









# Detection of Autism Spectrum Disorder Using Optimized Extreme Learning Machine Technique

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**Abstract.** Numerous disorders that cannot be diagnosed medically have emerged throughout the world, including Autism Spectrum Disorder (ASD). It impacts on the numerous aspects of behavior, such as social and language abilities in addition to stereotyped and repetitive behavior. This illness is a serious neurodevelopmental disorder. The symptoms of ASD and many other mental diseases are remarkably similar, making an accurate diagnosis of ASD challenging and time-consuming. The increasing use of the Optimized Extreme Learning Machine technology (OELM) in the prediction of many human diseases suggests that early diagnosis based on various physiological and health variables could be possible. This analysis attempts to develop a categorization model that can most accurately predict the risk of Autism. It was examined if it would be possible to evaluate and predict characteristics of autism spectrum disorders in toddler, child, adolescent, and adult age groups using the Optimized Extreme Learning Machine Technique. Therefore, improving people's overall mental health requires an early identification of autism spectrum disorders. The effectiveness of the models built for ASD detection was examined using a number of performance assessment criteria. The revolutionary concept of Optimized Extreme Learning Machines (OELM) for the early identification of autism disorders is presented in this analysis. The OELM algorithm offers reliable and precise predictions for autism diseases. ROC curve for this describes system shows better results in comparison. The suggested approach better the others in terms of F1- Score, precision, sensitivity, and accuracy. These algorithms are also evaluated on Kaggle ASD datasets and contrasted with other machine learning algorithms.

**Keywords:** Gene Hereditary · Optimized extreme learning machines (OELM) · Autism spectrum disorder (ASD) · Kaggle ASD

## 1 Introduction

Many medically undetected illnesses, such as Autism Spectrum Disorder (ASD), have recently become more prevalent around the world. Serious neurodevelopmental illness, this condition impacts multiple behavioral domains, including stereotyped and repetitive behaviors, as well as social and communication difficulties [1]. The illness's cause is unidentified, but biological variables such genetic abnormalities, brain inflammation, and unfavorable prenatal circumstances are thought to have an impact. The significant increase in the number of children with ASD in these residents highlights the need for more research on these residents.

Correct clinical practices are extremely important. The symptoms of ASD are very different. Along with behavior and educate, it has an impact on how individuals connect with one another. 0.63% of very young children are (ASD), which has now expanded to adolescence and adults, according to World Health Organization (WHO) statistics [2]. The symptoms and signs start to appear at a young age. An individual with ASD could struggle with communication problems and anxiety, which can limit their ability to function well at different stages of life. Early detection and treatment must this constantly be emphasized. Behavior of the affected individual, which may include inappropriate and dangerous actions motivated by films and cartoons is one of the most apparent symptoms of ASD [3].

Therefore, an individual's whole life is affected by ASD a lifelong developmental disorder of the human brain. Remember that this condition can develop due to a combination of genetic and environmental factors [4]. Although the exact causes of ASD have not been determined, scientists believe that human genes are at responsible. There are certain social interactions and communication patterns, even if a person with ASD typically finds it difficult to communicate and interact with others [5].

ASD is defined by a lack of social skills and nonverbal communication in the first three years of life, including avoiding eye contact and difficulty with emotion regulation and emotional interpretation in others. Some children with ASD frequently exhibit non-specific symptoms such abnormal sensory experiences, unskilled motor skills, and insomnia. Hyperactivity, cognitive impairment, aggressive, repeated behaviours are other signs. It is well established that ASD is complex results from both genetic environmental factors. 10% to 20% of people with ASD have chromosomal and gene problems, and siblings born into ASD families have a 50 times higher chance of developing the disorder. Relapse rates range from 5% to 8%.

ASD is additionally affected by environmental factors throughout the prenatal, perinatal, and postnatal periods. ASD may be caused by prenatal factors such exposure to teratogens that induce embryo defects, perinatal factors like exceptionally short gestation periods or birth hypoxia, and postnatal causes like virus infection or mercury poisoning. Compared to a kid without autism, the brain of a youngster with autism is characterized by an excess of connections between brain cells. This happens as a result of deterioration in the natural process of discarding injured or defective neurons during brain growth. This affects the brain network by creating nonuniformity in neuronal pattern, disconnectedness, and a lack of connection of cognitive function between various areas. Therefore, more dense neural connections are seen in an autistic brain, which explains the

ASD individuals have less developed social behaviour and cognitive abilities than typically developing youngsters. Thus, investigating brain activity and understanding neural patterns may help explain the certain characteristics of autistic children are present [6].

With 1 in 160 children predicted to be affected by ASD worldwide and the prevalence of ASD increasing over time, early intervention and prognosis are crucial. To determine whether basic symptoms such a lack of social relationships and communication problems exist, clinical assessments, such as screening tests, are frequently used to identify ASD in children with restricted habits and interests. Because these youngsters may appear with a wide range of diagnostic representations, specialists who don't see a lot of ASD patients may over- or under diagnose. This justifies the requirement for an automated diagnostic tool to support doctors in correctly identifying ASD. Electroencephalograms (EEGs) capture brain activity and offer useful information on the health of the brain. In order to investigate neurological illnesses such Parkinson's disease, depression, epilepsy, schizophrenia, autism, hyperactivity disorder, attention-deficit and Alzheimer's disease, brain signals are frequently used. Since EEG signals are non-stationary in nature, normal and abnormal EEG signals are defined using nonlinear characteristics.

The remaining sections of the analysis is arranged as follows: In this Sect 2, a literature survey, in Sect 3 is a methodology for detecting autism spectrum disorder using an optimized extreme learning machine technology, Sect 4 result analysis is observed and finally analysis is concluded in Sect 5.

## 2 Literature Survey

Abdullah A.A., Rijal S., Dash S.R. et al. [7] presented three methods for evaluating machine learning techniques that might be applied to regression and classification: selection operator (LASSO), least absolute shrinkage, and chi-square. Among these techniques are random forest (RF), K-nearest neighbors (K-NN), and logistic regression (LR). In comparison to other methodologies used, the testing results demonstrated that the LR model had the best accuracy, at 97.541%. 13 characteristics that were chosen through the Chi-square selection process constitute the foundation of their approach.

R. Vaishali, R. Sasikala, et al. [8] described a optimum behavioural sets as a method of autism detection. They utilized a binary firefly feature selection wrapper based on swarm intelligence to test for ASD. The dataset that has been analysed and categorised includes 21 characteristics that were taken from the ML repository. Only 10 of the 21 variables investigated in the ASD dataset, according to the authors, can be used to categorise individuals as having an ASD or not. The system's average accuracy from the ASD datasets was found to range from 92.12% to 97.95% according to their results of experiments.

K. Chowdhury, M.A. Iraj, et al. [9], comparison of many measurements produced by different classifiers is provided, such as Gaussian Radial Kernel and Support Vector Machine (SVM), to determine the most accurate technique to diagnose ASD. The data collected the greatest and highest accuracy at 95%. Utilize the widely accessible standard ASD dataset.

Masum M., Nur I., Hossain M.J. Faruk, Adnan M., Shahriar H., et al. [10] presented several strategies and procedures for locating and recognising ASD. They utilised a

number of machine learning techniques, such as classifiers and certain neural network-based classifiers. They performed a test to find out well the suggested method can identify ASD. Three datasets for children, adolescents, and adults were used in the trials. According to the experimental findings, when each ML classifier was evaluated using the preciseness, F-beta, and recall techniques are certain classifiers outperformed the others in terms of accuracy. Additionally, SHAP (Shapley Additive explanations) methods were utilised to examine the crucial components of ASD prediction in all three datasets.

S. Raj, S. Masood, et al. [11], tried to determine whether there were any precise measures to evaluate the likelihood of an ASD. They tested the relevant criteria, examined and classified ASD using Naive Bayes, logistic regression, K-NN, convolutional neural networks, and neural networks, support vector machines. The suggested techniques were tested using three ASD datasets (adolescents and adults, children). For the examination of 21 characteristics of ASD patients in children, there are 292 samples, 740 samples for adults, and 104 samples for adolescents. The proposed approach was shown to have the highest accuracy rate in the CNN classifier, with 98.30%, 99.53%, and 96.88% accuracy rates for testing to detect ASD in children, adults, and teenagers, respectively.

Nishat M.M., et al. [12] presented a model for predicting ASD using ML algorithms and related psychiatric illnesses that have a substantial impact on a person's social behaviour. To recognise the condition, examine it, and select the best method of action to reduce its severity, they used linear analysis and the quadratic discriminant approach. The University of California, Irvine (UCI) reservoir data was used to develop the machine learning (ML) model for analysis and discovery. They completely assessed the Youden index, sensitivity, F1 score, and accuracy. After adjusting the hyperparameters, with a high accuracy of 99.77%, the Quadruple Analysis Algorithm (QDA) was demonstrated. The outcomes of the experiment show the effectiveness and efficiency the proposed model.

M.M. Rahman, R. C. Muniyandi, O.L. Usman, S. Sahran, S. Mohamed, R.A.. Razak et al. [13], detailed the application of ML techniques and emphasised key autism-related themes. They also validated the necessity to identify the top characteristics of autism, improve categorisation, and preserve the highest degree of accuracy. By choosing the appropriate key autistic features and reducing data dimensionality, researchers may build an ML system that will show promise in identifying ASD. Several aspects that impact accuracy must be considered depending on the authors. Include redundant features, an unreliable sampling technique, an imbalanced and insignificant data set.

Hossain M.D., Anwar A., Kabir M.A., Islam M.Z., et al. [14], used existing classification algorithms to better diagnose ASD by attempting to identify the characteristics that mattered the most and automate the diagnostic process. They examined Autism datasets from adults, youths, toddlers, and children. In order to determine the ASD of the aforementioned dataset, they examined the most effective classifier among the most recent classification algorithms. For the four datasets, with 100% accuracy, the multi-layer perceptron (MLP) classifier achieved the maximum accuracy, is demonstrated to be effective and superior in the results. Additionally, they found that the best way to rank the most significant features in the four ASD datasets was to use the "Relief F" feature selection strategy.

Mashudi N.A., Ahmad N., Noor N.M., et al. [15] suggested a model based on several machine learning methods to recognise and evaluate the ASD categorization. A total of 16 features made up the dataset for analysis, which comprises 703 patients with and without autism. Support vector machines, Naïve Bayes (NB), K-NN, J48, bagging, and stacking were used to predict the status of ASD. The waikato setting for knowledge analysis (WEKA) platform was used to simulate the environment in which these methodologies were used. The obtained results showed that several ML classifiers outperformed J48, Stacking, SVM, and Bagging, the other classifiers under examination, with a 100% accuracy rate and a lower error rate.

Banna M.H. Al, Taher K.A., Ghosh T., Mahmud M., Kaiser M.S., et al. [16], Based on a patient's emotions and facial expressions, to monitor their condition, the scientists proposed a sensor network system based on artificial intelligence. In the case that the patient behaves improperly, the patient care committee is informed. The efficiency of the AI-based model and the possibility applications in researching the Corona pandemic were also discussed by the authors, along with the system's potential to support parents in developing their children's mental growth.

K. S. Omar, N. S. Khan, P. Mondal, K. Rizvi M. R., and Islam M. N., et al. [17] recommended using datasets for Autism Spectrum disease to apply supervised machine learning techniques. By deleting the outlier values, the datasets are reduced according to the technique. The XGBoost classifier and Gradient Boosting Classifiers were also used by the author to evaluate the datasets, and the results showed a 97.1% accuracy rate. Furthermore, the author has concluded the addition of a greater number of balanced datasets can increase accuracy of the classifier in predicting and classifying the above-mentioned disorders.

K. Kayleigh Hyde, Nicholas LaHaye, N Marlana. Novack. Chelsea Parlett-Pelleriti, Raymond Anden. R. Dennis Dixon, Erik Linstead., et al. [18] used Random Forest Classification & Regression Trees with Random Forest Iterative Dichotomies 3 to successfully predict autism. This work utilized dataset which is called AQ-10 having 250 data sets taken in real time. It is compiled from several individuals, with and without genuine characteristics. When compared to the conventional machine learning methods, technique produced predictions with greater accuracy and lower false rates.

Arumugam S. R., Balakrishna R., Khilar R., Manoj O. and Shylaja C. S., et al. [19] described the use of Convolution Neural Networks (CNNs) to categorize facial images into two classes: images affected by ASD and images normal, allowing us to determine whether a child has ASD. The earlier ASD is identified, the more quickly the problems are resolved by providing therapy to these children to help with their behavioral and social problems. A publicly accessible dataset from the Kaggle website was used for this study, and a 70:30 training to testing ratio was followed. In the end, the neural network-based model that was developed was able to get a 91% accuracy rate, and its loss value was found to be 0.53.

R. Mittal, V. Malik and A. Rana, et al. [20] The Kaggle dataset was utilized as the image dataset for the suggested model. The images are used to categorize people as having autism spectrum disorder (ASD) or not using an Improved Convolutional Neural Network (I-CNN) trained on the datasets. To determine the emotion, feature-based computations of internal and external distances are used. The returned facial

landmarks are processed by the Improved Convolutional Neural Network (I-CNN) using optimization techniques like dropout, batch normalization, and parameter update. In addition to the four general emotions, the suggested method accurately predicts six emotions. The approach suggested in this paper can achieve 98% classification accuracy, based on the testing results.

Kamala B., Mahanaga Pooja K. S., Varsha S. and Sivapriya K., et al. [21] The diagnostic process takes a long time and is not appropriate for early detection. This paper primarily focuses on early autism diagnosis using machine learning models. ML models are favored over alternative techniques because they often examine the connections between different brain regions. Additionally, compared to other models, machine learning algorithms are known for their higher prediction accuracy. Thus, through exploring its genetics and creating efficient interventions, machine learning, an area of artificial intelligence, can improve the techniques for detecting autism.

### 3 Detection of Autism Spectrum Disorder Using Optimized Extreme Learning Machine Technique

Figure 1 shows a frame of detection of autism spectrum disorder utilising an optimised extreme learning machine algorithm. As the four ASD screening datasets that are freely available are used in this study. The adopted datasets include those for toddlers, kids, teenagers, and adults. Each dataset consists of 21 characteristics with various sample sizes. Toddlers make up the largest observation dataset among them, with a composition (of 1054). The adjustments carried out on a data collection prior to feeding to the model are referred to as pre-processing. To make raw or noisy data better suitable for training and analysis, it is cleaned. The non-contributing characteristics, Case\_No, “Who completed the test,” and “Qchat-10-Score,” were eliminated.

To handle the categorical data, label encoding is used. Label encoding converts into numeric form to make labels machine-readable. Labels that are assigned again are given the same value as previously. Four attributes are represented in a binary label with two classes; these are the ones that are chosen. When there are more than two classes, Label Encoding is useless. One-Hot Encoding is used for multiclass features to prevent hierarchical ranking by the model. The 11 classes of the ‘Ethnicity’ feature have been one-hot encoded.

Reducing the amount of input variables is a step in the feature selection process while building a predictive model. In certain cases, less input variables might lead to better model performance and lower modeling calculation costs. Each input variable’s relationship to the target variable is evaluated using statistical analysis, and the input variables that have the highest correlation to the target variable are selected. Feature selection based on statistics is the term used for this procedure. These methods can be rapid and effective, even though the statistical measures selected depend on the type of data for the input and output variables. It has been demonstrated through feature reduction that increasing the amount of retrieved features can help algorithms in more robustly and meaningfully representing data.

However, the curse of dimensionality can generate problems and decrease performance. To avoid this, a number of techniques for lowering dimensionality and choosing

features have been proposed. Additionally, these techniques are frequently employed to improve Centre for Autism and Developmental Disorders (CADD) effectiveness in the area of autism spectrum disorders identification. This method for selecting characteristics that improves classification accuracy and reduces computation time while using fewer features. The extreme learning model is in training. OELM methods that may be used for regression and classification problems. Due to its efficacy and capacity to acquire great accuracy in the majority of data, it is typically utilised in categorization challenges. The goal of this method is to maximise the margin in order to discover the optimal level of separation between the classes. The model assessment metrics and outcomes are the chosen dataset. So, evaluate the model and predict the best outcomes.

## 4 Result Analysis

This section examines the effectiveness of an optimized extreme learning machine technique for the detection of autism spectrum disorder. In terms of sensitivity, accuracy, precision, and F1-Score, the comparison is observed (Table 1).

The above tabular form shows performance comparison between Multilayer Perceptron (MLP), Machine Learning (ML) and Autism Spectrum Disorder (ASD).

### 4.1 Accuracy Graph

In Fig. 2, accuracy comparison graph is observed between the Multilayer Perceptron (MLP), Machine Learning (ML) and Autism Spectrum Disorder (ASD). When utilizing an enhanced extreme learning machine technique to detect autism spectrum disorder, ASD demonstrates greater accuracy when compared to MLP and ML.

In Fig.3, graphical representation of Multilayer Perceptron (MLP), Machine Learning (ML) and Autism Spectrum Disorder (ASD). When utilizing an optimized extreme learning machine technique to detect autism spectrum disorder, ASD indicates greater precision in comparison to MLP and ML.

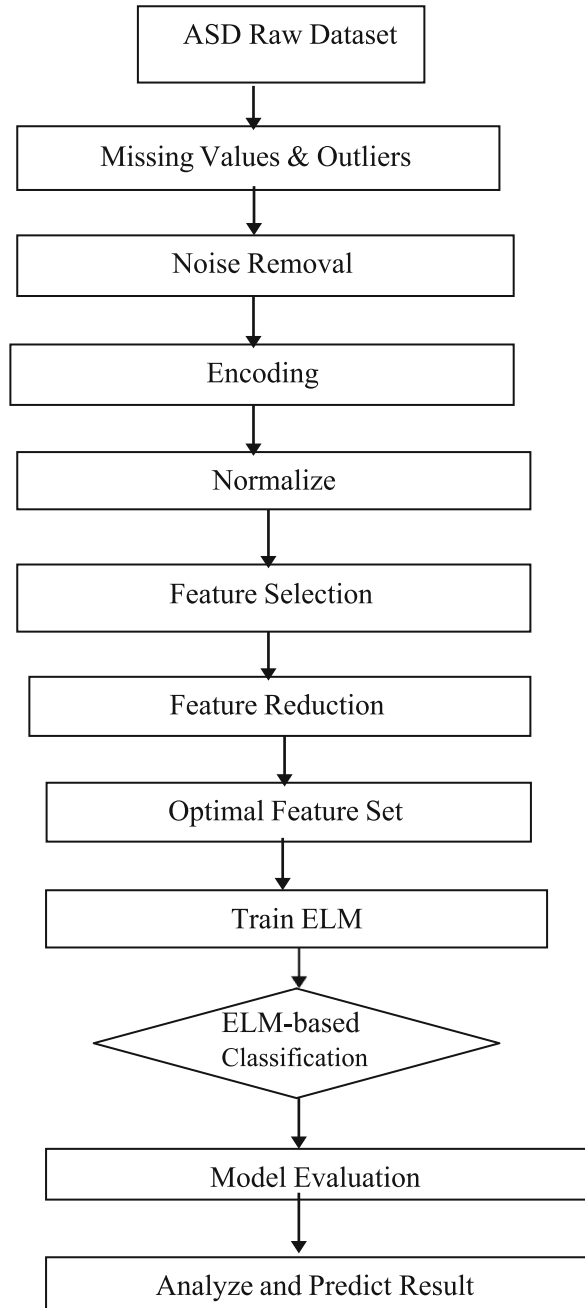
### 4.2 Precision Graph

### 4.3 Sensitivity Graph

Sensitivity comparison for Multilayer Perceptron (MLP), Machine Learning (ML) and Autism Spectrum Disorder (ASD). Figure 4 demonstrates that the optimized extreme learning machine technique for the detection of autism spectrum disorder has a higher sensitivity for ASD when compared to MLP and ML.

### 4.4 F1-Score

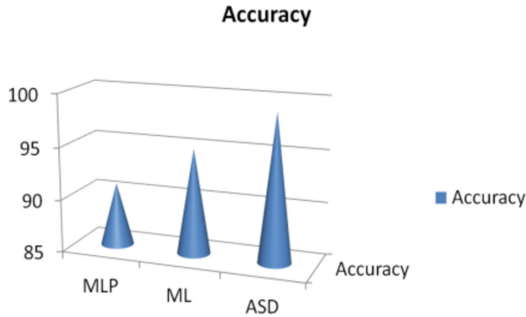
In Fig.5. F1 Score comparison graph is observed between Multilayer Perceptron (MLP), Machine Learning (ML) and Autism Spectrum Disorder (ASD). When utilizing an optimized extreme learning machine technique to detect autism spectrum disorder, ASD indicates greater precision in comparison to MLP and ML.



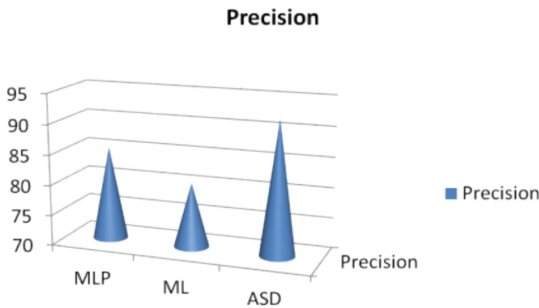
**Fig. 1.** Framework of Detection of Autism Spectrum Disorder Using Optimized Extreme Learning Machine Technique

**Table 1.** Performance Comparison

Parameters	MLP	ML	ASD
Accuracy	91	95	99
Precision	85.4	80.6	92
Sensitivity	95	90	95.5
F1-Score	89.7	85.1	90.4



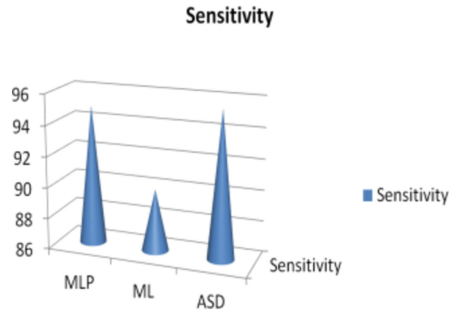
**Fig. 2.** Accuracy Comparison Graph



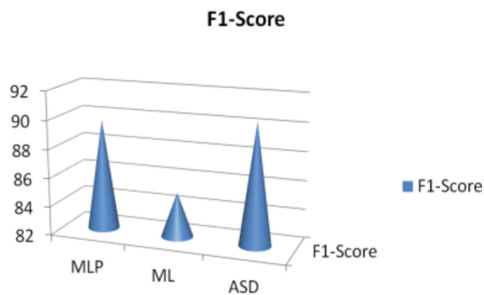
**Fig. 3.** Precision Comparison Graph

### 4.5 ROC Curve

In graphical representation of ROC curve for Multilayer Perceptron (MLP), Machine Learning (ML) and Autism Spectrum Disorder (ASD), when utilizing an optimized extreme learning machine technique to diagnose autism spectrum disorder, ASD has a greater rate of detection when compared to MLP and ML.



**Fig. 4.** Sensitivity Comparison Graph



**Fig. 5.** F1-Score Comparison Graph

## 5 Conclusion

In this analysis, using four publicly accessible, different Kaggle datasets for non-clinical ASD screening, Autism Spectrum Disorder (ASD) was diagnosed using an optimised extreme learning machine algorithm. These datasets have four age ranges associated with them: toddlers, children, teenagers, and adults. The effectiveness of the models built for ASD detection was examined using a number of performance assessment criteria. When compared to other algorithms that are already in use, the method outlined has proven to be more successful. ROC curve for this describes system achieves better results when compared with MLP, ML. This improved the results for the identification of autism spectrum condition using an optimized extreme learning machine method in terms of precision and accuracy, F1-Score, and sensitivity.

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