ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 5, Special Issue 12, April 2018

CARDIAC DISEASE PREDICTION USING DATA MINING TECHNIQUES:A SURVEY

R.Uma Devi
Research Scholar
Department of Computer Science
Bishop Heber College
Trichy,TamilNadu,India
umadevir95@gmail.com

M. Uma Maheswari
Research Scholar
Department of Computer Science
Bishop Heber College
Trichy,TamilNadu,India
umamanohar89@bhc.edu.in

Dr.J.G.R.Sathiaseelan
Head & Associate Professor
Department of Computer Science
Bishop Heber College
Trichy,TamilNadu,India
jgrsathiaseelan@gmail.com

Abstract: **The health care industry vastly uses the data mining techniques for various predictions and classification. The large repository of data generated is subjected to various algorithms to identify the patterns in the data. The cardiac disease is the most threatening disease such that it devours more than a million persons per year. In this paper the prediction of the heart disease by using various techniques like classification and prediction techniques decision tree, Naive Bayes, Random Forest(RF),clustering, K-Nearest Neighbour,K-means,K-medoids,SupportVector Machine,Neural Networks,Association rule mining and Genetic algorithm have been studied elaborately. The overview of the ongoing research on the cardiac disease prediction using the datamining techniques has been studied. It is observed from the study that the Naïve Bayes and the decision tree technique indicate to have better performance.**

Keywords: Data Mining, Cardiac Disease Prediction, Decision Tree.

1. INTRODUCTION

In the medical field large amount of data are created and stored in large data repositories so that they can be used in different data mining techniques for further knowledge discovery.Data mining used in the field of health care helps the physicians to improve the correctness by analyzing the information. Data mining provides different applications in the health care field include prevention of disease, prevention of deaths,money and cost savings and recognition of fraudulent insurance claims. Information digging holds enormous potential for the medicinal services industry to set up wellbeing frameworks to methodically utilize information and examination for deciding wasteful aspects and the finest practices that enhance mind and lessen costs. Most facilities today utilize kind of clinic data frameworks to oversee immense and voluminous measures of patients' information. There is an abundance of concealed learning in this information that is generally undiscovered, which utilizing information mining that can be transformed into helpful data that can enable medicinal services professionals to take careful clinical choices.There are many data mining techniques for diagnosing many diseases like heart diseases,cancer,stroke,diabetes.Mining had an enormous revelation for exploring the unknown patterns in the information of medical field.Now a day's cardio vascular disease is the highest deadly disease where every year more than 12 million peoples die due to the heart disease.Medical data mining is a challenge to involve a misdiagnosis andindecision. The following diagram depicts the process in medical data mining.

2. TECHNIQUES USED IN DATA MINING:

Knowledge discovery in medical data is the process of extracting different features from data in various steps. Fig.1[1] shows the process of Knowledge discovery from various medical data sources in a specific domain.

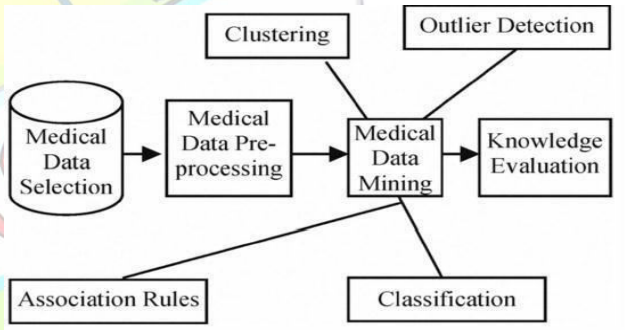

Figure 1: FrameWork For Medical DataMining

1. Classification:

Classification is the one of the data mining techniques.Every item in the data set having a classification into groups and methods.Order is one of the notable issues under information mining. For instance information can be separated as indicated by topical substance document write, normal record estimate, gigabytes, and megabytes. Arrangement is the procedure of taking in a capacity that stores information items to a subset of a given class set. A few sorts objectives of order, firstly finding a decent broad that can anticipate the class of yet far obscure information objects with high precision. Secondly, to discover a smaller and simple understandable classthat demonstrates for each different class.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 5, Special Issue 12, April 2018

Decision tree:

Another data mining techniques is decision tree. In the decision tree the values are represented in the form of tree. The data are from the top to bottom. The tree contains root nodes and childrennodes. The decision tree has many algorithms. This gives more accuracy than other techniques. The introduction of the Decision Tree technique in the treatment of coronary illness has been examined by the scientists with noteworthy achievement. Decision tree is a tree-like structure, which comprises of interior hubs, branches and leaf nodes, in which each branch indicates property estimation, each inward hub indicated a test on a quality which is utilized for and a leaf hub states to the anticipated classes or class disseminations. The grouping begins from the root hub, at that point crosses the tree in view of the prescient quality esteem. The idea includes information allotting, information grouping, decision tree classification determination, and the demand of diminishment of trimming to make optimized decision trees. Characterization techniques are sorted as administered and unsupervised approaches. The managed grouping strategies contain chi union and entropy while the unsupervised strategies incorporate indistinguishable width and indistinguishable recurrence. The information dividing includes testing with or without voting. Three Decision Tree typesare tried: Gini Index, Data Improvement, and Gain Ratio. At last, decreased mistake trimming is helpful to give more shut choice standards. The below diagram shows the data source in decision tree[2].

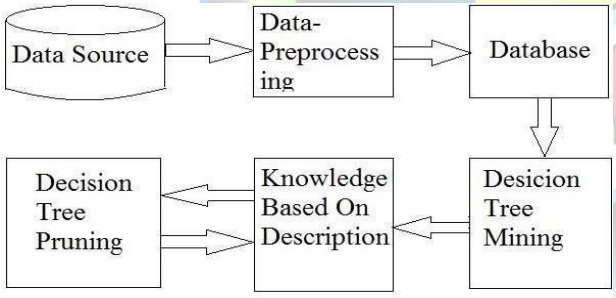

Figure 2: Framework For Decision tree pruning

Naive Bayes:

Naive Bayes is one of the most popular classification techniques. Inthis technique variables are independent.It gives the accurate results that have approximation and calculation having datasets.Advantage of Naive Bayes model is without using Bayesian methods The Naive Bayesian classifier depends on Bayes hypothesis with the freedom presumptions between indicators. A Naive Bayesian model is anything but difficult to work, with no convoluted iterative parameter estimation which makes it especially helpful for substantial datasets. In spite of its straightforwardness, the Naive Bayesian classifier frequently does shockingly well and is broadly utilized on the grounds that it regularly beats more advanced characterization techniques.

2. Clustering:

Clustering is distributing technique and set of information into pieces. Each section is a bunch, such that articles in a group are identified with another protest, still diverse to objects in different groups. The arrangement of groups showing up from a group investigation can be said as a clustering. Clustering is a gathering strategy and an arrangement of information protests more often than not containing all items in the informational indexes. A contrast amongst order and clustering is that clusters that can essentially discover the gatherings. In machine learning, Clustering is additionally eluded as unsupervised learning in light of the fact that the class mark direction is absent.

K-Means:

K-Means is an unconfirmed Clustering techniquefor ordinarily segmenting an informational collection into k groups. In this strategy, k speak to various groups, it is normally a client push to the strategy; some model can be utilized to consequently appraise K. The mean estimation of the constituent is full as far as possible to plan Clusters. The clusters mean or focus is to be created by the irregular choice. For every vector, this calculation figures the separation between information vectorsfurthermore by each group centroid utilizing the existing form.

K-MedoidAlgorithm:

K-Medoid calculations are accustomed to finding Medoid in a bunch which is focus position focuses in a group. The basic plan of a K-Medoid group calculation is to discover bunches in N protests by first arbitrarily finding a delegate question for each group. The each parallel question is grouped with the Medoid. It utilizes the delegate objects are reference focuses instead of taking the mean estimation of the components in each bunch. The calculation goes before the info factor of k, and the number of groups to be parcelled into an arrangement of N objects. Consequently, K-Medoid is stronger when contrasted with K-Means.

3. Association:

Association rule is the frequently used data mining techniques. It is based on the relationship between. The particulars items on the same data set. In the field of medical, the heart disease prediction, relationship between the different datasets as a dissimilar attributes for analyzing the risk factor and which are need for prediction of heart diseases.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 5, Special Issue 12, April 2018

4. Neural networks:

In down to earth applications, neural systems are notable to create exceptionally precise outcomes. By utilizing sustain forward neural organize model, variable learning rate and backpropagation learning calculation with energy, the neural system is prepared with Heart Diseases database. The outline of the model is as per the following: It begins with the contribution of clinical information and advances to create ANN calculation. In the wake of preparing model, it can create the expectation comes about. The computational strides of neural system calculation start with the characterization of clinical information into two equivalent amounts of haphazardly. One is utilized for testing and the other is utilized for preparing. An underlying weight is allocated to each element arbitrarily. The figured mistakes are utilized to change the heaviness of all highlights. Each component's last weight is discovered when the blunders meet with the end conditions. The procedure is rehashed for number of times. Subsequent to building the preparation models, we can figure the execution comes about because of the testing

3. LITREATURE SURVEY

Priyanka et al.[3] proposed the paper usage of data mining techniques in predicting the heart disease-Naive Bayes&Decision tree. Thispaper compared two algorithms Naive Bayes and decision tree. The two algorithms the decision tree algorithm gives more accuracy than a naive Bayes algorithm. This paper also used in a future project to detect the heart disease in particular.Theresa Princy et al. [4] developed the Human Heart Disease Prediction System using Data Mining Techniques The fundamental inspiration of this paper is to give a knowledge about identifying coronary illness chance rate utilizing information mining systems. Different Data mining strategies and classifiers are examined in numerous investigations which are utilized for effective and effectual coronary illness conclusion. According to the examination mode, it is seen that numerous creators utilize different advances and distinctive number of qualities for their examination. Subsequently, extraordinary advances give distinctive exactness relying upon a number of characteristics considered. Utilizing KNN and ID3 calculation the chance rate of coronary illness was distinguished and exactness level moreover accommodated a distinctive number of characteristics. In future, the quantities of characteristics could be decreased and precision would be expanded utilizing some different calculations.

Bangi et al. [5] proposed the paper on prediction of heart disease using data mining. This paper heart disease prediction is by the normalized the dataset. Clustering algorithm used to get accuracy 98% to another system. In future the classification accuracy is reduction of features.Sultana et al. [6] proposed Analysis of Data Mining Techniques for HeartDisease Prediction. This paper data mining hidden information has an important role in the decision. This paper has two sets collected and UCI standard. Bayes Net and SMO classifiers have the optimum and the investigated all and that classifiers. Four classifiers are used to get accuracy KStar, J48, SMO; Bayes Net in this classifier SMO has more accuracy.

Lakshmi et al. [7]proposed thefast rule-based heart disease prediction using associative classification mining. The more classifier is used such as Classifier C45, CBA, CMAR, L3, and SACHDP. In this paper the association rule for medical data. The decision algorithm had a support system is SACHDP (Stream Associate Classification Heart Disease Prediction). SACHDP has more accuracy 96.7%. In the future reduced the number of rules and performance of SACHDP is higher.Mane [8] designed this paper Smart heart disease prediction system using Improved K-Means and ID3 on Big Data. In this paper the clustering techniques are used K means algorithm. The two types of K mean algorithm uses K means algorithm and Improved K means algorithm. The accuracy level is higher in improved K means algorithm.

Seyedaminet al.[9] designed a paper comprehensive investigation and comparison of machine learning techniques in the domain of heart disease. Every technique executes in different level to get an accuracy level and comparisons. In this paper Naïve Bayes has more accuracy than other techniques. In future accuracy isimproved by enhancing the same techniques to get more accuracy.Sababet al.[10] developed a paper for a cardio vascular disease prognosis using classification and feature selection technique. In this paper, we endeavoured to centre around the significance of highlight determination in cardiovascular illness forecast treatment utilizing diverse information mining calculation. Using legitimate trait determination strategy, any grouping calculation can be enhanced essentially. Properties with less commitment in dataset frequently miss lead the arrangement model and results in poor expectation precision. In our work, we found that Naïve Bayes gave best outcome before characteristic selection but after Playing out a controlled and cautious component determination, SVM ended up being the best classifier Area under ROC bend examination indicated brings about our support where every one of the three classifiers demonstrated much better enhancements after element determination.

Xu et al. [11] proposed a paper on cardiovascular risk prediction method based on test analysis and data mining ensemble system. In this paper, a hazard expectation technique in light of test examination and information mining systems group was proposed. In information readiness, this paper demonstrates to better comprehend Chinese solution; how to separate essential data in Ultrasonic echocardiograph; and how to standardize and diminish dimensionality. Hazard forecast is actualized in information mining part utilizing 6 information mining classifiers group; it has a general accuracy of 79.3%, which

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 5, Special Issue 12, April 2018

is substantially higher than C4.5, Naïve Bayes and SVM. Since there is little application in Chinese content investigation, joined with information mining technique in CVD hazard expectation, the testing comes about demonstrate that the proposed technique has promising application in useful utilization of healing facility framework and specialist's conclusion.Umamaheswari et al.[13]developed predictionof myocardial infarction usingk-medoid clustering algorithm.This paper proposes prediction of myocardial infarction framework utilizing K-Medoid grouping calculation. K-Medoid grouping is expanding the productivity of the yield. This strategy is the most valuable model to distinguish patients who influenced by a heart assault. This method may reaction complex inquiries, each with its own quality with regard to straightforward model elucidation and access to whole data, exactness.

Kavitha et al.[19] proposed an efficient framework for heart disease classification using feature extraction and feature selection technique in data mining In this paper, we have seen the review of highlight determination and highlight extraction. In this technique a system is made with different advances like anomaly discovery;include extraction utilizing primary segment examination. The element subset choice is utilized with the wrapper channel utilizing a classifier to give better outcomes. The execution of the framework is enhanced contrast and the other scoring capacity like Euclidean separation and Pearson relationship coefficients. Facilitate later on work the exception, exhibit in the class limit will be tended to by indicating enhanced the precision.Likewise, the most recent strategies will be used for the expectation go the class mark for the obscure class names. This structure makes a difference in the forecast of the coronary illness and by demonstrating the lessened test credited required for the conclusion of the heart illnesses.Banu et al.[15]proposed the Prediction of Heart Disease at an early stage using Data Mining and Big Data Analytics: A Survey this proposed the possibility of various

Devi et al. [14] developed a paper on prediction of heart disease uses data mining techniques.The exactness of the calculations utilized as a part of every strategy can be upgraded by hybridizing or joining calculations to a solitary calculation which may not be exact for pitifully characterized sets of information, and is required to make speedier and more exact choices.Guftar et al.[17]developed a novel Framework for classification of syncope disease using k-means clustering algorithm attack falls in which cluster and doctors can proficiently treat the patient. Moreover, a comparison of k-means with other algorithms was also performed which illustrated that x-means and k-means fast giving similar results as k-means that we're better than k-medoids.

Rairikaret al.[16]designed the paper on heart disease prediction using data mining techniques The general target of our work is to foresee more precisely the nearness of coronary illness in the human body. Three information mining characterization procedures were connected with models accessible and the distinctive information mining procedures utilized. The exactness got with these models is likewise specified. It is watched that all the systems accessible have not utilized huge information examination. Utilization of enormous information examination alongside information mining will give promising outcomes to get the best precision in planning the expectation display.The Main goal is to distinguish the key examples and highlights from the restorative information of the patient by joining information mining methods alongside huge information investigation to foresee the coronary illness before it ceases to help the restorative professionals. The other target will be to decrease the information sets and increment the exactness of forecasts show.

Krishnaiah et al.[18] proposed a paper on heart disease prediction system using data mining techniques and intelligent fuzzy approach: a review.In this paper talked about an investigation of various information mining procedures that can be utilized in automated coronary illness forecast frameworks. The examination demonstrates that diverse innovations are utilized as a part of the considerable number of papers with taking a distinctive number of qualities achieved their outcomes diverse precision relies upon instruments utilized for usage. Despite the fact that applying the information mining methods helps the social insurance experts at the conclusion of coronary illness is having a different triumph.This paper gives a quick and straightforward attention of various expectation models in information mining and finds a most noteworthy model for additionally work. This work can be upgraded by expanding the quantity of traits for the current arrangement of our past work. The representative Fuzzy K-NN classifier can be tried with the unstructured information accessible on medicinal services industry information base by adjusting into falsified organized information with expanded characteristics and with an accumulation of a number of records to give better precision to the framework in foreseeing and diagnosing.

particular choice trees, Naive Bayes and KNN. From comes about, it has been seen that KNN gives exact outcomes as a contrast with Decision trees and Naive Bayes. In this paper, we have exhibited a productive approach for dividing and removing generous structures from the heart assault information distribution centres for the productive expectation of heart assault. In our future work, we have wanted to lead investigates extensive continuous wellbeing datasets to anticipate the infections like heart assault and look at the execution of our calculation with other related information mining calculations. A conclusion is regularly made that KNN is ideal among all the characterization procedures after we name forecast or on the other hand arrangement of nonlinear information. KNN employs closest neighbour to locate the ideal arrangement. Past form of KNN are restricted to the little size of datasets But the closest neighbour is exceptionally helpful and valuable for all sorts of datasets notwithstanding for huge size datasets. The arrangement discovered utilizing this strategy is

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 5, Special Issue 12, April 2018

exceptionally exact. It is additionally speedier the other two procedures we have said. It has a solid consistency comes about. We can build the speed of calculation utilizing vicinity diagrams In this paper, we tend to build up a cardiopathy forecast framework that may help therapeutic experts in assessing a patients cardiopathy bolstered the clinical learning of the patient. Our methodologies epitomize 3 stages. Right off the bat, we select thirteen fundamental clinical alternatives, i.e., age, sex, torment sort, test BP, cholesterol, restraint glucose, resting ECG, simple lay heartbeat rate, practice iatrogenic angina, old pinnacle, slant, assortment of vessels hued, and Finally, we have a inclination to build up a simple cardiopathy anticipate framework (HDPS) that produces expectation comes about exploitation manufactured KNN, Decision Tree, Naive mathematician Classification methods.

Bhatt et al. [20]made analytical study on cardiovascular health issues prediction using decision model-based predictive analytic techniques In this Paper, this review has talked about different late examinations that relate the different systems to distinguish the shrouded design shape scratch through looking at different prescient diagnostic strategies. This entire new measurement will recognize the underlying driver of the cardiovascular ailment and will help us to break down new datasets utilizing comes about created via preparing datasets. Prescient diagnostic system will help to produce choice model approach utilized as a part of request to get the profound understanding into cardiovascular medical problems and aides in telling the normal result in view of the probabilistic part of that information landed from demonstrate. Scientists have presented a viable strategy for speedier ECG information investigation when given in compacted frame. Changes in these qualities will cause impacts in the trustworthiness and precision of the outcome in light of the fact that we can't foresee the correct outcome in light of the preparation information. This paper has seen different situations indicate guarantees and give motivation about future work, and demonstrate the significance of utilizing every open level of information in cardiovascular issues expectation, portraying most ideal likelihood of building up a structure that will break down the patient's information and will assist create us with the basic GUI that can decide the expectation utilizing determining in light of patient's information. This system will be choice model-based sending office that can produce awesome probabilistic outcomes. More or less, we can reason that there is significantly more work is required in the field of machine learning and information mining having specific branch of prescient investigation which will empower to build up a framework that will work in the cell level to analyze human body and have a superior comprehension of applying more crossover what's more, compelling calculations.

TABLE 1: DIAGNOSIS OF HEART DISEASES USED DIFFERENT DATA MINING TECHNIQUES:

S.No.	Author	Techniques	Accuracy
1.	Priyanka et al.(2017)	Decision tree Naive Bayes	98.03% 96.35%
2.	Ms.Tejaswini et al. (2017)	K-means ImprovedK-means	92.70% 96.73%
3.	Seyedamin et al. (2017)	Decision tree Naive Bayes	77.55% 83.49%
4.	SanavarBangi et al. (2016)	Clustering algorithm	93%
5.	Majia et al. (2016)	K star J48 Bayes Net	75% 86% 87%
6.	ShahedAnzaru et al. (2016)	Naive Bayes Decision tree	83.17 73.19
7.	Theresa princy et al. (2016)	ID3	80.6%
8.	Shanuxu et al.(2016)	Regression Decision tree C4.5 Random forest	66.56% 62.91% 62.02% 55.15%
9.	K.Prasanalakshmi et al. (2015)	Classifier C4.5 CBA CMAR L3 SACHDP	80.8% 81.9% 82.2% 84.4% 96.6%
10.	Lokanath Sarangi et al. (2015)	GA Technique	90%

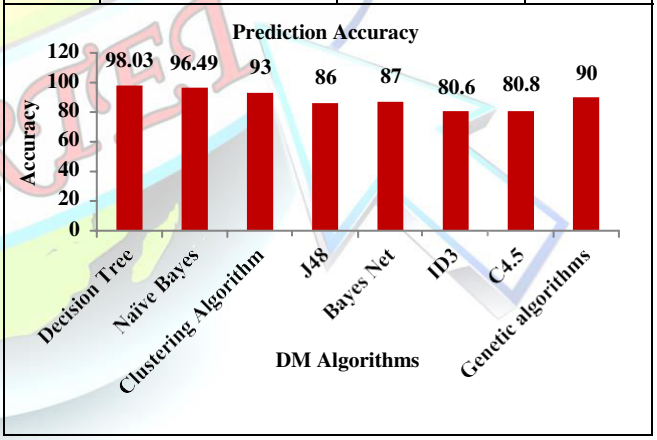

Figure.3:Graphical representation of the data mining techniques reviewed.

Conclusion:

On examining various data mining techniques for prediction of heart diseases, the Decision tree and Naïve Bayes shows more accuracy than other techniques. The following table has been observed from the extensive study on the algorithms in the prediction of the cardiac diseases. This review provides an elaborate study on the techniques, approaches, strengths and weaknesses. This review study provides recommendations for the researchers and cardiologists to collaborate to perform simple clinical datasets for the data mining models.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 5, Special Issue 12, April 2018

TABLE 2: STRENGTHS AND LIMITATIONS OF DATA MINING TECHNIQUES

DM objectives	DM techniques	Strengths	Limitations
Classification &Prediction	Decision Tree	Easy to understand.	Small data set
		Able to avoid over-fitting byPruning	Unbalanced data set. Lack of input attributes
		Accuracy, sensitivity and specificity rate enhanced	
	Neural Networks	Supervised learning	Different number of patterns in each class
		Can learn complex functions	Small data set
	Support Vector Machine	Avoid over-fitting	Undetected information
		Training time reduced	Heterogeneous data set
		Error rate reduced	Output are incomprehensible
	Genetic Algorithm	Efficient interpretation and analysis.	Expand the list of attributes, Missing variables.
		Accuracy, sensitivity andspecificity rate enhanced	Unavailable data. The need to validate models using external datasets
	K-Nearest Neighbour	Simple and flexibleArbitrary decision boundaries	Sensitive to noise andReplication, parametric
	Naive Bayes	Resistant to noise, missing values and irrelevant features	Accuracy degraded by Correlated attributes.
	Logistic Regression	Nice Probabilistic interpretation.	Limited expressive power
		Lots of ways to regularize your model	Hard to make incremental
	Random Forest	High accuracy Runs efficiently on large databases	Biased in favour of attributesincluding categorical variables with more levels
		Has an effective method for estimating missing data	More tests using external dataset is needed
Association	Apriori algorithm	Reduces the number of candidate item sets Enhance accuracy	Large number of item sets generated.
		Ease of interpretation	
		Extracted rules for the expert	
	Association rule algorithm	Accuracy improved	Clinical testing still needed
		Decision interpretation Provided	

REFERENCES

[1] Dr.B.Umadevi,M.SnehaPriya,"A Survey Paper on Prediction of Heart Disease using Data Mining Techniques",International Journal of science and Research,ISSN(Online):2319-7064 Index Copernicus Value(2015):78.96|Impact Factor(2015):6.391 volume 6 Issue 4,April 2017.

[2] AbhishekRairikar,Vedantkulkarni,Vikassabale,Harshavardhan kale,"AnuradhaLamgunde,"Heart Disease Prediction Using Data Mining Techniques",2017 International Conference on Intelligent Computing and Control (I2C2).

[3] Priyanka,Dr.PushpaRavikumar,"Usage of Data mining Techniques in predicting the Heart disease-NaiveBayes&Decision tree."2017 International Conference on circuits Power and Computing Technologies[ICCPCT].978-1-5090-4967-7/17/$31.00@2017 IEEE.

[4] TheresaPrincy.R,*J.Thomas*"HumanHeart Disease Prediction System using Data Mining Techniques",2016 International ConferenceonCircuit,PowerandComputingTechnologies [ICCPCT],978-1-5090-1277-0/16/$31.00@2016 IEEE.

[5] SanavarBangi,poojaGaakh,pradnyaGaikwad,PratikshaRajpure,"Surve y Paper on Prediction Of Heart Disease Using Data Mining Technique",InternationalJournalof Recent Trends in Engineering & Research.

[6] Marjia Sultana, Afrin Haider ,Mohammad Shorif Uddin "Analysis of Data Mining Techniques for HeartDisease Prediction" ICEEICT 2016 978-1-5090-2906-8/16/$31.00 ©2016 IEEE.

[7] K.Prasanna Lakshmi, Dr.C.R.K.Reddy"Fast Rule-Based Heart Disease Prediction usingAssociativeClassificationMining",IEEE International Conference on Computer, Communication and Control (IC4-2015).

[8] Ms. Tejaswini U. Mane"Smart heart disease prediction system using Improved K-Means and ID3 on Big Data"2017 International Conference on Data Management, Analytics and Innovation (ICDMAI) Zeal Education Society, Pune, India, Feb 24-26, 2017.978-1-5090-4083-4/17/$31.00 ©2017 IEEE.

[9] SeyedaminPouriyeh, Sara Vahid, Giovanna Sannino, Giuseppe De Pietro, Hamid Arabnia, Juan Gutierrez" A Comprehensive Investigation and Comparison ofMachine Learning Techniques in the Domain of Heart Disease" ,22nd IEEE Symposium on Computers and Communication (ISCC 2017): Workshops - ICTS4eHealth 2017, 978-1-5386-1629-1/17/$31.00 ©2017 IEEE.

[10] ShahedAnzarusSabab, Ahmed Iqbal Pritom, Md. Ahadur Rahman Munshi, Shihabuzzaman"Cardiovascular Disease Prognosis Using Effective Classification and Feature Selection Technique".

[11] Shan Xu, Haoyue Shi, XiaohuiDuan, Tiangang Zhu, Peihua Wu, Dongyue Liu,"Cardiovascular Risk Prediction Method Based on Test Analysis and Data Mining Ensemble System".

[12] LokanathSarangi,MihirNarayanMohanty,SrikantaPattnaik, "An Intelligent Decision Support System for Cardiac Disease Detection",IJCTA,International Press 2015.

[13] M.Umamaheswari, Dr. P. Isakki @ Devi,"Prediction of Myocardial Infarction UsingK-Medoid Clustering Algorithm",2017 IEEE International Conference On Intelligent Techniques In Control, Optimization And Signal Processing,978-1-5090-4778-9/17/$31.00 ©2017 IEEE.

[14] S.KiruthikaDevi,S.Krishnapriya,DristiponaKalita, "Prediction of Heart Disease using Data Mining Techniques",Indian Journal of Science and Technology,Vol 9(39), DOI: 10.17485/ijst/2016/v9i39/102078, October 2016.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 5, Special Issue 12, April 2018

[15] Salma Banu N.K, Suma Swamy,"Prediction of Heart Disease at early stage usingData Mining and Big Data Analytics: A Survey", 2016 International Conference on Electrical, Electronics, Communication, Computer and Optimization Techniques (ICEECCOT).

[16] Abhishek Rairikar, Vedant Kulkarni, VikasSabale, Harshavardhan Kale, AnuradhaLamgunde," Heart Disease Prediction Using Data MiningTechniques"2017 International Conference on Intelligent Computing and Control (I2C2).

[17] MadihaGuftar, Ammar Asjad Raja, Syed Hasnain Ali, Usman Qamar," A Novel Framework for Classification of SyncopeDisease using K-Means Clustering Algorithm" SAI Intelligent Systems Conference 2015November 10-11, 2015 | London, UK, 978-1-4673-7606-8/15/$31.00 ©2015 IEEE.

[18] V.Krishnaiah,G.Narsimha,N. Subhash Chandra,"Heart Disease Prediction System using Data Mining Techniques and Intelligent Fuzzy Approach: A Review" ,International Journal of Computer Applications (0975 – 8887) Volume 136 – No.2, February 2016.

[19] R.Kavitha, E.Kannan,"An Efficient Framework for Heart Disease Classificationusing Feature Extraction and Feature Selection Technique in Data Mining".

[20] Anurag Bhatt, Sanjay Kumar Dubey and Ashutosh Kumar Bhatt," Analytical Study on Cardiovascular Health Issues Prediction Using Decision Model-Based Predictive AnalyticTechniques" Springer Nature Singapore Pte Ltd. 2018 M. Pant et al. (eds.), Soft Computing: Theories and Applications,Advances in Intelligent Systems and Computing584.