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Deep learning models on Heart Disease Estimation - A review

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Abstract

Heart disease, also known as cardiovascular disease (CVD), is the foremost among all widespread diseases in the people community. Any disorder that affects the heart's function is typically called heart disease. Narrowing or blockage of the coronary arteries, which supply blood to the heart, is the most common cause of heart failure. Coronary Artery Disease (CAD) is a common form of heart disease and the leading cause of heart attacks. Nowadays, there is no age limit for people to get affected by this disease. There are so many diagnosis methods available where most are costly, the risk involved, and technical experts are needed to perform the disease diagnosis. Clinical research has pointed out different factors that increase the risk of CAD and heart attack. These factors can be categorized into two types, i.e., risk factors that cannot be changed and those that can be changed. Sex, age and family history are those factors that cannot be altered. In contrast, factors related to a subject's lifestyle, e.g., smoking, high cholesterol, high blood pressure and physical inactivity, can be changed. This paper reviews various deep learning techniques involving heart disease prognostic and their accuracy in predicting that they can be treated in advance to prevent fatalities.

Keywords: Deep learning, convolution neural network, heart disease, prediction

1. Introduction

The enormous developments in deep learning seek to create intelligent automated systems to assist doctors in predicting and determining the disease with the internet of things (IoT). Machine learning techniques are on a single data set that does not reflect the algorithm's true potential. Deep Learning was developed to enhance the accuracy of the

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existing machine learning algorithm. Deep learning uses artificial neural networks (ANN) having more hidden layers. The Neural Network is arranged in the cascading pattern to process non-linear data sets, i.e., cascading layers of non-linear processing units. The Deep Learning method started gaining momentum, and accuracy is gaining a significant edge over other older machine learning algorithm. Due to the lack of accurate medical support systems capable enough to find hidden patterns of medical data and predict diseases, people cannot know the occurrence of diseases in advance. Deep learning helps accurately predict heart diseases in an early stage that can be treated before they become severe.

2. Heart Disease prediction techniques

The CardioHelp [1] method with temporal data modelling with CNN [2] predicts for the cardio vascular problem in a patient. This hybrid method uses a temporal data modeling using CNN and the CardioHelp method prdicts the heart disease with 97% accuracy. Heart disease prediction uses a Deep Belief Network (DBN) classification and CNN [3] to predict the cardio vascular disease. The DBN classification algorithm includes the Deep Neural Network's [4] deep learning approach for feature extraction from the pre-processed data. Thus evaluated patterns are processed by multi-layered CNN and macx-pooling layers with 90% prediction of the heart disease.

A heart attack prediction method incorporates the deep learning and data mining [5] techniques to predict the cardio vascular problem with minimum error. In this the input is converted into dense vector representation generated by the embedding layer. Then GRU process the vector values, then the softmax function in the fully connected layer classifies the value to two categories – heart disease or non-heart disease with 92% accuracy.

Heart disease prediction using Deep Neural Network (DNN) with embedded feature selection [6] predicts heart disease accurately and quickly through various indicators of the body. The SVR [7] does the embedded feature selection to choose a subset of features of heart disease. The deep neural network whose weight initialized with He initializer accepts this subset features helps in preventing gradient varnishing or explosion problem for a better prediction. This model has an average area under curve (AUC) score of 0.983, which is efficient and reliable for predicting heart disease. DNN based heart disease prediction [8] preprocess the data via normalization and sampling. The preprocessed data is processed by DNN for predicting the heart diseases. The predicted values of DNN are then validated to

reduce the error and to increase the accuracy of 87.64%. This accuracy is maintained in any random data set taken for consideration.

An Enhanced Deep learning assisted Convolutional Neural Network (EDCNN) [9] which has been implemented on the Internet of Medical Things Platform (IoMT). This method serves as a support system for doctors in deciding on the cardiovascular disease. The effective heart diagnoses are designed to process the information of the patient available in the cloud platform. This helps the patient in any part of the world to get diagnosed by continuous monitoring of them via IoT devices. A deep architecture on EDCNN has a multilayer perceptron with regularization learning approaches validated with full and minimized features. The CNN extract the features in regard with the beat from the heart. Thus, generated information undergoes a batch normalization, an activation function and a basic convolution layer in the convolution process. This cloud supported monitoring system can achieve up to 99.1% accuracy in prediction the cardiovascular disease.

Heart disease prediction based on $\chi 2$ statistical model and DNN [10] focusses on eliminating the underfitting and the overfitting problems by refining the features. It is based on the concept that the relevant feature selection and network configuration overcomes the fitting problem. The $\chi 2$ statistical model eradicates the outlier features and the deep neural network (DNN) is for finding the strategy of better prediction and achieves a prediction accuracy of 93.33%. Also, with a flexible design and further tuning of EDCNN hyperparameters 99.1 % of accuracy can be achieved.

Coronary heart disease prediction using ANN is an efficient model with the addition of the neural network with classification. In this paper [11] the existing classification of feature selection method is enhanced with ANN to reduce the prediction rate by avoiding the error caused by inefficient classification algorithms. The ANN efficiently predicts the cardiovascular disease with the efficient features classified. Coronary heart disease prediction using CNN [12] is a two-step approach. First, the feature weight assessment is made by the minor absolute shrinkage and selection operator followed by majority voting for the identification of essential features. Second, a fully connected layer harmonizes the critical component which is passed into the convolution layer. The classification of the diseased and non-diseased persons is done accurately by a training routine per epoch, akin to a simulated annealing process. The CNN identifies the presence of coronary disease accurately by 77% and 81.8 % for the absence of coronary disease.

Heart disease prediction using deep learning modified Neural Network (DLMNN) is an IoT centered heart disease monitoring scheme [13] proposed to assist the doctors in diagnosis. This involves a three-step technique -Authentication, Encryption and Classification. The substitution cypher (SC) with the SHA-512, authenticates the heart patient. The IoT in the patient's body transmit the data to the cloud through the sensor. The PDH-AES technique encrypts the sensor data and transmitted securely to the cloud. The data from the decryption is analyzed by the deep learning technique. The deep learning modified neural network classifier classifies the data into the patient's normal and abnormal heart conditions and alert the patient based on the abnormality of the heart. The PDH-AES assures a secure data transmission with a highest level 95.87% security. This algorithm proves a better encryption and decryption than the existing Asymmetric Encryption Standard (AES).

Heart disease prediction with ensemble deep learning and feature fusion using an intelligent healthcare system for heart disease prediction [14] collects the data from the sensor and the electronic medical record. This healthcare data is processed by the information gain technique to eliminate irrelevant and redundant features, for decreasing the computational burden and for enhancing the system's performance. A specific feature weight is computed for each class using the conditional probability approach for a further improvement. The prediction is further enhanced by a deep learning technique. The ensemble deep learning with five layers - the input layer, three hidden layers, and the output layer helps in predicting the heart disease. Further, the LogitBoost [15] a meta-learning classifier boosts the deep learning model for a higher accuracy of 98.5%.

Heart disease prediction using DNN [16] predicts the risk profiled patients with the parameters obtained from clinical data. The deep neural network (DNN) with two statistical models eliminating the underfitting and overfitting problem of the dataset fitting in the classification. These problems are eliminated by better testing and training data results. Logical mining assisted heart disease prediction examines the risk factors to diagnose the cardiac disease at its early stage. The risk predictor selection is an efficient method for identifying and extracting essential information to describe aspects of developing a prediction model. A new technique Intelligent Learning Assisted Support Vector [ILASV] [17] is a multi-feature quick diagnosis of heart disease with risk factor specification. The mining concept identifies the high-risk variables for the heart disease for a fast and accurate heart disease prediction. This method predicts the heart disease by processing various healthcare data formats such as text, pictures, charts etc.

Descriptive and predictive analysis of heart disease is the methodology [18] for attaining higher accuracy is comprised of three machine learning and three deep learning models to predict heart disease. It includes Logistic Regression [19], Support Vector Machine (SVM), and Naïve Bayes of machine learning and Long Short-Term Memory (LSTM), Convolutional Neural Network (CNN), and Recurrent Neural Network (RNN) of deep learning methods. This method comprises of the high accurate methods - Logistic Regression [19] by 86%, SVM by 88%, and Naïve Bayes by 86% and LSTM of 84%, RNN of 90%, and CNN with 84%. Thus comprised models is with the highest accuracy by 90% is considered as one of the best one to predict the heart disease.

Heart disease detection using Deep learning with multiple input source detects the heart diseases by listening the heart beat [20] audio recording or real-time streaming of heartbeat. This method is adopted from the technique is adopted from the interpretations made by the heart specialist listening to the heart beat of the patients via stethoscope. This method analyses the patient for sickness so as to classify under two sections – sick or healthy. The required deep neural network for such classification is a hybrid of convolution and recurrent neural network (CRNN) model achieving higher accuracy in predicting the healthy and sick heart.

The technique uses the data augmentation technique on a combined dataset. SMOTE based deep learning model for heart attack prediction [21] is an accurate, reliable and cost-effective solution for predicting. It predicts the heart attack through various machine learning algorithms without involvement of feature engineering. It even works with the dataset of uneven distribution of positive and negative classes which may reduce the performance. With the inclusion of synthetic minority oversampling technique (SMOTE) we can even handle the imbalanced data. This system avoids the costly feature engineering for classifying the dataset. This SMOTE-based artificial neural network is better than all other existing models of machine learning algorithms.

Heart disease estimation using CNN is a deep learning architecture using a 1D convolutional neural network [22]. It classifies the person with and without heart disease and has been checked with a balanced dataset. This avoids the regular classical machine learning problems in classification. The convolution neural network identifies the hierarchical feature for a better classification. The embedding layer in the network allows classification by converting the feature vector into a new embedding vector. It avoids the overfitting even for some unseen dataset. Heart disease prediction using deep neural networks [23] with four

hidden layers of DNN detects the coronary heart disease with 98.77% accuracy. The best combined input, hidden, and output layer on the Statlog dataset has been proved with better accuracy. This method proved better in avoiding overfitting of the data.

Deep learning neural network with Talos optimization was designed to predict the heart diseases [24]. A hyperparameter Talos optimization in DNN certain techniques – prepare, optimize, deploy, process workflow and others for evaluating and reporting including visual analysis plotting. The hyperparameter talos optimization can predict the heart disease with 90.76% accuracy.

Deep Learning framework for heart disease classification with IoT [25] is structured for classifying the heart diseases. The server collects the ECG signals through proper authenticated channel of internet. The features from the signals are extracted by a kernel-based PCA algorithm after being preprocessed by the wavelet packet decomposition (WPD) for classification. The kernel based PCA is applied to the wavelet coefficients in the frequency domain. The weighted k-prototype clustering algorithm (wkPCA) deep learning algorithm classify the and identifies the heart disease. The identified classification of heart disease is shared with the diagnostic center and smartphones using the IoT based system to the doctor and patient with 90% accuracy.

3. Conclusion

The accurate automated heart prediction is a must in the present world with an increasing heart disease. The accurate prediction of the abnormal behavior of heart at an earlier stage has become more important to prevent the fatality rate. This paper defines many deep learning techniques for predicting the malfunctioning hearts at a high rate. It also predicts the varied heart disease, symptoms indicating various heart diseases with several deep learning techniques. In general, the accurate prediction is made by a better feature selection. By early diagnosis of the patients are alerted and warned to be consulted by a doctor. Also, these predictions assist the doctors in treating the patients and diagnosis of the heart vulnerabilities in advance. These algorithms also help in a continuous monitoring of the patients by the doctors even from the remote. We have summarized some algorithms which are accurate in predicting heart diseases. In the future, it is better to use search algorithms to select the features and then applying deep learning techniques for prediction will give us better results in predicting heart disease.

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