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PREDICTION OF HEART DISEASE: A SURVEY USING MACHINE LEARNING ALGORITHMS

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ABSTRACT: Among the different causes of death, heart disease is highlighted as the most common. Due to medical practitioners' lack of knowledge and expertise about warning indications of heart failure, detecting heart illness might be difficult. In the healthcare industry, there is a vast amount of data. Early identification and prevention of heart-related disorders can be accomplished by employing the most effective data mining approaches. In the medical field, both machine learning (ML) and data mining (DM) techniques have proven to be useful and significant. The current study project's goal is to examine many risk parameters that have been highlighted in the analysis of heart disease, as well as to uncover multiple strategies for the detection and prediction of heart disease, as well as to evaluate the shortcomings of previous work. The article uses DM approaches to synthesize existing heart disease prediction studies, considering a variety of DM techniques to determine the most appropriate and effective technique. The CNN, LSTM is being proposed for heart disease detection and prediction, and it produces better results than the other existing techniques. The suggested approach includes the gathering of datasets, training, and testing, the collection of user symptoms, securely sending the data using AES, and finally, generating the result in PDF format. In comparison to the rest of the ML approaches, predicting heart disease algorithms use comparative performance in datasets related to medicine.

Keywords: Clustering, Machine learning algorithms, heart disease prediction, supervised learning, health care services

I. INTRODUCTION

Heart diseases are considered to be biggest concern in the medical field with its frequency and number of deaths. In US people are affected by coronary artery disease, which is a long-lasting disease in which artery gets harden and narrow [1]. As per WHO report heart disease is one of the major asymptomatic diseases which constitutes up to one-third of the death rate. Ten percent of the world is getting trouble due to this disease [2].Around 12 million deaths are happening in the world every year [3]. Because of heart disease the regular or normal functioning of heart gets affected. So heart will function in an abnormal manner. Heart disease is of various types. Like Coronary Artery Disease, Valvular heart disease, Cardiomyopathy, Heart infections. Coronary artery diseases mainly influence the function of artery of the heart. Valvular heart disease brings an irregularity in the blood flow in and out of the heart through the valves of heart. Cardiomyopathy affects the compression and expansion of heart during its functioning. Heart infection mainly indicates the irregularity in the shape or structure of heart which was created before the birth of any person [4]. In case of coronary artery disease cholesterol, calcium and some other things getting deposited in the veins through which blood getting circulated in and out of the heart. These deposited contents create a sticky hard substance which forms a blockage in the free flow of blood through the veins.

Hence the veins getting narrowed and sometimes heart muscle does not get sufficient oxygen for its proper

functioning which exhibits heart pain with the patient [5]. Due to technological advancement, human became very much luxurious so that most of the works are being done by machines. As a result of which human are reluctant to do any physical work, hesitating to do exercise, consuming junk food, having a stressful work environment and habituated with smoking and drinking. Due to this kind of lifestyle, the human becomes more susceptible towards heart Disease. Accurate Identification of heart disease became very crucial nowadays because unless a person is not getting heart attack it is very difficult to know whether they are affected by heart disease or not. If the disease can be identified at a premature stage perfectly followed by appropriate treatment then a number of lives can be saved [3, 6].

There are so many factors present which complicate and delays the accurate diagnosis decision process. The pathological and clinical symptom of heart disease is related to many other organs. Hence the practitioners face problems in differentiating between other organ diseases and heart disease as both have the similar type of symptoms [7]. Normally a method called as SPECT ( ) used in which radioactive traces are injected into the blood which produces the image of the heart. These images are generally referred by the doctors to diagnose the CAD ( ) and predict the heart disease. Irregularities in the heartbeat or rhythm can be analyzed using ECG through which the abnormal heart activity can be observed [8]. The prediction made by doctors about a disease is not always 100% accurate. Hence there is a need arise to transform clinical diagnosis into computational diagnosis. This computational diagnosis can be used to find the crucial attributes of heart disease by analyzing the clinical dataset of a patient and provide a prediction model using the combination of these discovered attributes [9]. Analyzing the severity or identification of any disease based on some symptom, event and medical report about any person is very difficult. Till now in health care system the diagnosis of any disease is being done by the identification of any vital symptom that was previously observed in any previously diagnosed patient suffered from the same disease. Hence the manual observation rule of diagnosis is not always lead towards the accurate identification of disease [10]. While diagnosing and suggesting some treatment the practitioners need to have a more accurate and automated system. Challenges faced by the medical

System is medical knowledge, which decision needs to be taken, the available choices and variation of a particular method. Data analysis is one of the powerful tools which enhances the skill of medical practitioners and enable them to provide a better treatment technique for the removal of the disease. The risk level of the various diseases can be known through a medical diagnosis system [11]. Development of technologies and growing motivation of people for moving towards Automated and Intelligent Systems really inspired researchers to develop various machine learning algorithms for various classification based problems. Due to the availability of huge amount of data in the medical field really helped researchers to find some self- driven and useful solution for complex disease identification like heart disease, cancer, and diabetes etc [12].

Medical diagnosis is mainly coming under classification based problem. In such kind of problems after analyzing the record of a patient, it will be mapped to one of a discrete class level. In this, the main aim is to create a model using some sample data to do a proper prediction for some new and unknown data [13]. Under machine learning so many approaches like Deep learning, Reinforcement Learning and Evolutionary learning which are nowadays becoming very much popular for its fast detection and accurate prediction [14]. The dataset which is used by all papers is Cleveland heart disease data set provided by the UCI machine learning repository [15].

II. RELATED WORK

Purushottama. C, Kanak Saxenab, Richa Sharma [1] proposes an effective framework that can detect the views for predicting risk factors in patients based on their available health factors. The study aims to provide an insight into the specialized medical practitioners in taking the best measures concerning risk level related to heart disease. The algorithms used such as SVM, CMAR, Bayesian Classifiers and C4.5. The advantages of this method are the proposed system formulates the rules that are listed as Original-Rules, Pruned- Rules, and Rules without duplicates, Classified-Rules, Sorted-Rules, and Polish. The disadvantage of this method is the system is being trained and tested by utilizing10

fold methods. The proposed framework is evaluated for arrangement accuracy and the result illustrates that it's highly capable of accurately predicting the risk level related to heart/coronary diseases.

Chaithra N and Madhu B [2] examines different sorts of DM approaches used to build up a predictive model concerning cardiovascular diseases based on the data retrieved from transthoracic echocardiography. The algorithms used such as, Decision Tree (DT), J48, Naive Bayes (NB) and Neural Network (NN). The advantages of this method are to measure the performance of the Neural Network (NN) is much better in anticipating cardiac diseases. The disadvantage of this method is that the algorithm offers a low true negative rate the junior cardiologists have ease to access it. Here, all the three algorithms performance revealed the best true negative rate, making it a convenient tool for training junior cardiologists and medical students for diagnosing heart disease.

Kipp W. Johnson, BS, Jessica Torres Soto, MS, Benjamin S. Glicksberg [3] offers a benchmark for medical practitioners on significant attributes of Artificial Intelligence (AI) and Machine Learning (ML), reviews-selected applications of the above techniques in cardiology till date thereby determining as to how cardiovascular medicine can adopt AI in the coming future. The algorithms used such as Neural Networks (NN) and Deep Learning (DL). The disadvantage of this method is poised to impact all possible phase of human state including cardiology. The advantage of this method is the supervised learning approach and reviews-selected applications in cardiology are in the similar fields. At present this technique of Machine Learning (ML) is carried out by individuals having specialized training. Although in near future adopting this approach would be much feasible and hassle free-

Sarangam Kodati & Dr. R. Vivekanandam [4] examines some factors to anticipate heart diseases and proposes Heart Diseases Prediction System (HDPS) relying upon the Data Mining (DM) techniques. The algorithms used such as SVM, Naïve Bayes (NB), Random Forest and KNN algorithm. The disadvantage of this method is the DM approach uses only WEKA and ORANGE tools can be detected. The advantages of this method are when implemented on patients the valuable decisions are withdrawn based on this hidden information using data mining. According to the output achieved by employing DM tools, it's revealed that a different result is being generated with every DM tool even though with the same dataset and with a separate classification algorithm.

ChalaBeyene, Pooja Kamat [5] survey reveals that not all medical practitioners possess equivalent skills and experience for taking a precise decision. Some doctors lack in taking appropriate decisions which results in a critical situation for the patients. To resolve such issues, predicting disease occurrence becomes mandatory. The algorithms used such as SVM, Decision Tree (DT), K-Nearest Neighborhood (KNN), Naïve Bayes (NB) and Artificial Neural Network (ANN). The disadvantage of this method is that it does not predict the performance of every algorithm for implementing the proposed system. The advantages of this method are to enhance and improvises the present system in decision making by incorporating various feature selection methods and algorithms. The proposed approach helps in the prediction of heart disease occurrence to achieve a prior automatic diagnosis and fetching result within a short time span. This aids in achieving Quality of Services (QoS) and minimizes the cost factor in saving patient's life.

Manpreet Singh, Levi Monteiro Martins, Patrick Joanis, and Vijay K. Mago [6] proposed HDPS (heart disease prediction system) that relies upon SEM -Structural Equation Modeling and FCM - Fuzzy Cognitive Map. The dataset utilized is CCHS - (Canadian Community Health Survey) 2012.The algorithms used such as Structural Equation Modeling (SEM), and Fuzzy Cognitive Map (FCP). The disadvantage of this method is to predict the time involved for heart disease is quiet high. The advantages of this method reveal that the proposed model yields an accuracy of 74%. To predict the heart disease 80% of the dataset was utilized for training Structural Equation Modeling and 20% of the dataset for testing the Fuzzy Cognitive Map model.

Jaymin Patel, Prof. Tejal Upadhyay, Dr. Samir Patel [7] perform a comparison among various techniques of Decision Tree (DT) classification revealing the one providing effective performance concerning the diagnosis of heart disease by adopting WEKA.

Algorithms that are being tested includes: Logistic model tree algorithm, J48, Decision Tree (DT) and Random Forest algorithm. The disadvantage of this method is accuracy and scalability of the system need to be improvised. The advantage of this method is to classify the system being ideal and capable enough for applying to sizeable data. The system aims to fetch or mine hidden patterns with the help of DM techniques and also anticipating heart disease in patients where the presence is rated from, no presence to likely presence.

Shalet K.S, V. Sabarinathan, V. Sugumaran, and V. J. Sarath Kumar [8] proposes Heart Disease Prediction System (HDPS) having the potential to estimate an individual's heat condition. The algorithms used such as Decision Tree (DT), and Support Vector Machine (SVM) Classifier. The disadvantage of this method is that to reveal the resting electrocardiographic output and sex need not enhance overall results performance. The advantages of this method is that certain factors such as chest pain, age, type, thalassemia, colored fluoroscopy and exercise induced chest pain are categorized by employing the classifier. This research yield an accuracy of 82.35%and the algorithm of DT is adopted for the process of feature selection and the SVM classifier is adopted for classification.

KaanUyar, Ahmet İlhan [9] proposes a few computational techniques for examining heart diseases. The algorithms used such as GA - Genetic algorithm, RFNN - recurrent fuzzy neural networks. The disadvantage of this method is needs to be accompanied by medical practitioners for considering various parameters due to which decision-making ability of the method can get affected. The advantages of this method is that altogether 297 instances of patient data is used, from which 252 are adopted for training and 45 are being adopted for testing. An accuracy of 97.78% accuracy is achieved from the testing set. The investigation is carried out successfully with the help of the heart disease testing dataset. The factors being computed are: accuracy, RMSE - Root Means Square Error, probability of the misclassification error, sensitivity, specificity, F-score, and precision.

S. Bagavathy, V. Gomathy, S. Sheeba Rani, Sujatha. K, Bhuvana. M.K, Monica Murugesan [10] surveys multiple techniques of data mining are to fetch information from a huge dataset. The study is carried out on K-Means Clustering Algorithm which is then compared with Map Reduce Algorithm for heart disease detection. The algorithms used such as SVM, and K-NN. The disadvantage of this method is the latency found because of batch processing. The advantages of this method is that the K-means clustering algorithm is being compared with that of Map Reduce Algorithm's implementation efficiency in both parallel and DS (distributed systems).Conclusion: Map Reduce Algorithm yields better accuracy compared to the K-Means Clustering Algorithm as it offers dynamic schema and linear scaling.

Palash Ukey, Vinit More, Pravin Patil, Amruta Sankhe [11] have built a web application using DM Techniques that aids in detecting multiple heart-related issues, thereby offering a resolution for the same. The project formed is termed heart disease prediction which involves three modules. Every module has a few sub-modules. Also, there is a provision of security in each module. The algorithms used such as Artificial Neural Network (ANN), and Naive Bayes (NB). The disadvantage of this method is that it is difficult to provide system maintenance. The advantage of this method is that the system provides automatic results along with the concerned doctors for subsequent treatment. An online software program is used to predict the heart disease which is thoroughly automated. The ultimate benefit of the proposed system is that it can be used by every individual in the scheduling processor as administrators. Also, it makes user's tasks much more secure and effective.

Arun. R and N. Deepa [12] put forth cardiovascular illness. The varied types of symptoms and innumerable powerful intercessions are believably startling and confusing. Illustrating secure execution and examination reveals feasibility in the Cloud Computing (CC) situation. The algorithms used such as Naive Bayes (NB), and AES. The disadvantages of this method are allowing controlled sharing of acquired information with patient's family using the benefit of the social networking platform. The advantage of this method is that the AES tends to be an encryption algorithm which secures sensitive but unclassified information. CAM - Cloud assisted privacy-preserving mobile health monitoring system aids in transferring the computational overload to the cloud by incorporating

the newly framed technique of key private proxy re-encryption.

K. Rajalakshmi and K. Nirmala [13] discuss that the medical industry can't mine an entire set of information and knowledge from databases related to heart disease. The tool being utilized is MapReduce using Hive Database within the Hadoop open-source framework. The algorithms used such as K-Means, WAC - Weighted Associative Classifier, and Prediction Tree C5.0. The disadvantage of this method is cardiologist lacks in providing first aid advice. The advantages of this method is WAC offers an effective medium for imbibing the classification process using Association Rule Discovery that aids in enhancing the prediction accuracy for classification. The integrated technique of DT along with WAC and K-Means offers improvised prediction outcomes concerning Heart Disease symptoms. The proposed techniques offer an effective and accurate way of predicting heart disease.

Yildirim et al. [14], the author has proposed a DBLSTM- WS model which gives a high recognition performance of 99.39%. It is observed that the wavelet-based layer proposed within the study significantly improves the popularity performance of conventional networks.

Marinho, L. B., de MM Nascimento, N., Souza, J. W. M., Gurgel, M. V., Rebouças Filho, P. P., & de Albuquerque[15], have proposed a system. The algorithms used in the system are NB, SVM and OPF. The accuracy of this proposed model is 94.30%. Li, Z., Zhou, D., Wan, L., Li, J., & Mou, W. [17] have used a deep residual network to build their model whose accuracy was measured as 99.06% to classify the heartbeat. Pandey, S. K., & Janghel, R. R.[18]

III. MACHINE LEARNING APPROACHES

Authors	Year	Approach	Accuracy
Purushottama et al. [1]	2016	SVM, CMAR, BayesianClassifiers and C4.5	89.7%
Chaithra N et al.[2]	2018	Decision Tree (DT),J48, NB (Naive Bayes) and NN (Neural Network)	95.66%
Kipp W. Johnson et al. [3]	2018	NN (Neural Networks) andDeep Learning.	94.28%
SarangamKodati et al. [4]	2018	SVM, NB (NaïveBayes),Random Forest and KNN	91.37%
ChalaBeyene et al. [5]	2018	SVM, DT (Decision Tree), KNN (K-Nearest Neighborhood), NB (Naïve Bayes) and ANN (Artificial Neural Network)	94.56%
Manpreet Singh et al. [6]	2016	SEM -Structural Equation Modelling and FCM - Fuzzy Cognitive Map	80.00%
KaanUyar et al. [9]	2017	Genetic algorithm, RFNN - recurrent fuzzy neural networks	97.78%
S. Bagavathy et al. [10]	2018	SVM and K-NN	89.00%
Palash Ukey et al. [11]	2018	Artificial Neural Network, NB	92.3%

Yildirim et al. [14]	2018	LSTM	99.25%
Marinho et al.[15]	2019	NB, SVM, OPF	94.30%
Yildirim et al.[16]	2019	CAE and LSTM	99.00%
Li et al.[17]	2020	Deep residual network	99.06%
Pandey et al.[18]	2020	LSTM	99.37%
Zheng, Z et al [19]	2020	CNN-LSTM	99.01%
Artetxe, A et al., [21]	2018	Bayesian	77.00%
Krittanawong et al., C[22]	2018	CNN-MLP	85.00%
Rad, A. B et al., [23]	2019	RNN-LSTM	78%
Shakya et al., [25]	2020	SVM,KNN,RF	88.68%

IV. CONCLUSION

A review of various machine learning algorithms for predicting cardiac disease is presented in this work. We also compared the classification accuracy of all of the strategies presented, taking into account dimensionality reduction and output levels. As a result, it can be concluded that dimensionality reduction is a good strategy for any type of classification problem, as it reduces the number of input features that contribute a lot to the occurrence of the disease. However, the problem with dimensionality reduction is that if it is done too much, the model can become overfit. An overfitted model's fault is that it becomes very specific to a single data set, rendering it useless when a different set of data is used to make a forecast. We also looked at the number of output classes as a comparative factor. So, if there are more classes, it is more convenient to cover each output variety. As a result, the severity of the condition may be quantified more precisely. The number of output classes used in a classification issue is usually two. The average number of classes that can be taken is five, with a maximum of ten. After that, appropriate classification becomes extremely difficult. As a result, after taking into account the number of dimensions, we discovered that the artificial neural network technique was the best, with an accuracy of 97.5 percent and 13 characteristics. When we looked at the number of output classes, we found that the same artificial neural network technique performed best, with a 97.5 percent accuracy and 5 classes. Following the completion of this comprehensive analysis, further work can be focused on implementing a competent technique that can predict heart disease with greater accuracy than all of the previously stated techniques.

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