1. **Introduction**
   1. **Purpose**

The purpose of this document is to specify the software requirements for the Autism Spectrum Disorder (ASD) Prediction System. This system aims to facilitate early diagnosis and intervention for ASD by providing a preliminary risk assessment based on responses to the Q-CHAT-10 questionnaire and storing patient data in individualized profiles.

* 1. **Scope**

The ASD Prediction System will collect and process Q-CHAT-10 responses to predict the likelihood of ASD in toddlers. It will include data preprocessing, machine learning techniques, a user-friendly interface, and integration for clinical use. The system will support healthcare professionals by supplementing traditional diagnostic methods and maintain patient profiles that contain risk assessments and treatment suggestions to both healthcare providers and parents of the patient.

* 1. **Definitions, Acronyms, Abbreviations**

**ASD**: Autism Spectrum Disorder

**Q-CHAT-10**: Quantitative Checklist for Autism in Toddlers (10 questions)

**ML**: Machine Learning

**EHR**: Electronic Health Record

* 1. **References**
  2. **Overview**

This document includes the overall description of the ASD Prediction System, specific requirements, system features, external interface requirements, and other non-functional requirements

1. **Overall Descriptions**
   1. **Product Perspective**

The ASD Prediction System is an independent tool designed to integrate seamlessly into existing clinical workflows. It utilizes machine learning algorithms to analyze Q-CHAT-10 responses, providing a risk assessment score for ASD and storing patient data in individualized profiles accessible to both healthcare providers and parents.

* 1. **Product Functions**
     1. Collect Q-CHAT-10 response data from users.
     2. Preprocess and normalize the data for analysis.
     3. Train and validate machine learning models to predict ASD risk.
     4. Provide a risk assessment score and recommendations.
     5. Store patient data in individualized profiles.
     6. Offer a user-friendly interface for healthcare professionals and parents.
     7. Provide access to patient profiles for both healthcare providers and parents.
  2. User Classes and Characteristics
     1. **Healthcare Professionals**: Primary users who will input Q-CHAT-10 data, interpret the risk assessment scores, and access patient profiles.
     2. **Parents**: Users who will view the risk assessment scores and treatment suggestions in their child's profile.
     3. **Data Scientists**: Users involved in model training, validation, and system maintenance.
     4. **System Administrators**: Users responsible for system deployment, integration, and support.
  3. Operating Environment

The system will operate in a secure, cloud-based environment accessible via web browsers. It must comply with healthcare data privacy standards such as HIPAA.

* 1. Design and Implementation Constraints
     1. Compliance with data privacy regulations.
     2. Scalability to handle large datasets.
     3. Integration with existing electronic health record (EHR) systems.
  2. Assumptions and Dependencies
     1. Reliable internet connectivity for data collection and system access.
     2. Accurate and complete Q-CHAT-10 responses from users.
     3. Continuous collaboration with clinical experts for system validation.

1. Specific Requirements
   1. Functional Requirements
      1. Data Collection

FR1.1: The system shall provide a secure web interface for healthcare professionals to input Q-CHAT-10 responses.

FR1.2: The system shall validate the completeness and correctness of the input data.

* + 1. Data Preprocessing

FR2.1: The system shall preprocess collected data to handle missing values and outliers.

FR2.2: The system shall normalize and encode the data for machine learning compatibility.

* + 1. Model Development

FR3.1: The system shall implement multiple machine learning algorithms for model development.

FR3.2: The system shall train the models using the preprocessed dataset.

FR3.3: The system shall evaluate model performance using accuracy, sensitivity, and specificity metrics.

* + 1. Risk Assessment

FR4.1: The system shall generate a risk assessment score based on the model’s prediction.

FR4.2: The system shall provide recommendations for further evaluation based on the risk score.

* + 1. User Interface

FR5.1: The system shall offer a user-friendly interface for data input and result interpretation.

FR5.2: The interface shall display risk assessment scores and recommendations clearly.

* + 1. System Integration

FR6.1: The system shall integrate with existing EHR systems to import/export data.

FR6.2: The system shall ensure secure data transfer between the prediction system and EHR systems.

* + 1. Patient Profiles

FR7.1: The system shall create and store individualized patient profiles containing Q-CHAT-10 responses, risk assessment scores, and treatment suggestions.

FR7.2: The system shall provide access to patient profiles for both healthcare providers and parents.

FR7.3: The system shall ensure that parents can view but not modify the risk assessment and treatment suggestions in the profiles.

FR7.4: The system shall allow healthcare providers to update and manage patient profiles.

* 1. Non-Functional Requirements
     1. Performance Requirements

NFR1.1: The system shall respond to user inputs within 2 seconds.

NFR1.2: The system shall process and display risk assessment scores within 5 seconds after data submission.

* + 1. Security Requirements

NFR2.1: The system shall comply with HIPAA and other relevant healthcare data privacy regulations.

NFR2.2: The system shall ensure data encryption during transmission and storage.

* + 1. Usability Requirements

NFR3.1: The system shall provide an intuitive interface accessible to users with basic computer skills.

NFR3.2: The system shall offer online help and documentation to assist users.

* + 1. Reliability Requirements

NFR4.1: The system shall have an uptime of 99.9%.

NFR4.2: The system shall include backup and recovery mechanisms to prevent data loss.

* 1. External Interface Requirements
     1. User Interfaces
        1. The system will have a web-based interface accessible via major web browsers (Chrome, Firefox, Safari).
     2. Hardware Interfaces
        1. No specific hardware interfaces are required beyond standard computing devices (PCs, tablets).
     3. Software Interfaces
        1. Integration with EHR systems through standardized APIs.
        2. Compatibility with common data formats (CSV, JSON).
     4. Communication Interfaces
        1. HTTPS for secure web communication.
        2. Standard API protocols (RESTful API).

1. System Features
   1. Feature: Data Input

Description: Users can input Q-CHAT-10 responses through a secure web form.

Priority: High

* 1. Feature: Data Preprocessing

Description: The system preprocesses data to prepare it for analysis.

Priority: High

* 1. Feature: Machine Learning Model

Description: The system trains and validates a machine learning model to predict ASD risk.

Priority: High

* 1. Feature: Risk Assessment

Description: The system generates and displays a risk assessment score with recommendations.

Priority: High

* 1. Feature: User Interface

Description: The system provides a user-friendly interface for data input and result interpretation.

Priority: High

* 1. Feature: System Integration

Description: The system integrates with existing EHR systems for data interoperability.

Priority: Medium

* 1. Feature: Patient Profiles

Description: The system stores patient data in individualized profiles accessible to both healthcare providers and parents, containing risk assessment scores and treatment suggestions.

Priority: High

1. Other Non-Functional Requirements
   1. Performance

NFR1.1: The system shall handle up to 1,000 concurrent users without performance degradation.

* 1. Security

NFR2.1: The system shall implement multi-factor authentication for user access.

* 1. Usability

NFR3.1: The system shall include a guided walkthrough for new users.

* 1. Reliability

NFR4.1: The system shall log all user activities for auditing purposes.

1. 6. Appendices
   1. Appendix A: Glossary
      1. Q-CHAT-10: A screening tool consisting of 10 questions used to identify early signs of autism in toddlers.
      2. ASD: Autism Spectrum Disorder, a developmental disorder characterized by difficulties with social interaction and communication.
   2. Appendix B: Analysis Models
      1. Data Flow Diagram: Illustrates the flow of data within the system.
      2. Use Case Diagram: Depicts the interactions between users and the system.