

ADVANCED HEART ATTACK RISK PREDICTION USING STACKED HYBRID MACHINE LEARNING

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Abstract—Heart disease is one of the leading causes of death worldwide, and early prediction of heart attack risk is essential for improving patient survival. This paper presents an advanced heart attack risk prediction system using a stacked hybrid machine learning approach. The proposed model combines multiple machine learning algorithms to improve prediction accuracy and reliability. Medical parameters such as age, blood pressure, cholesterol level, heart rate, blood sugar, and other clinical attributes are used as input for the system. In the first stage, different base models such as Decision Tree, Random Forest, Support Vector Machine, and K-Nearest Neighbour are trained individually. Their outputs are then combined using a stacking technique with a meta-classifier to generate the final prediction. The proposed system also includes data preprocessing techniques such as handling missing values, normalization, and feature selection to improve model performance. Experimental results show that the stacked hybrid model achieves higher accuracy, precision, recall, and F1-score compared to traditional single machine learning models. The system can assist doctors and healthcare professionals in identifying high-risk patients at an early stage and support better medical decision-making. This approach demonstrates the effectiveness of ensemble learning techniques in developing intelligent and reliable healthcare prediction systems.

Keywords— Logistic Regression, Decision Tree, and KNN

I. INTRODUCTION

Heart disease is one of the major health problems and a leading cause of death across the world. A heart attack occurs when the blood supply to the heart is blocked, which can seriously affect human health and may lead to death if not identified early. Early prediction of heart attack risk can help doctors provide proper treatment and preventive measures, thereby reducing mortality rates and improving patient care. With the growth of healthcare data and artificial intelligence, Machine Learning (ML) techniques are widely used in the medical field for disease prediction and diagnosis.

Traditional prediction methods mainly depend on basic machine learning algorithms such as Logistic Regression, Decision Tree, and K-Nearest Neighbour. Although these methods provide useful results, they often suffer from limitations such as low accuracy, overfitting, and inability to capture complex relationships in medical datasets. To overcome these limitations, advanced ensemble learning methods are becoming more popular. Ensemble techniques combine the strengths of multiple machine learning models to produce better prediction performance. Among these methods, stacked hybrid machine learning is an effective approach where several base models work together, and their outputs are combined using a meta-classifier to improve prediction accuracy and reliability. This project proposes an “Advanced Heart Attack Risk Prediction Using Stacked Hybrid Machine Learning” system that uses multiple machine learning algorithms to analyse patient health data and predict heart attack risk more accurately. The system uses important medical parameters such as age, blood pressure, cholesterol level, blood sugar, heart rate, and other clinical features for prediction. Data preprocessing techniques such as missing value handling, normalization, and feature selection are also applied to improve model performance. The main objective of this work is to develop an intelligent and efficient prediction system that can support doctors and healthcare professionals in early diagnosis and decision-making. By using a stacked hybrid model, the proposed system aims to achieve higher accuracy and better reliability compared to traditional single-model approaches. This research demonstrates how machine learning and ensemble techniques can contribute to the advancement of smart healthcare systems.

II. LITERATURE SURVEY

Many researchers have applied Machine Learning (ML) techniques to predict heart disease and heart attack risk. Different algorithms and ensemble methods have been developed to improve prediction accuracy and support early diagnosis in the healthcare field. In earlier studies, traditional machine learning algorithms such as Logistic Regression, Decision Tree, Naive Bayes, and K-Nearest Neighbour

(KNN) were widely used for heart disease prediction. These models were simple and easy to implement, but their prediction accuracy was limited when handling large and complex medical datasets. Researchers found that single algorithms often suffer from overfitting and poor generalization. Later, advanced algorithms such as Random Forest and Support Vector Machine (SVM) were introduced to improve prediction performance. Random Forest provided better accuracy by combining multiple decision trees, while SVM performed well in handling non-linear medical data. However, these models still had limitations in achieving highly reliable predictions when used individually..

III. PROBLEM STATEMENT

Heart disease is one of the most serious health problems and is considered a leading cause of death worldwide. A heart attack occurs when the blood flow to the heart is blocked, which can result in severe health complications and even death if not detected at an early stage. Early identification of heart attack risk is very important because it helps doctors and healthcare professionals provide timely treatment and preventive care to patients. However, predicting heart attack risk accurately is a difficult task due to the complexity of medical data and the presence of multiple risk factors such as age, blood pressure, cholesterol level, blood sugar, heart rate, obesity, smoking habits, and lifestyle conditions. Traditional heart disease prediction systems mainly depend on manual diagnosis and basic statistical methods, which may not always provide accurate results. In recent years, machine learning techniques have been introduced for disease prediction, but many existing systems use only single machine learning algorithms such as Logistic Regression, Decision Tree, Naive Bayes, K-Nearest neighbour (KNN), and Support Vector Machine (SVM). Although these methods can predict heart disease to some extent, they often suffer from several limitations. Single machine learning models may fail to capture complex and non-linear relationships present in medical datasets. They may also produce lower prediction accuracy and unreliable results when handling large and diverse healthcare data. Another major problem in existing systems is overfitting and underfitting, which reduces the overall performance of prediction models. Many healthcare datasets contain missing values, noisy data, and imbalanced class distributions, making the prediction process more challenging. In addition, some models are sensitive to irrelevant features, which affects their efficiency and increases computational complexity. Existing systems also lack proper integration of multiple algorithms that can utilize the strengths of different models together for better prediction performance.

IV. PROPOSED SYSTEM

A. System Overview and Design Approach

The proposed system is an advanced heart attack risk prediction system designed to identify the possibility of heart attacks at an early stage using stacked hybrid machine learning techniques. The system analyzes patient medical data and generates accurate heart attack risk predictions that can assist doctors and healthcare professionals in making effective medical decisions. The system uses important medical parameters such as age, blood pressure, cholesterol level, blood sugar, heart rate, chest pain type, and other

clinical attributes for prediction. The architecture integrates data collection, preprocessing, feature extraction, machine learning model training, stacked ensemble learning, prediction analysis, and result generation into a unified framework. The proposed system is designed to be accurate, reliable, low-cost, and user-friendly. It provides real-time prediction performance and can be used in hospitals, clinics, and healthcare centers for early diagnosis and prevention of heart diseases.

B. SYSTEM ARCHITECTURE

The proposed Advanced Heart Attack Risk Prediction System follows a modular and layered architecture designed to provide accurate, reliable, and real-time prediction of heart attack risk using stacked hybrid machine learning techniques. The architecture is divided into two major phases: Training Phase and Real-Time Prediction Phase. Each phase contains multiple modules that work together to process medical data, train machine learning models, and generate prediction results efficiently. The system architecture is designed to handle large healthcare datasets, improve prediction performance, reduce errors, and support healthcare professionals in early diagnosis and treatment planning. By combining multiple machine learning algorithms through stacking ensemble learning, the proposed system achieves better prediction accuracy compared to traditional single-model systems.

1) Training Phase

In the training phase, patient healthcare data is collected and processed to build prediction models:

- Patient medical datasets are collected from healthcare sources
- Data preprocessing is performed to remove missing values and noisy data
- Feature vectors are generated from important medical parameters
- Data is preprocessed through normalization and scaling techniques
- Machine learning models such as Random Forest, SVM, KNN, and Logistic Regression are trained
- Outputs from different models are combined using stacking ensemble learning
- Models are evaluated using accuracy, precision, recall, and F1-score
- The best-performing stacked hybrid model is selected for deployment

2) Real-Time Prediction Phase

In the real-time phase:

- Patient medical details are entered through the user interface
- Input data is preprocessed and normalized
- Extracted features are passed to the trained machine learning models
- Base models generate individual prediction outputs
- The stacking meta-classifier combines all outputs
- The system predicts the heart attack risk level
- The prediction result is displayed instantly for doctors and users

SYSTEM ARCHITECTURE



FIG. 1.STEM ARCHITECTURE

C. FUNCTIONAL MODULES

1) Data Collection Module

Collects patient healthcare data from medical datasets or user inputs. The data includes age, blood pressure, cholesterol level, blood sugar, heart rate, chest pain type, and other clinical attributes.

2) Data Preprocessing Module

The collected data is cleaned and processed by handling missing values, removing noise, normalization, and scaling to improve data quality and consistency.

3) Feature Selection Module

Important medical features that contribute most to heart attack prediction are selected to improve prediction accuracy and reduce computational complexity.

4) Machine Learning Training Module

Machine learning algorithms such as:

- Random Forest
- Support Vector Machine (SVM)
- K-Nearest Neighbours (KNN)
- Logistic Regression

are trained using the processed healthcare dataset.

5) Stacked Hybrid Learning Module

The outputs from multiple machine learning models are combined using stacking ensemble techniques. A meta-classifier generates the final prediction result with improved accuracy and reliability.

6) Prediction Module

The trained stacked hybrid model predicts the patient's heart attack risk level such as low risk, medium risk, or high risk based on the medical data.

7) User Interface Module

Provides a simple and user-friendly interface to enter patient details and display real-time prediction results for healthcare professionals and users.

D. Working Principle

The system works by collecting patient healthcare information and processing it through various machine learning stages in real time. Initially, the medical data is preprocessed to remove noise and improve consistency. Important features are selected and passed to different machine learning models such as Random Forest, SVM, KNN, and Logistic Regression. Each model independently generates prediction outputs, which are then combined using a stacking ensemble method. The meta-classifier analyses the outputs

from all models and generates the final heart attack risk prediction. The predicted result is displayed instantly to assist doctors and healthcare professionals in early diagnosis and decision-making.

E. DESIGN CONSIDERATIONS

The system is designed with the following considerations:

Real-Time Performance:

Provides fast prediction with minimal delay between input and output.

Accuracy:

Uses optimized stacked hybrid machine learning models for reliable prediction.

Cost Efficiency:

Can be implemented using standard computing systems without expensive hardware.

Scalability:

New medical features and machine learning models can be added easily.

Usability:

Provides a simple interface suitable for healthcare professionals and non-technical users.

F. ADVANTAGES OF THE PROPOSED SYSTEM

- Provides early prediction of heart attack risk
- Improves accuracy using stacked hybrid machine learning
- Works in real time with minimal delay
- Reduces prediction errors compared to single models
- Assists doctors in medical decision-making
- Low-cost and easy to deploy in hospitals and clinics

V. IMPLEMENTATION DETAILS

The proposed “Advanced Heart Attack Risk Prediction Using Stacked Hybrid Machine Learning” system is implemented using machine learning techniques and healthcare datasets to predict heart attack risk accurately. The implementation process includes data collection, preprocessing, feature selection, model training, stacking ensemble learning, prediction generation, and result display. The complete system is developed using Python and machine learning libraries.

A. Tools & Technologies

The proposed system is implemented using various programming tools, machine learning libraries, and visualization technologies to develop an efficient heart attack risk predictions system.

- Python
- Pandas
- NumPy
- Matplotlib
- Machine Learning Libraries
- Healthcare Dataset

B. Algorithms Used

The proposed “Advanced Heart Attack Risk Prediction Using Stacked Hybrid Machine Learning” system uses multiple machine learning algorithms to improve prediction accuracy and reliability. Each algorithm analyzes patient healthcare data differently and contributes to the final prediction process.

- Random Forest
- Support Vector Machine (SVM)
- K-Nearest Neighbours (KNN)

- Logistic Regression
- Stacking Ensemble Learning

C. Evaluation Metrics

The performance of the proposed “Advanced Heart Attack Risk Prediction Using Stacked Hybrid Machine Learning” system is evaluated using different machine learning evaluation metrics. These metrics help measure the accuracy, reliability, and efficiency of the prediction models.

- Accuracy
- Precision
- Recall
- F1-score
- Confusion Matrix
- ROC-AUC Score

VI. Results and Discussion

The proposed “Advanced Heart Attack Risk Prediction Using Stacked Hybrid Machine Learning” system was successfully implemented and tested using healthcare datasets containing patient medical information. The system was trained using multiple machine learning algorithms such as Random Forest, Support Vector Machine (SVM), K-Nearest Neighbor (KNN), and Logistic Regression. The outputs from these models were combined using a stacking ensemble technique to improve prediction accuracy and reliability.

During experimentation, the dataset was preprocessed using normalization, scaling, and feature selection techniques to improve data quality and reduce noise. The processed data was divided into training and testing datasets for model evaluation. Different machine learning models were trained individually, and their performances were compared using evaluation metrics such as accuracy, precision, recall, and F1-score.

The experimental results showed that the stacked hybrid machine learning model achieved better performance compared to individual machine learning models. The stacking ensemble method improved prediction accuracy by combining the strengths of multiple algorithms and reducing prediction errors. The proposed system was able to classify heart attack risk levels effectively based on patient medical data.

Among the trained models, Random Forest provided good accuracy and handled complex data efficiently, while SVM performed well in identifying non-linear relationships in the dataset. KNN produced satisfactory results for smaller datasets, and Logistic Regression provided stable baseline predictions. However, the stacked hybrid model outperformed all individual models by generating more accurate and reliable prediction results.

The system successfully predicted heart attack risk levels such as low risk, medium risk, and high risk in real time. The prediction results were displayed instantly through the user interface, making the system useful for doctors and healthcare professionals in early diagnosis and medical decision-making.

The evaluation metrics confirmed the effectiveness of the proposed system:

- High prediction accuracy was achieved using stacked ensemble learning
- Precision and recall values indicated reliable classification performance
- F1-score demonstrated balanced prediction capability
- Reduced error rates compared to traditional single-model approaches

The proposed system also demonstrated good scalability and usability. New medical parameters and machine learning algorithms can be added in the future to further improve prediction performance. The user-friendly interface and real-time prediction capability make the system suitable for hospitals, clinics, and healthcare applications.

Overall, the results indicate that the proposed stacked hybrid machine learning approach is effective for heart attack risk prediction and can support healthcare professionals in providing early treatment and preventive care for patients.

Different machine learning models were trained individually, and their performances were compared using evaluation metrics such as accuracy, precision, recall, F1-score, confusion matrix, and ROC-AUC score. Among the individual models, Random Forest produced good prediction accuracy and handled complex medical data efficiently. Support Vector Machine (SVM) performed well in identifying non-linear relationships in the healthcare dataset. K-Nearest Neighbour (KNN) provided stable classification results, while Logistic Regression generated reliable baseline predictions.

The stacked hybrid machine learning model outperformed all individual models by combining the strengths of multiple algorithms.

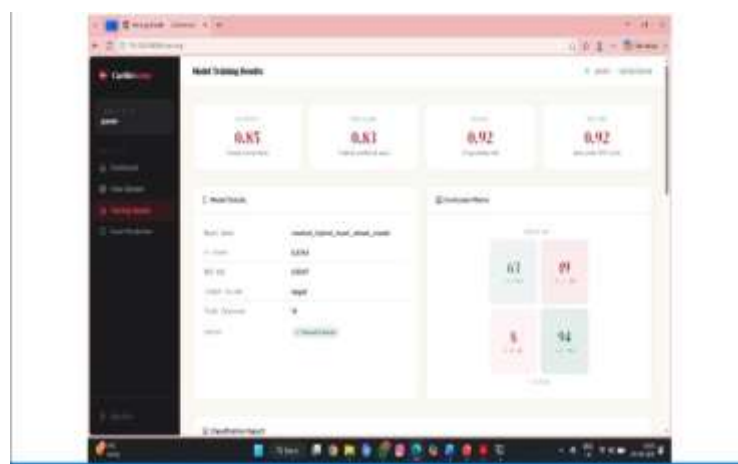


FIG. 2. OUTPUT

VII. CONCLUSION

The proposed “Advanced Heart Attack Risk Prediction Using Stacked Hybrid Machine Learning” system was successfully developed to predict heart attack risk using patient healthcare data. The system combines multiple machine learning algorithms such as Random Forest, Support Vector Machine (SVM), K-Nearest neighbour (KNN), and Logistic Regression through stacking ensemble learning to improve prediction accuracy and reliability. The implementation of data preprocessing techniques such as missing value handling, normalization, scaling, and feature selection improved the quality of the dataset and enhanced model performance. The stacked hybrid model achieved better accuracy, precision, recall, and F1-score compared to traditional single machine learning models. The system is capable of predicting heart attack risk levels in real time and provides instant results through a user-friendly interface. This helps doctors and healthcare professionals identify high-risk patients at an early stage and make effective medical

decisions. The proposed system is low-cost, scalable, and suitable for hospitals, clinics, and healthcare applications. Overall, the project demonstrates that stacked hybrid machine learning techniques can provide accurate and efficient heart attack risk prediction.

VIII. REFERENCES

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