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Performance enhancement of machine learning system applicable to detect heart disease

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Abstract: *Present paper is considering existing researches related to heart disease detection using ML and considering factors those are influencing performance during heart disease detection. Research paper is proposing hybrid model by integration of compression to resolve the performance issues faced in conventional research related to heart disease detection. Finally, comparison of performance in case of heart disease detection for conventional and proposed work has been made.*

Keywords: *Heart disease detection, Machine learning, Performance enhancement, Compression.*

1. INTRODUCTION :

In the realm of healthcare, the integration of ML for the classification of heart disease marks a transformative leap towards precision medicine and proactive patient care. Leveraging advanced algorithms, this approach analyzes a spectrum of patient data, encompassing variables. By discerning intricate patterns and correlations within this wealth of information, machine learning models can effectively categorize individuals into those at risk of heart disease and those with a lower likelihood. This not only facilitates early diagnosis but also empowers healthcare providers with personalized insights, allowing for tailored treatment plans and preventive measures. The fusion of machine learning and healthcare in heart disease classification exemplifies a paradigm shift, promising improved diagnostic accuracy, resource optimization, and ultimately, enhanced patient outcomes.

Predicting heart disease through machine learning classification has emerged as a groundbreaking approach in modern healthcare. Harnessing the power of artificial intelligence, this method leverages intricate patterns within diverse patient data to distinguish between individuals with and without heart disease. By utilizing features ML algorithms are trained on extensive datasets to learn the subtle relationships that may elude traditional diagnostic methods. This innovative classification process not only facilitates early detection of cardiac issues but also enables personalized risk assessment. As technology seamlessly, integrates into the realm of healthcare, the classification of heart disease through machine learning stands as a beacon of hope for more accurate, timely, and proactive interventions in cardiovascular health.A healthcare system has been considered as organized structure, institutions, resources, and people involved in delivering healthcare services to a population. It encompasses a wide range of components working together to promote, maintain, and restore health. Implementing machine learning in healthcare systems holds immense promise for revolutionizing patient care, optimizing processes, and enhancing overall efficiency. One key application lies in predictive analytics, where ML algorithms can analyze patient data to predict likelihood of diseases, enabling early intervention and preventive measures. This not only improves treatment efficacy but also minimizes adverse effects. In diagnostic imaging, machine learning algorithms can assist in the rapid and accurate interpretation of medical images, aiding healthcare professionals in detecting anomalies and making more informed decisions. This can significantly reduce time required for diagnosis and enhance the precision of medical assessments. Additionally, machine learning algorithms can be employed for the efficient management of healthcare resources. This includes predicting patient admission rates, optimizing staff schedules, and streamlining inventory management, leading to cost savings and improved overall healthcare system performance. However, the integration of machine learning in healthcare comes with its challenges, such as ensuring data privacy, addressing ethical considerations, and establishing robust security measures to protect sensitive patient information. Striking a balance between innovation and the ethical use of technology is crucial for the successful implementation of ML in healthcare systems. Overall, synergy between machine learning and healthcare has the potential to usher in a new era of patient-centric, data-driven, and efficient healthcare delivery. Here are key elements of a healthcare system.

2. Literature Review :

There several Existing researches related to heart disease prediction that considered machine learning and deep learning.

P. Singh et al. (2023) presented ML for diagnosing heart disease. This work gives a systematic overview of models built using these methods and methodologies, discussing their strengths and weaknesses. SVM, KNN, DT, and Random Forest (RF) were all examples of supervised learning techniques used to train models. The Random forest classifier has accuracy (87.96%).

N. Biswas et al. (2023) focused on the goal of this research was to use several feature selection strategies to construct a viable ML for early stage heart disease. The features that were chosen using the chi-square, ANOVA, and mutual information methods are referred to as SF1, SF2, and SF3, respectively. Finally, we determined that for SF3 feature subsets, random forest delivered the most promising results, with an accuracy of 94.51%, sensitivity of 94.87%, specificity of 94.23%, area under the ROC curve (AURC) of 94.95, and log loss of 0.31.

H. Jindal et al. (2021) introduced automatic diagnosis of heart disease using ML. Primary goal of this study was to determine whether patients are at higher risk for developing heart disease based on a number of clinical characteristics. When compared to other classifiers utilized in the past, such as naive bayes and logistic regression, the suggested model's strength was rather gratifying. It accurately predicted whether or not a given person had heart disease.

A. Garg et al. (2021) presented machine learning for cardiac illness prognosis. By taking into account factors like chest discomfort, cholesterol level, and age, machine learning can determine whether a person is suffering from cardiovascular disease. In this research, they use two supervised ML: K-NN and Random Forest. KNN achieves 86.885% accuracy in its predictions, whereas the Random Forest method achieves 81.967% accuracy in its predictions.

S. Mohan et al. (2019) provided effective cardiac disease prediction utilizing mixed ML approaches. Recent advancements in several sub-domains of the Internet of Things (IoT) have also made use of ML approaches. Predicting cardiac disease using ML approaches was only partially explored in the available research. The heart disease prediction model achieves an enhanced performance level with an accuracy level of 88.7 percent by using HRFLMmodel.

V. V. Ramalingam et al. (2018) provided machine learning for cardiac illness prognosis. This study provides a comprehensive overview of models built using these methods and methodologies, and evaluates how well they work. SVM, KNN, NB, DT, RF, and ensemble models were all examples of supervised learning that have proven successful with academics.

C. B. C. Latha et al. (2019) introduced predictions of heart disease risk may be made more precisely using ensemble classification methods. In this study, they not only construct the method using a medical dataset to demonstrate its value in early illness prediction, but we also concentrate on improving the accuracy of weak classification systems. The research found that using ensemble methods to improve poor classifiers' prediction accuracy led to adequate performance in predicting cardiovascular disease risk. With the aid of ensemble classification, the accuracy of even the most ineffective classifiers might be improved by as much as 7%. The approach was further improved by including feature selection, which led to a significant rise in prediction accuracy.

M. S. Amin et al. (2019) presented data mining and feature discovery methods for cardiovascular disease prediction. This research set out to improve cardiovascular disease prediction via the use of data mining techniques and the identification of essential features. NN, KNN, DT, NB, LR, SVM, and a hybrid method called vote (combining NB and LR) were among the seven classification methods used to build models for making predictions. Based on the identified key parameters and the best-performing data mining technique, the experimental results show that a heart disease prediction model may achieve an accuracy of 87.4%.

S. Mohan et al. (2019) introduced predicting the occurrence of heart disease with accuracy utilizing a combination of several machine learning methods. Recent advancements in several sub-domains of the Internet of Things (IoT) have also made use of ML approaches. Predicting cardiac disease using ML approaches was only partially explored in the available research. They provide a novel strategy for predicting cardiovascular disease using machine learning techniques to isolate key characteristics. The prediction model is constructed using a number of feature combinations and well-established classification algorithms. An 88.7 percent accuracy rate in predicting cardiac illness is achieved by using HRFLM.

T. Akter et al. (2019) presented pre-symptomatic identification approaches for autism spectrum disorders using machine learning. Toddler, child, adolescent, and adult datasets for early-detected ASD were processed using a number of feature transformation methods, such as the log, Z-score, and sine functions. Afterwards, several classification algorithms were evaluated using these altered ASD datasets. Adaboost produced the greatest outcomes for children, Glmboost for adolescents, and SVM for toddlers, while Glmboost and Adaboost respectively performed best for adults. For toddler dataset, the sine function produced the highest results for classification, while the Z-score performed best for the child and adolescent datasets.

I. D. Mienye et al. (2021) reviewed this research was to identify key markers that may be used to foretell cardiovascular problems. The recursive feature elimination (RFE) method relies on a number of different foundational algorithms to choose features. Set theory was then used to combine the properties that were projected to be important by the multiple RFE implementations. Six ML models are constructed utilising the condensed data set and several machine learning methods.

S. Razia et al. (2019) introduced taking into account factors like chest discomfort, cholesterol level, and age, ML can determine whether person was suffering from cardiovascular disease. Supervised learning, a classification system based on ML, may simplify the diagnosis of cardiovascular illnesses. KNN and Random Forest were two of the algorithms used to distinguish between those with and without cardiac disease. In this research, we use two supervised machine learning algorithms: KNN and Random Forest. KNN achieves 86.885% accuracy in its predictions, whereas the Random Forest method achieves 81.967% accuracy in its predictions.

3. Problem statement :

Enhancing the performance of a machine learning system for heart disease detection poses several challenges that need careful consideration. One significant issue is the availability and quality of data. In healthcare, obtaining a large and diverse dataset can be challenging due to privacy concerns, data silos, and the need for domain-specific expertise. Cleaning and preprocessing such data require meticulous attention, as missing values, outliers, and imbalances can adversely affect model training. Additionally, the complexity of the underlying physiological processes involved in heart disease demands advanced feature engineering and careful selection to capture relevant information effectively. Another critical challenge is the interpretability of the models. In the context of healthcare, especially when dealing with patients' well-being, understanding how a model arrives at a particular decision is crucial. Many sophisticated machine learning models, such as deep neural networks, often act as black boxes, making it difficult for healthcare professionals to trust and interpret their predictions. Striking a balance between model complexity and interpretability is essential to gain the trust of medical practitioners and ensure the clinical relevance of the system. Furthermore, the dynamic nature of healthcare data and evolving medical knowledge poses an ongoing challenge. Models need to adapt to new information and be continuously updated to maintain their relevance and accuracy. Collaboration with domain experts, such as cardiologists, is essential to incorporate their clinical insights, ensuring that the model aligns with the latest medical understanding and practices. Deploying and monitoring these models in real-world clinical settings introduces additional complexities, including ethical considerations, regulatory compliance, and the potential impact on patient outcomes. Addressing these multifaceted challenges requires a holistic approach that combines technical expertise with a deep understanding of healthcare domain intricacies.

4. Proposed model for Predicting heart disease using Machine learning with better performance

There is great medical value in applying machine learning for the prediction of cardiac illness. Classifying people into various risk groups using machine learning algorithms may assist with early diagnosis and intervention. Here's an overview of how you can use classification techniques in machine learning to predict heart disease:

1. Data Collection: Gather a dataset that includes relevant medical information from individuals. You'll also need a label that indicates whether or not each individual has heart disease.

2. Data Preprocessing: Remove any discrepancies, outliers, or missing values from the dataset. The numerical characteristics should be standardised or normalized so that they are all on the same scale.

3. Feature Selection and Engineering: It characteristics are the most important for making cardiac disease predictions. Selecting the most informative features may be accomplished via the use of methods such as feature significance analysis or domain knowledge. You can also create new features based on the existing ones if it helps improve predictive performance.

4. Data compression and Splitting: Dataset has been compressed and create a training set and a test set from dataset. Machine learning model is trained using the training set, and its performance is evaluated using the testing set.

5. Model Selection: Select an appropriate classification method for this job. Heart disease prediction algorithms often used include:

- Logistic Regression
- Decision Trees
- Random Forest
- Support Vector Machines
- k-Nearest Neighbors
- Gradient Boosting (e.g., XGBoost or LightGBM)
- Neural Networks

6. Model Training: Train your chosen ML model on raining dataset. Model will learn to classify individuals into those with heart disease and those without, based on the provided features.

7. Model Evaluation: To evaluate the model's efficacy, use the testing dataset. Standard measures for assessing categorization initiatives. Choose the metrics that are most appropriate for your specific problem.

8. Hyperparameter Tuning: To get the most out of your model of choice, tweak its hyper parameters. To locate the optimal values for the hyperparameters, you may use methods such as grid search or random search.

9. Cross-Validation: Implement cross-validation to ensure that your model's performance is robust and not over fitting the training data.

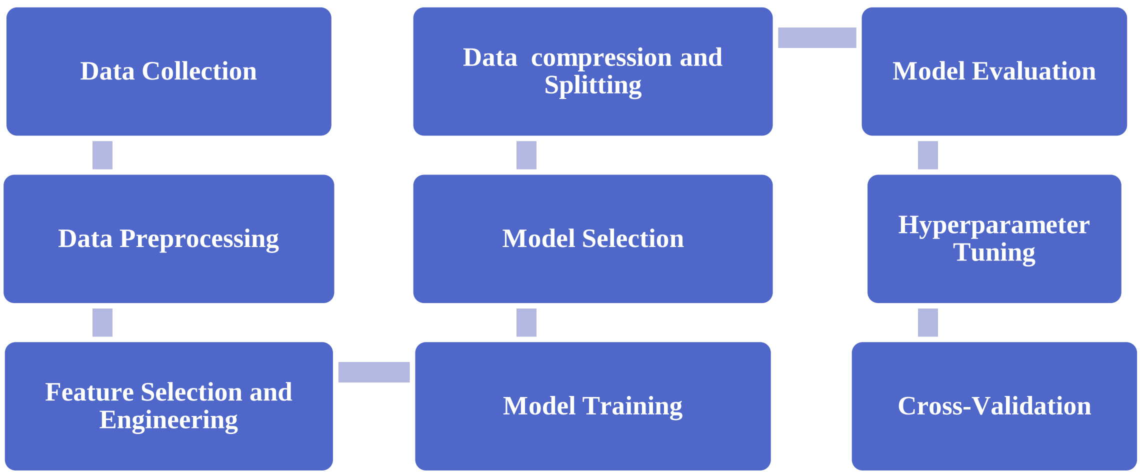

Fig 1. Heart disease prediction using machine learning with high performance

5. Simulation of Time consumption :

This work employs image analysis, border detection, deep learning, and medicinal therapy. Implementing the recommended methodology might potentially decrease the duration and exertion needed to detect cardiac disease. The neural network's predictive accuracy and precision will be evaluated throughout its operation. Suggested research involves integrating several compression and edge detection approaches, together with deep learning algorithms. Upon completing training on the heart disease dataset, the confusion measures will be computed and used to the test outcomes in order to assess the dependability of the generated predictions. The proposed model is assessed based on the performance and accuracy of current models. These photographs depict the first stage of the four-step process required to complete the shown artwork. Step one encompasses the acquisition of the photographs and the first processing, while step two entails the use of an artificial neural network for their classification. The third step involves training and testing to enhance precision, accuracy, F1 score, and recall value. Stage 4 evaluates the performance and accuracy of both existing and future projects. The following images depict a physically fit physique juxtaposed with one afflicted by a cardiovascular ailment.

The matching score is computed based on the neural network's capacity to categorize input. The work reported here utilizes ANN after the completion of edge detection and feature extraction. We used an ANNclassifier for this purpose. The duration of the sorting step is also considered. The following charts provide a comparison between the processing time and accuracy of an ANN algorithm when applied directly to a heart disease sample, and when applied to a heart disease sample with detected edges. At this juncture, the classifier is used to allocate a grade.

Table 1Comparison of Time consumption

Image	Conventional work (minute)	Proposed work (minute)
10	11.3909	9.13444
20	22.9314	17.5112
30	31.4828	28.2084
40	41.0296	38.2736
50	52.5443	49.5651
60	63.2974	58.236
70	72.958	66.1826
80	81.7232	78.3188
90	91.734	87.3784
100	101.404	97.3878

Time's results for both a conventional work and proposed work are shown in Figure 2.

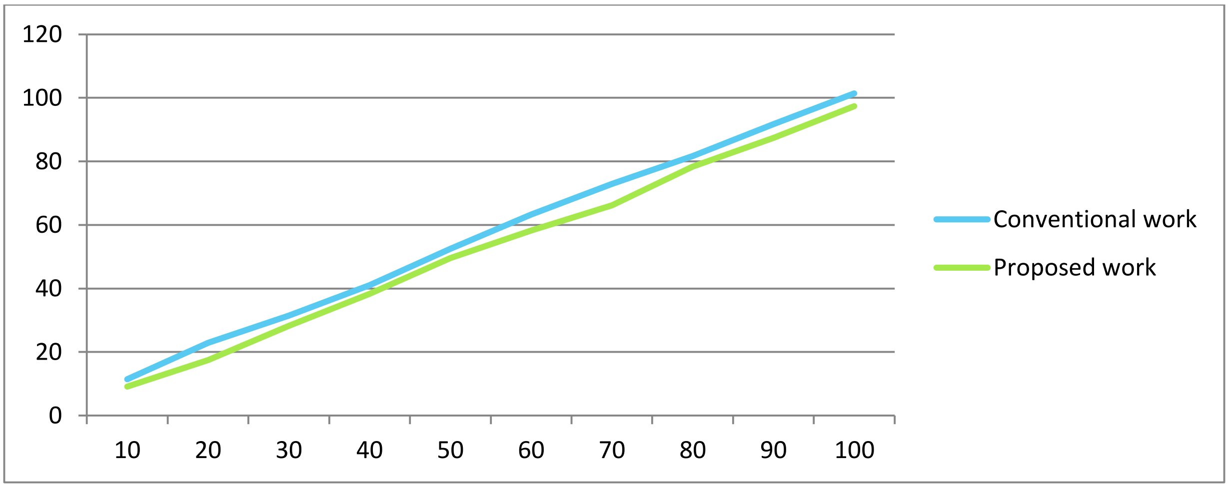

Fig 5.5 Time comparison

6. Conclusion :

In conclusion, the integration of compression techniques has demonstrated a notable enhancement in the performance of deep learning systems designed for heart disease detection and prediction. Compression methods have proven effective in reducing the computational and memory requirements of deep neural networks, facilitating more efficient model training and inference. This improvement in efficiency translates to faster processing times and reduced resource utilization, making deep learning models more practical for real-time applications in the healthcare domain. Moreover, the enhanced performance brought about by compression techniques contributes to the scalability and deployability of these models across various computing platforms, including edge devices with limited resources. This is particularly crucial for the widespread adoption of heart disease detection models in diverse clinical settings, where resource constraints may be a significant consideration. Additionally, compression can lead to a reduction in the model's storage footprint, enabling easier deployment and management of these models in resource-constrained environments. This is especially beneficial for healthcare systems with limited storage capacity, where the efficient use of resources is paramount. While compression has clear advantages in terms of performance optimization, it is essential to strike a balance between compression ratios and model accuracy. Careful consideration should be given to the choice of compression techniques and their impact on the overall predictive capabilities of the deep learning model. Collaborative efforts between machine learning practitioners and healthcare experts are crucial to ensuring that compressed models maintain their efficacy in accurately detecting and predicting heart disease, ultimately contributing to more accessible and efficient healthcare solutions.

7. Future Scope :

The future holds promising opportunities for the performance enhancement of heart disease detection systems, driven by advancements in technology and a deeper understanding of cardiovascular health. One area of significant potential lies in the integration of emerging technologies such as artificial intelligence (AI) and machine learning (ML) with advanced imaging techniques. Harnessing the power of high-resolution imaging, including techniques like functional MRI and 4D echocardiography, can provide a more detailed and nuanced assessment of cardiac function, thereby improving the sensitivity and specificity of detection systems. Continuous monitoring facilitated by wearable devices and Internet of Things (IoT) technologies presents another avenue for future development. Real-time data collection and remote patient management can enable early detection of anomalies or changes in cardiovascular health, allowing for timely interventions and personalized treatment plans.Overall, the future scope for performance enhancement in heart disease detection systems encompasses a multidisciplinary approach, leveraging advancements in technology, data integration, and model interpretability to create more accurate, accessible, and patient-centric solutions for cardiovascular healthcare.

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