

SRS for Minor Project-II

Title Of Project: Autism Spectrum Disorder Detection with Explainable AI
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1. Introduction

1.1 Purpose

The purpose of this project is to provide an intelligent tool for identifying Autism Spectrum Disorder at an early stage. Early detection is crucial for timely intervention, which can significantly improve developmental outcomes. Key objectives include:

- **Accurate Prediction:** A machine learning-based model predicts ASD likelihood based on user-provided behavioral traits.
- **Guidance:** Actionable recommendations for caregivers and professionals.
- **Transparency:** Explainable AI ensures the prediction process is clear and trustworthy.
- **Awareness:** Educates users about ASD and its signs through an interactive platform.

ASDInsight aims to bridge the gap between technology and healthcare, enabling data-driven decisions for better outcomes.

1.2 Scope

ASDInsight focuses on the following functionalities:

1. **ASD Prediction:**
 - Users complete a questionnaire about behavioral traits (e.g., social interaction, communication, repetitive behavior).
 - A trained Random Forest model processes the data to provide predictions.
2. **Explainable AI (XAI):**
 - SHAP (SHapley Additive exPlanations) is used to explain the predictions, highlighting key behavioral traits influencing the results.
3. **Personalized Recommendations:**

- Based on prediction results, the platform offers tailored advice, such as consulting a specialist or engaging in therapy.
4. Educational Content:
- Provides information about ASD and its symptoms.
 - Explains the science behind the platform's prediction model.
5. Future Enhancements:
- Multi-language support for broader accessibility.
 - Chatbot for instant support.
 - Progress tracking to monitor behavioral improvements over time.

The platform serves caregivers, educators, and healthcare professionals seeking data-driven insights into ASD.

1.3 Definitions, Acronyms, and Abbreviations

- **ASD:** Autism Spectrum Disorder – A developmental condition affecting communication, behavior, and social interaction.
- **XAI:** Explainable Artificial Intelligence – Techniques to make AI predictions interpretable.
- **SHAP:** SHapley Additive exPlanations – A method for understanding feature importance in AI predictions.
- **Behavioral Data:** Information about individual traits and habits used for analysis.

1.4 Overview

ASDInsight integrates machine learning and Explainable AI to provide a streamlined process for ASD prediction and support. Users begin by completing a behavioral questionnaire on the Prediction Page, where data is processed by the Random Forest model. Results, accompanied by SHAP-based explanations, are displayed on the Recommendation Page, highlighting influential traits and offering personalized advice.

The About Page educates users about ASD, while planned features such as multi-language support and progress tracking aim to enhance accessibility and usability. Through this approach, ASDInsight bridges the gap between technology and healthcare, fostering early detection and actionable intervention strategies.

2. Overall Description

2.1 Product Perspective

ASDInsight is a web-based platform designed to bridge the gap between technology and healthcare by facilitating early detection of Autism Spectrum Disorder (ASD). It uses machine learning (Random Forest) to predict the likelihood of ASD based on behavioral data and integrates Explainable AI (SHAP) to ensure transparency. The platform is built to assist caregivers, educators, and healthcare professionals in identifying ASD at an early stage and provides tailored recommendations for intervention.

This product represents an innovative tool in the healthcare domain, combining data science and AI to improve the accuracy and accessibility of early diagnosis

2.2 Product Functions

The core functionalities of ASDInsight include:

1. **Prediction:**
 - Allows users to input behavioral data through a questionnaire.
 - Predicts the likelihood of ASD using a trained Random Forest model.
2. **Explainable AI (XAI):**
 - Uses SHAP to provide detailed explanations of predictions.
 - Highlights influential traits contributing to the results.
3. **Recommendations:**
 - Offers actionable advice based on predictions, such as consulting specialists or engaging in therapy.
4. **Education:**
 - Provides information about ASD, its symptoms, and the science behind the platform's model.

2.3 User Classes and Characteristics

ASDInsight is designed for the following user groups:

1. **Caregivers:**
 - Parents or guardians seeking early detection for their child.
 - Require a simple interface and easy-to-understand recommendations.
2. **Educators:**
 - Teachers and school counselors identifying behavioral traits in students.
 - Need clear explanations and actionable insights.
3. **Healthcare Professionals:**
 - Doctors, therapists, and psychologists using predictions as part of broader diagnostic assessments.
 - Require detailed explanations of model predictions and visualizations.

2.4 Operating Environment

ASDInsight is a web-based application that operates in the following environment:

1. **Browser Compatibility:**
 - Compatible with modern web browsers (Chrome, Firefox, Safari, Edge).
2. **Device Support:**
 - Accessible on desktops, laptops, tablets, and mobile devices.
3. **Server Requirements:**

- Backend hosted on a cloud server, such as AWS or Google Cloud, for scalability and security.

4. **Data Storage:**

- Behavioral data and prediction results stored in a secure database.

2.5 Design and Implementation Constraints

- **Model Accuracy:**

The Random Forest model must be thoroughly validated to minimize false positives/negatives.

- **Processing Time:**

Predictions and recommendations must be generated quickly for seamless user experience.

2.6 User Interface

The user interface is designed to be intuitive and accessible:

1. **Home Page:**

- Brief introduction to the platform with navigation links.

2. **Prediction Page:**

- Form for behavioral data input.
- Submit button to process predictions.

3. **Recommendation Page:**

- Displays prediction results with SHAP-based explanations.
- Provides actionable advice and an option to download a report.

4. **About Page:**

- Educates users about ASD and the science behind the platform.

2.7 Assumption and Dependencies

The implementation of **ASDInsight** depends on the following:

1. **Data Availability:**

- The model requires a high-quality behavioral dataset for training and validation.

2. **Internet Connectivity:**

- Users need stable internet access to use the platform.

3. **Third-Party Tools:**

- Dependencies include Python libraries (e.g., scikit-learn, SHAP), web frameworks (e.g., Flask/Django), and visualization libraries (e.g., Matplotlib, Plotly).

4. **User Input:**

- Assumes users provide accurate and complete behavioral data for reliable predictions.

3. Functional Requirements

3.1 Introduction

The functional requirements of ASDInsight ensure the platform operates effectively, delivering accurate predictions, clear explanations, and actionable recommendations for Autism Spectrum Disorder (ASD). These requirements focus on user interaction, backend functionality, and integration with external tools.

3.2 Functional Requirements

1. **Behavioral Data Input:**
 - Provide an intuitive form for users to input behavioral traits.
2. **Prediction Engine:**
 - Process input data using a Random Forest model to predict ASD likelihood.
3. **Explainable AI (XAI):**
 - Generate SHAP-based feature importance to explain predictions.
4. **Recommendations:**
 - Offer personalized advice based on prediction results.
5. **User Reports:**
 - Enable users to download detailed prediction reports.

3.3 External Interface

1. **Frontend:**
 - Web interface using HTML, CSS, and JavaScript for seamless interaction.
2. **Backend:**
 - Flask/Django for data processing and model integration.
3. **Database:**
 - Secure storage for user inputs and predictions.
4. **Third-Party APIs:**
 - Utilize APIs for chatbot and visualization functionalities

4. Interface Requirements

4.1 User Interfaces

Web Interface:

- A clean, user-friendly interface with intuitive navigation.
- Pages include: Home, About, Prediction, Recommendations, and Chatbot.
- Hover effects and responsive design for seamless use across devices.
- Visual elements such as graphs, charts, and SHAP-based explanations to present results.

- Accessible features like multi-language support and tooltips.

4.2 Hardware Interfaces

Compatible with standard devices, including:

- **Desktop/Laptops:** Requires a basic processor and minimum 2GB RAM.
- **Mobile/Tablets:** Responsive design ensures functionality on smaller screens.
- **Internet Connection:** Required for accessing the web application and sending data.

4.3 Software Interfaces

- **Frontend:**
 - Built using HTML, CSS, JavaScript, and frameworks like React/Bootstrap.
- **Backend:**
 - Flask/Django handles user data, prediction processing, and APIs.
- **Machine Learning Model:**
 - Trained Random Forest model integrated with Python libraries.
- **Database:**
 - Uses MySQL/PostgreSQL for secure data storage and retrieval.
- **APIs:**
 - Third-party APIs for chatbot and data visualization tools like Plotly.

4.4 Communication Interfaces

- **Client-Server Communication:**
 - HTTP/HTTPS protocols for secure data exchange.
- **APIs:**
 - REST APIs for frontend-backend integration and third-party services.
- **Realtime Interaction:**
 - Live chatbot conversations and dynamic updates.

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