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AI Powered Stroke Prediction and Prevention System Using NLP

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Abstract - This system offers an advanced solution for stroke prediction by combining Artificial Intelligence (AI) and Natural Language Processing (NLP) to enhance early detection and prevention. It analyses structured health data, including medical records and wearable vitals, alongside unstructured data from clinical notes, patient reports, and online health forums. Advanced machine learning techniques such as Random Forest and Gradient Boosting are applied for accurate stroke risk prediction. NLP methods like Named Entity Recognition (NER) and sentiment analysis extract valuable insights from unstructured medical text. The model delivers personalized prevention strategies, including lifestyle changes, dietary recommendations, and early medical intervention. Real-time alert mechanisms are also integrated to detect warning signs and initiate emergency responses. This system helps prevent strokes by enabling timely risk detection, improving patient care, and supporting early, personalized treatment decisions using AI-driven insights.

Key Words: Stroke prediction, Artificial Intelligence (AI), Natural Language Processing (NLP), Early detection, Random Forest, Gradient Boosting, Named Entity Recognition (NER), Personalized prevention.

1. INTRODUCTION

Stroke disease is a major cause of death and long-term disability worldwide, making early prediction and prevention very important. This system uses Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP) to study both structured health data, like medical records and wearable data, and unstructured data, such as doctor's notes and patient reports. Traditional stroke risk methods often lack accuracy and don't provide personal advice. To solve this, the system uses advanced models like Random Forest and Gradient boosting. NLP techniques like Named Entity Recognition (NER) and sentiment analysis help the system understand important information from medical texts. It provides real-time stroke risk predictions along with personalized prevention tips, including lifestyle changes, diet suggestions, and early medical help. This system's goal is to support people with smart, timely health insights that help lower stroke risk and improve overall care.

2. OBJECTIVE

The objective of this system is to build an accurate and smart way to predict and prevent strokes using Artificial Intelligence (AI) and Machine Learning (ML). The system looks at both structured data, like medical records, age, blood pressure, and readings from health devices, and unstructured data, like doctor's notes, patient reports, and online health forums. It uses strong machine learning models such as Random Forest and Gradient Boosting to find the risk of stroke early. To make the predictions better, the system first cleans the data by filling missing values, turning text into numbers, and fixing class imbalance using a method called SMOTE. After the data is ready, the system trains the model to understand patterns in stroke cases. Once trained, the system gives real-time predictions about stroke risk and also offers useful prevention tips like healthy lifestyle changes, better diet plans, and early medical advice. This helps doctors and patients take action early, reduce the risk of stroke, and improve overall health in a simple and effective way.

3. LITERATURE SURVEY

[1]. D.-H. Shih, Y.-H. Wu, T.-W. Wu, H.-Y. Chu, and M.-H. Shih, "Stroke Prediction Using Deep Learning and Transfer Learning Approaches," IEEE Access, vol. 12, pp. 130091-130104, 2024.

This Research explores stroke prediction using deep learning and transfer learning methods to improve early diagnosis. The system studies patient health data to find patterns linked to stroke risk. By using transfer learning, it can work well even with smaller datasets, making it both efficient and practical. The model shows high accuracy in identifying patients at risk of stroke. This helps doctors take early action and plan better treatments. Overall, the approach supports timely care, reduces serious health effects, and improves the chances of preventing strokes in high-risk individuals. It also supports smarter healthcare decisions.

[2]. K. Mridha, S. Ghimire, J. Shin, A. Aran, M. M. Uddin, and M. F. Mridha, "Automated Stroke Prediction Using Machine Learning: An Explainable and Exploratory Study With a Web Application for Early Intervention," IEEE Access, vol. 11, pp. 52288-52308, 2023.

This paper reviews an automated stroke prediction system using machine learning models to help with early detection and prevention. It explains how the system uses health data such as age, blood pressure, heart disease, and other factors to predict stroke risk. The study also introduces a web application that allows users to check their stroke risk easily. The system provides clear explanations for each prediction, making it easier for doctors and patients to understand the results. This helps in taking early medical steps and improving stroke prevention.

[3]. S. Gupta and S. Raheja, "Stroke Prediction using Machine Learning Methods," in Proceedings of the 12th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Noida, India, 2022, pp. 553-558.

This paper Reviews the use of different machine learning methods for predicting stroke risk. It focuses on how models like Logistic Regression, Decision Tree, and Random Forest can help analyze patient data such as age, blood pressure, and health history. The study compares these models based on accuracy and performance to find the best one for stroke prediction. The goal is to support early diagnosis and reduce stroke impact. The research highlights how machine learning can be a helpful tool in improving healthcare and saving lives.

[4]. Ponmalar A, Nokudaiyaval G, Vishnu Kirthiga R, Pavithra P, Sri Rakshya R.V.T, "Stroke Prediction System Using Artificial Neural Network," in Proceedings of the 6th International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2021, pp. 1898-1902.

This Research explores a stroke prediction system that uses Artificial Neural Networks (ANN) to predict stroke risk based on patient data. It explains how the system collects important health information like age, blood pressure, and medical history, and then uses the ANN model to analyze this data. The study shows that using ANN can improve prediction accuracy and help in identifying stroke risk at an early stage. The goal is to support quick decision-making and provide timely care, helping to reduce the effects of stroke on patients

4. METHODOLOGY

In the current method used for predicting strokes, doctors usually check a person's age, blood pressure, BMI, and other health details. Based on this, they try to find out if the person has a risk of stroke. However, this process is done manually and may not always give accurate results. It also takes more time and can differ based on the doctor's experience. Also, this method might not fully use all the data available to understand patterns that lead to stroke. To improve this, the proposed method uses artificial intelligence (AI) with machine learning techniques. In this method, a computer model is created using algorithms like Random Forest and XGBoost. These algorithms are trained using a dataset that includes information such as age, sugar level, heart disease, and other medical details. Before training, the data goes through several steps like cleaning, encoding the values into numbers, and using SMOTE to balance the data so that the model learns better. This AI-based model is able to find hidden patterns in the data and can predict stroke risk more accurately and quickly. The result is more reliable and consistent. The model is also connected to a chatbot, which gives users the stroke prediction and also provides prevention tips based on the input given. This helps users understand their risk and take early steps to prevent stroke.

5. ARCHITECTURE DIAGRAM

This system enhances the prediction of stroke risk by using both structured and unstructured health data. It begins with collecting data from different sources like medical records, health history, clinical notes, and patient feedback. This data includes both structured (like numbers for blood pressure and age) and unstructured information (like written doctor notes). Next, the data is cleaned and prepared. Missing values are filled, numbers are normalized, and text values like gender or smoking habits are turned into a format that the model can understand. For unstructured data, the system uses NLP (Natural Language Processing) methods like Named Entity Recognition (NER), which finds important medical terms like symptoms and medicines from written notes. This is done with the help of the Google Gemini API. After preparing the data, machine learning models are used to predict the chance of stroke. By combining both types of data, the system gives more accurate and real-time results. These predictions help doctors and patients take early action to reduce stroke risk.

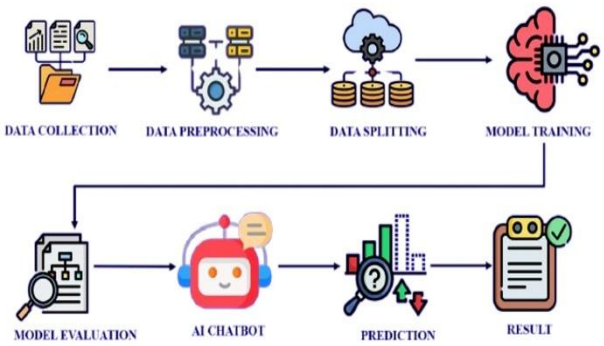

Figure 1: Architecture Diagram

6. SYSTEM OVERVIEW

6.1. STROKE RISK PREDICTIONS MODEL:

The stroke risk prediction model uses Machine Learning to find stroke risk early and help prevent it. The dataset is taken from Kaggle and electronic health records (EHRs). It includes important health details like age, blood pressure, heart disease, BMI, smoking status, and glucose levels. The data is read using pandas and stored in a DataFrame for easy processing. Machine learning models like Random Forest and Gradient Boosting are used to make accurate predictions. The dataset is divided into 80% for training and 20% for testing, helping the model learn from a wide range of health conditions effectively. SMOTE is used to handle data imbalance and improve prediction for stroke cases. The model helps healthcare providers take early action and give better care. It also supports continuous updates using new patient data to maintain accuracy. Overall, it provides a reliable system for early stroke detection and prevention.

6.2. NLP ANALYSIS USING GEMINI API:

Natural Language Processing (NLP) is used with the Google Gemini API to understand unstructured medical text like clinical notes and doctor-patient conversations. Named Entity Recognition (NER) helps identify important medical terms such as symptoms, medications, and stroke-related factors from the text. Sentiment Analysis is also done to detect emotional and mental signs that may relate to stroke risk. The API helps detect voice tone and patient behavior patterns during interactions, offering clues for early stroke prediction. These insights are then combined with structured data to improve the overall accuracy of the model. The NLP system also supports chatbot conversations, allowing users to get personalized health advice. Clinical terms are matched with known stroke indicators for early detection. Context

understanding helps the model recognize subtle signs from patient language. This intelligent processing adds more depth to the stroke prediction system, making it more reliable and user-friendly.

6.3. MODEL DEPLOYMENT:

The trained stroke prediction model is deployed using the Google Gemini API for real-time stroke risk detection and patient interaction. The API allows users to safely enter health details like age, blood pressure, and lifestyle habits to get instant stroke risk results. It gives an accurate score based on machine learning analysis. The Gemini API is also used to set up secure connections so that patient data is protected while receiving predictions. As more users enter data, the system learns and updates itself, helping improve the accuracy of predictions over time. It also supports integration with mobile and web applications for better accessibility. Healthcare professionals can use this tool to support early diagnosis and provide personalized care plans.

6.4. LANDING PAGE AI CHATBOT:

A user-friendly landing page is created using HTML, CSS, and JavaScript and hosted on Netlify. It gives easy access to the AI-powered stroke prediction system. The website has a modern and interactive design that shows important information about stroke prediction and ways to prevent it. Users can fill out a form with their health details to get real-time stroke risk results using the connected API. A floating "Open Chatbot" button is available on the page, which opens a chatbot window when clicked. Users can ask stroke-related questions, check symptoms, and get tips for a healthy lifestyle. The chatbot uses the Google Gemini API to give smart and helpful replies in real time. It helps users understand their risks better and get suggestions for prevention based on medical insights. The interface is mobile-friendly, making it easy to use on smartphones and tablets. Regular updates are added to improve user experience and provide the latest health features.

7. RESULT & DISCUSSION

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df.head()
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	id	gender	age	hypertension	heart_disease	ever_married	work_type	Residence_type	avg_glucose_level	bmi	smoking_status	stroke
0	9046	Male	67.0	0	1	Yes	Private	Urban	228.69	36.6	formerly smoked	1
1	51676	Female	61.0	0	0	Yes	Self-employed	Rural	202.21	NaN	never smoked	1
2	31112	Male	80.0	0	1	Yes	Private	Rural	105.92	32.5	never smoked	1
3	60182	Female	49.0	0	0	Yes	Private	Urban	171.23	34.4	smokes	1
4	1665	Female	79.0	1	0	Yes	Self-employed	Rural	174.12	24.0	never smoked	1

Fig 7.1 Sample Data for Stroke Prediction Analysis

In Figure 7.1, this output shows the first five rows of a dataset for stroke prediction. It includes information like gender, age, hypertension, heart disease, marital status, work type, and living area (urban or rural). It also shows glucose level, BMI, smoking status, and whether the person had a stroke. This data will be used to predict stroke risk.

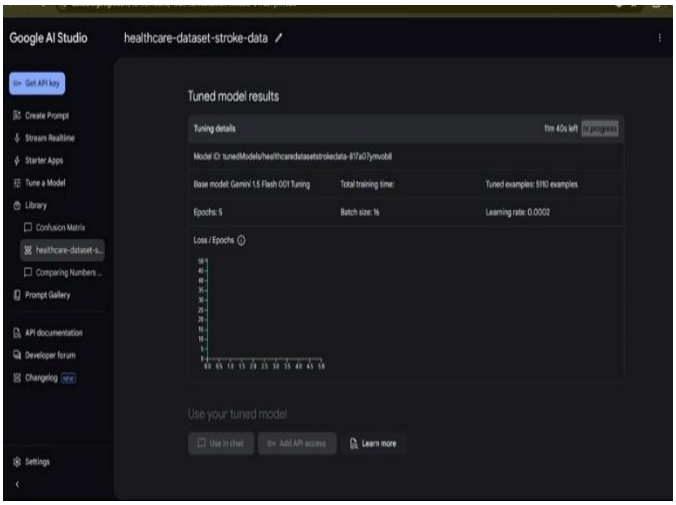

Fig 7.2 Model Tuning for Stroke Prediction Model in Google AI Studio

In Figure 7.2, the stroke risk prediction model is fine-tuned in Google AI Studio by adjusting hyperparameters using GridSearchCV. The model, which uses algorithms like Random Forest, undergoes a tuning process to optimize parameters such as the number of estimators, max depth, and learning rate. This helps enhance the model's ability to accurately predict stroke risk based on input features. The fine-tuning process systematically evaluates different parameter combinations to find the most effective configuration.

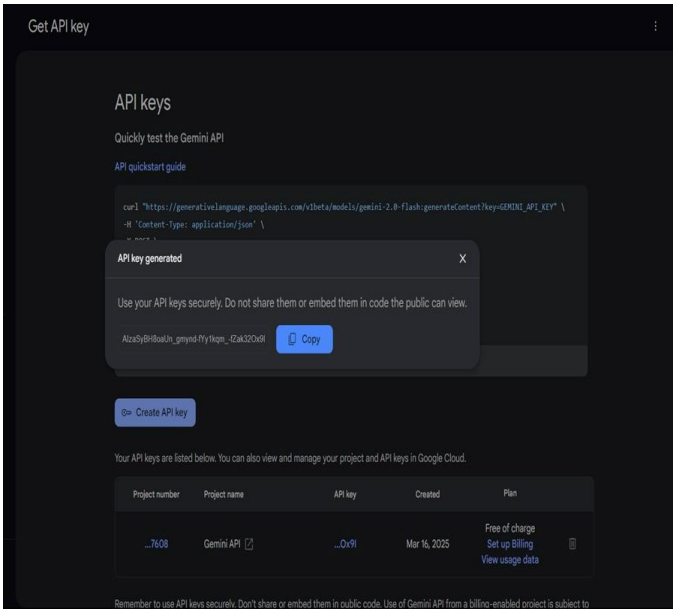

Figure 7.3 Model Deployment Using Google Gemini API

In Figure 7.3, this output shows the model deployment process using the Google Gemini API. The trained stroke risk prediction model is deployed as an API, allowing it to make real-time predictions by receiving patient data inputs. The deployment on Google Gemini ensures that the model is scalable, secure, and capable of handling multiple requests simultaneously from healthcare providers and other users. This integration allows seamless access to stroke risk assessments through web or mobile applications.

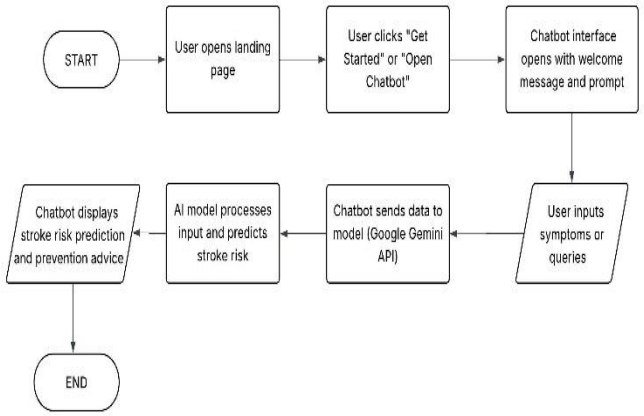

Figure 7.4 AI Stroke Detection Chatbot Flowchart

In Figure 7.4, This flowchart illustrates the working of an AI-powered stroke detection chatbot. The process begins when the user opens the landing page and clicks on “Get Started” or “Open Chatbot”. The chatbot interface loads with a welcome message, prompting the user to provide their symptoms or health queries. This input step is shown using a parallelogram, which represents user input. Once the user enters their data, the chatbot sends the input to the backend AI model, which is powered by Google Gemini API. The AI model analyzes the symptoms and predicts the risk of a stroke. The chatbot then displays the prediction along with relevant prevention advice, shown again in a parallelogram as it is an output step. Finally, the flow ends. The entire flow ensures a simple and user-friendly experience to guide users through early stroke risk detection and promote timely awareness.

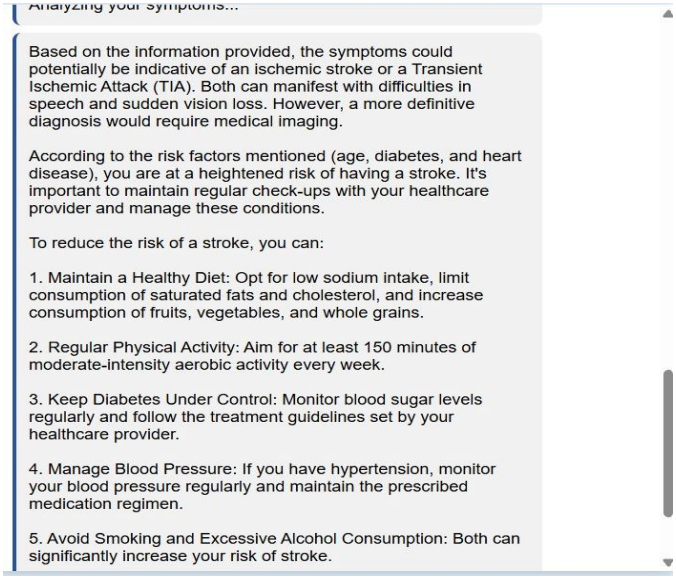

Figure 7.5 Stroke Risk Prediction and Prevention Advice by AI Chatbot

In Figure 7.5, the AI chatbot displays personalized stroke risk prevention advice based on the user’s stroke risk prediction score. The chatbot suggests lifestyle changes, such as improving diet, quitting smoking, or managing hypertension, depending on the individual’s risk profile. It acts as an interactive tool for helping patients understand their health status and take preventive action.

8. CONCLUSION

This model presents a stroke risk prediction system using Random Forest, Gradient Boosting, and Deep Learning, with Gemini API for NLP tasks. After completing data collection, preprocessing, training, and testing, Random Forest delivered the best accuracy and performance in identifying true stroke risk cases. The Gemini API enhanced the model through real-time chatbot interactions, allowing users to receive personalized stroke prevention tips and lifestyle guidance. Among all models, Random Forest proved most effective and reliable. The combined approach offers an efficient solution for early stroke prediction, supporting healthcare professionals with actionable insights to improve diagnosis, prevention, and patient outcomes.

9. FUTURE ENHANCEMENT

The stroke prediction system can be enhanced by adding multiple advanced features to improve its usability, accuracy, and reach. First, multi-language support can be added to the chatbot interface using the Google Gemini API. This allows users to interact in their preferred language, making the system more inclusive and user-friendly. Next, real-time health monitoring can be included by connecting with smartwatches or fitness bands. These devices can track vital signs like heart rate, blood pressure, and activity levels, helping the system provide timely alerts and early warnings. Telemedicine integration will enable users to share their health data and predictions with doctors directly through the system. This helps in remote consultations and personalized prevention plans. The system can also be made cross-platform compatible, so it works smoothly on mobiles, tablets, desktops, and web apps. This ensures users and doctors can access it anytime, anywhere. Lastly, a process for continuous model updates will keep the predictions accurate. The model can retrain regularly using new medical data, patient records, and research findings. This keeps the system current and improves its ability to detect stroke risk accurately over time.

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