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Fine Tuning Bert Based Approach for Cardiovascular Disease Diagnosis

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Abstract: A range of diseases that affect your heart are considered to as coronary disease. The greatest hazard syndromes in the world, cardiovascular diseases (CVD) are regarded as having the greatest mortality rates. The healthcare systems of countries they have become very common and are now overstretching, over a period of time. Cholesterol, family background, higher The arterial pressure is, gender, stress, ageing that are an unhealthy lifestyle are the main danger elements for cardiovascular diseases. Predicated with these considerations, Experts have suggested others preliminary diagnosis techniques. Therefore, correct CVD prediction can both prevent life-threatening conditions and be fatal if incorrect. The majority times, cardiovascular disease is deadly. Medical diagnosis is a challenging task that is usually performed by domain experts. In the Natural language processing (NLP) field, Bidirectional encoder representations from transformers (BERT) and related models have recently achieved significant success. Contextual embeddings are created by pre-training BERT on a larger training corpus, and these embeddings can be used to enhance the efficiency of CVD data sets when implemented to small datasets with fine-tuning. Hence in this approach, Fine tuning BERT Based Approach for Cardio Vascular Disease diagnosis is presented. This approach will provide effective and accurate diagnosis to the CVD patients. This method's performance is evaluated in related to accuracy, precision, and recall (True Positive Rate).

***Keywords**: Cardio Vascular Disease/Heart disease, Bi-directional Encoder Representations from Transformers (BERT), Fine Tuning*

1. Introduction

A type of heart disease known as cardiovascular disease (CVD) still Over thirty percent of the deaths are caused by this worldwide [1]. A heart attack or stroke can occur as a result of plaques on the arterial walls obstructing blood flow. To refer to any cardiovascular or blood vessel disease the term "Cardiovascular Disease" (CVD) is used. Aortic disease, illness of the heart or blood vessels (also termed like TIA/mini-stroke), and external vascular diseases are the four main types of cardiovascular disease. The specific Unknown causes of CVDs; danger factors such as high BP, smoke, diabetic, BMI is also called as Body Mass Index, steroid alcohol, aging, personal background, and so on can contribute to these disorders. These factors are different for various persons. A few other significant risk factors for CVDs include aging, genders, stresses, and an unhealthy lifestyles [5]. A healthy lifestyle, which includes avoiding salt intake, eating more fruits and vegetables, getting regular exercise, and avoiding from alcohol and cigarettes, can help lower the risk of heart diseases.

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A vital organ is the heart in the human beings which supports in the cleansing and bodywide blood circulation [4]. Any problem with the cardiovascular system has a significant effect on an individual's well-being since it is considered a crucial organ in the functioning of a human being. Coronary artery disease is frequently regarded to be one among the world's deadliest disorders. Many millions more instances increasing in past few years, much people died from cause of heart issues. Heart disease symptoms include heartburn and nausea, respiration and swelling legs difficulties, drowsiness and erratic heartbeat [6]. cardiovascular diseases have a considerable effect on healthcare. find them exceedingly risky and having a global impact. Precious forecast of heart diseases or CVD, also includes 24-hour monitoring of patients, due to a lack of knowledge and time, this isn't feasible. Particularly in developing or undeveloped countries, care or diagnosing heart disease is very difficult. Proper medical treatment or a timely in treatment of a disease is also lead an individual's demise. The presence of cardiac disease is growing substantially on a day by day, making early detection of these conditions essential and significant. Given the difficulty of this diagnosis, it must be carried out precisely and effectively [10].

Therefore, the identification of heart illness a crucial Life's everyday essentials, but as a consequence several uncertainties and hazard factors, it can occasionally be difficult for experts to reach such diagnosis. The quick identification of a heart attack is important for both the patient's life and the prevention of heart damage [7]. In medical practice, clinicians typically base their diagnoses on the morphology waveforms of the Electrocardiogram (ECG), although it can be complicated to establish a medical decision, particularly any time the signs are muddled by noises. This highlights the relevance of growth tools to be correctly diagnose heart diseases [8].

Technology lends immense support in automating various tasks is now essential in every field, including The process of identifying condition, or injury from its signs and symptoms. The diagnostic decision is based on knowledge, skill, ability to the use of the proper method with strong logical reasoning abilities. It is not an easy task to examine a patient's heart condition because there are many aspects involved, which makes the doctor's job complicated. However, a specific tool is required in order to consider and identify risk variables based on data provided by specialists. Clinical diagnostics that integrate computers and measurement technology can produce effective methods for collecting patient information. Cardiovascular disorders have put a lot of pressure on physicians since they can lead people to die suddenly or become paralyzed in the bed. The globe continues to keep going forward heavily spend in cardiovascular disease research, despite that they are still unable to successfully reduce cardiovascular disease mortality and computer prediction in heart problems are very essential.

the primary factor leading to mortality in numerous countries is cardiovascular disease. Cardiovascular diseases are frequently diagnosed by physicians utilizing the results of the most recent clinical evaluations and their prior encounters diagnosing individuals with comparable diseases. Heart disease persons must receive prompt diagnosing, prompt treatment, and constant monitoring [11]. In the past, several data mining methodologies have been utilized to diagnose and predicting heart diseases in order to meet their requirements. The capability to predict diseases with the use of artificial intelligence (AI) has improved significantly in recent years. It is currently capable of enhancing diagnosis precision, facilitating disease prevention through early warning, streamlining clinical decision-making, and minimizing cost of health care [9]. In clinical predictive modelling, powerful AI tools, advanced conventional ML [12], and DL approaches being widely utilize and have achieved several successes. Deep-learning models can execute as well as or better than experts in their field in identifying some diseases if they have access to enough training samples. However, there is still a need for an efficient method for accurate CVD disease prediction.

This problem is addressed through transfer learning, in which some representations are initially pre-trained on sizable amounts of unannotated information and then further changed to direct other activities. Self-supervised learning on large regular datasets to develop a general-purpose pre-trained model that understands the data's internal structure is a recent transfer learning trend. One of the most popular models is Bidirectional Encoder Representations from Transformers (BERT), which has many variations for handling sequential inputs like text. Therefore, these models have only been trained for clinical NLP tasks and on clinical text. Through fine-tuning, it can be used for a specific purpose with a specific data set.

Hence in this analysis, fine tuning BERT based approach for cardiovascular disease diagnosis is presented. the remaining portion of writing is organised as following: Section II provides a description of the available literature review. and The presented methodology for cardiovascular disease diagnosing is shown in section III. The section or part IV describes the evaluation of the strategy that was provided. at last, section V provides a work's conclusion.

2. Literature Survey

P. Umasankar, V. Thiagarasu et. al. [16] provides a rule of mining fuzzy association & interval set-based decision system support to the detection of cardiovascular disease. This framework primarily concentrated on the standards that lead to cardio attacks in people. A heart disease dataset is reduced by a pre-processing step. Based on the selected criteria, a generated rule’s set using the Rule Mining method for the prediction of heart diseases. Choosing between several treatments for people with heart disease that feel apprehensive stage is addressed using the interval vague set.

Tanmay Kasbe, Ravi Singh Pippal et. al. [19] finding out whether have heart disease this research is performed using a fuzzy experts systematic approach. For cardiac disease diagnosis diseases in this analysis, the fuzzy experts systems are utilized. Fuzzification, defuzzification and , rule base are 3 fundamental components of a proposed expert system is based on fuzzy. which has 13 input and 1 output parameters here. Software called MATLAB is utilized performance analysis tools. The Long Beach VA Medical Center and Cleveland Clinic Foundation provided the database.

Plekhova N.G, Nevzorova V.A., Grunberg K.V., Dolzhikov S.V, Rodionova L.V et. al. [20] provides a medical device-computer system for determining out whether cardiovascular diseases will be fatal. To analysis the information and estimate the overall and comparative risk of fatal cardiovascular illnesses, a specific data system is offered in this analysis. This programme was created using data that was collected and analyzed using biochemical analyzers to find biomarkers in patient blood serum while taking into consideration the patient's age, sex, and weight. To increase prediction accuracy and expand the use cases for the risk scale, particular patient characteristics are taken into consideration.

Sanjeev Kumar Jain and Basabi Bhaumik et. al. [23] describes the energy-efficient ECG signal processing for smartphone detection of cardiovascular disorders. For the diagnosis of cardiovascular disorders on smartphones, an innovative diagnosing method for ECG signal processing depending on forward searching has been developed. Utilizing the Physionet PTB (Pulmonary Tuberculosis) diagnostic ECG database, the Application specific integrated chip (ASIC) and android applications are examined for the identification of combine branching blocks, myocardial infarctions, and hypertrophic, arrhythmias,. The energy-efficient wearing cardiovascular disease detection device would work best with the ASIC mentioned and the Android app.

Dell'Olio, M. De Palo,N. Armenise , D. Conteduca, M., C. Ciminelli et. al. [24] introducing a framework for resonant nanoplasmonic detection of cardiovascular disorders. This study reports the development of a novel label-free protein biomarker detection platform for nanophotonics with approximately 1 μm footprint. Finite Element Method simulations were used to develop the platform. By fast analyzing a drop of blood, the device is intended to be used for the in the early hours identification of heart diseases. A biosensor was specifically created to identify people β2-microglobulin in plasma, which could utilized as a molecular marker and signature molecule to predict peripheral arterial disease.

Chun-yan Zhu, Run-ze Li, Yu Tian, Dan-yang Tong, Sheng-qiang Chi, Jing-song Li et. al. [25] describes the planning and creation of a system for cardiovascular disease patients to measure their readmission risk. The designing and creating a the readmission risk evaluation systems to the people afflicted by cardiovascular disease was done after a risk identification model for patients was created utilizing data mining technologies. There are three components to the risk assessment model: risk predictions, clustering analysis, and regression analysis of risk factors. These components work together to automatically estimate the risk levels and risk variables for patients who will be discharge within 30 days.

3. Fine Tuning Bert Based Approach for Cvd Diagnosis

In this section, BERT based method using Fine tuning for cardiovascular disease is presented. The quick pace of life has a big impact on people's lives forward recent lifestyle. a lot of people all around the globe are suffering with cardiac arrest the outcome of stress, daily life behaviour, and, in few cases, regardless of age or DNA. The objective of this study aims to anticipate the emergence of coronary artery bypass graft during its initial stages, helping doctors to make proactive diagnoses and save many people's lives. The flowchart shows the proposed procedure for cardiovascular disease diagnosis be shown as Fig. 1.

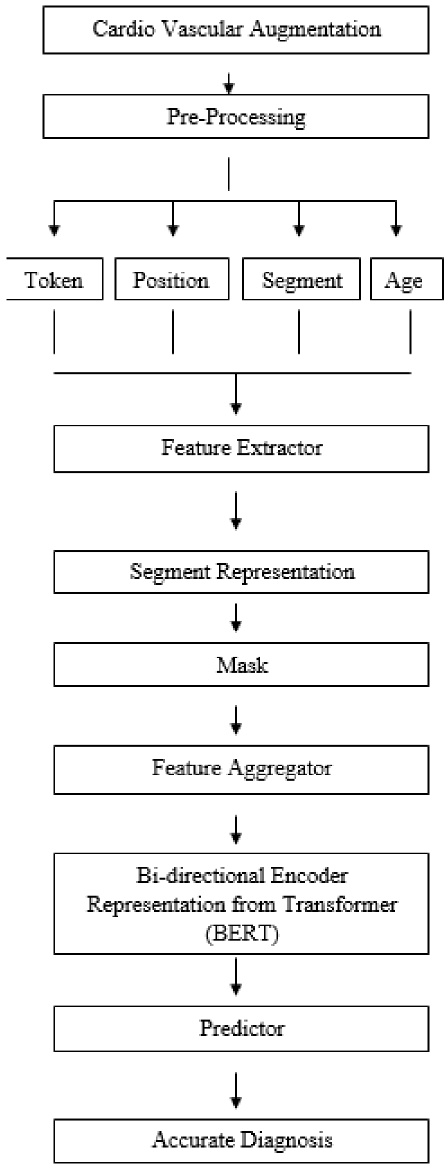

Fig. 1: Block Diagram of Fine Tuning BERT based Approach for Cardio Vascular Disease Diagnosis

The system gathers information on patients diagnoses, drugs, hospital procedures, general practice examinations, blood pressure measures, BMI, smoking habits and alcohol use. Both drinking and smoking habits, including present drinkers and smokers, previous smokers, and non-smokers, were recorded as categorical values. Systolic, diastolic, and BMI values for continuous values ranged from eighty to two hundred mmHg, fifty to one hundred forty mmHg, and sixteen to fifty kg/m2, correspondingly. Next, bins with a step size of 5 mmHg are used to classify systolic and diastolic pressure (eg, 80–85 mmHg). With a step size of 1 kg/m2, BMI is measured in the same manner. All of a patient's records are ultimately organized in a sequence and sorted by the date of the incident. The patient's date of birth is also used to compute the age of each record's additional feature, the event date, to make modeling easy.

By creating new data points from existing information, a process known as "data augmentation" artificially increases the amount of data available. This includes modifying the data significantly or developing new data points in the original data's latent space using ML models are to increase in the dataset. It is utilized for cardiovascular infection has 70 000 patient records, 11 features, and a target. There are three kinds of input features: I Objective: factual information; ii) Examination: medical examination results; and iii) Subjective: patient provided information.

Features: The objective features are as follows. Age: Age is a objective feature measured in days. Height is measured in centimetres (cm); weight is measured in kilogrammes (kg); Gender (Categorical code). Systolic blood pressure, Diastolic blood pressure, Cholesterol (1: normal, 2: over normal, 3: significantly above normal), Glucose (1: normal, 2: above normal, 3: well above normal). Alcohol consumption, physical exercise, and smoking are examples of subjective symptoms. Cardiovascular disease was either absence or presence as the target variables describe. The medical examination includes the collection of all current values. The CVD is augmented before the sliding window.

Pre-processing is data preparation for primary processing or further analysis. The term can be used to describe any initial or preparatory processing step when preparing data for the user requires numerous steps. Data manipulation or removal before usage in order to ensure or improve performance is referred to as pre-processing of data. The method of getting data ready for the BERT model is referred as data pre-processing.

Four different embedding types are used as inputs for the BERT model. Token embeddings are evaluated using all codes or categorical data from tests, medication, procedures, measurements of blood pressure, alcohol and smoking status and BMI. Age embedding is the measurement of age in years. With values of 0 and 1, the segmentation embeddings alternated between visits whereas the position embeddings increased monotonically with moment. A combination of recording, ages, segments, and location embeddings provides as a representation of each encounter, including the records and its related ages, segmentations, and locations. A transformers models is used after inputs to extract features interactions, and a pooling layer, used as the final layer for risk prediction, estimates the latent representation of the initial time step.

The procedure of transforming available in terms of unprocessed data into computations, that can also be utilized for Feature extraction, is the procedure for analysing while keeping the data from the original data collection. By removing redundant data from a data set, feature extraction can decrease the amount of redundant information. In the end, the reduction in data helps learning stage and generalisation stages of the method while also acquires less amount of machine to build the model.

BERT Model is utilized rather than extracting the interactions between all of the medical history's records. The BERT model utilizes sliding window while partition the entire health information in and to manageable segments, then it implements a transformers like local attribute extraction to extract the temporal interactions in every sector. The local feature extraction determines the most representational embedding for every segments considering health records generally have strong correlations when they're close to the time. Either the segment representation is hidden by casting it to 0, or the latent representation is either masked by adding Gaussian noise.

During fine-tuning on a particular dataset, a feed-forward classification layer is introduced after pre-training. two weeks, three months, six months, and a year before the time of the CVD diagnosis. In order to prevent bias towards patients with extensive medical histories, the duration of each data window was restricted to six months rather than the patient's complete history. Included patients had at minimum one drug or topic attribute from a CVD dataset in each of four time windows.

Transformers, a DL model where the weights across each of the output and input elements are continually linked and coupled to each other calculated depending on their connection, BERT, uses a foundation. A group of voxel values from feature response maps (across a ROI) are combined by feature aggregation techniques into one or more scalar values that can be input into statistical or deep learning algorithms. Using statistical techniques, aggregating features allows you to group them into logical groups.

A BERT model serves as the study's encoder, and a multi-layer perceptron (MLP) network serves as the study's predictor. A supplement to Neural systems that feed forward is MLP. Hidden, output and input layers were the type of different layers. MLPs are developed to approximation any continuous function and are capable of solving issues that cannot be divided linearly. MLP's primary applications include pattern classifications, identifying, predictions, and approximations. Additionally, a CVD augmentation method is used in the present study for CVD diagnosis in order to adapt BYOL (Boot your Own Latent) for CVD diagnosis. Each token is randomly masked with a probability P_m and a random crop is applied with a probability P_c. Random crop refers to the selection of a subset of CVD data at random. The predictor predicts weather particular patient has CVD or not. If patient has CVD then effective diagnosis is provided to the patient.

4. Result Analysis

In this section, Fine tuning BERT based approach for cardiovascular disease diagnosis is implemented. The outcome study of obtainable strategy is demonstrated here. Here this approach, the CVD dataset contains dissimilar features related to CVD. CVD augmentation is effectively carried out to extend the data collection and enrich the patient data. Every input element interacts with every output element in the deep learning model known as BERT, and their weights are calculated dynamically according to this correlation. Finally predictor predicts either patient has CVD or not. Based on the prediction results accurate and effective diagnosis is provided to the patient. The effectiveness of proposed methodology will be evaluated using the parameters of the confusion matrix. like (FP) and (FN) which is known as False positive, False Negative, True Positive (TP), True Negative (TN), are defined as follows:

True Positive (TP): A true positive is a instances are that was correctly predicted to be positive and is in fact positive.

True Negative (TN): if a instances are actually negative despite being correctly predicted to be negative.

False Positive (FP): if a instances are correctly predicted to be positive but is actually negative.

False Negative (FN): if an instances are correctly predicted to be negative but actually positive.

Accuracy: It describes as the proportion of properly identified instance to all instances and it is presented as

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \times 100 \quad (1)$$

Sensitivity: Its mathematical definition is the proportion of TP cases to real positive cases, and it is sometimes referred to as the True Positive Rate (TPR) or recall.

$$TPR = \frac{TP}{TP + FN} \times 100 \quad (2)$$

Precision: The precision is determined by the ratio of total positive predictions (TP+FP) to total TPs.

$$Precision = \frac{TP}{(TP + FP)} \times 100 \quad (3)$$

The ratio of negative events that were incorrectly classified as positive (false positives) to all real negative outcomes is used to calculate the false positive rate. The expectations of the false positive ratio is typically referred to as the false positive rate (or "false alarm rate").

$$FPR = \frac{FP}{FP + TN} \times 100 \quad (4)$$

A term "Area Under the Receiver Operating Characteristic curve (AUROC)" refers to the difference between the TP and the FP rate. Table 1 displays the performance metrics evaluation and comparison of the provided BERT-based approach with other models.

Table 1: Performance Metrics Evaluation

Methodologies	**Heart Attack Prediction Using Deep Learning**	**Big Data and machine learning techniques allow for an accurate prediction of coronary heart disease in hypertensive patients from electronic health records.**	**BERT based approach**
Sensitivity (%)	82.12	90.6%	96.7%
Precision (%)	83.45	90.3%	95.8%

The performance of presented BERT based approach evaluated as accuracy, precision, as well as recall. Compared to earlier approach, presented BERT based approach has greater precision and recall. The fig. 2 shows the performance comparison in terms of precision and sensitivity. In fig.2, the x-axis represents different methods for CVD prediction whereas y-axis represents the precision and sensitivity in terms of percentage.

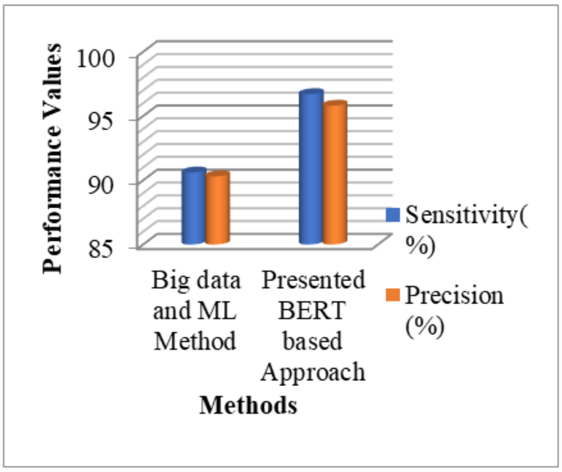

Fig. 2: Performance Comparative Graph

The BERT based approach has high precision and sensitivity for CVD prediction than Earlier method using big data and ML method. In terms of accuracy, the performance comparison of various methods is shown in table Two (2).

Table 2: Accuracy Performance Assessment

Methodologies	**Accuracy (%)**
Cardiovascular disease prediction using ML algorithms	87.5%
Heart Attack Prediction with the help of Deep Learning	92%
Accurate Prediction of Coronary Heart Disease for Patients With Hypertension From Electronic Health Records With Big Data and ML Method	92.3%
BERT based approach	97.6%

The fig. three show the correctness performance of different methods.

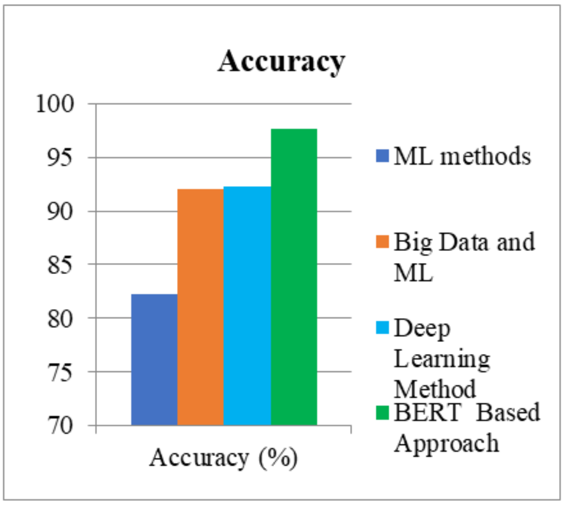

Fig.3: Comparative Graph for Accuracy

In fig.3, indicates x-axis is representing different approaches for CVD prediction whereas y-axis representing Accuracy of the model. While Comparing different earlier approaches, presented BERT based system has high accuracy for cardio vascular disease prediction. An overview of diagnostic precision is provided by the AUC (Area under the RoC Curve).

AUC is typically equals to point five(0.5) when ROC curve is 1.0 for perfect accuracy and reliable with random chance. The estimated AUC is <0.5 on rare instances, demonstrating that the test performs worse than chances. The AUROC of the presented BERT technique is displayed in Fig. 4. FPR is shown on the x-axis in Figure 4, while the True Positive Rate (TPR) values are shown on the y-axis.

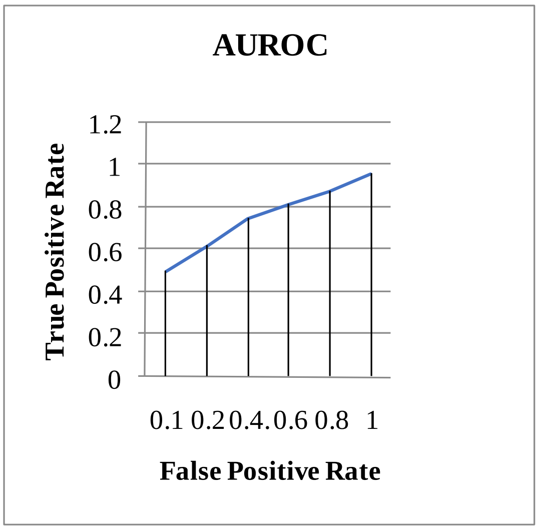

Fig. 4: AUROC for CVD Prediction

The AUROC of presented BERT approach is 0.96. Hence presented BERT based approach has better

AUROC than earlier approaches. If the CVD disease is predicted accurately then the doctor provides appropriate treatment to the patient. As a result, patient life will be saved.

5. Conclusion

In this analysis, Fine tuning BERT based approach for cardiovascular disease diagnosis is presented. The dataset utilized for cardiovascular disease has 70,000 patient records, 11 features, and a target. The patient's diagnosis, medications, hospital procedures, general practitioner tests, blood pressure readings (both systolic and diastolic pressure), alcohol and tobacco use, and BMI are all recorded using this approach. The BERT is a deep learning model that dynamically determines the weights of each input and output element by connecting them to each other. The MLP (Multi-Layer Perceptron) is used as a predictor to predict the cardio vascular disease. This approach has accurately predicts weather a patient has CVD or not. Based on the prediction results, appropriate diagnosis is provided, thereby patient life can be saved. The Accuracy, Precision, Recall, and AUROC of the presented system are evaluated. Compared to earlier methods, presented BERT based approach has better results. Hence this system provides effective and accurate diagnosis to the CVD patients.

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