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Autism Spectrum Disorder Recognition with AI-Powered Model

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Abstract

The neurodevelopmental disorder known as the autism spectrum disorder (ASD) has a major influence on social interaction, communication, and behavioral reactions. Early detection is critical to enable timely intervention and improve longterm outcomes. A machine learning framework using a support 2 vector machine (SVM) classifier is presented in this work for the ASD prediction based on behavioral and diagnostic features. To maximize model performance, the dataset was preprocessed using feature selection, cleaning, and normalization.Implementation was carried out in Python using scikit-learn, pandas, and NumPy, followed by deployment through a Streamlit interface for real-time screening. The framework underscores the potential of AI-assisted tools in supporting healthcare professionals and caregivers for faster and more efficient ASD screening.Ongoing effort will be directed toward extending the present study into validation with larger and more diverse datasets, in contrast with the other classification algorithms, and evaluation of its long-term clinical applicability.

Keywords: Autism spectrum disorder, support vector machine, scikit learn, numpy, machine learning, neurodevelopmental

1. Introduction

ASD is a developmental condition that involves difficulties in the communication, social interaction, and patterns of restricted or repetitive behaviors that can be seen in a children. The increasing number of ASD cases worldwide has led to a greater need for the tools that enable early and accurate diagnosis. Identifying the ASD at an early stage can lead to more effective support, which helps improve developmental progress and long-term results. Traditional diagnostic methods are usually time-consuming, expensive, and depend on expert evaluations, making them difficult to access in many regions. Therefore, integrating Artificial Intelligence (AI) and Machine Learning (ML) into healthcare has become a promising approach to assist doctors and caregivers in detecting and monitoring ASD.

Machine learning techniques have been leveraged to various medical diagnostic fields during the last ten years.These models offer strong, data-driven insights that help improve clinical judgment. For autism spectrum disorder (ASD), these methods can assess behavioral and diagnostic characteristics to estimate the likelihood of the condition in children, thereby reducing the need for extensive manual evaluations. Support vector machines(SVMs)are Acknowledged as widely preferred algorithms for the binary classification.tasks, making them a suitable option for predicting ASD.

This research will present a unified platform enabling machine learning processes makes use of an SVM classifier to forecast ASD in children using a publicly accessible dataset. The dataset underwent several preprocessing stages, such as cleaning, normalization, and encoding, followed by feature selection to identify the most significant indicators. The model was trained and evaluated with standard performance metrics and subsequently deployed through a Streamlit-based web application to enhance accessibility. The proposed system demonstrates not only robust predictive abilities but also offers an interactive interface that can function as an important healthcare tool for 2professionals and caregivers in their decision-making process.

2. Literature Review

The integration of computational intelligence to diagnose autism spectrum disorder(ASD)has garnered a broad spectrum of attention in the recent years. Although the Autism Diagnostic interviewRevised (ADI-R) and the Autism Diagnostic oberservation Schedule(ADOS) are still the gold standards in clinical practice, these tests requires prolonged execution time and money, and the outcomes may differ based on the assessor[1]. This has prompted researchers to use machine learning (ML)-based screening and early detection methods to improve conventional psychology-based diagnoses. The application of traditional machine learning algorithms to datasets pertaining to autism spectrum disorder (ASD) has been the focus of the several studies. Some of the representative algorithms namely Random forests ,Decision Trees, Naïve Bayes, and SVM-based approach, for instance, have proven to be successful in distinguishing between situations that are ASD-positive and those who aren't. Interestingly, SVM is especially robust.

Researchers have also explored the deep learning techinques for predicting the Autism Spectrum Disorder(ASD).Heinseld et al.[4]utilized deep neural networks(DNNs)with the Autism Brain imaging Data Exchange (ABIDE)dataset and achieved high precision in distinguishing between ASD and control groups. Convolutional Neural Networks (CNNs) have been utilized to identify intricate patterns in behavioral and neuroimaging data.Nevertheless,these approaches typically require large datasets and substantial computational resourses[5].

Researchers' interest in improving predictive models' usability in real-world settings has grown recently..They have proposed interactive platforms and online interfaces that enable clinicians and caregivers to utilize machine learning models[6].These tools bridge the gap between algorithm development and clinical application by offering userfriendly interfaces for prediction and visualization.

3. Problem Statement and Objectives

A. Problem

ASD diagnosis is often slow and costly,limiting the early intervention. This work proposes an SVM-based web tool for fast and accessible ASD screening

B. Objectives

*a)*To construct an SVM-based classifier model that is capable of making accurate predictions on Autism Spectrum Disorder (ASD).

*b)*To improve the dataset's quality through preprocessing and feature analysis to boost predictive accuracy.

c) 3.To build a responsive and intuitive web interface with Streamlit that allows clinicians and caregivers easy access to ASD predictions.

4. Methodology

A. Acquisition of Datasets ASD-related behavioral and diagnostic datasets were gathered from openly accessible databases. Features like communication abilities, social interaction patterns, and repetitive behaviors were all included in the data.

B. Preparing Data The dataset was meticulously cleansed of missing and inconsistent values. To align all features on a consistent scale, normalization techniques were used. The most important characteristics influencing the prediction of ASD were found using feature selection techniques.

C. Development of Models Because of notable effectiveness in addressing problems characterized by the binary classification, A classifier using support vector Machines(SVM)was used. The preprocessed dataset was utilized for model training with various kernel functions, and hyperparameters were adjusted to increase accuracy.

D. Tools for Implementation we use machine learning libraries like scikit-learn, pandas, and NumPy were used to implement the framework in Python

E. Implementation of the System To enable real-time interaction, a user interface was created with Streamlit. The system would instantly produce predictions based on behavioral data entered by users.

F. Assessment of Performance include common measurements such as recall,accuracy and precision, and specificity were deployed to validate the trained model. ROC curves and confusion matrices were created to highlight the classifier's benefits and drawbacks.

G. upcoming improvements by using bigger and more varied datasets,experimenting with deep learning methods and verifying the framework in clinical settings,the methodology can be expanded.

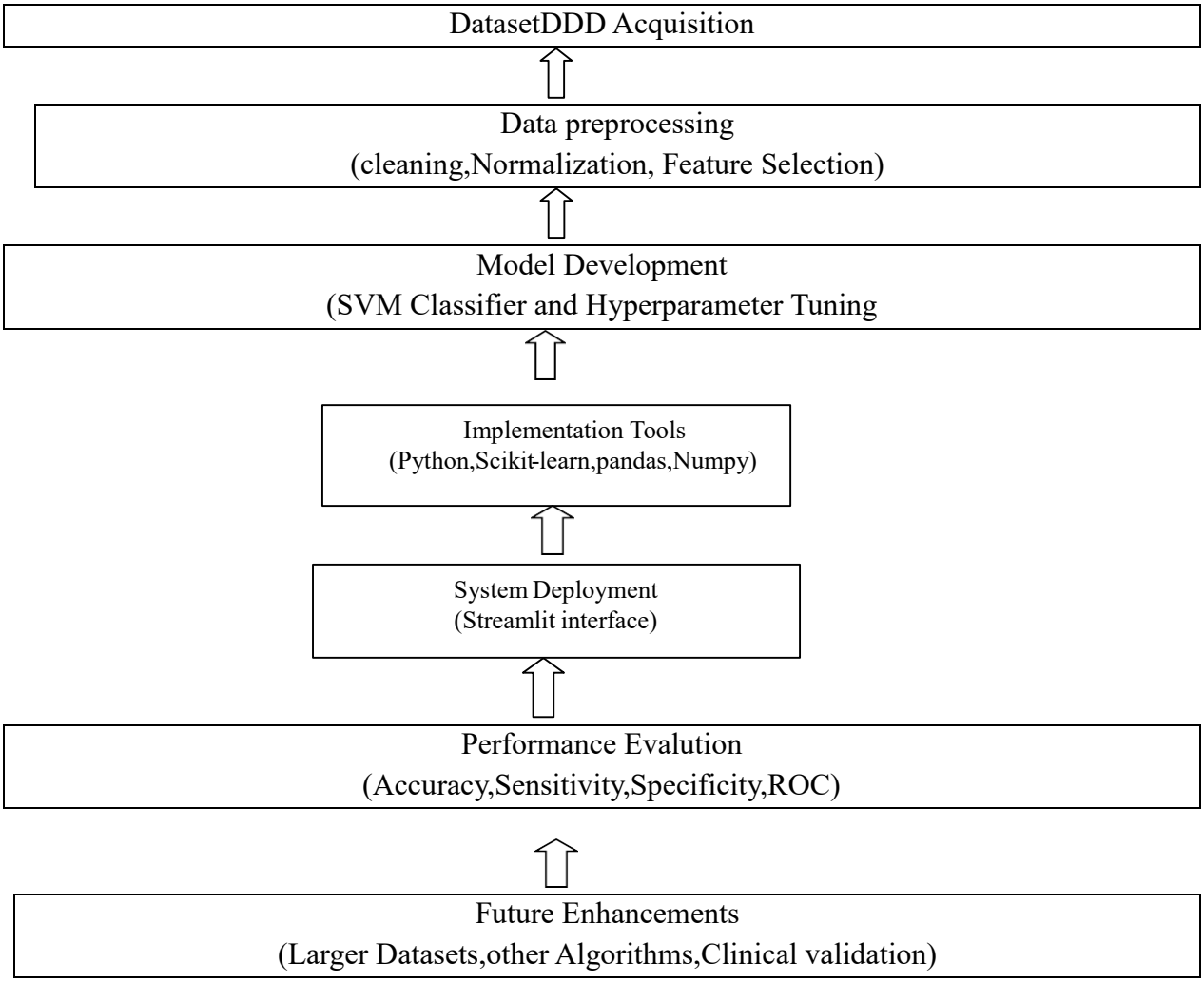

Fig 1. System design methodology for ASD detection using SVM

5. Results and Assessment

The Following feature selection and preprocessing, the experimental study assessed three machine learning classifiers on the ASD dataset: Random Forest (RF), Support Vector Machine (SVM), and Logistic Regression (LR). To maintain class balance, stratified sampling was used to test each model on 20% of the data after it had been trained on 80% of it.

A. Performance metrics

Frequently employed metrics for binary classification were used in the evaluation: The total percentage of accurate forecasts is known as accuracy. Precision measures the proportion of accurately predicted ASD cases out of all those that were predicted. The ability to accurately identify people with ASD is reflected in recall (sensitivity). The percentage of correctly identified non- ASD people is known as specificity. The F1-Score, which is the precision and recall harmonic mean, is a balanced metric.

B. Comparative Analysis

The comparison of performance is summarized in Table I. The SVM classifier outperformed than LR and RF among the tested models on all important metrics, proving that it is appropriate for binary classification in ASD detection.

Table 1- performance of classifiers on ASD Dataset

Algorithm	**Accuracy**	**precision**	**recall**	**specificity**	**F1- score**
Logistic Regressi on	86.8	85.2	87.0	86.5	86.1
Random forest	89.7	88.6	90.1	89.3	89.3
Support vector machine	92.5	91.2	93.1	90.4	92.1

C. Confusion Matrix and ROC Analysis

With comparatively few misclassifications, the SVM confusion matrix showed a high percentage of true positives and true negatives. Furthermore, with AUC stands for Area under the curve value of 0.95, the operating characteristic of the receiver(ROC)curve showed excellent discriminative performance.

D. Overall Assessment

The findings suggest that machine learning can significantly aid in the early detection of ASD.With high sensitivity in detecting ASD and strong specificity in excluding non-ASD cases, the SVM model continuously outperformed LR and RF. Additionally, the real-time Streamlit deployment demonstrates potential for useful application in educational and clinical settings

6. Arrangements for System

The framework is formed by the five elements to Suggest the ASD prediction sysytem.A user-friendly Streamlit interface allows users or clinicians to enter behavioral and diagnostic data. To address any missing values and categorical features, the data is then cleaned, normalized, and encoded in a preprocessing module. To reduce noise and increase learning efficiency, we identify pertinent attributes while choosing the features. The SVM,classifier then examines the refined data to determine if the child is at risk for ASD. The web interface,which gives users access to an interactive and easily accessible decisionsupport tool, is employed to display the results.

7. Conclusions and Future Research

This research presented a machine learning approach aimed at predicting Autism Spectrum Disorder (ASD) early on, utilizing a Support Vector Machine (SVM) classifier. The model showed promising results, boasting high accuracy, sensitivity, and specificity.Additionally,it was made available via a streamlit web application,which made interacting with it simple for users. These findings indicate that machine learning may prove to be a practical instrument for the clinicians and caregivers who are involved in ASD screening in making decisions. To enchance the model's generalization, future research

could benefit from enlarging the dataset to include bigger and more varied samples. Additionally, contrasting this strategy with other advanced algorithms, like deep learning and ensemble methods, might lead to even better outcomes. Longitudinal studies and real- world clinical validation could also be pursued to bolster the system's applicability and reliability

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