

## **“A Model based on Convolutional Neural Network (CNN) to predict heart disease “**

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### **ABSTRACT**

Here it is a necessity for physicians to foresee heart problems before they see them in their cases. The factors that contribute to the odds of heart diseases are smoking, absence of physical work regime, hypertension, elevated cholesterol, improper diet, alcohol consumption, obesity, and sugar level variation in the body, etc. Heart related disease clinically is known as cardiovascular disease. Many factors and reasons influence the heart disorder, and it is the one of fundamental cause of death worldwide. Since, cardiovascular related ailments and diseases can be diagnosed through various clinical test results, these factors that leads to the test results give an opportunity to perform analysis on them and enable to predict the cardio disease at an early stage by identifying the contributing risk factors and treating them to prevent fatality. There are techniques like Data mining approaches and machine learning (ML) algorithms like Naïve bayes, Random Forest, Decision tree, Support vector machine, K-nearest neighbor, Convolutional Neural network, these will facilitate predicting the current condition of heart health. ML is the process of data evaluation from different perspectives and combines useful information. Machine learning technique is used for attempting to predict the future scenario by training the machine.

This research work emphasis more on study and analysis of the Convolution Neural Network approach, Random Forest techniques, Naïve bayes, decision tree and support vector technique's applicability for predicting heart health by anticipating the heart disease in patients. The reason behind choosing these two techniques is that majority of the research work carried out earlier contains these two techniques in majority and tried to analyze the performance difference between them through executing these algorithms on the selected dataset. To solve the complexities in identifying the heart disease and a decision support system, is based on the machine learning algorithms such as, Support vector Machine, k-nearest neighbor (k-nn), Convolutional neural network, random forest, naïve bayes, decision tree, because of this reason we have chosen these algorithms for comparison with proposed model. With help of comparison came know that convolution neural network is best classifier for existing heart dataset. Performance of these algorithms like support vector, k-nearest neighbor (k-nn), support vector, random forest, naïve bayes, decision tree calculated through factor like f-measure, accuracy, precision, recall, execution time.

**Keyword:** Data mining, Convolutional Neural Network, Classification, prediction model.

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### **I. INTRODUCTION**

In this 21st century, medical science has become more important as part of the healthcare industry, appreciated by healthcare professionals like doctors and practitioners for its ability to give useful information and insights quickly. Therefore, medical data comes in the form of electronic healthcare records collected from patients. Data in healthcare is commonly used for building decision support systems, this uses domain knowledge along with patient data and artificial intelligence. which can give information to aid healthcare like doctor in their work environment as well as to find the major critical situations of patients or errors and alert the doctors accordingly to patients.

Number of the methods that are often used to build into medical decision support systems are models based on machine learning (ML) algorithms like support vector Machine, k-nearest neighbor (K-NN), Convolutional neural network, random forest, naïve bayes, decision tree these can forecast the presence of a disease in a patient based on a set of risk factors smoking, absence of physical work regime, hypertension, elevated cholesterol, improper diet, alcohol consumption, obesity, and sugar

level variation in the body, etc. In this paper we will be building a predictive model for cardiovascular heart disease. As per the World Health Organization each year 17.9 million people die from heart disease, which accounts takes for around 31% of deaths worldwide, due to this it makes the leading cause of death worldwide.

Even though ML models like support vector Machine, k-nearest neighbor (K-NN), Convolutional neural network, random forest, naïve bayes, decision tree have been widely used and got to be more successful, heart-disease prediction is one of most complicated problem as there are still many improvements needs to be made and methods of ML algorithms like support vector Machine, k-nearest neighbor (K-NN), Convolutional neural network, random forest, naïve bayes, decision tree needs to explore. This kind of problem comes under the supervised learning classification within ML algorithms. We use classification algorithms to get know the relationship between a set of risk factors like smoking, absence of physical work regime, hypertension, elevated cholesterol, improper diet, alcohol consumption, obesity, and sugar level variation in the body, etc. and the num class. In this case we have heart-disease risk factors such as age, cholesterol, and the prediction of medical tests and numb class is able fine the presence of heart disease for that patient.

This research focuses on data pre-processing before going build the predictive model by classification algorithms like support vector Machine, k-nearest neighbor (k-nn), Convolutional neural network, random forest, naïve bayes, decision tree. These risk factors smoking, absence of physical work regime, hypertension, elevated cholesterol, improper diet, alcohol consumption, obesity, and sugar level variation in the body, etc. passed into the classification ML algorithms to give a model to predict heart disease. These models are then compared with performance metric Recall, F-Measure, Accuracy, Precision, Execution Time (Seconds).

The main aim of this research is to identify classification methods that work well together to get good accuracy for heart-disease prediction. To get this aim achieve, we need to follow classification methods as following support vector Machine, k-nearest neighbor (KNN), Convolutional neural network, random forest, naïve bayes, decision tree is conducted on exiting datasets related to heart disease published at the University of California Irvine data repository (UCI). Once The experiment done it has aims to answer the two research questions: Whether using ML classification methods increase the performance of heart-disease prediction model using the existing dataset for heart-disease prediction, and which is most affective risk factor for the heart-disease dataset.

The experimental result will take some inspiration from previous experimental literature as we used the ML algorithms as support vector Machine, k-nearest neighbor (K-NN), Convolutional neural network, random forest, naïve bayes, decision tree these had the most success rate when we are building heart-disease prediction model. Our approach differs in the classification methods that are used, as well as in using an existing heart-disease dataset collected from the University of California Irvine data repository (UCI). We build predictive model using web application and then compare that with other existing prediction model like support vector Machine, k-nearest neighbor (K-NN), Convolutional neural network, random forest, naïve bayes, decision tree using performance metrics including accuracy, precision and recall, F-Measure, Execution Time (Seconds), with this able identifying the most effective ones that can be used for heart-disease prediction and can also be useful to the medical organization. This research will be for anyone who has an interest in working in medical diagnosis using ML.

This paper is organized as follows: we had the first survey of common methods in ML algorithms related to heart-disease forecast, then methodology used in prediction of heart disease.

## **II. RELATED WORK**

The main reason for death worldwide is due to heart disorder including South Africa. For heart attack condition and its discovery at an earlier stage will help to decrease heart attacks. Medical partitioners make the information with an abundance of hidden data present, and it's not just utilized for forecasts. Hence, the investigation changes the unused information into a dataset for utilizing various information in ways. Nowadays, people die of having heart attack symptoms, because earlier that was not taken into consideration. There's an interest for medical partitioner and middle people to describe heart issues before they do occur in their cases. The parameters that extension the chances of cardiovascular disappointments are smoking, shortfall of genuine exercises, hypertension, raised cholesterol, unhealthy eating standard, unconditional usage of alcohol, and high-level sugar conditions. Cardiovascular diseases (CVD) set up coronary heart, Cardiovascular or Stroke, hypertensive heart issue, standard heart, supplemental road, rheumatic heart issue, and insubordinate heart issue [1].

Data mining is a process of information evolution and synopsisizes it into helpful data. The current research work helps to estimate the likelihood of getting coronary illness given in the patient informational index. Predictions and depictions are head

objectives of information mining; by and by Prediction in information mining includes characteristics or factors in the informational collection to observe obscure or future state upsides of different qualities. Description and analyzing on observing examples that portray the information to be comprehended by people. Data mining is the process of an information analysis according to alternate points of view and enters valuable data. This process is utilized for endeavoring to anticipate heart problems. Based on hazard factor of the heart conditions can be characterized without any problem. This work centers to measure distinctive danger elements and order with them which might empower the ways of foreseeing coronary illness. ECG numeric dataset is utilized in this work. Everything begins with information pre-processing. Using data mining algorithms like Convolution Neural Network

(CNN)., features are extracted and classified. Comparing CNN with other data mining approaches, CNN provides better performance. For performance evaluation, criteria like accuracy, measures, and F- measure, Precision, Recall are to be calculated. Compared to KNN, Convolution Neural Network gives better results. The correlation measures are ready to observe that Convolution Neural Network is the fulfilled classifier for the instance of anticipating coronary illness on the heart dataset as information [2].

In 1960s, when Hubel and Wiesel explored the neurons network, it is utilized for neighborhood delicate finding the sickness of heart in the lifeline's visual framework, they build up the extraordinary organization construction can adequately decrease the intricacy of Feedback Neural Networks and afterward Convolutional Neural Network. CNN is a proficient acknowledgment calculation, which is broadly utilized in design acknowledgment and data handling. It has different appearances like basic construction, low preparing boundaries and inflexibility [3].

This article, authors portray the prediction of heart issue in the clinical field utilizing information of medical data science. After a ton of investigation does, this investigation connected with that heart issue, the accuracy of the cast still can't seem to be bettered. Hence, this literature work has an aim of feature selections method and algorithms, which used different types of datasets for predictions of heart diseases to do exhibitions, analysis to get a more accuracy [4].

In this article, authors propose a new system model that has aims to find significant features of heart dataset using machine learning algorithms that results in the improvement in finding accuracy of prediction of cardiovascular disease. The new prediction model is launched with distinct combinations features and many known, new classification methods [5].

In this article, Author made analysis of classification using machine learning algorithms for medical heart dataset that help to get or predicts the heart disorder, heart disorder is one of common cause of death, in whole worldwide. It's very difficult for doctors and professionals to identify heart disorders, as it needs experience and knowledge. Decisions made and experiment taken to reveal these ML algorithms as expected J48, K-Nearest Neighbor, Decision tree, Support vector, Naive bayes and CNN are considered more efficient for this work, To different calculations for heart disease prediction [6.]

In this article, Authors represent a highly required accurate mixture of identifying coronary artery disorder. As it's a subjected as fact, proposed model has ability to improve the performance of convolutional neural network by nearly 10% by making extension of its starting weights using traditional algorithms Like KNN [7].

In this article, Authors presented developed framework dependent on related classification method based on the heart dataset for identifying heart disorder. The process to carry out this work is done through a heart dataset, and it is collected from UCI machine learning database to make test on distinct data mining skills. There are many more factors that are related to the cause of heart disorder i.e., gender, age, chest pain type, blood pressure, blood sugar etc. By this forecast the early features of heart disorder [8].

Nearest neighbor (KNN) is authentically basic, generally it is famous, to a great extent successful and it is one the best method for pattern recognition. Classification is done based on the class of their Near neighbor node using KNN as its one of the straightforward classifiers. As we all know, medical databases are always in huge volume in nature. Dataset contains unwanted, irrelevant attributes, it may lead to less accurate results for heart disease predictions. Nowadays, people die because of heart attack and its one of best cause of death in India. Comparing other country, it has high rate for Canada (35%) and USA. Henceforth there is a need for a decision support system with the help of this doctor can take precautionary steps. In this literature work presented the new method which combines KNN with GENETIC method for best classification. Genetic method does the global research work in complex huge and multi-model ways to get optimal solution for prediction [9].

In this article, authors say to get output as high-quality image, we need method called image de-noising that has skill of manipulation of image data. To reduce the noise, originally the non-local means and Gaussian noise removal filter used in image de-noising method. There are techniques called medical ultrasound imaging noise, originally known as the speckle noise it used to filter out. This literature reviews the being non-local means based filtered for image de-noising [10].

In this article, the authors say, the proposed system uses a greater number of attributes as input for predictions of heart disorder. This literature work utilizes clinical terms as comparable as gender, pulse, sex, blood pressure, chest pain cholesterol like 13 attributes to visualize the risk of patient getting a Heart disorder. As recently, 13 attributes are utilized for forecast. This investigation work added two further characteristics, for example obesity and smoking. Decision Trees, Naive Bayes, and Neural Networks are data mining classification algorithms to analyze heart disorder from database [11].

In this article, Author says heart disease diagnosis and treatment is done using medical diagnosis system as its plays important roles in medical practice. In this literature review, the risk of cardiovascular disease can be predicted using a medical diagnosis system. Benefits of inheritable design and neural organizations that are collected by the framework. For most complex sections issues here specially assigned the multifaced-feed forward neural organizations. The loads of the neural not really settled utilizing inheritable style since it tracks down pleasantly great arrangement of loads in lower number of duplications [12].

In this article, Authors say based on ECG report heart conditions can defined through examination features as its wide range used. Vital cardiac disease can be identified by features with automatic extraction. This work presents a multi-goal ocean change framework for revelation 'P','Q','R','S','T' tops complex from unique ECG signal. 'R-R' time pass is a significant of the ECG signal that relates to the sparkle of the associated individual. Sudden expansion in tallness of the R' flood or changes in the component of the 'R-R' indicate bright peculiarities of mortal heart. Likewise, 'P-P','Q-Q','S-S','T-T' also relate to various anomalies of the heart and their peak amplitude also envisages other cardiac diseases. In this proposed framework the 'PQRST' tops are articulated and put away over the whole sign and time span between two progressive 'R' tops and different pinnacles stretch are estimated to track down peculiarities in Gesture of heart, if any [13].

KNN (k-neural network) is one of machine learning algorithms that gives less classification accuracy due to large volume of medical dataset used to identify heart diseases. different approaches of machine learning algorithms like Decision Trees, Naive Bayes, and Neural Networks used to get the better accuracy for classification but Used Minimum attribute dataset for the prediction of heart attacks [14].

As per the survey, different classification techniques used (Naïve Bayes, KNN, Decision Tree Algorithm, Neural Network) for predicting the risk level of each person based on age, gender, Blood pressure, cholesterol, pulse rate. This can only reduce the risk of having heart attacks [15].

Random forest algorithm on Spark framework for predicting heart diseases but it uses the minimum attribute dataset that leads to get a low accuracy for the predictions heart diseases. Considering the ECG as dataset for prediction of heart diseases, the P', 'Q', 'R', 'S', 'T' peaks make complex from ECG signals to identify heart disease [16].

### **III. METHODOLOGY**

#### **STEP 1: Dataset and its Collection**

Dataset can be defined in machine learning, in a very simple words, a collection of data that makes the computer a single unit for analysis and prediction. This means collected data is made uniform and able understand a machine that is not able see data as human do.

Dataset for heart disease prediction will be collected from UCI machine learning site as its most popular and widely used for collection of data record, based on this dataset, going predict heart diseases using six machine learning algorithms by comparing with parameter like f-measure, recall, precision, accuracy execution time.

Table shown below, Contains numbers of attributes and their detailed information. Attribute like Age, Sex, Chest pain, Tresbps, Chol FBS, Resting, Thali, Exang , Old peak, Slope, Ca, Thal, Num. These are the attributes used to identify heart disease where a total of 14 attributes are used. 270 rows of records are there in this UCI heart dataset that will be considered for this project.

Table 4.1.1: UCI dataset range, datatype and UCI dataset attributes detailed information.

Feature	Description	Type	Values
Age	Age in years	Numerical	28–77, mean: 51.9
Sex	Gender	Nominal	0 = female (188)1 = male (532)
Cp	Chest pain type	Nominal	1 = typical angina (38)2 = atypical angina (160)3 = non-anginal pain (157)4 = asymptomatic (365)
Trestbps	Resting blood pressure in mmHg	Numerical	80–200, mean: 131.8missing values (2)
Chol	Serum cholesterol in mg/dl	Numerical	0–603, mean: 204missing values (23)
Fbs	Fasting blood sugar >120 mg/dl	Nominal	0 = false (567)1 = true (70)
Restecg	Resting electrocardiographic results	Nominal	0 = normal (471)1 = having ST-T wave abnormality (86)2 = showing probable left ventricular hypertrophy (161) missing values (2)
Thalach	Maximum heart rate achieved	Numerical	60–202, mean: 140.6missing values (2)
Exang	Exercise induced angina	Nominal	0 = no (476)1 = yes (242) missing values (2)
Oldpeak	ST depression induced by exercise relative to rest	Numerical	–2.6–6.2, mean: 0.8missing values (6)
Slope	The slope of the peak exercise ST segment	Nominal	1 = upsloping (187)2 = flat (292)3 = down sloping (34) missing values (207)
Ca	Number of major vessels colored by fluoroscopy	Nominal	0 (179)1 (67)2 (41)3 (20) missing values (413)
Thal	Heart rate	Nominal	3: normal 196 = fixed defect (38)7 = reversible defect (170) missing values (320)

## **STEP 2: Data – Preprocessing**

The pre-processing of data is necessary for effective representation of data and machine learning algorithms, classifier which should be trained and tested in an effective manner. Using Weka application, it has an in-built application to data pre-processing ways like removing missing values, standard scalar, and Minimax Scalar have been applied to dataset for effective use for classifiers. Standard scalar ensures that every point has a mean 0 and friction 1, bringing all features to same measure. Also, Minmax Scalar shifts data is like all features that are between 0 and 1.

## **STEP 3: Data Feature Extraction**

There will be 14 attributes of data set in 270 records of existing heart dataset, two attributes pertaining to age and gender are used to identify the information of the case or patient. The remaining 12 attributes are taken as important as they contain important medical records. Clinical records are important to opinion and learning the inflexibility of heart disorders.

By using the Machine learning algorithm in Weka application, feature extraction of existing dataset will be taken care and obtained features 270 records going take UCI site. for classification purposes, this step will take care and once classification will be done using machine learning algorithms like naïve bayes, random forest, support vector machine, decision tree, convolutional neural network, k-neural network.

## **STEP 4: Classification**

In this step dataset will be classified based on various attributes and their values, with respective ML algorithms, like naïve bayes, support machine vector, random forest, Decision tree, K-nearest neighbor, convolutional neural network. Once we will be done classification. ML algorithms applied on, classified dataset to measure performance of everyone's algorithms. Based on the performance of each algorithm, we can identify which is best suitable for this research work with the help of accuracy.

To get know which will be suitable for this research to do so, comparison of six algorithms will be done with parameters like precision, F-measure, Accuracy, random forest, support machine vector.

The following algorithms will be explained briefly as follows with respective theory aspects like how they work on heart dataset.

**CONVOLUTIONAL NEURAL NETWORKS:** Neuron factors include inputs  $x_i$ , retired layers and affair  $y_i$ . The final prediction result is given through the activation function like sigmoid and a bias constant variable  $b$ .

$f(b \sum_{i=1}^n x_i)$

**RANDOM FOREST:** This ensemble classifier builds several decision trees and incorporates them to get the stylish result. For tree literacy, it substantially applies bootstrap aggregating or bagging. For the given data,  $X = x_1, x_2, x_3, x_n$  with given  $Y = y_1, y_2, y_3, y_n$  which repeats the beginning from  $b = 1$  to  $B$ .

**K-NEAREST NEIGHBOR (K-NN):** KNN is used to find pattern recognition for heart dataset and find the close to the  $k$  point using the training datasets. classification is done by using the KNN. It calculates the position of data within the type of attributes with its nearest neighbor. Consider  $K=1$  then the data position of the class should be 1.

**DECISION TREE:** A decision tree is also known as a supervised machine learning algorithm. Decision is in the form of a tree. it has a node or leaf node or decision node. Method used in decision tree is very simple and easy to understand, for how to make the decision. A decision tree has an internal and external knot linked with each other. Internal nodes can take the decision and child nodes must visit the next nodes of the decision tree. Leaf node on other ways has no node and is Marks with a label.

**SUPPORT VECTOR MACHINE:** Before getting into Support Vector Machines (SVM), let's understand the basics of how SVM works. SVM is a supervised Machine Learning algorithm that's used in numerous groups and retrogression problems. It still presents as one of most habituated robust predictions methods that can be applied to numerous use cases involving groups.

Support vector machines work by anticipating an optimal separation line called hyperplane's directly separate 2 or further different classes in a categorizations problem. The thing is to find optimal hyperplane separation through training data linearly divisible data with SVM algorithm.

**NAIVE BAYES:** Naive Bayes is an easy, yet effective and well known used, machine learning algorithms classifier. It's a classifier that makes groups using the Maximum A Posteriori decision rule in a Bayesian setting. It can also be represented using a veritably simple Bayesian network. Naive Bayes classifiers have been especially popular for classification and are a traditional result for problems like spam discovery

#### **STEP 4: Prediction**

This research paper has a discussion of classification models and their outcomes from a different perspective. Checked performance of various types of machine learning algorithms such as k-nearest Neighbor, support vector machine, Naive Bayes, and decision tree, random forest applied on UCI heart disease dataset. To check performance of classifiers, performance evaluation metrics will be considered. Performance evaluation metrics are as follows Precision, F- measure, Recall, Accuracy, Execution time (MS).

Based on comparison between existing models with proposed models for metrics like recall, F-measures, precision, accuracy, execution time(s). With accuracy, CNN gives higher accuracy than others. Hence, Convolution Neural networks are considered satisfactory results for classification.

Based on results of comparing all existing models like k-Nearest Neighbor, support vector machine, Naive Bayes, and decision tree, random forest, convolutional neural network will be considered best for classification. Considering this web application will be developed for predicting heart disease.

#### **V. CONCLUSION**

Heart disease dataset collected and analyzed to predict the asperity of the heart disease. As per the survey machine learning algorithms like k-Nearest Neighbor, support vector machine, Naive Bayes, and decision tree, random forest, convolutional neural network will be considered best for classification. Considering this web application will be developed for predicting heart diseases. A convolution neural network method is used to predict the asperity of the disease. The data in the dataset is preprocessed to make it suitable for classification. The convolution neural network approach to generate efficient classification rules is proposed. To perform classification task of existing medical data, the neural network is trained using Convolutional neural network. With help of performance metric Precision, F-measure, Recall, Accuracy, Execution Time(seconds) for all machine learning algorithms with help accuracy able find the best mechanism for prediction of heart disease.

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