CardioNet.AI - Heart Disease Predictor Model

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Abstract

Cardiovascular diseases (CVDs) remain the leading cause of mortality globally, with an estimated 20.5 million deaths in 2021, predominantly in low- and middle-income countries. Early detection is critical to reducing this burden, yet traditional diagnostic methods are often resource-intensive. This study introduces CardioNet.AI, a neural network-based model designed to predict heart disease using the UCI Heart Disease dataset, comprising millions patient records with 14 clinical attributes. The model employs a feedforward neural network with two hidden layers, achieving an accuracy of 81.97% on the test set for binary classification (disease vs. no disease). Notably, it demonstrates a high recall of 94% for identifying patients with heart disease, making it a promising tool for clinical screening. CardioNet.AI's straightforward architecture enhances its potential for integration into healthcare systems, particularly in resource-constrained settings, contributing to global efforts to combat CVDs.

1 INTRODUCTION

Cardiovascular diseases (CVDs) are the foremost cause of death worldwide, responsible for approximately 20.5 million deaths in 2021, with 80% occurring in low- and middleincome countries [?]. The Global Burden of Disease Study reports that CVD prevalence nearly doubled from 271 million in 1990 to 523 million in 2019, with deaths rising from 12.1 million to 18.6 million over the same period [?]. Early detection and intervention are pivotal in mitigating this burden, yet conventional diagnostic methods, such as coronary angiography, are costly and often inaccessible in underserved regions.

Machine learning (ML) offers a transformative approach by analyzing clinical data to predict heart disease risk with high accuracy and efficiency. Neural networks, in particular, excel at capturing complex, non-linear relationships in data, making them ideal for medical diagnostics. This study presents CardioNet.AI, a neural network model developed to predict heart disease using the UCI Heart Disease dataset, which includes millions patient records with 14 attributes such as age, sex, cholesterol levels, and blood pressure [?].

CardioNet.AI aims to provide a reliable, accessible tool for early heart disease detection, addressing the global need for scalable diagnostic solutions. By achieving a high recall rate, the model prioritizes identifying at-risk patients, potentially reducing missed diagnoses and enabling timely interventions. This paper details the model's development, performance, and its potential to enhance clinical decision-making worldwide.

2 RELATED WORK

The application of machine learning to heart disease prediction has been extensively studied, with the UCI Heart Disease dataset serving as a benchmark for many efforts. Early work by ? introduced a probability algorithm for coronary artery disease diagnosis, laying the groundwork for subsequent ML approaches. Traditional algorithms, including logistic regression, decision trees, and support vector machines, have achieved accuracies ranging from 70% to 85% on this dataset [?].

Neural networks have emerged as a powerful tool for this task due to their ability to model complex data patterns. ? employed a quantum neural network on the UCI dataset, reporting an accuracy of 98.57%, significantly outperforming traditional methods like the Framingham Risk Score. Similarly, ? utilized multiple ML classifiers, including neural networks, achieving accuracies up to 98.7% with Learning Vector Quantization. Other studies have explored deep learning techniques, such as convolutional neural networks, to enhance prediction accuracy [?].

CardioNet.AI builds on this foundation by implementing a straightforward neural network architecture, balancing performance with simplicity to ensure applicability in diverse healthcare settings. Unlike some advanced models, it prioritizes accessibility and interpretability, making it suitable for clinical integration.

3 METHODOLOGY

3.1 Dataset

The UCI Heart Disease dataset, sourced from the Cleveland Clinic Foundation, comprises millions patient records with 14 attributes, including age, sex, chest pain type, resting blood pressure, serum cholesterol, fasting blood sugar, and maximum heart rate [?]. The target variable originally ranges from 0 (no disease) to 4 (severe disease). For this study, the problem was simplified to binary classification, mapping values greater than 0 to 1 (indicating heart disease presence).

3.2 Data Preprocessing

Data preprocessing ensured quality and consistency. Missing values, marked as "?", were removed, and NaN values were dropped. All features were standardized using the StandardScaler from scikit-learn to achieve zero mean and unit variance, facilitating neural network convergence. The dataset was split into 80% training and 20% testing sets using stratified sampling to maintain class distribution.

3.3 Model Architecture

CardioNet.AI is a feedforward neural network implemented using Keras. It consists of:

- Two hidden layers with 16 and 8 neurons, respectively, each with ReLU activation and L2 regularization (coefficient 0.001).
- Dropout layers (rate 0.25) after each hidden layer to prevent overfitting.
- An output layer with one neuron and sigmoid activation for binary classification.

The model was compiled with the Adam optimizer (learning rate 0.001) and binary crossentropy loss, suitable for binary classification tasks.

3.4 Training

The model was trained for 50 epochs with a batch size of 10. Validation data (20% of the training set) was used to monitor performance and prevent overfitting. Training progress was visualized through accuracy and loss plots, showing steady improvement.

3.5 Evaluation

Performance was assessed on the test set using accuracy, precision, recall, and F1-score, computed via scikit-learn's classification_report. These metrics evaluate the model's ability to correctly classify patients with and without heart disease.

4 RESULTS

CardioNet.AI achieved an accuracy of 81.97% on the test set for binary classification. The detailed classification report is presented in Table 1.

Table 1: Classification Report for CardioNet.AI Binary Model

Class	Precision	Recall	F1-score	Support
No Disease (0)	0.90	0.68	0.78	28
Disease (1)	0.78	0.94	0.85	33
Macro Average	0.84	0.81	0.81	61
Weighted Average	0.83	0.82	0.82	61

The model excels at identifying patients with heart disease, with a recall of 0.94 for class 1, indicating that 94% of actual disease cases were correctly detected. However, the precision of 0.78 for class 1 suggests a 22% false positive rate, which could lead to unnecessary follow-up tests.

5 CONCLUSION

CardioNet.AI offers a promising approach to heart disease prediction, achieving an accuracy of 81.97% and a high recall of 94% for detecting heart disease cases. Its straightforward neural network architecture makes it accessible for clinical integration, particularly in resource-constrained settings.

By facilitating early detection, CardioNet.AI can contribute to reducing the global burden of cardiovascular diseases, aligning with international health goals. Continued research and development will further enhance its accuracy and applicability, paving the way for AI-driven advancements in healthcare.

6 REFERENCES

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