ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
CJSSR

CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW

Vol.03 No.04 (2025)

# DETECTION OF CARDIOVASCULAR DISEASES THROUGH MACHINE LEARNING AND DEEP LEARNING APPROACHES

***Raza Naeem[1], Hijab Sehar[2], Fawad Nasim[1]***
*[1]Faculty of Computer Science and Information Technology, Superior University, Lahore, 54000, Pakistan.*
*[2]Riphah School of Computing and Innovation, Lahore*

**Abstract**
*Cardiovascular diseases (CVDs) claim millions of lives each year and continue to pose a major threat to global health. Machine learning (ML) techniques are promising to enhance diagnostic accuracy, which is essential for early detection and effective treatment. In this study, various ML algorithms are explored for identifying CVDs using datasets containing patient demographics and key health indicators. Recent research highlights advanced methods such as hybrid genetic algorithms for diagnosing atherosclerotic heart disease and random search algorithms for predicting heart failure. The effectiveness of models like Decision Trees, Naïve Bayes, and Random Forests in classifying cardiac conditions has also been examined.*
*This paper proposes and evaluates a novel neural network architecture for cardiovascular disease prediction. A detailed performance analysis—using metrics such as accuracy, precision, recall, and F1-score—demonstrates the capability and potential of ML models in improving cardiovascular healthcare. The results are promising, with the proposed prediction model achieving a classification accuracy of 74%, indicating its potential to support physicians in timely interventions and improved patient outcomes.*
***Keywords:*** *Heart disease, Machine learning, Feature selection, Cardiovascular diseases, Quality of life, Disease prevention, CVD.*

## 1. Introduction:

Cardiovascular disease (CVD) is a major global public health issue, causing millions of deaths each year. It includes conditions like coronary artery disease, heart failure, peripheral artery disease, and stroke [1].

The symptoms differ with the type and severity of heart failure[2]. The most common ones are chest ache or pain, angina, difficulty breathing, lethargy, nausea, vomiting, dizziness, palpitations, sleep problems, etc [3]. Depending on the intensity, these signs and symptoms can signal anything from the onset of chronic heart failure to arterial diseases. If you develop any of the above signs, seek immediate medical help because early diagnosis and treatment bring good results. Cardiovascular problems identified and treated earlier may improve the patients' prognosis and quality of life[4],[5]. Early recognition of these signs may lead to effective therapy and help avoid serious consequences[6],[7].

Some major risk factors that strongly tend to put one at risk of a heart attack include sedentary lifestyle choices, high blood pressure, diabetes, obesity, tobacco use, bad eating habits, and lack of exercise. External factors and inheritance contribute significantly to the causation of illness. All these things amount to causing cardiovascular problems such as heart attacks and seizures. These risk indicators can be influenced by achieving a better lifestyle, adhering to a regular schedule for health screening, and effectively managing chronic diseases. Such influence on these variables is related to risk reduction and improvement in cardiovascular health.

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.04 (2025)

Modifying such variables through proactive steps can lead to the successful prevention and management of heart failure [8]. A healthy lifestyle that involves frequent exercise, a good diet, and low salt and saturated fat intake will go a long way toward preventing heart disease. Quit smoking because it increases the risk of heart disease significantly. Other ways to reduce your risks of having a heart attack or stroke are learning relaxation when stressed and surrounding yourself with positive people. To further manage and reduce overall risk, adherence to recommended drug regimens for treating illnesses such as hypertension and insulin is essential. By adjusting their lifestyles, individuals can significantly enhance their heart health and lower the risk of coronary heart disease if they adhere to their doctors' orders.

The complications of cardiovascular disease are improved through early detection and management using modern state-of-the-art technologies[9],[10]. Electrocardiograms, echocardiograms, and cardiac stress tests are examples of essential diagnostic tools that aid in spotting problems at an early stage, which can lead to difficulties with cardiac health[11],[12]. Intelligent medications[13], behavioural changes, and surgical operations like angioplasty and coronary artery bypass grafting are some standard treatment options for the disease. These methods are directed toward the alleviation of symptoms and improvement of cardiac function, reducing the risk of myocardial infarction and stroke. Early identification of these disorders and initiation of appropriate therapy help healthcare professionals improve patients' quality of life and optimally manage cardiovascular disorders.

In this way, health promotional projects and outreach efforts are significant in raising awareness of the causes, symptoms, and preventive measures for heart failure. Some main goals include reducing cigarette use, increasing lifestyles that seem to be more active, and improving dietary choices. Both activities wish that cardiovascular diseases can be better handled and prevented worldwide with increased awareness and promotion of prevention information. Better heart health can be ensured if people are informed about their lifestyle and early diagnosis. Should the global burden of heart disease be reduced, then it would be of numbing importance that societies and hospitals set up an environment where prevention strategies can be implemented with success.

Artificial Intelligence's fundamental and advanced theoretical frameworks [14],[15] and Machine Learning[16],[17], which provide intricate pattern identification and predictive modeling across various domains[18],[19], are perpetually being investigated and developed. The principles extracted from studies on next-generation intelligent systems, including real-time adaptive defense mechanisms [20], self-learning cognitive digital twins [21], and the evolution of foundational computer science paradigms [22], collectively highlight the growing sophistication and intricacy of AI/ML methodologies [23],[24] currently employed in critical applications such as medical diagnostics.

Although this work emphasizes the predictive capabilities of AI/ML in cardiovascular diagnostics, it is essential to also consider the security and robustness[25] of deploying intelligent systems in a broader context[26]. The growing complexity of threat mitigation and generative AI technologies in domains like as cybersecurity[27] underscores the critical necessity for secure and resilient AI[28]. These findings[29] illustrate that the methodologies employed for robust detection in medicine are vulnerable to adversarial attacks and data poisoning, which are significant hazards that must be mitigated in the development of clinical AI models.

## 2. Literature review:

Given the high mortality caused by CVD and its global expansion, early detection was vital. Many methods have been applied to this field, such as phonocardiogram (PCG) signals, which are cost-effective. Cardio Net is a lightweight end-to-end CRNN architecture that classifies five heart status conditions—normal, aortic narrowing, mitral stenosis, mitral swelling, and mitral valve prolapse—directly from raw PCG signals [30]. Features are extracted through two learning stages in the sequenced residual learning and image learning approaches. CardioXNet outperforms earlier techniques k achieving very high accuracy on datasets like PhysioNet/Cinch 2016. Being highly efficient and having minimal computation needs, this technique fits perfectly for use on applications in mobile devices that will be utilised in resource-constrained environments for monitoring CVDs at the point of care.

[31] Stated that even if incorrect predictions could be life-threatening, still predictions of cardiac disease should be made accurately to avoid fatal situations. This paper uses different machine learning algorithms and deep learning approaches to review the UCI Machine Learning Heart Disease dataset, including 14 major features. These approaches have already shown great achievement in different medical fields such as brain tumour and skin cancer detection. The different algorithms are compared regarding the accuracy of several metrics and the confusion matrix. The Isolation Forest identifies and manages unimportant information, while data normalisation methods are used for the same speed improvements. This paper also contains integrating this discovery within multimedia technology, comprising handheld devices, and regarding a deep learning approach that gathered an accuracy of 94.2%.

Although CVDs are classified as serious health problems, their fatality rates can be reduced if detected at an early stage. Machine learning presents a possible solution for identifying the risk factors and predicting diseases in the heart. [32] contributed a model that incorporated several techniques to ensure accurate prediction. He combined the Statlog, Long Beach VA, Cleveland, Switzerland, and Hungarian datasets and applied both Relief and LASSO methods for choosing features. The new hybrid classifiers are the AdaBoosting Boosting Method, Gradient Boosting Method, K-Nearest Neighbors Bagging Method, Decision Tree Bagging Method, and Random Forest Bagging Method. All these classifiers combine one classic classifier with bagging and boosting techniques for training. Assessing the model is done according to metrics like F1 Score, Accuracy, Sensitivity, Error Rate, Precision, Negative Prognostic Value, False Positive Rate, and False Negative Rate. Results indicated that the model with the highest accuracy for extracting the important features was Relief in combination with RFBM.

According to Shaker [33] heart disease is the world's biggest cause of death and the heart is an extremely crucial organ. It becomes critical to predict heart failure, which is one of the top causes of death. The dataset was a derivative component of the study which was a merger of data existing in pre-determined eleven areas. Find from the results show that deep learning Diagnoses of cardiovascular disorders will not be more potent than the machine learning techniques. The below fields existing within the dataset were considered using the PCA technique and sampling approaches to benefit from recall and accuracy rates. Random Forest, Decision Tree, and Naive Bayes performed much better than other machine learning algorithms out of all those tested.

The current paper by [34] talks about developing an artificially intelligent device for cardiac disease detection with the help of machine learning algorithms. It involves preprocessing to convert the categorical columns and handling the categorical variables. The three stages therein are database gathering, logistic regressions, and last but not least, the evaluation of dataset attributes. It is a random forest classifier algorithm used to increase accuracy in the diagnoses of several heart diseases, which purportedly returns up to 83% on a training data set. It also discusses the Random Forest Classifier technique and its respective trials, with the improved diagnosis accuracy findings. The conclusion of the paper discusses the goals, constraints, and implications made by the study.

The associated health hazards have ushered in a method for interactive deep learning to help in classifying the concerned human cardiac arrhythmia condition . The process utilizes peak separation of R-R with means of filters to minimize noise, and then, design for CNN with various optimizers. It has been tested on some ECG databases, and good accuracy was achieved. The fact of low computing complexity confirmed by GPU implementation opens an opportunity for real-time pre-diagnosis with portable medical equipment.

Thanks to the development in technology, collecting various attributes of diagnosis for heart disease is possible. However, large datasets bring about several problems, both in processing and storage time. Taking/ Basing on the fact that heart disease has developed to become a common trend across the world, striving for diagnosis at an earlier stage is significant for successful medical intervention. In this work, machine learning techniques were used by [35] to predict heart illness. In this paper, both types of ensemble predictors have been used. This whole technique is divided into two phases: firstly, data imbalance is addressed using SMOTE, and then classification using Naive Bayes, Decision Tree, and their ensembles. Based on the experimental results, the AdaBoosting-RF classifier has more accuracy.

The knowledge and prediction of the risk of CVDs in a healthy person are highly needed to treat the diseases efficiently. Exploiting the richness of health data available on CVDs within any hospital database could provide better disease outcomes. This would improve early detection and diagnosis. This paper by Baghdadi, [36] proposes the development of unique, robust, productive, and efficient data mining algorithms specifically tailored to automate important selected features, allowing for early-stage heart disease detection in the pursuit of optimum early prediction and therapy for CVDs. The Cat Boost model performance proposed in this study is good, since the average accuracy in Table 16% was slightly around 90.94%, with an F1-score of about 92.3%. This effectively maximizes classification performance with increased precision and accuracy of performance compared to many of the current state-of-the-art techniques.

As per the World Health Organisation, heart diseases and stroke claim approximately 17.9 million—almost 31 per cent of all—lives across the world. It's the leading cause of mortality worldwide. Several unexpected outcomes have been found, such as the classifiers that machine training employs and the various popular techniques used for encoding categorical data, among classifying and diagnosing cardiac illness using limited datasets. Such works [37] suggest that effective cardiovascular illness prediction by the said patient data can be facilitated with the help of a deep learning-based architecture, specifically, a CNN coupled with BiLSTM. The selection of the most dominant illness dataset using ranking and choosing the produced attributes was conducted in the first instance. The process was followed by the use of a hybrid deep learning technique with unconditional CNN + BiLSTM for predicting the forecast in the selected cardiovascular illness; when this trial results or outputs were compared, the findings showed promising results, in the context of both higher accuracy and precision opposite to previously conducted research of the similar type.

WHO surveys state that cardiovascular disease is a killer that causes 17.9 million deaths annually throughout the world. With existing scientific knowledge and intricate analyzing capabilities of the current medical systems, CVDs are pretty hard to diagnose in their early stage. Gradual improvement in the prediction accuracy may improve the diagnosis and will significantly reduce the risk of CVDs. Accurately, [38]in this article developed 96.7% of this trained model for CVD prediction using machine learning methods such as logistic regression, Naive Bayes variations, KNN, SVM XGBoost, and random forestry. Besides this, deep data learning algorithms could enhance the design of medications, detection methods, and patient diagnoses. Deep learning in medical imaging would find some similarity between imaging of the past and present case subjects, reducing the price incurred during clinical trials. Heart diseases are one of the extremely dangerous illnesses people suffer.

the World Health Organization reports that heart disease is responsible for about 17.9 million deaths across the globe. Such influential variables include diabetes, increased blood pressure, LDL lipids, obesity, and lack of physical activity. Making early detection facilitates fast therapy and lifestyle changes, which may be applied to spare lives. [39] in cardiac illness efficiently explore machine learning; supervised learning engines like K-NN, SVM, and RF applied on the datasets available to heart disease are correlated with the experimented results, showing an outperforming rate of RF over SVM and KNN models.

Cardiovascular disorders are among the major health anomalies worldwide; as such, it requires efficient and accurate detection techniques. This work by [40]identifies early cardiac illnesses, especially myocardial angina, using machine intelligence methods. Literature is reviewed, and seven machine training and deep learning classifiers—K-Nearest Neighbors, Support Vector Machinery, Logistic Regression, Convex Neural Network, Gradient booster, XGBoost, and Random Forest—are applied to deal with the problem of imbalanced datasets. In the present study, interactions of how well these classifiers have been considered working through insightful information for making reliable prediction frameworks. It follows from these results that this research is involved in the optimization of an XGBoost simulator for cardiovascular disorders. For example, it improved significantly in the diagnosis of heart diseases to 98.50% precision, 99.14% exactness, with 98.29% recall coupled with a 98.71% rating on the F1 score.

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
CJSSR



## 3. Methodology:

### 3.1 Data introduction:

The study is based on a dataset received from Kaggle, containing data from 70,000 patients, for creating a prediction model that would help in predicting cardiac disease. Every record of all patients includes eleven different characteristics against which the goal prediction is present, so it becomes a thorough ground for analysis and modeling. The features give an understanding of all the variables impacting good cardiovascular health, which range from demographics to various health-related characteristics.

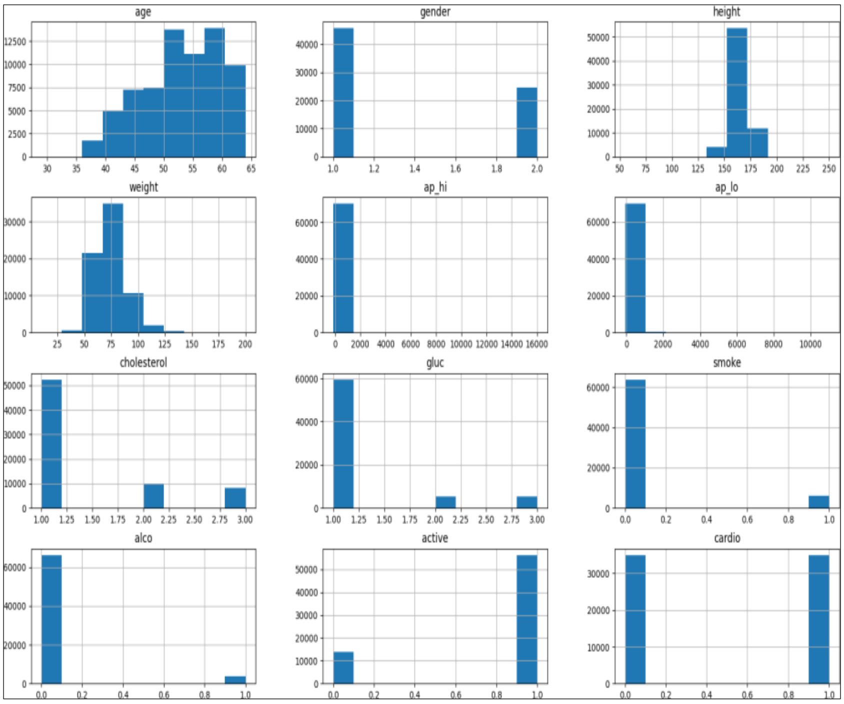


**Figure 1.** Feature wise Data distribution

| | |
|---|---|
| Age | Objective Feature |
| Height | |
| Weight | |
| Gender | |
| Systolic blood pressure | Examination feature |
| Diastolic Blood pressure | |
| Cholesterol | |
| Glucose | |
| Smoking | Subjective feature |

| | |
|---|---|
| Alcohol intake | |
| Physical activity | |
| Presence or absence of Cardiovascular disease | Target Variable |

**Table 1.** Categories of features.

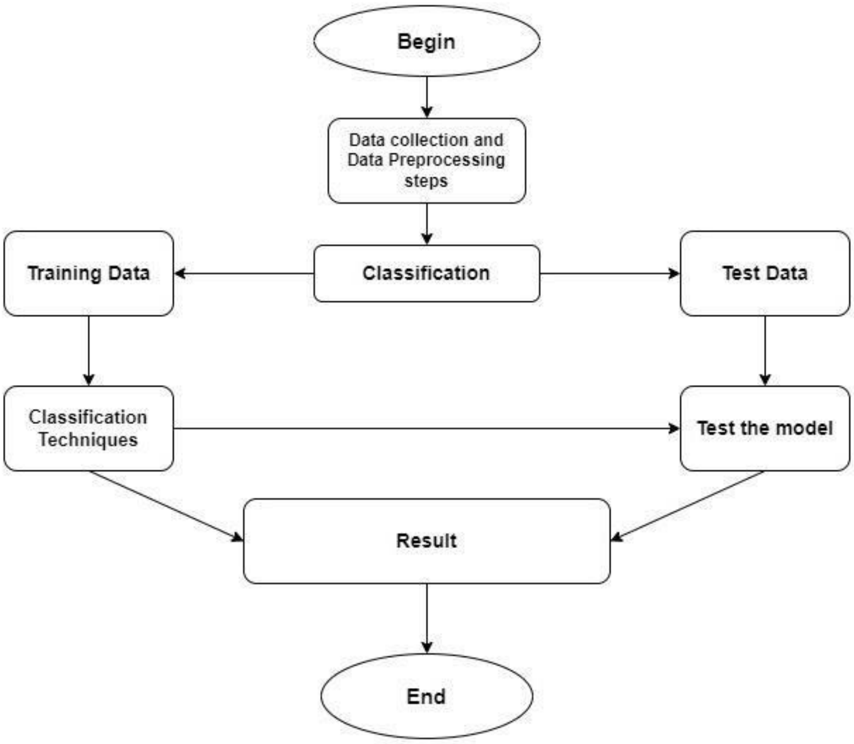


**Figure 2.** Process

**3.2 Data processing:**

Extensive data preparation was done using Python before the model training to guarantee that the dataset would be of good quality and relevant. The first stage in this pipeline ensured that the geographic distribution of a targeted varying indicating whether people have or not cardiovascular disease was analyzed to ensure balanced model training. Fortunately, the dataset showed an equal split, thus ensuring a similar proportion of both groups with approximately 34,979 individuals diagnosed with cardiovascular disease and a similar number without. In addition, there were no null or NA values in the dataset; therefore, mean, median, or mode-filling imputation methods were not required. This clean dataset boosted the analysis process and model creation.

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
CJSSR



Distributions of key characteristics, including age, sex, and a range of health markers, were explored to see if any trends or relationships could be discerned with cardiovascular disease. More specifically, age—and to an extent, gender-based trends presented themselves during the exploration for any relevant patterns that would enrich this modeling strategy.

**3.2.1 Gender wise distribution:**

Information was further categorized according to gender and was used to analyze the mixture of patients in a gender grouping of males and females. The objective of this research study was to find out about any gender trends related to the incidence and risk factors for heart failure.

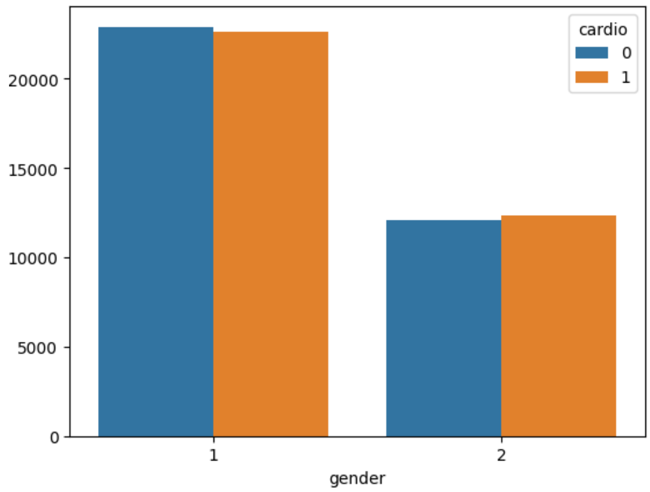


**Figure 3.** Cardio disease detection based on gender

**3.2.3 Age-wise distribution:**

The age distribution was further divided according to the different age groups so that the distribution of a person in these different age groups could be known. The determination of changes in risk for blood vessels with age is quite necessary for a prediction model to work.

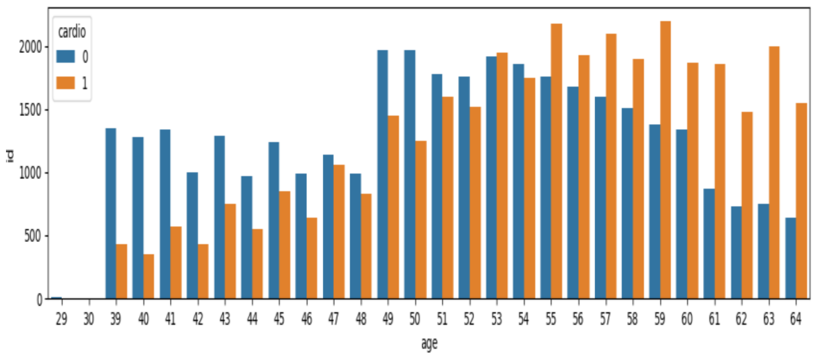


**Figure 4.** Cardio disease detection based on age

**3.2.4 Training the model:**

So, to start working on training the model, as the very first step, it's important to install the sci-kit-learn package, known as sklearn, via the Python environment. It is an open-source package for machine learning written in Python. It is quite easy to do and offers very high efficiency for

data mining and data analysis. The package is based on Matplotlib, SciPy, and NumPy. It contains several algorithms for applications, from clustering and regression to classification, reducing dimensionality. Both academics and businesses rely heavily on it for many applications, ranging from simple statistical analysis to a complex machine learning pipeline. I used the same software to split my data, in the same manner, using the train_test_split. It has been divided putting 30% aside for testing and 70% for training. I used 21,000 samples for tests and 49,000 entries for retraining. trained the model using the machine training classifier patterns below:
Random forest classifier
Naïve bays classifier
Decision tree classifier

**3.3 Random forest classifier:**

It is applied to a wide array of tasks, from marketing and banking to healthcare, including fraud detection, consumer behavior predictions, and medical diagnosis support. With the ability to handle very large datasets with excellent accuracy, it is one of the preferred tools for dealing with complex classification problems. This model returned an accuracy rate of 70% when applied to our dataset.

**3.4 Naive Bayes classifier:**

It finds applications in text classification tasks, be it spam filtering, sentiment analysis, or document categorization. Its simplicity and efficiency make it suitable for situations where computational resources are limited or when there's a need for real-time classification. This model gave an accuracy of 58% after applying to our dataset.

**3.5 Decision tree classifier:**

Decision trees are used in various fields like manufacturing, finance, and medicine for risk assessment, diagnosis, and defect control. They are very useful due to the interpretability and transparency of their results for specifying a decision-making process. By their nature, Decision Trees are appropriate for a wide range of problems in classification because of their flexibility and ability to handle quantitative and qualitative data. The model represented an accuracy of 62% when applied to our dataset.

**3.6 Neural network:**

Further testing of the data set on an artificial brain is done concerning whether the model provides more accuracy, keeping in mind previously acquired correctness and increasing this. Nevertheless, the neural system is constructed below:

**3.6.1 Model architecture definition:**

A model was defined using the Sequential API for neural networks.
It initializes a sequential neural network model.
Added a fully connected layer of size 32 with an input dimension of 11, and applied the ReLU activation function.

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.04 (2025)

Added one more fully connected layer with 8 units and the ReLU activation.
Added the output layer with 1 unit for binary classification and applied the sigmoid activation to output probabilities.

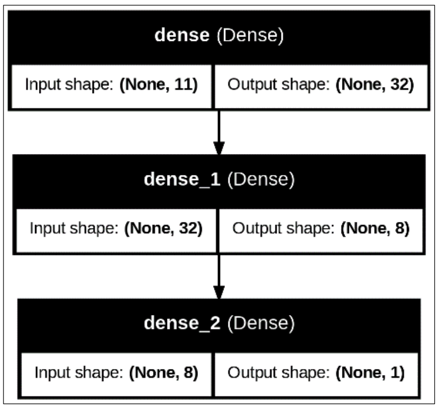


**Figure 5.** Model Architecture

**3.6.2 Model compilation:**

Assemble the algorithm for training by supplying the ideal algorithm (Adam), the assessment metric (consistency), and the loss calculation (binary crossing entropy over binary classification).

**3.6.3 Tensor Board Callback Setup:**

Set the log directories to hold the training records and the visualization settings when configuring a Tensor response for visualization while learning.

**3.6.4 Model training:**

I built the model with a batch size of 16, then trained it on the original dataset (X_train, y_train) using a 20% validation split and more than 100 epochs. We plotted success metrics and monitored the training progress by passing the tensor closure.

**3.6.5 Model evaluation:**

This indicates the correctness of the model as determined by the examination.

## 4. Result and discussion:

Some typical metrics for assessing how well categorization models do are accuracy, precision, recall, F1 score, and recall. Their definitions and their motivations are:

Precision, on the other hand, measures the ratio of true positive predictions to all positive predictions of the model. It answers the question: "How many of all instances that are predicted as positive are truly positive?" A high accuracy rating indicates reduced false positives in the model's predictions.

Recall is measured as the ratio of the number of actual positive instances to all positive data occurrences and is also sometimes identified as sensitivity or true positive rate. It is nothing but "Of all the actual positive instances, how many did the model correctly predict?" High recall means that the model can catch a big chunk of the positive instances.

F1 Score: Harmonic mean of recall and accuracy giving a single measure of balancing memory

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
CJSSR



and accuracy. Very useful when one has an unbalanced dataset where one class is much more frequent than the other, which obtains a maximum of 1 and a minimum of zero.
Accuracy: It is the percentage of correctly predicted cases against all instances in the dataset. It answers, "Out of every case in the dataset, how many did the model predict correctly?" While accuracy is a commonly used metric, it often turns out to be misleading in datasets that are imbalanced with a dominant class.
These metrics will give you a complete picture of how your model is performing and help you know where to improve. They help one in tuning the model for best performance in real life and gain insight into the trade-offs between false positives and inaccurate results.\

| **Classifier** | **Accuracy** | **Precision** | **Recall** | **F1 Score** |
|---|---|---|---|---|
| Neural Network | 73% | 74% | 69% | 72% |
| Naïve Bayes | 58% | 72% | 27% | 40% |
| Decision Tree | 62% | 63% | 61% | 62% |
| Random forest | 70% | 70% | 70% | 70% |

**Table 2.** Confusion Matrix

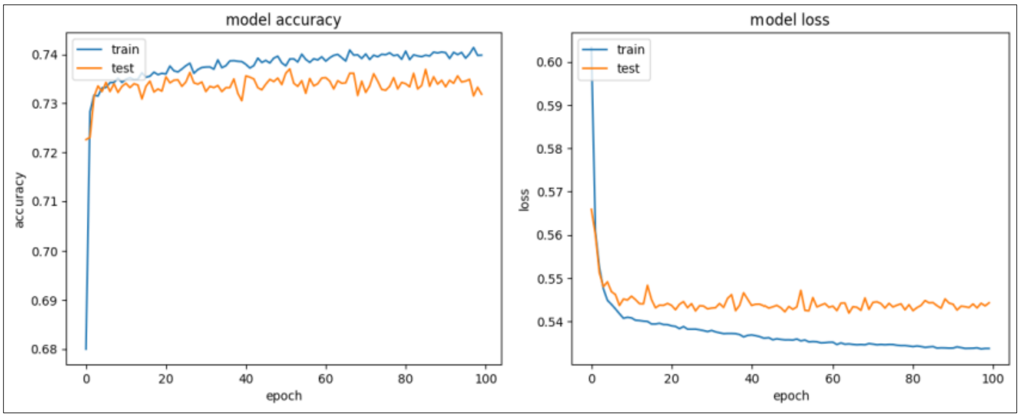


**Figure 6.** Performance of neural network model

Every neural system and algorithmic learning strategy matrix of confusion.

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
CJSSR
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.04 (2025)

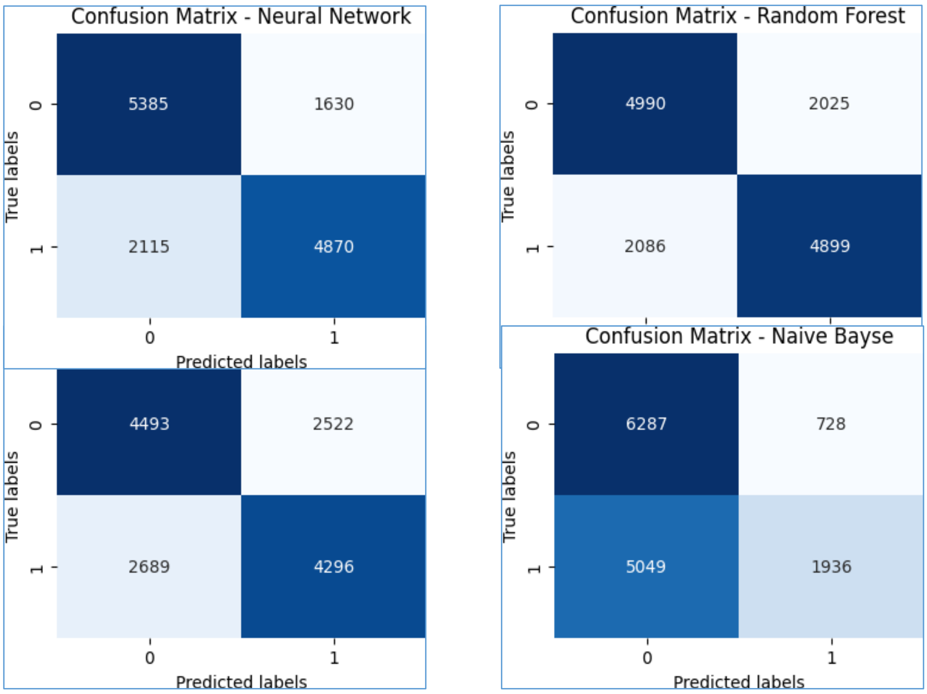


**Figure 7.** Evaluation of model

## 4.1 Conclusion:

The development of a neural networking model for cardiovascular disease prediction is described in this study. Layers that are fully connected employing ReLU activation made up the architecture of the model, which was trained to utilize the Adam optimizer and the binary cross-entropy loss function. While the assessment offered details on the model's performance, TensorBoard visualization helped to monitor the training process. Predictive models of this kind have the potential to help medical professionals identify people who are at risk of heart disease, which would allow for prompt intervention and better patient outcomes. In comparison to previous research tackling comparable classification issues in the literature, our approach has shown promise with a categorization accuracy of 74.00% for various metrics.

## 4. References:

1.Asim, Muhammad, Fawad Nasim, Hijab Sehar, and Suhaib Naseem. "A DEEP LEARNING-BASED APPROACH FOR HEART DISEASE DETECTION AND EARLY WARNING." Contemporary Journal of Social Science Review 3, no. 2 (2025): 2856-2872.

2.Zainab, Hira, Ali Raza A. Khan, Muhammad Ismaeel Khan, and Aftab Arif. "Ethical Considerations and Data Privacy Challenges in AI-Powered Healthcare Solutions for Cancer and Cardiovascular Diseases." Global Trends in Science and Technology 1, no. 1 (2025): 63-74.

3.Badar, Muhammad Aqeel, Fakhar Ur Rehman, Javeed Ali, Fawad Nasim, and Hijab Sehar. "PREDICTIVE MODELING OF CARDIOVASCULAR DISEASE US-ING MACHINE LEARNING." Contemporary Journal of Social Science Review 2, no. 04 (2024): 1467-1481.

4.Zainab, Hira, Muhammad Ismaeel Khan, Aftab Arif, and Ali Raza A. Khan. "Deep Learning in

Precision Nutrition: Tailoring Diet Plans Based on Genetic and Microbiome Data." Global Journal of Computer Sciences and Artificial Intelligence 1, no. 1 (2025): 31-42.
5.Aish, Muhammad Abdullah, Amina Abdul Ghafoor, Fawad Nasim, Kiran Irfan Ali, Shamim Akhter, and Sumbul Azeem. "Improving stroke prediction accuracy through machine learning and synthetic minority Over-sampling." Journal of Computing & Biomedical Informatics 7, no. 02 (2024).
6.Zainab, Hira, Ali Raza A. Khan, Muhammad Ismaeel Khan, and Aftab Arif. "Innovative AI Solutions for Mental Health: Bridging Detection and Therapy." Global Journal of Emerging AI and Computing 1, no. 1 (2025): 51-58.
7.Khan, Ali Raza A., Muhammad Ismaeel Khan, and Aftab Arif. "AI in Surgical Robotics: Advancing Precision and Minimizing Human Error." Global Journal of Computer Sciences and Artificial Intelligence 1, no. 1 (2025): 17-30.
8.Consortium, G. C. R. (2023). "Global effect of modifiable risk factors on cardiovascular disease and mortality." New England Journal of Medicine 389(14): 1273-1285.
9.Jabed, Mohammad Majharul Islam. "Self-Supervised Learning for Efficient and Scalable AI: Towards Reducing Data Dependency in Deep Learning Models." International Journal of Intelligent Systems and Applications in Engineering 10, no. 10 (2022).
10. Sharmin Akter; Muntaha Islam; Jannatul Ferdous; Md Mehedi Hassan; Mohammad Majharul Islam Jabed. Synergizing Theoretical Foundations and Intelligent Systems: A Unified Approach Through Machine Learning and Artificial Intelligence. Iconic Research And Engineering Journals, vol. 6, no. 9, pp. 466–477, 2023.
11. Zainab, Hira, Muhammad Ismaeel Khan, Aftab Arif, and Ali Raza A. Khan. "Development of Hybrid AI Models for Real-Time Cancer Diagnostics Using Multi-Modality Imaging (CT, MRI, PET)." Global Journal of Machine Learning and Computing 1, no. 1 (2025): 66-75.
12. Khan, Shaz Mumtaz, Fawad Nasim, Jawad Ahmad, and Sohail Masood. "Deep learning-based brain tumor detection." Journal of Computing & Biomedical Informatics 7, no. 02 (2024).
13. Zainab, Hira, A. Khan, Ali Raza, Muhammad Ismaeel Khan, and Aftab Arif. "Integration of AI in Medical Imaging: Enhancing Diagnostic Accuracy and Workflow Efficiency." Global Insights in Artificial Intelligence and Computing 1, no. 1 (2025): 1-14.
14. Arif, Aftab, Fadia Shah, Muhammad Ismaeel Khan, Ali Raza A. Khan, Aftab Hussain Tabasam, and Abdul Latif. 2023. “Anomaly Detection in IoHT Using Deep Learning: Enhancing Wearable Medical Device Security.” Migration Letters 20 (S12): 1992–2006.
15. Khan, Muhammad Ismaeel. "Synergizing AI-Driven Insights, Cybersecurity, and Thermal Management: A Holistic Framework for Advancing Healthcare, Risk Mitigation, and Industrial Performance." Global Journal of Computer Sciences and Artificial Intelligence 1, no. 2: 40-60.
16. Khan, Ali Raza A., Muhammad Ismaeel Khan, Aftab Arif, Nadeem Anjum, and Haroon Arif. "Intelligent Defense: Redefining OS Security with AI." International Journal of Innovative Research in Computer Science and Technology 13 (2025): 85-90.
17. Tariq, Muhammad Arham, Muhammad Ismaeel Khan, Aftab Arif, Muhammad Aksam Iftikhar, and Ali Raza A. Khan. "Malware Images Visualization and Classification With Parameter Tunned Deep Learning Model." Metallurgical and Materials Engineering 31, no. 2 (2025): 68-73.https://doi.org/10.63278/1336.
18. Nasim, Fawad, Sohail Masood, Arfan Jaffar, Usman Ahmad, and Muhammad Rashid. "Intelligent Sound-Based Early Fault Detection System for Vehicles." Computer Systems Science &

Engineering 46, no. 3 (2023).
19. Nasim, Fawad, Muhammad Adnan Yousaf, Sohail Masood, Arfan Jaffar, and Muhammad Rashid. "Data-Driven Probabilistic S for Batsman Performance Prediction in a Cricket Match." Intelligent Automation & Soft Computing 36, no. 3 (2023).
20. GUPTA, A. B., AKTER, S., ISLAM, M., JABED, M. M. I., & FERDOUS, J. (2023). Smart Defense: AI-Powered Adaptive IDs for Real-Time Zero-Day Threat Mitigation.
21. "Cognitive Digital Twins For Cyber Defense: Self-Learning Ai Agents Against Emerging Threat Landscapes ", Int. J. Environ. Sci., pp. 320–330, Sep. 2025, doi: 10.64252/t82vzq74. Accessed: Sept. 27, 2025. [Online]. Available: https://theaspd.com/index.php/ijes/article/view/10178
22. Hassan, M. M. (2023). From Formalism to Functionality: Leveraging AI and Ml to Advance Foundational Computer Science Paradigms. International Journal on Recent and Innovation Trends in Computing and Communication, 11(3), 707–719. https://doi.org/10.17762/ijritcc.v11i3.11594.
23. Khan, Muhammad Ismaeel, Aftab Arif, and Ali Raza A. Khan. "The Most Recent Advances and Uses of AI in Cybersecurity." BULLET: Jurnal Multidisiplin Ilmu 3, no. 4 (2024): 566-578.
24. Khan, Muhammad Ismaeel, Aftab Arif, and Ali Raza A. Khan. "AI's Revolutionary Role in Cyber Defense and Social Engineering." International Journal of Multidisciplinary Sciences and Arts 3, no. 4 (2024): 57-66.
25. Arif, Aftab, Muhammad Ismaeel Khan, and Ali Raza A. Khan. "An overview of cyber threats generated by AI." International Journal of Multidisciplinary Sciences and Arts 3, no. 4 (2024): 67-76.
26. Khan, M. I., A. Arif, and A. R. A. Khan. "AI-Driven Threat Detection: A Brief Overview of AI Techniques in Cybersecurity." BIN: Bulletin of Informatics 2, no. 2 (2024): 248-61.
27. Arif, Aftab, Muhammad Ismaeel Khan, Ali Raza A. Khan, Nadeem Anjum, and Haroon Arif. "AI-Driven Cybersecurity Predictions: Safeguarding California's Digital Landscape." International Journal of Innovative Research in Computer Science and Technology 13 (2025): 74-78.
28. Khan, Muhammad Ismaeel, Aftab Arif, Ali Raza A. Khan, Nadeem Anjum, and Haroon Arif. "The Dual Role of Artificial Intelligence in Cybersecurity: Enhancing Defense and Navigating Challenges." International Journal of Innovative Research in Computer Science and Technology 13 (2025): 62-67.
29. Arif, A., A. Khan, and M. I. Khan. "Role of AI in Predicting and Mitigating Threats: A Comprehensive Review." JURIHUM: Jurnal Inovasi dan Humaniora 2, no. 3 (2024): 297-311.
30. Shuvo, S. B., S. N. Ali, S. I. Swapnil, M. S. Al-Rakhami and A. Gumaei (2021). "CardioXNet: A novel lightweight deep learning framework for cardiovascular disease classification using heart sound recordings." ieee access 9: 36955-36967.
31. Bharti, R., A. Khamparia, M. Shabaz, G. Dhiman, S. Pande and P. Singh (2021). "Prediction of heart disease using a combination of machine learning and deep learning." Computational intelligence and neuroscience 2021(1): 8387680.
32. Ghosh, P., S. Azam, M. Jonkman, A. Karim, F. J. M. Shamrat, E. Ignatious, S. Shultana, A. R. Beeravolu and F. De Boer (2021). "Efficient prediction of cardiovascular disease using machine learning algorithms with relief and LASSO feature selection techniques." IEEE Access 9: 19304-19326.
33. Shaker, C. R., A. Sidhartha, A. Praveena, A. Chrsity and B. Bharati (2022). An Analysis of Heart Disease Prediction using Machine Learning and Deep Learning Techniques. 2022 6th International Conference on Trends in Electronics and Informatics (ICOEI), IEEE.

34. Chang, V., V. R. Bhavani, A. Q. Xu and M. Hossain (2022). "An artificial intelligence model for heart disease detection using machine learning algorithms." Healthcare Analytics 2: 100016.
35. Srikanth, V. and T. Mahesh (2022). A Cardiovascular Disease Detection System using Machine Learning. 2022 5th International Conference on Contemporary Computing and Informatics (IC3I), IEEE.
36. Baghdadi, N. A., S. M. Farghaly Abdelaliem, A. Malki, I. Gad, A. Ewis and E. Atlam (2023). "Advanced machine learning techniques for cardiovascular disease early detection and diagnosis." Journal of Big Data 10(1): 144.
37. Ahmad, S., M. Z. Asghar, F. M. Alotaibi and Y. D. Alotaibi (2023). "Diagnosis of cardiovascular disease using deep learning technique." Soft Computing 27(13): 8971-8990.
38. Mandava, M., S. R. Vinta, H. Ghosh and I. S. Rahat (2023). "An All-Inclusive Machine Learning and Deep Learning Method for Forecasting Cardiovascular Disease in Bangladeshi Population." EAI Endorsed Transactions on Pervasive Health and Technology 9.
39. Kamala, S. P. R., S. Gayathri, N. M. Pillai, L. A. Gracious, C. Varun and R. S. Subramanian (2023). Predictive Analytics for Heart Disease Detection: A Machine Learning Approach. 2023 4th International Conference on Electronics and Sustainable Communication Systems (ICESC), IEEE.
40. Ogunpola, A., F. Saeed, S. Basurra, A. M. Albarrak and S. N. Qasem (2024). "Machine learning-based predictive models for detection of cardiovascular diseases." Diagnostics 14(2): 144.