### BATCH-3

### QUANTUM GDM

### S.R.S DOCUMENT

### | Version | Date | Description |

### | 1.0 | 29-08-2024 | Initial Draft of SRS Document |

## 1. Introduction

### 1.1 Purpose

The purpose of this Software Requirements Specification (SRS) document is to outline the functional and non-functional requirements for the development of a gestational diabetes prediction system using a Quantum Support Vector Machine (QSVM). The system will predict the likelihood of gestational diabetes in pregnant women based on a dataset containing 23,000 entries and 37 columns of clinical and demographic data. Additionally, the system will feature a module that predicts the potential development of type 2 diabetes based on the presence of gestational diabetes.

### 1.2 Scope

This project aims to utilize quantum support vector machines to enhance the accuracy of gestational diabetes prediction. The system will analyze various clinical and demographic factors from the GDM dataset to provide early predictions. The secondary module will extend the functionality to predict the future risk of type 2 diabetes in women who have had gestational diabetes. A user interface will be developed for the input of relevant parameters and the display of prediction outcomes.

### 1.3 Definitions, Acronyms, and Abbreviations

* **SRS**: Software Requirements Specification
* **QSVM**: Quantum Support Vector Machine
* **GDM**: Gestational Diabetes Mellitus
* **T2DM**: Type 2 Diabetes Mellitus
* **UI**: User Interface
* **AI**: Artificial Intelligence

### 1.4 References

* [1] Quantum Computing for Everyone, Michio Kaku
* [2] Research papers and articles from ResearchGate, Physics.org, etc.
* [3] IEEE Standard for Software Project Documentation

### 1.5 Overview

This document provides a comprehensive overview of the requirements for the gestational diabetes prediction system, including functional and non-functional requirements, interface specifications, and analysis models. It is intended for software developers, project managers, and other stakeholders involved in the project.

## 2. General Description

### 2.1 Product Perspective

The gestational diabetes prediction system is an advanced machine learning application that leverages quantum computing techniques, specifically quantum support vector machines, to deliver high-accuracy predictions. The system will be part of a broader healthcare analytics platform and is intended to be used by healthcare providers for early detection of gestational diabetes. A user interface will be developed to facilitate the input of patient data and display the prediction results.

### 2.2 Product Functions

* **Prediction of Gestational Diabetes**: The primary function of the system is to predict the likelihood of gestational diabetes in pregnant women using quantum support vector machines.
* **Future Risk Assessment**: The system will also include a module to predict the potential development of type 2 diabetes in women who have had gestational diabetes.
* **Data Management**: The system will manage and store patient data, including clinical and demographic information, securely and efficiently.
* **User Interface**: The system will provide a user-friendly interface for healthcare providers to input relevant parameters and view prediction results. The interface will allow users to enter features from the dataset (e.g., age, BMI, glucose levels) and obtain the probability of GDM.

### 2.5 Assumptions and Dependencies

* The accuracy of the predictions is dependent on the quality and quantity of the input data.
* The system assumes the availability of quantum computing resources for running the QSVM.
* The project is dependent on access to the GDM dataset for training and validation.
* The user interface will require a stable internet connection for communication with the backend processing unit.

## 3. Specific Requirements

### 3.1 External Interface Requirements

#### 3.1.1 User Interfaces

* **Input Form**: The UI will feature an input form where healthcare providers can enter patient data, including clinical and demographic factors such as age, BMI, glucose levels, etc.
* **Prediction Display**: The UI will display the prediction results, indicating the likelihood of GDM and, if applicable, the future risk of developing type 2 diabetes.
* **User Feedback**: The interface will provide visual feedback, such as color-coded risk indicators, to make the results easily interpretable.

#### 3.1.2 Hardware Interfaces

* The system will require quantum computing hardware to execute the quantum support vector machine algorithms.

#### 3.1.3 Software Interfaces

* The system will interface with healthcare data management systems to import patient data.
* Integration with quantum computing platforms such as IBM Quantum or Google Quantum AI.

#### 3.1.4 Communications Interfaces

* The system will use secure API protocols for communication between the user interface and the back-end processing unit.

### 3.2 Functional Requirements

#### 3.2.1 Prediction Algorithm Implementation

* **Methodology**: The system will implement a quantum support vector machine (QSVM) algorithm for predicting gestational diabetes. This involves leveraging the principles of quantum computing to enhance the accuracy and efficiency of support vector machines.
* The algorithm will be trained on the GDM dataset, which includes 23,000 entries and 37 columns of clinical and demographic factors relevant to gestational diabetes, such as age, BMI, glucose levels, blood pressure, and more.

#### 3.2.2 Future Risk Module

* **Methodology**: The future risk assessment module will extend the QSVM to evaluate the potential for developing type 2 diabetes based on historical data and the initial GDM prediction. This module will utilize advanced machine learning techniques and quantum algorithms to assess long-term risk factors.
* The module will provide additional insights into the likelihood of developing T2DM in the future, helping in proactive healthcare planning.

### 3.5 Non-Functional Requirements

#### 3.5.1 Performance

* **Response Time**: The system must provide predictions in less than 5 seconds, ensuring that users receive results promptly. This is crucial for real-time applications in clinical settings where quick decision-making is essential.
* **Throughput**: The system should be capable of processing multiple prediction requests concurrently without significant degradation in performance. It should handle at least 100 simultaneous users with a consistent response time.
* **Scalability**: The system should be designed to scale horizontally, meaning it can accommodate increased load by adding more computational resources, particularly for the quantum computing back-end.

#### 3.5.2 Reliability

* **System Uptime**: The system must maintain an uptime of 99.9%, meaning it should be available for use with minimal downtime. This includes ensuring that the quantum computing resources are reliable and accessible when needed.
* **Fault Tolerance**: The system should be able to handle failures gracefully. For example, if the quantum computing platform is temporarily unavailable, the system should either queue the request or fallback to a classical algorithm with a clear notification to the user.
* **Data Consistency**: The system must ensure that all patient data is processed accurately and consistently across all modules, without data loss or corruption.

#### 3.5.3 Availability

* **Global Access**: The system should be accessible to healthcare providers 24/7, with no restrictions on time zones or geographic locations. This is essential for a global healthcare application.
* **Redundancy**: To ensure high availability, the system should employ redundant servers and quantum computing resources. This includes having backup servers in different locations to prevent service disruptions due to local issues.

#### 3.5.4 Security

* **Data Encryption**: All patient data, both in transit and at rest, must be encrypted using industry-standard encryption protocols (e.g., AES-256). This ensures that sensitive information is protected from unauthorized access.
* **User Authentication**: The system must implement strong user authentication mechanisms, such as multi-factor authentication (MFA), to prevent unauthorized access to the system.
* **Access Control**: Role-based access control (RBAC) should be implemented to restrict access to certain features and data based on the user's role (e.g., doctor, admin, researcher).
* **Audit Trails**: The system must log all user activities, including data access and modifications, to provide a comprehensive audit trail for security monitoring and compliance purposes.

#### 3.5.5 Maintainability

* **Modular Design**: The system should be designed with a modular architecture, where each component (e.g., UI, QSVM algorithm, risk assessment module) can be developed, tested, and maintained independently. This facilitates easier updates and modifications.
* **Documentation**: Comprehensive documentation should be provided for each module, including the codebase, APIs, and system configurations. This documentation should be kept up-to-date to assist developers in maintaining and enhancing the system.
* **Automated Testing**: The system should include automated testing frameworks to ensure that new updates do not introduce bugs or regressions. Continuous integration/continuous deployment (CI/CD) pipelines should be employed to streamline the deployment process.

#### 3.5.6 Portability

* **Cross-Platform Compatibility**: The system should be portable across different quantum computing platforms (e.g., IBM Quantum, Google Quantum AI) without requiring significant modifications to the codebase. This ensures that the system is not tied to a specific vendor.
* **Operating System Independence**: The system should be compatible with various operating systems, including Windows, macOS, and Linux, to accommodate different user environments.
* **Data Portability**: The system should support exporting and importing data in standardized formats (e.g., CSV, JSON) to facilitate integration with other healthcare systems.

### 3.6 Future Enhancements

* **Integration with Wearable Devices**: Future enhancements could include integrating the system with wearable health devices (e.g., smartwatches) to gather real-time health metrics, providing more accurate and timely predictions.
* **Machine Learning Model Update**: As more data becomes available, the machine learning models should be periodically retrained and updated to improve prediction accuracy and adapt to changing patterns in gestational diabetes incidence.

## 4. Conclusion

The gestational diabetes prediction system aims to leverage the power of quantum computing to enhance the accuracy and efficiency of predicting gestational diabetes and assessing the future risk of type 2 diabetes. This document outlines the key requirements, features, and considerations for developing a robust and effective system that meets the needs of healthcare providers and patients alike.