Early Cardio Vascular Disease Detection using Machine Learning and Explainable AI

Interim Report

by

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Background

1 | Literature Review

Data Preprocessing and Ensemble Learning techniques

Absar, Nurul, et al has used good data preprocessing techniques before applying ML models. The researcher has incorporated ensemble techniques like Bagging, Boosting to get the final predictions and narrowed down the final predictions using voting technique. In their research, they have used standard heart disease dataset to make predictions whereas in real-time the heart disease data may contain some uncertainties [1].

In the same way Shrestha, D., have implemented ML and DL models on standard dataset with only 303 instances. For industry advancement we must try to integrate real-time dynamic data and train our model to make better classifications [11].

Rajendran, R., Karthi, et al have focused on building a pipeline to integrate live patients records as an input and classify the patients. They have used Principal Component Analysis (PCA), Independent Component Analysis (ICA) and Linear Discriminant Analysis (LDA) for data pre-processing and extracted important features. In this research they have used novel techniques to handle the missing values and they have used covariance based multivariate outlier detection procedure to detect the outliers and remove them [9].

In our research, As a novel approach, we aim to train our model using the same dataset, but we are trying to incorporate XAI techniques like SHAP and LIME to explain our model predictions. This results in better understanding for both the doctors and researchers, which variables play an important role in classifying the presence of heart disease.

Hyperparameter tuning and Feature Engineering

Chandrasekhar, N. and Peddakrishna, S, et al, implemented GridSearch CV technique used for hyperparameter tuning. They have used five fold cross validation technique to train their model and employed soft voting ensemble method to increase model predictions. Though they have used hyperparameter tuning, they did not focus much in feature engineering techniques [3].

Similarly, Ahmad, Bilal, et al, has focused on using feature selection techniques to extract appropriate features for model training. But, the feature selection techniques used in this model are static and they may lead to increase biasness in the predictions [2].

So, in our research we aim to use feature engineering techniques to create new features and try to use XAI techniques to know which feature contributed more for model predictions. For eg: if we consider a person age and LDL cholesterol into consideration, then by combining these individual features we can create a new feature and focus on estimating the risk of early heart attacks of the patients.

Explainable AI (XAI) for Model Transparency

Harshkumar Mehta and Kalpdrum Passi tried to classify the Hate Speech(HS) by using machine learning and deep learning models and evaluated the models performance. They have used Google Zigsaw and HateXplain to train different machine learning and deep learning models respectively. Out of the existing machine learning models, LSTM model has shown the best performance when

trained on Google Zigsaw dataset with an impressive accuracy and recall score [6]. To achive this result, they have used Count Vectorization and TF-IDF techniques for feature extraction. After pre-processing they have implemented decison tree, KNN, random forest, multinomial naive Bayes, LR and LSTM models on the google jigsaw dataset. They have implemented BERT + MLP and BERT + ANN models on the HateXSpeech dataset. Further to evaluate the model's predictions they have implemented XAI techniques like LIME on BERT variants and not other models because Google jigsaw dataset is not annotated like HateXSpeech dataset. By using XAI techniques, they further fine tuned the model for 50 epochs.Though this paper is not related to cardio vascular disease, this paper briefly explained about XAI techniques and how they play major role in interpretting model's predictions. Based on these techniques we can have better understanding of the model's algorithm and individual feature's contribution on the final prediction.

Lee, HyeYoung, et al, used the Random Forest machine learning model to predict the mortality of the patient. They major contribution with this research is the feature extraction techniques used and the implementation of XAI techniques like SHAP to explain the reasoning behind the model predictions. For the feature selection, they have used LASSO regression(Least Absolute Shrinkage and Selection Operator) to shrink the less relevant features to 0. Then further they implemented the RFE technique to recurssively eliminate the unwanted features and reduced the dimentionality of the training data. By using these techniques they have achieved good model performance and further implemented XAI techniques to explain the probability of the features which contribute to the model predictions [5].

Qadri, Azam Mehmood, et al, performed the standard feature engineering technique which is Principle Component Heart Failure (PCHF) feature engineering technique and converted the standard features to reduced features. This technique extract the important components from the dataset and they are further implemented into the ML models. By using this technique they have achieved good results and the Decision trees, Random Forest algorithms have outperformed the other ML models (LR, SVM, NB, MLP) [8]. From their research we can consider two major gaps, first they did not explain the importance of newly created features which we include in our research. Secondly, the real time heart disease data is very dynamic and can be varying from patient to patient. So, we can propose few feature engineering techniques on multiple sub groups of patients as our future study.

In our research, we aim to create new features, and check the LASSO Regression values of them and proceed to implement our ML model on it. We can also further use the same XAI techniques used in this paper and evaluate the importance of newly created features.

Integration with IoT and Real-Time Systems

Guleria, Pratiyush, et al, aimed to integrate AI framework with ML and IoT technologies. This approach is highly used in medical industry these days. They have compared the classification models within each and also with/without using the XAI techniques. Out of them, they have realised that models with XAI techniques are more trust worthy, when compared with the one that do not use XAI. They have used ealuation metrics like AUC and ROC curve, sensitivity and specificity to evaluate the model performances. The SVM classifier score high accuracy among all the implemented models. Techniques like feature selection, explainable feature weight initialisation, normalisation and optimisation have been used in this paper along with XAI. We can critically appreciate their approach where they tried to integrate the ML technologies with IoT devices. They have also used XAI technology which acts like a bridge for medical industry and researchers for both of them to better understand how the ML models are classifying patients. They have considered secondary evaluation done by doctors to check if the model has taken right parameters to make the predictions. In this particular research, they have mentioned their limitation that they trained their model with a dataset that contains limited variables. They have suggested to implement same techniques on other complex datasets as their future study. We can bridge this research gap in our thesis by implementing similar techniques in our dataset[4].

Deep Learning and ECG-Based Predictions

Mhamdi, Lotfi, et al, have applied algorithmic models to analyze ECG signal in an eiffective way. They used 2 deep learning algorithms Mobile net V2 and VGG16 to classify ECG images. This study focus on reading the ECG images of the patient and classify them wether they are suffering from heart disease or not. To achieve this they have implemented the Deep Learning models on the ECG images dataset. We can critically appreciate their approach of reducing the dimensionality of the dataset. Because Deep Learning models have complex algorithms and we do not know what happens inside those algorithms. So reducing the dimentionality using brightness, contrast, gamma, hue, saturation and central-crop is very brilliant. But, They did not explain the model's predictions. They are focussing on deep learning techniques and hyperparameter tuning techniques to optimise the model performance, but they are not considering which feature contributed more for model prediction. If they can find out that, they can gather a dataset accordingly which reduces the effort in dataset pre-processing [7].

Sharma, Vijeta, et al., used 4 different ML models to classify the heart disease of patients. They have taken 80/20 split of the train/test dataset and trained, Naïve Bayes, Randokm Forest, Decision tree and Logistic regression ML models. They have used F1- Measure, Precision, Accuracy and recall as their evaluation metrics to evaluate the performance of the model. Based on their research, they have classified that Random forest has the highest accuracy among the models [10].

In our research we aim to consider this research as base and work their future work by implementing Explainable AI techniques on ML model to explore reasoning of model's classification.

2 | Exploration of Data and Methods

3 | Proposed Future Analysis

4 | Conclusion

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