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RESEARCH ARTICLE

Improving the Efficiency by Novel Feature Extraction Technique Using Decision Tree Algorithm Comparing with SVM Classifier Algorithm for Predicting Heart Disease

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ABSTRACT

Aim: The objective of the research work is to use the two machine learning algorithms Decision Tree(DT) and Support vector machine(SVM) for detection of heart disease on earlier stages and give more accurate prediction. **Materials and methods:** Prediction of heart disease is performed using two machine learning classifier algorithms namely, Decision Tree and Support Vector Machine methods. Decision tree is the predictive modeling approach used in machine learning, it is a type of supervised machine learning. Support-vector machines are directed learning models with related learning calculations that break down information for order and relapse investigation. The significance value for calculating Accuracy was found to be 0.005. **Result and discussion:** During the process of testing 10 iterations have been taken for each of the classification algorithms respectively. The experimental results shows that the decision tree algorithm with mean accuracy of 80.257% is compared with the SVM classifier algorithm of mean accuracy 75.337% **Conclusion:** Based on the results achieved the Decision Tree classification algorithm better prediction of heart disease than the SVM classifier algorithm.

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Introduction

The aim of our study is to create a more efficient deployable model in predicting heart diseases using Decision Tree classifier and Support Vector machine classification machine learning algorithms. We would be able to predict heart disease in its early stages using machine learning techniques. (Methaila et al. 2014) In this article, we will use a health record dataset to estimate the heart disease of patients. Since the dataset contains all of the parameters, features, and attributes needed to predict heart disease, it can be used to make predictions. (Mohan, Thirumalai, and Srivastava 2019) Heart disease prediction modelling methods have been used to monitor the rise in CVD in patients when millions of people suffer from cardiovascular diseases.

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(Krishnaiah, Narsimha, and Subhash Chandra 2015) Furthermore, using machine learning methods, we will be able to identify patients at an early stage. By using early prediction, we can treat patients at early stages and cure them. The various applications of DT are efficient classification of mineral group classification and the identification of mineral members (Akkaş et al. 2015), Popularity Forecast (Zeng et al. 2014),

Different combinations of elements, as well as many classification techniques, are used to implement the prediction model. As a result of the heart disease prediction model, they achieve an increased level of success with a level of accuracy of 90.16 percent. (Mohan, Thirumalai, and Srivastava 2019). Coronary artery disease, in particular, is a chronic cardiovascular disease associated with a high mortality rate. (Arabasadi et al. 2017). CVD (or) heart disease is characterised as the heart's inability to function properly as a result of blocked veins and blood flow to other

parts of the body. Data mining is a method of analysing data automatically using traditional classification methods. (Dbritto, Srinivasaraghavan, and Joseph 2016). This paper is the highest cited article and has been cited for 1600 times. Using homogeneous data mining techniques, this study attempted to pinpoint the most important factors in heart disease and predict risk. Finally, the SVM classifier and decision tree algorithms will be compared to present an accurate value (or) model. (T. et al. 2013). Numerous ongoing components, for example, individual and expert propensities and hereditary inclination represents coronary illness. (Ramalingam, Dandapath, and Karthik Raja 2018).The medical services industry gathers a lot of medical care information and that should be mined to find secret data for viable dynamics. Roused by the overall expanding mortality of heart infection patients every year and the accessibility of immense measure of patients' information from which to extricate helpful information, analysts have been utilizing information mining procedures to help medical services experts in the determination of coronary illness (Helma, Gottmann et al. 2000). Information mining is the investigation of enormous datasets to remove covered up and already obscure examples, connections and information that are hard to distinguish with customary factual strategies (Lee, Liao et al. 2000).(Shah, Patel, and Bharti 2020).[7].To robotize the analysis of enormous and complex data, AI calculations and methods have been applied to various clinical datasets. Recently, a number of scientists have been employing a number of AI techniques to assist the medical care industry and specialists in the study of heart-related illnesses. (Bouali and Akaichi 2014). The SVM algorithm has also been used predict HeartDisease ("PREDICTION OF GEAR PITTING DEFECT BY USING DECISION TREE CLASSIFIER MACHINE LEARNING ALGORITHM" 2020; Sujatha and Mahalakshmi 2020).

Previously our team has a rich experience in working on various research projects across multiple disciplines (Sathish and Karthick 2020; Varghese, Ramesh, and Veeraiyan 2019; S. R. Samuel, Acharya, and Rao 2020; Venu, Raju, and Subramani 2019; M. S. Samuel et al. 2019; Venu, Subramani, and Raju 2019; Mehta et al. 2019; Sharma et al. 2019; Malli Sureshbabu et al. 2019; Krishnaswamy et al. 2020; Muthukrishnan et al. 2020; Gheena and Ezhilarasan 2019; Vignesh et al. 2019; Ke et al. 2019; Vijayakumar Jain et al. 2019; Jose, Ajitha, and Subbaiyan 2020). Now the growing trend in this area motivated us to pursue this project.

The drawbacks of the proposed framework SVM classifier algorithm are that it does not specify how it should be implemented because it only evaluates, and it performs poorly when the dataset is noisy. (Sriramya and Manoj Kumar 2021) Furthermore, the existing algorithm is unsuitable for large datasets. Machine learning approaches have grown in popularity as a result of their ability to account for the shortcomings of traditional techniques. (Voznesenskaya 2018) The aim of our study is to create a most efficient deployable model in predicting heart diseases using decision tree algorithms.

Materials and Methods

The research work was performed in the Department of Computer Science and Engineering, Saveetha School of Engineering, SIMATS. The sample size taken for conducting the experiment was 10. We consider two groups of classifiers algorithms in order to classify the heart patients and healthy people, machine learning classification algorithms are used. Group 1 is the SVM classifier algorithm and the Decision tree algorithm is group 2 and they are compared for more accuracy score and precision score values for choosing the best algorithm.The required samples for this analysis is done using G power calculation(Kane, Phar, and BCPS n.d.). Minimum power of the analysis is fixed as 0.8 and maximum accepted error is fixed as 0.5.

SVM Classifier

SVM (Support Vector Machine) is a supervised machine-learning algorithm that is primarily used to categorise data into various categories. SVMs are commonly used to produce several separating hyperplanes, splitting the data into segments with each segment containing only one quiet data point. It is a regulated machine-learning algorithm which can be utilized for both classification and regression challenges. In this study to train the SVM the svc class of scikit learn library was used. Import the heart.csv dataset and load the dataset. The dataset is randomly split into training(80%) and testing(20%) sets.The target variable is selected. Then the SVM based on the training set is generated. The testing set is generated based on the training set. The SVM classifier is evaluated and the accuracy is calculated.

Decision Tree Classification

The proposed system was created with the intention of distinguishing between people who have a heart disease and others who are well. The methodology of the proposed system is structured into five stages including (1) Pre-processing of dataset, (2) Feature selection, (3) Cross-validation method, (4) Predicting the output.

Fig. 1 gives the overall process architecture of the proposed system. The pre-processing of data is important for efficient representation of data and machine learning classifiers which should be trained and tested in an efficient manner. Pre-processing techniques like removing missing values, standard scalar, and MinMax Scalar are applied to the dataset for effective use within the classifiers. All these data pre-processing techniques were utilized in this research.

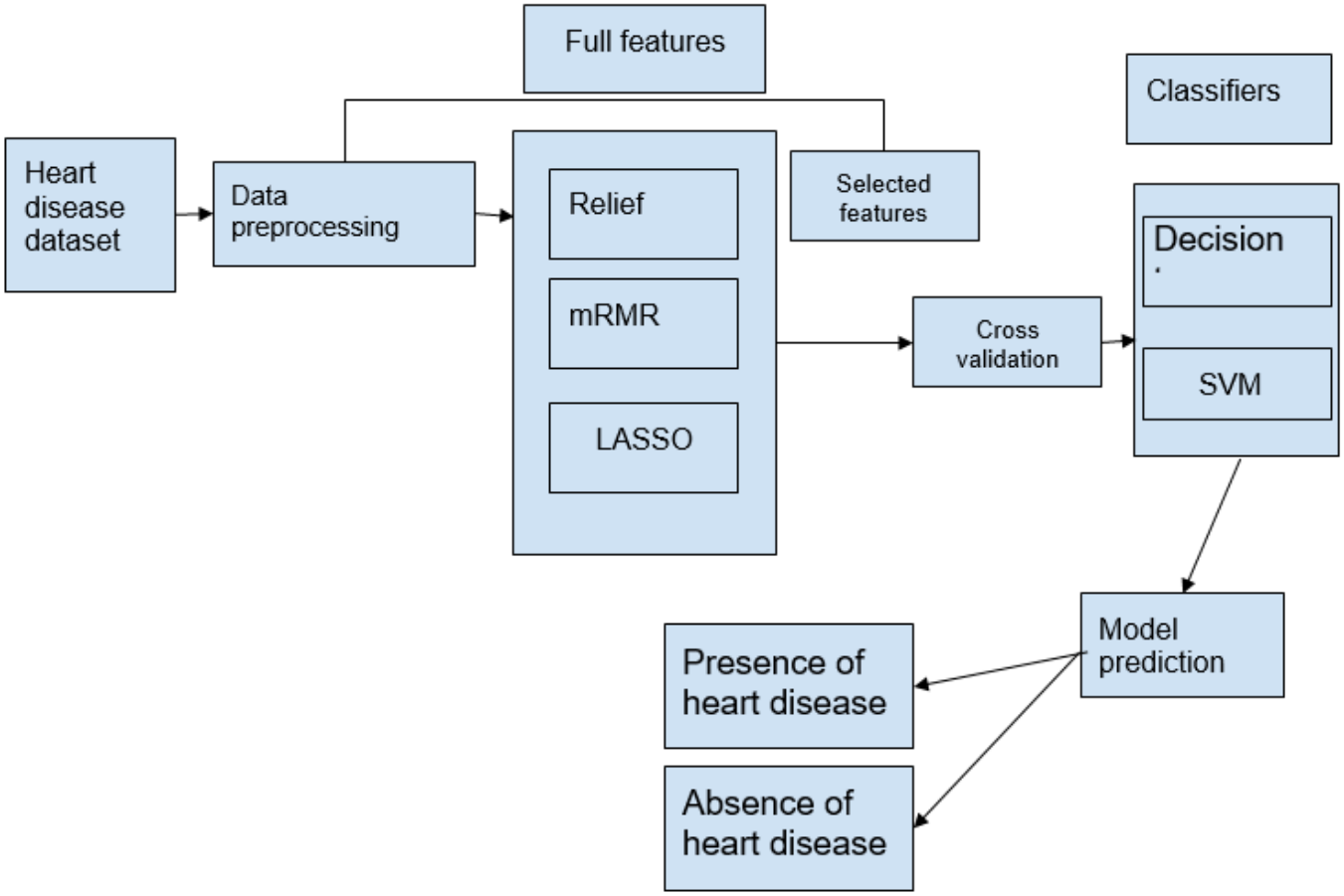

Fig. 1. Architecture diagram for methodology

Feature selection is important for the machine learning process because sometimes irrelevant features affect the classification performance of the machine learning classifier. The FS algorithms are Relief Feature Selection Algorithm, Minimal-Redundancy-Maximal-Relevance Feature Selection Algorithm, Least Absolute Shrinkage and Selection Operator

Predicting the output after the process is done by the classification technique, as it will show whether the person is having and heart disease (or) not having heart disease. Here in this paper we are going to create a most efficient deployable model and with that model we are going to predict heart disease using decision tree algorithm based on the input dataset, compare the attributes like age, sex, chol, fbs and etc... and predict the output.

Physical computers resources, also known as hardware, are the most common set of specifications specified by any operating system or software application. The following are the minimum hardware requirements: windows-7/8/10, Processor with minimum space of 1 GHZ, Main memory-4GB RAM, Processing speed of 600MHZ, Hard disk drive of 1 TB. Software specifications are concerned with specifying the resources and prerequisites that must be installed on a device in order for an application to work. The following are the minimum software requirements: Front end with python language, IDE-jupyter notebook.

To perform heart disease prediction the data sets used is heart disease dataset which was downloaded from Kaggle.com. Table 1 has the sample of 5 pre-processed input dataset taken. Table 2 shows descriptions of the various attributes in the dataset and whether the attribute is qualitative or quantitative. And the total number of features considered is 14. We have taken totally 297 patient entries of input data.

Table 1. Heart Disease Input Dataset sample

age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
41	0	1	130	204	0	0	172	0	1.4	2	0	2	1
56	1	1	120	236	0	1	178	0	0.8	2	0	2	1
57	0	0	120	354	0	1	163	1	0.6	2	0	2	1

Table 2. Description of input Dataset which gives the Quantitative and Qualitative Attributes

Column Position	Attribute Name	Description	Attribute Type	Dependent/Independent Attributes
1	Age	Age of the patient	Quantitative	Dependent
2	Sex	Gender of patients	Qualitative	Independent
3	CP	Type of Chest Pain (1: Typical angina, 2:Atypical angina, 3:Non-anginal Pain, 4:Asymptomatic)	Qualitative	Independent
4	Trestbps	Resting Blood Pressure (in mm/Hg on admission)	Quantitative	Dependent
5	Chol	Serum Cholestrol in mg/dl	Quantitative	Dependent
6	FBS	(Fasting blood sugar>120mg/dl)1=true; 0=false	Qualitative	Dependent
7	Thalach	Mazimum Heart rate achieved	Quantitative	Dependent
8	Exang	Exercise induced angina (1=yes; 0=no)	Qualitative	Dependent
9	Restecg	Resting electrocardiographic results (0=normal; 1 and 2 =abnormal)	Qualitative	Dependent
10	Oldpeak	ST Depression induced by exercise relative to rest	Quantitative	Dependent
11	Slope	Segment (1=upsloping; 2=flat; 3=downsloping)	Qualitative	Independent
12	CA	Number of major vessels (0-3) colored by fluoroscopy	Qualitative	Dependent
13	Thal	A blood disorder called thalassemia. (0=Null; 1=fixed defect-no blood flow in some part of heart; 2=normal blood flow; 3=reversible defect-blood flow observed but not normal	Qualitative	Dependent
14	Target	Heart disease (1=no, 0=yes)	Qualitative	Independent

Results

From fig. 4 we observed that the Decision Tree algorithm has better mean accuracy and precision score than SVM classifier algorithm with 79% and 85% respectively. The bar graph indicates that the error rate of DT(0.995)is also lesser than SVM (2.534). The 10 iteration accuracy and precision values of both the algorithms are plotted as graphs in fig.2 and fig.3. From this it is observe that the accuracy and precision values are higher for DT when compared to SVM in all the 10 iterations.

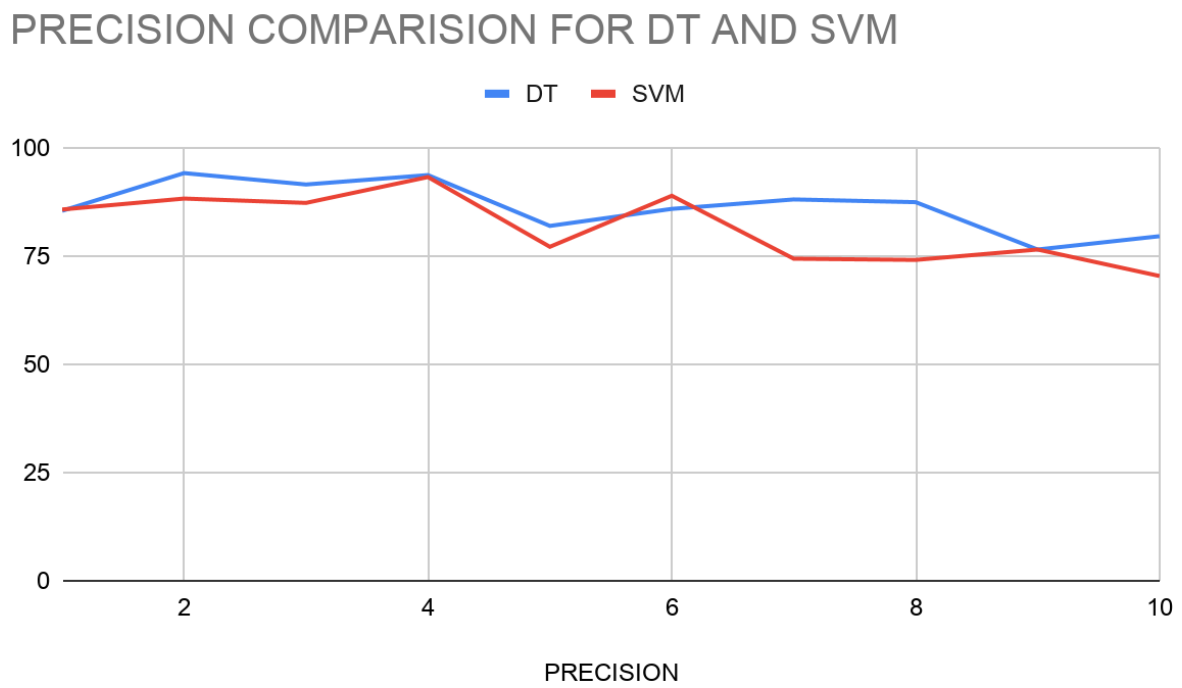

Fig. 2. Comparing Precision of Decision tree and SVM for 10 iterations (Decision tree algorithm gives more accuracy of 72.15 and for SVM is 71.51 for the 10th iteration)

From Fig.2, it was observed that the increase in iterations showed different precision values at different levels in the Decision Tree algorithm. At the 10th iteration, DT was found to achieve a precision of 72.15%.

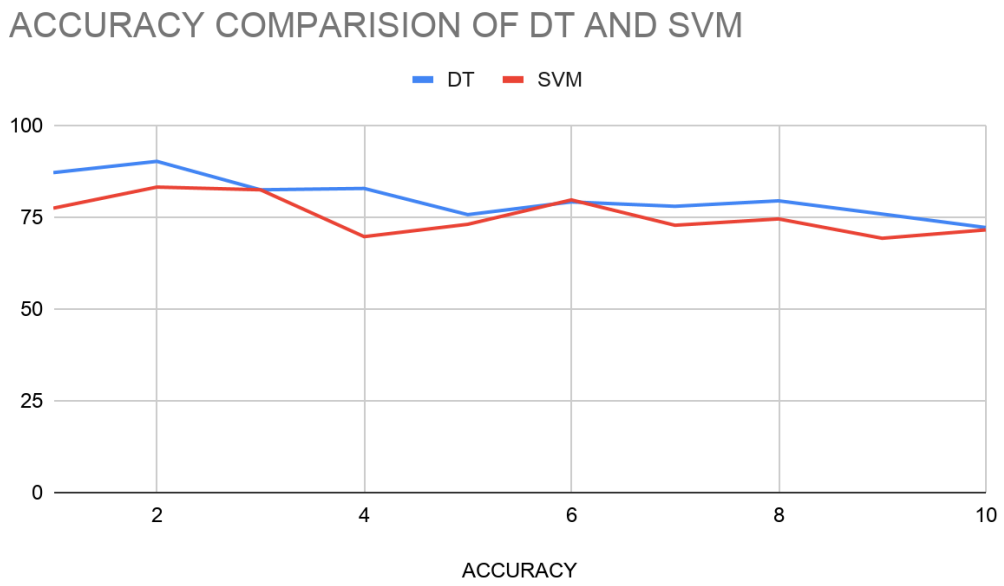

Fig. 3. Comparing Accuracy of Decision Tree and SVM for 10 iterations (Decision tree algorithm gives more accuracy of 79.54 and for SVM is 70.36 for the 10th iteration)

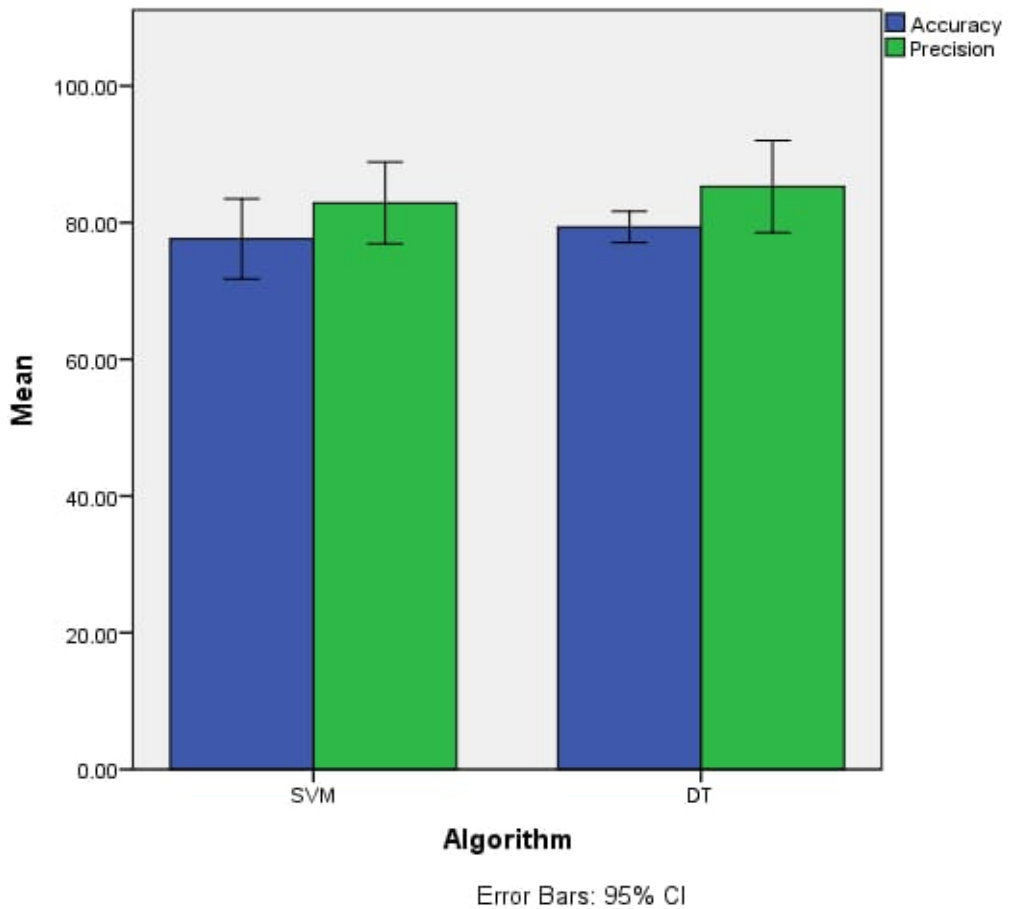

Fig. 4. Bar graph for Comparison of DT algorithm and SVM classifier in terms of mean accuracy and precision. The mean accuracy and precision of DT is better than SVM and the standard deviation of DT is marginally better than Naive bayes. X Axis: DT vs SVM Algorithm Y Axis: Mean accuracy and precision of detection ± 1 SD.

From Fig.3, it was observed that the increase in iterations showed different accuracy values at different levels in the Decision Tree algorithm. At the 10th iteration, DT was found to achieve an accuracy of 79.54%.

From Table 3 it is observed that Mean of DT (79.35%) is more compared with SVM (77.61%) and Std. Error Mean for DT is 0.995 and SVM is 2.534. The significance value observed from table 4 is DT appears to perform significantly better than SVM with the value of p=0.005.

Table 3. Group statistics T-Test for DT and SVM Std error mean (Mean of DT (79.35%) is more compared with SVM (77.61%) and Std. Error Mean for DT is 0.995 and SVM is 2.534)

	Algorithm	N	Mean	Std. Deviation	Std. Error Mean
ACCURACY	SVM	10	77.6156	7.60219	2.53406
	DT	10	79.3544	2.985	0.99500
PRECISION	SVM	10	82.8700	7.77473	2.59158
	DT	10	85.2611	8.77213	2.92404

Table 4. Independent sample T-Test is applied for the data set fixing confidence interval as 95% and level of significance (DT appears to perform significantly better than SVM with the value of p=0.005)

Levene's Test for Equality of variances				t-test for Equality of Means					95% Confidence interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Accuracy	Equal variances assumed	10.484	.005	-.639	16	.532	-1.73889	2.72241	-7.51014	4.03236
	Equal variances not assumed			-6.39	10.410	.537	-1.73889	2.72241	-7.77260	4.29482
Precision	Equal variances assumed	.003	.958	-.612	16	.549	-2.39111	3.90721	-10.67403	5.89180
	Equal variances not assumed			-.612	15.722	.549	-2.90721	3.90721	-10.68375	5.90153

Discussion

In this study, based on the experimental and statistical results, DT has better accuracy than SVM with the reference to the significance value to be less than 0.005. The figure 4 given bar graph represents the comparison of SVM classifier algorithm and Decision Tree algorithm. The mean error rate for accuracy in DT is 0.9950 and for SVM is 2.53406 and mean error rate for precision in DT is 2.92404 and for SVM is 2.59158 respectively. The decision tree algorithm shows more significant results than the SVM classifier algorithm.

This paper examines the performance of a variety of models based on such algorithms and methods supervised learning algorithms-based models. (Ramalingam, Dandapath, and Karthik Raja 2018). In this paper, the author presents a novel method for identifying significant features using machine learning methods, which improves the accuracy of cardiovascular disease prediction. Different combinations of features and some well-known classification methods are used to introduce the prediction model. (Mohan, Thirumalai, and Srivastava 2019). The features affecting the accuracy and precision are sex, cp, trestbps, fbs, restecg, thalach, exang, oldpeak, slope, ca, thal. When these features have an increase or decrease in the dataset then the accuracy and precision are changed.

Our institution is passionate about high quality evidence based research and has excelled in various fields ((Vijayashree Priyadharsini 2019; Ezhilarasan, Apoorva, and Ashok Vardhan 2019; Ramesh et al. 2018; Mathew et al. 2020; Sridharan et al. 2019; Pc, Marimuthu, and Devadoss 2018; Ramadurai et al. 2019). We hope this study adds to this rich legacy.

Although the results of the study are better in both experimental and statistical analysis there are limitations in the work. The evaluation of accuracy cannot provide a better outcome on a larger dataset. Moreover in the Decision tree the mean error appears to be higher than SVM. It would be better if the mean error can be reduced to a considerable extent. However the work can be enhanced by applying optimization algorithm techniques, to achieve better accuracy and less mean error. The existing algorithm will not predict the correct results in case of large data. The accuracy may fall if we are having huge data. By using the machine learning algorithms we can be able to reduce (or) predict heart disease earlier in the medical industry it can be much useful. As we can increase our accuracy value with these classifications methods.

Conclusion

In this paper, we proposed a method for heart disease prediction using machine-learning techniques, these results showed a better accuracy standard for producing a near accurate estimation result. Based on the significance value(0.005) achieved through SPSS the decision tree algorithm has a higher percentage of 90.16% compared with the SVM classifiers of 83.76%. So, the decision tree classification algorithm gives us a better accuracy rate when compared to SVM classifiers.

Conflicts of Interest

The author declares no conflict of Interest.

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Authors Contributions

Author SKLS was involved in data collection, data analysis, manuscript writing. Author PSR was involved in conceptualization, data validation, and critical review of manuscript.

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