<.001	.00774	-.13326	-.10185

Independent sample T-test results show that there is a statistically insignificant difference in accuracy (P<0.001), precision (P<0.001), recall (P<0.001), and F1 (P<0.001) as shown in table 3. Bar Chart representing the comparison of mean accuracy, mean precision, mean recall, and mean F1 values of Naive Bayes and Support Vector Machine as shown in Fig 1. Fig 2a and 2b represent the confusion matrix of Novel Naive Bayes and Support vector machine respectively.

DISCUSSION

In this research paper for the prediction of cardiovascular diseases, we observed Support vector
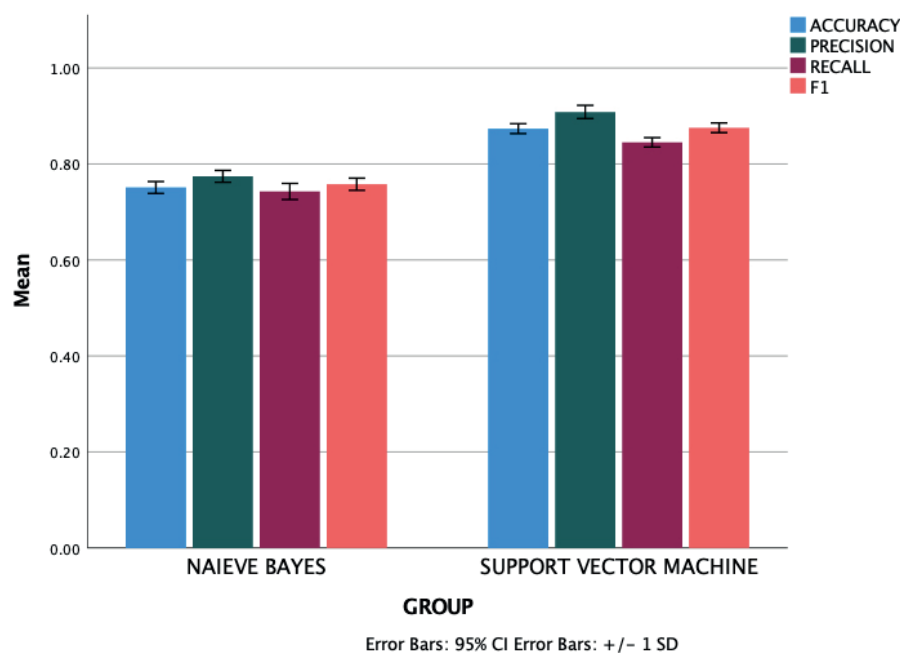

Fig. 1. Bar chart representing the comparison between Naive Bayes and Support Vector Machine algorithms in terms of mean accuracy, mean precision, mean recall, mean F1 for the prediction of cardiovascular diseases. Both the classifiers appear to produce similar rate accuracies but Support Vector Machine algorithms with slightly higher accuracy, precision, recall, and F1 values of 87.38%,90.85%,84.52%, and 87.55% respectively. Naive Bayes resulted in an accuracy of 75.13%, precision of 77.45%, recall value of 74.29%, and F1 value of 75.80%.Y-axis: Mean of accuracy rates for identification of keywords ± 1SD with 95% CI.
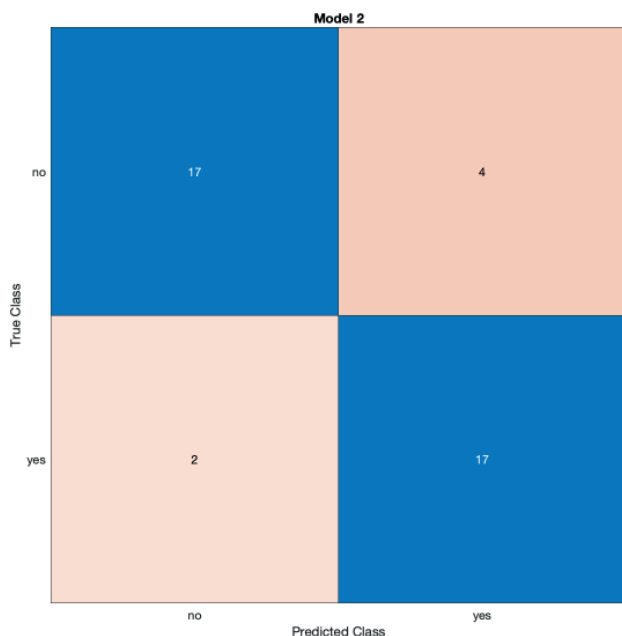
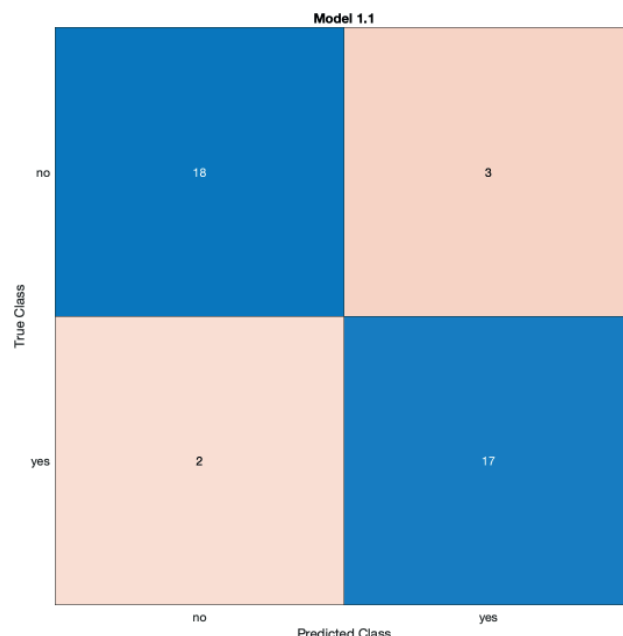Fig. 2a. confusion matrix of Naive Bayes for K= 5

Fig. 2b. confusion matrix of Support Vector Machine for K=5

Machine had performed better with an accuracy of 87.38%, the precision of 90.85%, recall of 84.52%, and F1 value of 87.55% when compared to Naive Bayes accuracy of 75.13%, precision of 77.45%, recall value of 74.29% and F1 value of 75.80%. Although not statistically significant, the significant difference appears to have slightly increased table 3. Machine Learning algorithms play an important role in the early detection of cardiovascular diseases.

Related works by many researchers (Mohan, Thirumalai, and Srivastava 2019) proposed using similar comparison and by using machine learning algorithms and the main aim is to accurately evaluate the model in terms of accuracy, precision, sensitivity, specificity, and F- measure (AhmedMedjahed, Saadi, and Benyettou 2013). Another study was done by (Haq et al. 2018) this paper the author implemented a Machine Learning algorithm for the prediction of cardiovascular diseases and by using a cardiovascular dataset which resulted from Accuracy, sensitivity, specificity, and MCC (Azeraf, Monfrini, and Pieczynski 2022). A paper by (Nikam et al. 2020) used a similar feature section by using similar machine learning algorithms in which Naive Bayes had shown a lower accuracy value of 70.82% for the prediction of cardiovascular disease (Le 2021). A comparative study of various classifiers was done in this paper (Jiang 2020) and the results reach the highest accuracy over the UCI Machine Learning Repository dataset.

The major factors that are affecting the accuracy are data redundancies and depending on the data size the accuracy may be varied. Further increase in the sample size will be yielding better accuracy, precision, recall, and F1 values. Preprocessing of the data is much needed for the optimal results for the prediction of cardiovascular diseases.

Limitation of this development of an efficient classification system that combines the effectiveness of the best accuracy obtained for the improvement of the prediction. A large dataset of real-time applications paired with other machine learning algorithms and deep learning algorithms may improve the accuracy in future and the overall performance of the output. Overall, the findings of this study are highly promising for the future.

CONCLUSION

In this study of prediction of cardiovascular diseases, the support vector machine algorithm has a higher accuracy of 87.38% than the Naive Bayes which has an accuracy of 75.13%. Support vector machine with an accuracy of (87.38%), a precision of 90.85%, recall of 84.52%, and an F1 value of 87.55%. whereas Naive Bayes accuracy of 75.13%, precision of 77.45%, recall value of 74.29%, and F1 value of 75.80%. The performance of these algorithms can be increased with the increase of the data size.

DECLARATION

Conflicts of Interest

No conflict of interest in this manuscript

Author Contributions

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