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# An Intelligent Machine Learning and Deep Learning Framework for Early Prediction of Autism Spectrum Disorder

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## ABSTRACT

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that can affect communication, social interaction, behavior, and learning abilities. Early identification of ASD is important because timely intervention can improve developmental outcomes and support personalized care. However, conventional diagnosis often depends on behavioral assessments, clinical observations, and specialist expertise, which can be time-consuming and difficult to access. This study proposes an intelligent framework for the early prediction of Autism Spectrum Disorder using Machine Learning (ML) and Deep Learning (DL) techniques. The proposed system processes relevant clinical, behavioral, demographic, and assessment-based features to identify patterns associated with ASD. Various machine learning algorithms are applied for classification, while deep learning models are explored to automatically learn complex relationships within the input data. Data preprocessing techniques such as missing-value handling, normalization, feature selection, and data balancing are incorporated to improve prediction performance. The models are evaluated using performance measures including accuracy, precision, recall, F1-score, and ROC-AUC. The proposed framework aims to provide an efficient and reliable computer-assisted approach for early ASD risk prediction, potentially supporting healthcare professionals in making timely decisions. By combining ML and DL methods, the framework seeks to improve predictive capability while reducing the limitations associated with traditional screening approaches.

**Keywords:**Autism Spectrum Disorder, Early Prediction, Machine Learning, Deep Learning, ASD Screening, Classification, Feature Selection, Healthcare AI, Predictive Analytics, Neurodevelopmental Disorder.

## I.INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition that affects an individual's communication, social interaction, behavior, and learning abilities. The characteristics of ASD can vary significantly from one person to another, making its identification a challenging process. Some individuals may show noticeable developmental differences during early childhood, while others may not be identified until later stages of life. Early prediction and identification of ASD are important because appropriate interventions, educational support, and behavioral therapies can be provided at an earlier stage. Therefore, developing efficient and reliable methods for early ASD screening has become an important area of research.

Traditional ASD diagnosis generally involves behavioral observation, developmental assessments, interviews with parents or caregivers, and evaluation by trained healthcare professionals. Although these approaches are useful, they can require considerable time and expertise. In addition, access to specialized diagnostic services may be limited in some regions. The variability of ASD symptoms can also make the assessment process more difficult. These limitations have encouraged researchers to investigate computational techniques that can assist in identifying individuals who may be at a higher risk of ASD.

Machine Learning (ML) has become increasingly useful in healthcare because it

can analyze large amounts of data and identify patterns that may not be easily recognized through conventional methods. In the context of ASD, ML algorithms can analyze demographic information, behavioral characteristics, questionnaire responses, developmental indicators, and other relevant clinical features to classify individuals into different risk categories. Algorithms such as Support Vector Machine, Random Forest, Decision Tree, Logistic Regression, and K-Nearest Neighbors can be trained using previously collected datasets to predict ASD-related outcomes. Proper preprocessing and feature selection can further improve the performance of these models by reducing irrelevant or redundant information.

Deep Learning (DL), a subfield of machine learning, provides additional capabilities for learning complex relationships from data. Unlike conventional ML techniques that often depend on manually selected features, deep learning models can automatically learn useful representations from sufficiently large datasets. Neural networks and other deep learning architectures can therefore be investigated for ASD prediction when the available data are suitable for such approaches. Combining ML and DL techniques can provide a broader framework in which different models are evaluated and the most effective approach is selected based on prediction performance.

The proposed work, "An Intelligent Machine Learning and Deep Learning Framework for Early Prediction of Autism Spectrum Disorder," focuses on developing a computational framework for early ASD prediction. The system involves data preprocessing, feature preparation, model training, prediction, and performance evaluation. Multiple ML and DL techniques can be compared using measures such as accuracy, precision, recall, F1-score, and ROC-AUC. The objective is not to replace professional diagnosis, but to provide a computer-assisted screening mechanism that can help identify potential ASD risk at an earlier stage.

Such an intelligent framework can support healthcare professionals by providing a rapid and data-driven preliminary assessment. It may also help reduce the time required for initial screening and encourage timely referral for detailed clinical evaluation. By integrating machine learning and deep learning approaches, the proposed framework aims to improve the reliability and efficiency of ASD risk prediction and contribute toward more accessible, technology-assisted early screening.

## II.LITERATURE SURVEY

1. Thabtah (2018)

Thabtah presented a machine learning-based approach for the screening and classification of Autism Spectrum Disorder using behavioral and demographic attributes. The study emphasized the use of questionnaire-based datasets to identify patterns associated with ASD. Different classification algorithms were investigated to determine their suitability for automated ASD screening. The findings showed that machine learning can provide effective preliminary screening and reduce the dependence on lengthy conventional assessment procedures. The work also highlighted the importance of selecting relevant features and preparing the dataset before applying classification algorithms.

2. Bone et al. (2016)

Bone and colleagues investigated computational methods for detecting Autism Spectrum Disorder using behavioral and clinical information. Their work demonstrated that machine learning techniques can assist in identifying individuals with ASD by analyzing patterns within collected assessment data. The study examined the challenges associated with heterogeneous clinical data and variations in ASD characteristics. The researchers concluded that computational models have potential for supporting clinical decision-making, particularly when combined with

appropriate feature engineering and validation techniques.

3. Wall et al. (2012)

Wall and co-authors developed computational methods for improving the efficiency of autism screening. Their research explored machine learning approaches for analyzing autism-related behavioral characteristics and demonstrated that automated classification could achieve promising results. The study focused on reducing the complexity and time involved in traditional screening while maintaining useful predictive performance. Their findings established an important foundation for subsequent research involving machine learning-based ASD screening systems.

4. Kosmicki et al. (2015)

Kosmicki and colleagues investigated the application of machine learning algorithms to autism screening questionnaires. Their research evaluated multiple classification approaches for distinguishing individuals with ASD from those without ASD based on questionnaire responses. The study demonstrated that carefully selected behavioral and demographic attributes can provide valuable information for automated prediction. The results indicated that machine learning-based screening could serve as a useful preliminary tool, although clinical assessment remains necessary for definitive diagnosis.

5. Duda et al. (2014)

Duda and co-authors studied machine learning techniques for improving the identification of autism using behavioral and developmental data. The researchers explored predictive models capable of distinguishing ASD-related patterns from non-ASD patterns. Their work highlighted the importance of combining meaningful features with suitable classification algorithms to improve prediction accuracy. The study showed the potential of computational intelligence for supporting early identification and provided motivation for further research using advanced machine learning and deep learning techniques.

## III.EXISTING SYSTEM

The existing system for Autism Spectrum Disorder (ASD) identification mainly depends on traditional clinical screening and assessment methods. These methods involve behavioral observation, developmental history, interviews with parents or caregivers, questionnaires, and evaluation by healthcare professionals. Although these approaches can provide reliable diagnostic information, they are often time-consuming and require trained specialists. In addition, the subjective nature of behavioral assessment may result in variations between evaluators. Several existing research studies have introduced machine learning techniques such as Decision Tree, Random Forest, Support Vector Machine, Logistic Regression, and K-Nearest Neighbors for automated ASD screening. These systems generally use demographic, behavioral, and questionnaire-based features to classify individuals as likely to have ASD or not. However, many existing systems rely on limited datasets, manually selected features, or a single machine learning algorithm. They may also have difficulties handling missing values, imbalanced data, and complex relationships between multiple features. Deep learning approaches have been explored to overcome some of these limitations, but their effectiveness can depend heavily on dataset size and quality. Hence, the existing systems provide useful support for ASD screening but still have scope for improvement in terms of prediction accuracy, robustness, feature learning, and integration of multiple ML and DL techniques.

## IV.PROPOSED SYSTEM

The proposed system, “An Intelligent Machine Learning and Deep Learning Framework for Early Prediction of Autism Spectrum Disorder,” is designed to provide an automated and efficient approach for identifying the likelihood of ASD at an

early stage. The system takes relevant demographic, behavioral, clinical, and questionnaire-based information as input and performs preprocessing operations such as handling missing values, removing irrelevant data, encoding categorical features, normalization, and feature selection. The prepared dataset is then provided to multiple Machine Learning and Deep Learning models for training and prediction. Machine learning algorithms such as Random Forest, Support Vector Machine, Decision Tree, Logistic Regression, and K-Nearest Neighbors can be used to identify important patterns in the data, while deep learning models such as Artificial Neural Networks can learn complex relationships between the input features. The performance of the models is compared using accuracy, precision, recall, F1-score, and ROC-AUC to determine the most effective prediction model. The selected model is then used to classify an individual as having a higher or lower likelihood of ASD, providing a preliminary screening result. The proposed framework is intended to support healthcare professionals and researchers by providing fast, consistent, and data-driven screening assistance. It does not replace professional clinical diagnosis but can help identify individuals who may benefit from further clinical evaluation and early intervention.

## V.SYSTEM ARCHITECTURE

The proposed system architecture represents the complete workflow of the Intelligent Machine Learning and Deep Learning Framework for Early Prediction of Autism Spectrum Disorder (ASD). The architecture consists of several major stages, including Input Data, Data Preprocessing, Model Training, Model Evaluation, Prediction, and Output. Each stage performs a specific task and passes the processed information to the next stage to generate an effective ASD prediction.

The Input Data stage is the starting point of the system. It collects the information required for ASD prediction, including demographic information, behavioral or questionnaire data, clinical information, and an ASD/non-ASD dataset. Demographic information may include details such as age and gender, while questionnaire and behavioral information represents responses related to ASD-associated characteristics. Clinical information can provide additional assessment-related details. These different types of information form the basis for training and testing the prediction models.

The next stage is Data Preprocessing, where the collected data is prepared for machine learning and deep learning algorithms. Initially, data cleaning is performed to handle missing or inconsistent values. The data is then transformed through techniques such as categorical encoding and normalization, allowing different types of input values to be represented in a suitable numerical form. Feature selection is subsequently applied to identify the most relevant attributes for ASD prediction and reduce unnecessary information. The final result of this stage is a prepared dataset that can be effectively used for model training.

In the Model Training stage, the prepared dataset is provided to different machine learning and deep learning algorithms. The machine learning section includes Random Forest, Support Vector Machine (SVM), Decision Tree, Logistic Regression, and K-Nearest Neighbors (KNN). These algorithms learn patterns from the training data and determine the relationship between the input features and ASD classification. In addition, a Deep Learning model, such as an Artificial Neural Network (ANN), is used to learn more complex relationships among the input features. Using multiple models allows the system to compare different prediction approaches.

After training, the models undergo Model Evaluation to determine their effectiveness. The architecture considers important performance measures such as accuracy, precision, recall, F1-score, and ROC-AUC.

Accuracy indicates the overall correctness of the predictions, while precision measures how accurately positive ASD predictions are made. Recall represents the ability of the model to identify relevant ASD cases, and the F1-score provides a balance between precision and recall. ROC-AUC is used to evaluate the model's ability to distinguish between ASD and non-ASD cases. Based on these metrics, the most suitable model can be selected.

The Prediction stage uses the trained model to analyze new patient data. When new demographic, behavioral, questionnaire, or clinical information is provided, it undergoes the same preprocessing steps used during model development. The processed information is then supplied to the selected trained model, which generates an ASD or Non-ASD prediction. This enables the framework to provide a quick preliminary screening result based on the learned patterns.

Finally, the Output stage presents the prediction generated by the system. The output can include the prediction result (ASD/Non-ASD), probability score, and relevant insights that may assist healthcare professionals. The system is intended as a computer-assisted screening and prediction framework rather than a replacement for professional clinical diagnosis. Overall, the architecture provides an end-to-end pipeline that combines data preprocessing, multiple ML and DL models, performance evaluation, and automated prediction to support the early identification of Autism Spectrum Disorder.

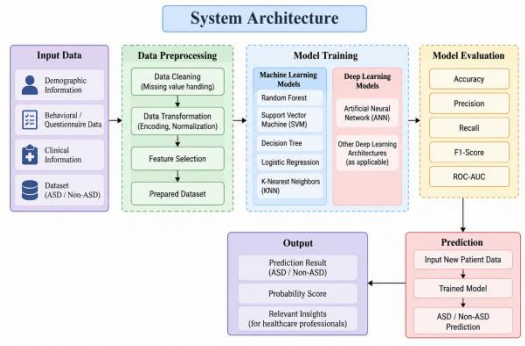



**Fig 5.1 System Architecture**

## VI.IMPLEMENTATION




Fig 6.1 Home Page

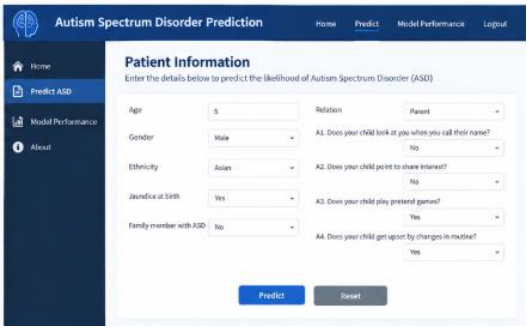



Fig 6.2 Input Form For Prediction

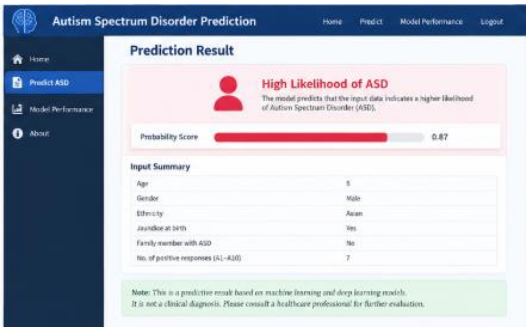



Fig 6.3 Prediction Result




Fig 6.4 Model Performance

## VII.CONCLUSION

The proposed Intelligent Machine Learning and Deep Learning Framework for Early Prediction of Autism Spectrum Disorder provides an automated and data-driven approach for supporting the early screening of ASD. The framework integrates data

preprocessing, feature selection, machine learning, and deep learning techniques to analyze demographic, behavioral, questionnaire, and clinical information. By preparing the input data effectively and applying multiple predictive models, the system can identify patterns associated with ASD and generate a preliminary prediction.

The use of different machine learning algorithms, including Random Forest, Support Vector Machine, Decision Tree, Logistic Regression, and K-Nearest Neighbors, along with deep learning techniques such as Artificial Neural Networks, enables a comparative evaluation of predictive performance. Metrics such as accuracy, precision, recall, F1-score, and ROC-AUC provide a comprehensive assessment of the models. This comparison helps in selecting a suitable model for reliable ASD risk prediction and demonstrates the potential of intelligent computational techniques in healthcare screening applications.

Overall, the proposed framework can reduce the time and effort involved in preliminary ASD screening and provide consistent, data-based results. The system can help identify individuals who may require further professional assessment and early intervention. However, the prediction generated by the framework should be considered a screening aid rather than a clinical diagnosis. Further validation using larger, diverse, and clinically validated datasets can improve the robustness and practical applicability of the proposed system.

## VIII.FUTURE SCOPE

The future scope of the proposed Intelligent Machine Learning and Deep Learning Framework for Early Prediction of Autism Spectrum Disorder is extensive. The system can be improved by training the models on larger and more diverse datasets collected from different age groups, geographical regions, and demographic backgrounds. This can help improve the generalization and reliability of the prediction models. Additional behavioral, developmental, genetic, and clinical features can also be incorporated to provide a more comprehensive assessment of ASD-related patterns.

Future work can focus on implementing advanced deep learning architectures such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) networks, and Transformer-based models, depending on the type of data available. Ensemble learning can also be explored by combining the predictions of multiple ML and DL models to improve robustness. Explainable Artificial Intelligence (XAI) techniques can be integrated to show which input features contributed most to a prediction, making the system more transparent and useful for healthcare professionals.

The framework can also be extended into a web-based or mobile-based screening application that allows users or healthcare professionals to enter assessment information and receive a preliminary risk prediction. Integration with electronic health records and other healthcare information systems could enable more efficient data analysis while maintaining appropriate privacy and security measures. In addition, continuous model validation, bias assessment, and clinical testing can be performed to ensure that the system remains reliable across different populations.

Finally, future developments can focus on creating a personalized early-intervention support system that provides appropriate recommendations based on the individual's predicted risk and relevant behavioral characteristics. With further research, real-world validation, and collaboration with clinical experts, the proposed framework could become a useful decision-support tool for early ASD screening while continuing to emphasize that final diagnosis must be performed by qualified healthcare professionals.

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