Software Requirements Specification

for

Heart Stroke Assessment System

Version 2.0

Prepared by

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REVISIONS **II**

Revisions

Version	Primary Author(s)	Description of Version	Date Completed
Version 1	Shreyas Challa Shishir Challa Praneeth Dakoji B.N. Varun Nitish Reddy Nihaal Patnaik	Initial draft of SRS (HeartGuard) a Heart Stroke Risk Assessment System.	11/03/2025
Version 2	Shreyas Challa Shishir Challa Praneeth Dakoji B.N. Varun Nitish Reddy Nihaal Patnaik	Revised roles and added architecture diagram	5/05/2025

1 Introduction

1.1 Document Purpose

The purpose of this document is to provide a detailed description of 'Machine Learning-Based Heart Stroke Risk Assessment System'.This document provides a comprehensive understanding of the system's purpose, functionality, and constraints under which the system will operate. This document is intended for developers, testers, doctors, and professors.

1.2 Product Scope

The Machine Learning-Based Heart Stroke Risk Assessment System is a predictive analytics tool that evaluates stroke risk using machine learning models. The system is designed to assess stroke risk based on patient data, medical history, and lifestyle factors. It aims to enhance early detection by providing real-time risk assessments and personalized health recommendations.

1.3 Intended Audience and Document Overview

This document is intended for the individuals or family of individuals who are at risk of strokes, developers, and professors. For users, it is recommended to read the product overview and product functionalities. For developers, it is recommended to read the overall description, specific requirements, and other non-functional requirements sections. The rest of the document is organized in the following manner: 1. Overall Description - gives the product functionality, constraints under which it operates, and dependencies. 2. Specific Description - provides external interface and functional requirements. 3. Other Non-Functional Requirements - provides security and performance requirements along with quality attributes.

1.4 Definitions, Acronyms and Abbreviations

- *ABDM: Ayushman Bharat Digital Mission – A government initiative to integrate digital health infrastructure across India.*
- *API: Application Programming Interface – A set of functions and protocols that allow different software components to communicate.*
- *BP: Blood Pressure – The pressure of circulating blood on the walls of blood vessels.*
- *DPDP Act: Digital Personal Data Protection Act, 2023 – A law governing the collection, processing, and storage of personal data in India.*
- *EHR: Electronic Health Record – A digital version of a patient's paper chart that contains medical history, diagnoses, medications, and treatment plans.*
- *GDPR: General Data Protection Regulation – A data protection and privacy law applicable in the European Union.*
- *GUI: Graphical User Interface – A user interface that allows users to interact with the system through visual elements like buttons, icons, and menus.*
- *HDM Policy: Health Data Management Policy – A set of guidelines under ABDM to manage and protect health-related data.*
- *PCA: Principal Component Analysis – Used in feature extraction.*
- *OTP: One-Time Password – A single use password generated for user authentication.*

- *PII: Personally Identifiable Information – Any data that can identify a specific individual, such as name, address, and contact information.*
- *UI: User Interface – The point of interaction between a user and a digital device or application.*
- *URL: Uniform Resource Locator – The address used to access a web-based resource.*

1.5 Document Conventions

IEEE Standard for Software Requirements Specifications (IEEE 830-1998).

1.6 References and Acknowledgments

1. *IEEE 830-1998 Standard for SRS*
2. *Digital Personal Data Protection Act, 2023*
3. *American Heart Association Stroke Prevention Guidelines*

2 Overall Description

2.1 Product Overview

Machine Learning-Based Heart Stroke Risk Assessment System is a data-driven software system that takes patient health records and lifestyle information as inputs and estimates the chance of stroke occurrence. It employs machine learning algorithms to mark high-risk subjects and offer actionable insights for intervention at an early stage.

2.2 Product Functionality

The system will provide the following major functions:

1. *User Data Input: Enables users to input personal health records and lifestyle behaviors*
2. *Automated Risk Assessment: Applies machine learning algorithms to assess stroke likelihood.*
3. *Data Visualization: Presents risk levels in interactive charts and reports.*
4. *Sessions: A user accesses the service within a defined session. A session remains active as long as the user interacts with the website. If the user remains inactive for more than 2 minutes, the session automatically expires. Upon session expiration, the user is logged out and must authenticate again to initiate a new session.*
5. *Secure Database:*
6. *Secure User Authentication: Provides authorized access to sensitive health information.*

2.3 Design and Implementation Constraints

- *Regulations on Data Privacy: The system should conform to The Digital Personal Data Protection Act, 2023 (DPDP Act) and Health Data Management (HDM) Policy under the Ayushman Bharat Digital Mission (ABDM) to provide secure processing and storage of personal health data.*
- *Machine Learning Model Choice: Demands highly accurate and low-bias trained AI models.*
- *Computational Resources: AI-based predictions need adequate processing power.*

2.4 Assumptions and Dependencies

- *User Accessibility: The user will be provided with a computer or smartphone with an internet connection to use for entering health information and obtaining risk assessments.*
- *Data Availability: The system takes it for granted that current and accurate patient health information is available to input, either by user, or through linkage from healthcare databases.*
- *Machine Learning Model Updates: The models will require periodic retraining to stay accurate as new medical research and patient information become available.*
- *User Compliance: The system's effectiveness is based on the assumption that users will comply with the given preventive guidelines to lower their risk of stroke.*

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

User interface provides the following features:

- *Login/Sign-Up for Account: The users will have to sign up or log in with secure authentication (email or phone number).*
- *Medical Records Input: Users can enter their health information manually.*
- *Dashboards and Graphical Reports: An interactive dashboard will present stroke risk evaluations, sharing in the form of interactive charts, risk scores, and historical trends, enabling users to monitor their health over time.*
- *Personalized Recommendations: Depending on the risk assessment, the system will offer preventive healthcare advice, such as lifestyle changes, dietary recommendations, and medical consultations.*
- *Multi-Language Support: For accessibility, the interface will have support for several regional languages.*

3.1.2 Hardware Interfaces

- *Computing Devices: The system will be compatible with desktops, laptops, tablets, and smartphones (service must be accessed through a web application for any device)*
- *Local Servers: Depending on deployment, the system will either keep and process data in on-premises servers for hospitals.*

3.1.3 Software Interface

- *Machine Learning Model API: The predictive analytics engine will use trained machine learning models APIs for real-time predictions.*
- *User Authentication System: The system will interact with the authentication system for secure login into the account using password-based login and two-factor authentication.*
- *Data Storage and Management: The processed data will be stored in cloud-based services like Amazon S3 or Google Cloud Service.*
- *Notification and Alerts System: Alerts will be provided through email, SMS, WhatsApp or push notifications.*

3.2 Functional Requirements

3.2.1 User Registration and Login

- The system shall allow users to create a new account using their name, email, phone number, and password.
- The system shall allow existing users to log in using their registered email/phone number and password.
- The system shall support multi-factor authentication using OTP for enhanced security.

- The system shall allow users to recover forgotten passwords via email or SMS.

3.2.2 Health Data Input and Management

- The system shall allow users to input personal health information such as age, gender, blood pressure, cholesterol levels, smoking habits, and medical history.
- The system shall retrieve health data from Electronic Health Records (EHR) if available.
- The system shall allow users to update and delete their health records.

3.2.3 Stroke Risk Prediction

- The system shall apply machine learning models to predict the stroke risk based on the user's health data.
- The system shall display the predicted stroke risk in percentage along with a risk category (e.g., low, moderate, high).
- The system shall process the data within 5 seconds of input submission.

3.2.4 Personalized Recommendations

- The system shall generate personalized recommendations based on the stroke risk assessment.
- The system shall provide recommendations on lifestyle changes, medication adjustments, and exercise plans.

3.2.5 Doctor Review and Feedback

- The system shall allow doctors to review the stroke risk assessments and provide feedback.
- The system shall allow doctors to modify or approve the recommendations provided by the system.

3.2.6 Notifications and Alerts

- The system shall send notifications to users when new recommendations are available.
- The system shall send an emergency alert to the user and their doctor if a high stroke risk is detected.

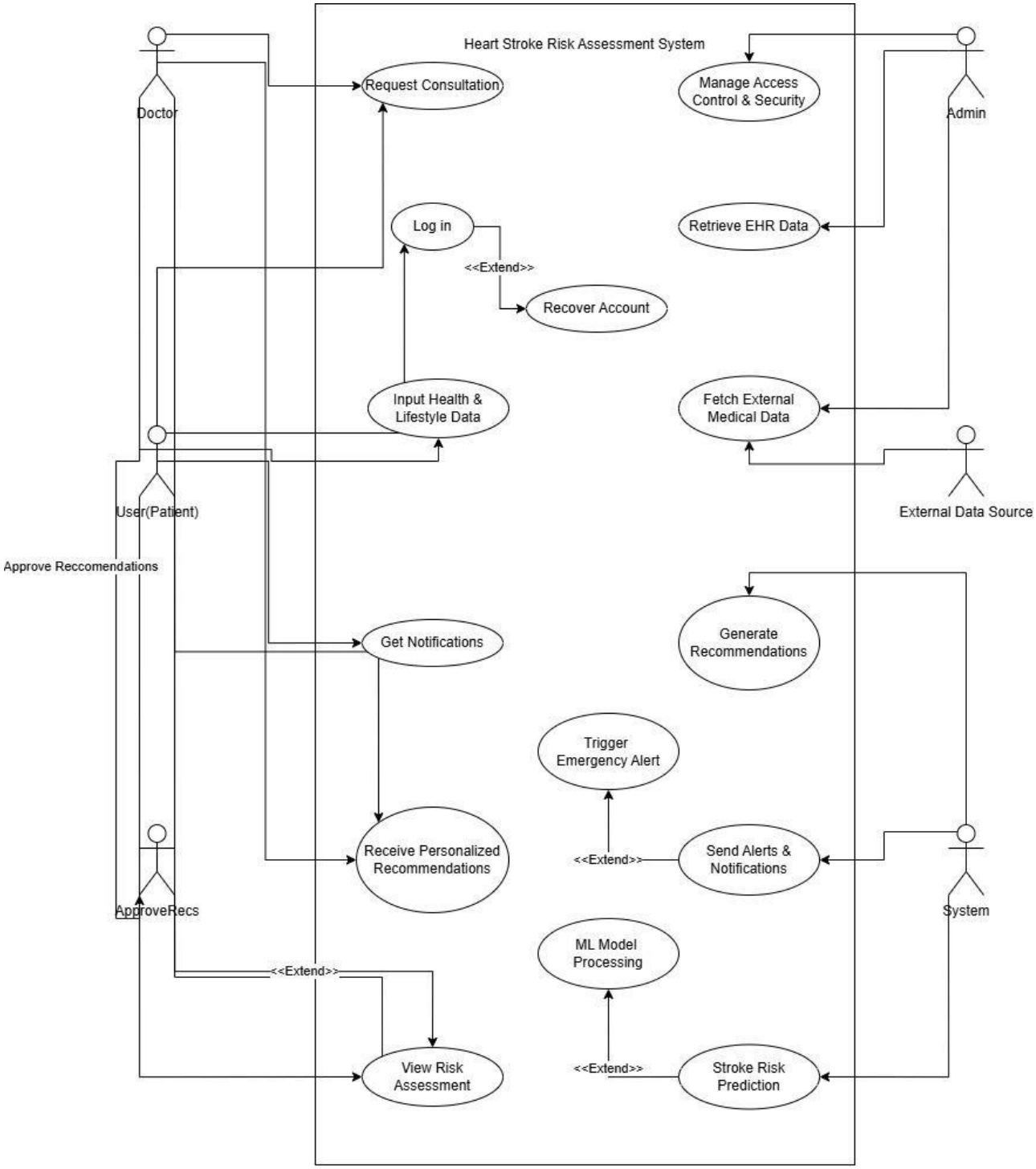
3.2.7 Security and Data Protection

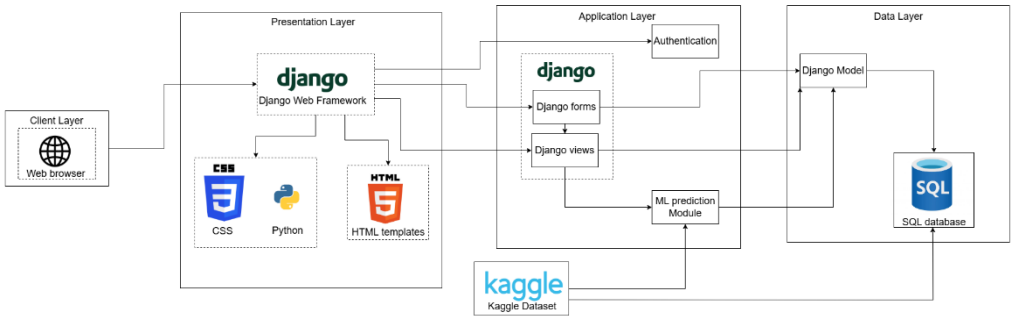
- The system shall encrypt all health data using AES-256 encryption.
- The system shall comply with DPDP Act, 2023 and ABDM guidelines for health data protection.
- The system shall implement role-based access control (RBAC) for data access and modification.

3.2.8 Multi-Language Support

- The system shall support multiple regional languages for improved user accessibility.

3.3 Use Case Model & Architecture Diagram





Use Case #1: User Registration and Login Author: Challa Shreyas Reddy

Purpose: The purpose of this use case is to enable users to create an account and log into the Heart Stroke Risk Assessment System securely. The system ensures that only authorized users can access their health data and receive personalized stroke risk assessments.

Requirements Traceability:

- The system shall allow users to create a new account using their name, email, phone number, and password.
- The system shall allow existing users to log in using their registered email/phone number and password.
- The system shall support multi-factor authentication using OTP for enhanced security.
- The system shall allow users to recover forgotten passwords via email or SMS.

Priority: High

Preconditions:

- The user must have a valid email address or phone number.
- The system must be operational and accessible.
- Internet connectivity must be available for email or SMS verification.

Postconditions:

- The user account is created successfully.
- The user is logged in and redirected to the dashboard.
- If login fails, the user is prompted with an error message and an option to recover their password.

Actors:

- User
- System
- OTP Verification Service

Extends:

- None

Flow of Events:

Basic Flow:

1. The user accesses the login/registration page.
2. If the user is new, they select "Sign Up" and enter their details (name, email, phone number, and password).
3. The system validates the input and sends an OTP to the user's email or phone.
4. The user enters the OTP, and the system verifies it.
5. Upon successful verification, the system creates the user account and logs them in.
6. If the user is existing, they enter their credentials (email/phone and password) on the login page.
7. The system verifies the credentials.
8. If credentials are correct, the user is logged in and redirected to the dashboard.

Alternative Flow:

- If the user enters incorrect credentials, an error message is displayed with an option to retry or recover their password.
- If the user does not receive the OTP, they can request a resend.
- If the password is forgotten, the user can select "Forgot Password" and receive a reset link via email or SMS.

Exceptions:

- If the system is down, an error message is displayed prompting the user to try again later.
- If the OTP verification fails more than three times, the account registration/login process is locked for security reasons.
- If the email or phone number is already in use, an appropriate message is displayed.

Includes:

- OTP Verification
- Password Recovery

Notes/Issues:

- Need to ensure OTP delivery service reliability.
- Consider implementing CAPTCHA to prevent bot sign-ups.
- Define session timeout policies for security.

3.3.2 Use Case #2: Input Health and Lifestyle Data

Author: Sesha Sai Dakoji Praneeth

Purpose:
To allow users to input their personal health and lifestyle information.

Requirements Traceability:

- F2: Health Data Input and Management

Priority: High

Preconditions:

- User must be logged into the system.

Postconditions:

- Health data is securely stored.
- Data is available for prediction processing.

Actors:

- User (Patient)
- System

Extends:

- None

Flow of Events:

Basic Flow:

1. User selects “Input Health Data” option.
2. System presents a form with fields for age, BP, smoking status, cholesterol, etc.
3. User fills out the form and submits it.
4. System validates and stores data securely.

Alternative Flow:

- If input is incomplete or invalid, the system shows an error message.

Exceptions:

- If the session times out, the user is prompted to log in again.

Includes:

- None

Notes/Issues:

- The system should validate user input in real-time to prevent submission of incomplete or invalid data.
- Health data is sensitive and needs to be encrypted during transmission and storage.
- The system should handle a large volume of user input without performance issues.
- If the session expires during data input, the user should be warned to save data.

3.3.3 Use Case #3: Stroke Risk Prediction

Author: B.Nihaal Patnaik

Purpose:
To calculate and display the stroke risk for the user.

Requirements Traceability:

- Stroke Risk Prediction

Priority: High

Preconditions:

- User must have logged in and provided health data.

Postconditions:

- Predicted stroke risk is displayed to the user.
- Risk data is stored for future analysis.

Actors:

- User (Patient)
- System

Extends:

- None

Flow of Events:

Basic Flow:

1. System retrieves health data from the user's record.
2. System processes data using the ML model.
3. System displays the predicted stroke risk.

Alternative Flow:

- If the prediction confidence is low, the system prompts the user to consult a doctor.

Exceptions:

- If the ML model fails, the system notifies the admin and falls back to previous data.

Includes:

- ML Model Processing

Notes/Issues:

- The ML model should be retrained regularly to improve prediction accuracy and reduce bias.
- The system should only present predictions if the model's confidence level is above a defined threshold (e.g., 80%).
- In case of ML model failure, a rule-based fallback system should be available.
- Ensure that health data used for prediction is consistent and up-to-date.

3.3.4 Use Case #4: Generate and Review Personalized Recommendations

Author: B.N Varun

Purpose:
To generate health recommendations based on the predicted stroke risk.

Requirements Traceability:

- Personalized Recommendations
- Doctor Review and Feedback

Priority: Medium

Preconditions:

- Stroke risk prediction must have been completed.

Postconditions:

- Recommendations are displayed to the user.
- Doctor feedback is recorded.

Actors:

- User (Patient)
- Doctor
- System

Extends:

- None

Flow of Events:
Basic Flow:

1. System generates recommendations based on stroke risk.
2. System displays recommendations to the user.
3. Doctor reviews the recommendations and approves them.

Alternative Flow:

- If the recommendation is incorrect, the doctor can modify it.

Exceptions:

- If the doctor is unavailable, the system marks the recommendation as pending.

Includes:

- Risk Prediction

Notes/Issues:

- The system should allow doctors to review and modify recommendations before they are sent to the user.
- Recommendations should be aligned with the user's health data and risk category.
- The system should allow users to provide feedback on recommendations to improve the model.
- Ensure that recommendations are available in multiple languages for better user accessibility.

3.3.5 Use Case #5: Send Emergency Alert

Author: Challa Shishir Reddy

Purpose:
To notify the user and doctor if the predicted stroke risk is high.

Requirements Traceability:

- Notifications and Alerts

Priority: High

Preconditions:

- Stroke risk prediction must exceed a defined threshold (e.g., 80%).

Postconditions:

- Emergency alert is sent to the user and doctor.
- Alert is logged for review.

Actors:

- User (Patient)
- Doctor
- System

Extends:

- None

Flow of Events:
Basic Flow:

1. System identifies high stroke risk based on ML model output.
2. System sends a high-priority alert to the user and their assigned doctor.
3. Doctor acknowledges the alert and takes action.

Alternative Flow:

- If the user or doctor is unavailable, the system retries after 30 seconds.

Exceptions:

- If the system fails to deliver the alert, it notifies the admin.

Includes:

- Stroke Risk Prediction

Notes/Issues:

- Emergency alerts should be sent through multiple channels (SMS, email, push notifications) to increase reliability.
- If the doctor does not respond within a defined time (e.g., 2 minutes), the system should escalate the alert.
- The system should minimize false positives by improving ML model accuracy.
- Emergency alerts should not expose sensitive health information to unauthorized recipients.

3.3.6 Use Case #6: View and Download Health Reports

Author: B.V.V Nitesh Reddy

Purpose:
To allow users to view and download their health reports, including stroke risk assessment results and recommendations, in a secure and accessible format.

Requirements Traceability:

- The system shall allow users to view their past stroke risk assessments and recommendations.
- The system shall allow users to download their health reports in PDF format.
- The system shall ensure that only authorized users can access their health reports.

Priority: High

Preconditions:

- The user must be logged into the system.
- The system must have stored at least one stroke risk prediction result for the user.

Postconditions:

- The user successfully views or downloads their health report.
- The downloaded report is formatted correctly and securely stored.

Actors:

- User (Patient)
- System

Extends: None

Flow of Events:
Basic Flow:

1. The user navigates to the "Health Reports" section.
2. The system displays a list of previous stroke risk assessments.
3. The user selects a specific report to view.
4. The system retrieves and displays the report details, including stroke risk percentage, health data, and recommendations.
5. The user selects the option to download the report.
6. The system generates a PDF version and provides a secure download link.

Alternative Flow:

- If the user has no previous reports, the system displays a message indicating that no reports are available.
- If the user cancels the download, they are returned to the reports page.

Exceptions:

- If the system fails to generate the PDF, an error message is displayed, and the user is asked to try again later.
- If the session expires before the report is generated, the user is prompted to log in again.

Includes:

- Stroke Risk Prediction
- Personalized Recommendations

Notes/Issues:

- The PDF report should be formatted in a user-friendly manner with clear charts and explanations.
- Reports should be encrypted and stored securely to prevent unauthorized access.
- The system should provide an option to email the report to the user upon request.

4 Other Non-functional Requirements

4.1 Performance Requirements

1. *Response Time: Since real-time analysis is an important factor for the effectiveness of the system, it must react to user input and output quickly (under a second)*
2. *Workload management: The system must operate properly even when a large number of people are using the system.*
3. *Resource Utilization: The system must efficiently use resources like CPU and memory.*

4.2 Safety and Security Requirements

1. Data Privacy and Protection

- *It will be DPDP Act, 2023 and Health Data Management (HDM) Policy compliant under Ayushman Bharat Digital Mission (ABDM) for secure storage and management of individual health data.*
- *All personal and health information will be encrypted with AES-256 encryption before storage and transmission.*
- *The system will never store any Personally Identifiable Information (PII) in plaintext.*
- *All data transmission over the network must be encrypted with SSL/TLS to avoid intercepts and tampering.*

2. Secure User Authentication

- *The system will also have multi-factor authentication (MFA) on user log-in, which includes:*
- *Password authentication*
- *OTP-based authentication through SMS or email*
- *The system will lock the user account for 5 consecutive failed attempts.*
- *The system will automatically log out users after 2 minutes of inactivity to avoid unauthorized access.*

3. Role-Based Access Control (RBAC)

- *The system will implement role-based access control to restrict the access of the users to sensitive information:*

- *User: Can see personal health information and advice.*
- *Doctor: May review and alter suggestions.*
- *Admin: Can set system settings and monitor performance.*
- *Licensed physicians and system administrators only will be able to view sensitive health information.*

4. Data Integrity and Availability

- *The system will save all information daily to avoid data loss.*
- *If the system fails, the system will recover data from the most recent backup in 5 minutes.*
- *The system will conduct regular integrity checks to detect and fix data corruption.*

5. Emergency Response and Alerts

- *The system will alert the user and their physician if there is a high risk of stroke.*
- *If the sending of an alert fails, the system will attempt to resend the notification after 30 seconds.*
- *If the emergency alert fails even after multiple attempts, the system will notify the system administrator of the same.*

6. Security for Mobile Access

- *System access by mobile shall be protected by:*
- *Biometric login (face ID or fingerprint) if supported by the device. Session expires after 2 minutes of inactivity. App sandboxing to keep sensitive health information separate from other apps.*

7. Compliance and Certifications

- *The system will meet the following security certifications: ISO/IEC 27001 – Information security management, HIPAA – Health Insurance Portability and Accountability Act compliance for protecting medical information.*

4.3 Software Quality Attributes

4.3.1 Reliability

- *The system will provide accurate stroke risk predictions with an 85% and higher confidence rate based on the machine learning model.*
- *The system would be made operational at 99.9% uptime to permit the doctors and patients to take advantage of the service without disturbances.*
- *If the ML model predicts incorrectly because of data problems, the system automatically alerts the admin and reverts to a default risk assessment algorithm after 5 seconds.*
- *Redundant storage of health data will be performed on multiple cloud servers to prevent loss of data in case of system failure.*

4.3.2 Accuracy

- *The machine learning model will be retrained every 30 days on the most recent medical data to guarantee that risk predictions are made using the most recent medical guidelines and research.*

- *The system should be at least 85% accurate for low-risk predictions and 90% for high-risk predictions.*
- *Cross-match with external medical research databases (e.g., American Heart Association guidelines) to minimize bias and false positives.*
- *In case the accuracy of the model falls below 80%, the system will alert the admin to retrain the model immediately.*

4.3.3 Security

- *All health records and personal information will be stored and transferred with AES-256 encryption.*
- *The system will comply with DPDP Act, 2023 and Health Data Management (HDM) Policy of ABDM to ensure patient data privacy.*
- *The system will have multi-factor authentication (MFA) support for safe user login.*
- *The system will log out automatically after 2 minutes of inactivity to avoid unauthorized access.*
- *Sensitive patient information will be released only to authorized healthcare professionals.*

4.3.5 Maintainability

- *Its codebase would be modular such that it's simple to modify and debug the system without its impact on the whole system.*
- *Any critical bug found in the production environment should be fixed within 24 hours of identification.*
- *The recommendation engine and machine learning model will give dynamic updates without system downtime.*
- *System logs and user activity reports need to be maintained for at least 6 months for audit and debugging.*

4.3.6 Adaptability

- *The system will also make provision for updating the stroke risk prediction model based on advancing medical research.*
- *The system will be trained to accommodate multiple user profiles (e.g., age, gender, medical history) to enhance prediction accuracy.*
- *The system will be capable of future development to evaluate risk for other cardiovascular diseases.*

5 Other Requirements

- *Integration with Healthcare Systems: Compatibility with current hospital management software. (This would require NLP on National Health Records)*

Appendix A – Data Dictionary

<Data dictionary is used to track all the different variables, states, and functional requirements that you described in your document. Make sure to include the complete list of all constants, state variables (and their possible states), inputs and outputs in a table. In the table, include the description of these items as well as all related operations and requirements.>

Appendix B - Group Log

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B.N. Varun, SE22UCSE042, Role: Frontend

Dakoji Sesha Sai Praneeth, SE22UCSE074, Role: Backend

Challa Shishir Reddy, SE22UCSE067, Role: Full Stack

B.V.V. Nitesh Reddy, SE22UCSE046, Role: Project Manager