DIAGNOSIS OF AUTISM SPECTRUM DISORDER USING FEATURE SELECTION BASED MACHINE LEARNING TECHNIQUES

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***Abstract*—Autism Spectrum Disorder is a developmental disorder caused by brain abnormalities. Recent studies indicate that 1 in 44 American children suffer from autism. Today's urgent need is for the advancement of more reliable diagnostic tools for early autism diagnosis. With the help of various machine learning techniques, this may be accomplished. The goal of this project is to examine the accuracy of implementing backward feature selection-based machine learning algorithms such as SVM, Random Forest, Logistic Regression, Naive Bayes, and K- Nearest Neighbor on three separate ASD datasets from the UCI Machine Learning Repository, each of which contains 21 features. We obtained that for all three data sets, Logistic Regression performs better both before and after the use of feature selection.**

Keywords: Autism spectrum disorder, Feature Selection, Logistic Regression, Random Forest, Naïve Bayes, K-Nearest Neighbor(KNN)

I. INTRODUCTION

Autism Spectrum Disorder, often known as ASD, is a neurological and developmental condition that affects how people behave, interact, and communicate with others. Children with autism frequently exhibit symptoms before the age of three. Studies reveal that there is no one aetiology for autism, even though the root cause is still unclear. Autism may be brought on by a genetic disorder as well as environmental elements like having elderly parents or being underweight at birth. People with ASD might have a range of abilities. While some might not speak at all, others might have highly developed communication skills. While some people may need assistance from others on a daily basis, some people can work and live on their own. ASD affects 31% of kids intellectually (intelligence quotient [IQ] <70), 25% are borderline ([IQ] 71-85), and 44% have IQs that are ordinary to above average ([IQ] >85) [14]. Children with autism spectrum disorders may struggle with basic social interactions. Some signs and symptoms include:

- Engaging and connecting with others seems challenging
- Having trouble making eye contact
- Having difficulty in comprehending what other people are thinking or feeling
- Using a distinctive tone or rhythm when speaking
- Fails to responds to his or her name

The most crucial actions to be taken to lessen the symptoms of autism spectrum disorder and to enhance the quality of life for ASD sufferers are early detection and treatment. Early screening is always advised by experts because it enables the early identification of children who are more likely to have autism spectrum disorder and encourages their families to take the necessary steps to get the children access to early intervention services. There is, however, no method or medical test for autism detection. Observation is usually how ASD symptoms are identified.

Autism may now be predicted at an early level because of the advances in artificial intelligence and machine learning. In addition to assisting in a quick and accurate assessment of ASD risk, machine learning techniques are crucial for accelerating the entire diagnostic process and assisting families in getting to the critical therapies more quickly [16].

With the use of machine learning algorithms and the Autism Spectrum Quotient (AQ) as the screening tool, we aim to make a contribution to the early detection of ASD.

II. LITERATURE SURVEY

Suman Raja et al.[1] together published a paper which attempts to investigatethe use of various machine learning and deep learning algorithms like Naive Bayes, SVM, Logistic Regression, KNN, Neural Network, and Convolutional Neural Network in an effort to anticipate and analyze ASD issues in children, adolescents, and adults.. The results strongly suggest that CNN-based prediction models perform better on all of these datasets after the application of various machine learning techniques and the handling of missing values, with higher accuracy of 99.53%, 98.30%, and 96.88% for Autistic Spectrum Disorder Screening in three datasets. These findings suggested that a CNN-based model rather than a conventional machine learning classifier could be employed to detect autism.

Vaishali R. et al.[2] have proposed to create machine learning-based behavioral analytics in order to detect the risk of autism quicker than traditional diagnostic methods. For this, an ASD diagnosis dataset is tested using a binary firefly feature selection wrapper based on swarm intelligence. The experiment's alternative hypothesis asserts that a machine learning model can achieve better classification accuracy with fewer feature subsets to decide subset fitness. It was found that 10 of the 21 features in the ASD dataset are sufficient to distinguish between ASD and non-ASD patients using only a Swarm intelligence-based solitary binary firefly feature selection framework. The outcomes of their method verify the above mentioned premise by generating an average accuracy of 92.12% to 97.95% with optimal feature subsets, which is almost equivalent to the average accuracy generated by the complete ASD diagnosis dataset. The wrapper based on swarm intelligence, according to this article, is a preferable option to feature reduction techniques.

J.A Kosmicki et al.[3] conducted a study on a limited range of behaviours for autism detection using feature selection-based machine learning. In this study, they used machine learning to evaluate the Autism Diagnostic Observation Schedule (ADOS), one of the finest and most broadly used equipment for clinical examination of ASD, to determine if only a subset of behaviours can make a distinction between children on and off the autism spectrum. ADOS consists of four modules with module 2 for individuals with some vocabulary and module 3 for higher levels of cognitive functioning. The outcomes supports the fact that the fewer features when measured using machine learning tools can have higher levels of accuracy in autism detection.

Ashima Sindhu Mohanty et al.[4] presented a innovative method for identifying early ASD using a deep classifier. In this study, an attempt is made to include Principal Component Analysis (PCA) for feature dimension reduction in the number of attributes by the use of 10-fold cross validation, followed by the use of Deep Neural Network (DNN) for ASD class type classification. The different evaluation parameters such as sensitivity, accuracy, specificity and F-measure produced suitable results. The results of the experiment show that PCA in combination with DNN provides clinically acceptable output for effective ASD identification

Basma Ramadan Gamal Elshoky et al.[5] investigated the various feature selection methods on four ASD datasets for extracting important features for improving the ASD classification system. To rank significant features, several feature engineering techniques are used. The steps followed are filter, select features, dataset splitting, classification algorithms, time performance measurement, and performance. The correlation matrix method demonstrated the relationship between features, allowing to select the most significant features. A number of machine learning classifiers are used. On different sizes of data, the selected features achieve 100% accuracy, specificity, sensitivity, AUC, and f1 score using adaboost, linear discriminant analysis, and logistic regression classifier. Cross-validation with 10 k-fold was used to validate the results.

Md. Mokhlesur Rahman et al.[6] focuses on current studies on machine learning methods for feature selection and classification of ASD. They propose methods for improving machine learning's speed of execution when processing complex data for conceptualization and its application in ASD diagnostic research This study has the potential to significantly benefit future research using a machine learning approach for feature selection, classification, and processing imbalanced data in autism. A machine learning algorithm will show promising results in diagnosing ASD by reducing data dimensionality and selecting the appropriate and essential autism features.

Md Delowar Hossain et al.[7] the goal of this paper is to identify the most important characteristics and analyze the diagnosis process using available classification techniques for improved diagnosis. They examined ASD datasets from toddlers, children, adolescents, and adults and tested cutting-edge classification and feature selection techniques to determine the best performing classifier and feature set for these four ASD datasets. For toddler, child, adolescent, and adult datasets, their experimental results show that the multilayer perceptron (MLP) classifier outperforms all other benchmark classification techniques and achieves 100% accuracy with the fewest attributes. They also discover that the' 'relief F' feature selection technique works best for ranking the most significant attributes in all four ASD datasets.

Kaushik Vakadkar et al.[8] aims to determine if the child is likely to be exposed to ASD in its early stages, which will help in the diagnosis process. They used models like Support Vector Machines (SVM), Random Forest Classifier (RFC), Nave Bayes (NB), Logistic Regression (LR), and KNN to analyse the data and build predictive models based on the results. They have created an automated ASD prediction model using the minimum behaviour sets from each diagnosis dataset. Logistic Regression was found to be the most accurate of the five models tested on our dataset.

Kayleigh K. Hyde et al.[9] provides a review of 45 papers with applications of supervised machine learning in ASD, including classification and text analysis algorithms. The paper's goal is to identify and describe supervised machine learning trends in the ASD literature. In the 35 ASD reviewed research, SVM and ADtree were the most widely used supervised machine learning algorithms, and in the 10 reviewed articles, nave Bayes, SVM, and Random Forest were the most popularly used.

Tania Akter1and et al.[10] collected early-detected ASD datasets from toddlers, children, adolescents, and adults and applied several feature transformation methods to these datasets, including log, Z-score, and sine functions (FT methods). The performance of various classification techniques was then analysed using these transformed ASD datasets. SVM performed best on the toddler dataset, while Adaboost performed best on the children dataset, Glmboost on the adolescent dataset, and Adaboost on the adult dataset. By implementing FT methods, they discovered significant features that are highly predictive of ASD using a variety of feature selection.

It is clear from the preceding section that there is a clear need to investigate the possibility of using machine learning- models through feature selection for the detection of ASD in the human population. The majority of the work discussed above employs traditional machine learning approaches, which limit their performance. In this article, the performance of multiple machine learning models before feature selection were compared to the learning model after the feature selection. Separate models have been developed and compared for each population set (discussed further below).

III. DATASET

Three different types of ASD datasets, each with 21 features, were acquired from the UCI machine learning repository. There are 292 instances in the first dataset that are connected to ASD screening in children [11], 292 instances in the second dataset that are connected to ASD screening in adults[13], and 104 cases in the third dataset that are connected to ASD screening in adolescents [12]. The screening procedure in the AQ test allots a point for each question. If the person receives a score higher than 6, it is determined that they may have an ASD trait and they are forwarded for more diagnostic testing. In the adult category in table 1, if the response is either "slightly agree" or "definitely agree" for question items 1, 7, 8, and 10, a point is awarded; for the remaining questions, a point is awarded for answers that are either "slightly disagree" or "definitely disagree." For question items 1, 5, 8, and 10 in the adolescent group in table 2, if the response is either "slightly agree" or "definitely agree," a point is awarded; for standing questions, a point is awarded for either "slightly disagree" or "definitely disagree." For the child category in table 3, if the response is "slightly agree" or "definitely agree" to question items 1, 5, 7, and 10, then a point is awarded; for the remaining questions, a point is awarded for the response to be "slightly disagree" or "definitely disagree" [4] [17] [18]. The AQ questionnaires for the adult, adolescent, and child categories are shown in the tables below.

TABLE I.

No.	AQ questionnaires for adult.				
	AQ-10 Adult questionnaire	*Definitely agree*	*Slightly agree*	*Slightly disagree*	*Definitely disagree*
1	I frequently hear faint noises that others do not.				
2	Normally, I pay more attention to the big picture than the specifics.				
3	I have no trouble managing multiple tasks at once.				
4	I can swiftly resume what I was doing in the event of an interruption.				
5	I am good at "reading between the lines" when people are speaking to me.				
6	I know how to tell if someone listening to me is getting bored				
7	When I'm reading a story I find it difficult to work out the characters' intentions				
8	I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant etc)				
9	I find it easy to work out what someone is thinking or feeling just by looking at their face				
10	I find it difficult to work out people's intentions				

TABLE II.

No.	AQ questionnaires for adolescent.				
	AQ-10 Adolescents questionnaire	*Definitely agree*	*Slightly agree*	*Slightly disagree*	*Definitely disagree*
1	S/he notices patterns in things all the time				
2	Typically, s/he focuses more on the big picture than the specifics.				
3	In a social group, s/he can easily keep track of several different people's conversations				
4	If there is an interruption, s/he can switch back to what s/he was doing very quickly				
5	S/he frequently finds that s/he doesn't know how to keep a conversation going				
6	S/he is good at social chit-chat				
7	S/he used to enjoy pretending games with other kids when they were younger.				
8	S/he finds it difficult to imagine what it would be like to be someone else				
9	S/he finds social situations easy				
10	S/he finds it hard to make new friends				

TABLE III.

No.	AQ questionnaires for children.				
	AQ-10 Children questionnaire	*Definitely agree*	*Slightly agree*	*Slightly disagree*	*Definitely disagree*
1	S/he often notices small sounds when others do not				
2	Typically, s/he focuses more on the big picture than the specifics.				
3	S/he can readily follow the conversations of multiple persons in a social group.				
4	S/he has little trouble switching back and forth between several activities				
5	S/he struggles to maintain a discussion with classmates.				
6	S/he is good at social chit-chat				
7	When reading a story, the s/he has trouble figuring out the character's motivations or emotions.				
8	When s/he was in preschool, s/he used to enjoy playing games involving pretending with other children				
9	S/he finds it simple to determine someone's thoughts or feelings only by seeing their face.				
10	S/he finds it hard to make new friends				

The other common features are: age, gender, ethnicity, whether been affected with jaundice, country of residence, family members with autism, Used the app before, result, age description, relation and class/ASD traits.

IV. METHODOLOGY

i. *Data Pre-Processing*

Data pre-processing is a data mining technique used to turn the raw data into a format that is both practical and effective. There may be a lot of useless information and missingness in the data. Large datasets must be prepared properly to allow for the interpretation of the data they contain. The datasets employed for this project have missing values that were handled using mean and mode imputation techniques. The dataset's categorical variables were transformed into numeric values with the use of python libraries. In order to standardize the characteristics in the data into a fixed range before applying machine learning methods, feature scaling was also carried out.

ii. *Machine Learning Algorithms*

With a ratio of 80:20, the dataset has been divided into training and testing sets. The accuracy of methods like Naive Bayes, Support Vector Machine, Logistic Regression, Random Forest, and K-Nearest Neighbor is then evaluated.

a. *Naïve Bayes*

The Naïve Bayes algorithm is a supervised learning method for classification problems that is based on the Bayes theorem. The Naive Bayes Classifier is one of the most straightforward and efficient classification algorithms available today. It aids in the development of quick machine learning models capable of making accurate predictions.

b. *Support Vector Machine*

Support vector machines (SVMs) are a group of supervised learning techniques for classifying data, performing regression analysis, and identifying outliers. The support vector machine approach seeks to locate an N-dimensional space hyperplane that clearly categorises the data points.

c. *Logistic Regression*

The method of modelling the likelihood of a discrete result given an input variable is known as logistic regression. For situations involving binary and linear classification, logistic regression is a straightforward and more effective approach. It's a classification model that's incredibly simple to implement and performs admirably with linearly separable classes [15].

d. *Random Forest*

Random Forest is a supervised machine learning technique that develops and merges several decision trees to form a "forest." Its foundation is the idea of ensemble learning. Random Forest is a classifier that uses many decision trees on different subsets of the input dataset and averages the results to increase the dataset's predicted accuracy.

e. *K-Nearest Neighbor*

The k-nearest neighbors algorithm, sometimes referred to as KNN or k-NN, is a supervised learning classifier that employs proximity to produce classifications or predictions about the grouping of a single data point. A new data point is classified using the K-NN algorithm based on similarity after all the existing data has been stored.

iii. *Feature Selection*

Features are the input variables that we provide to our machine learning models. Our dataset's columns each represent a feature. Making ensuring that we only use the necessary features will help us train an optimal model. When there are too many characteristics, the model may pick up on noise and uninteresting patterns. The process of selecting the crucial aspects of our data is known as feature selection. In order to compare the accuracy before and after feature selection, our technique includes training algorithms employing backwards feature elimination. Regression analysis use the technique of backwards elimination to pick a subset of explanatory variables for the model. Backward elimination is applied on the model's initial and all explanatory variables. The variable with the greatest p-value is next taken out of the model.

V. RESULT AND INTERPRETATION

i. Exploratory Data Analysis

Fig.1 shows the percentage of three age groups (children, adolescents, and adults) who have autistic symptoms. The results of the ASD screening in children reveal that 48.3% of them have autism, the results in adolescents reveal that 36.7% do, and the results in adults reveal that 26.8% have autism.

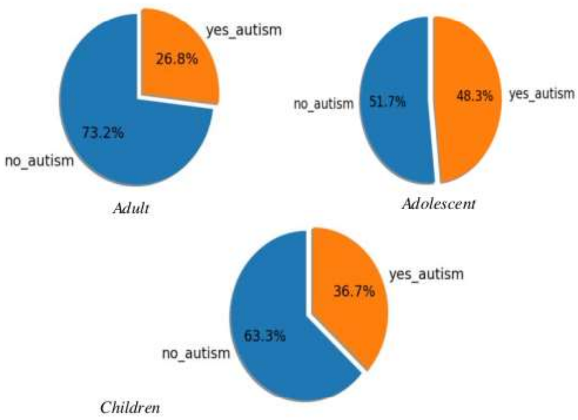

Fig.1. Percentage of types of age group having autistic symptoms

ii. Model Evaluation

Model evaluation is the practise of applying several evaluation measures to comprehend the performance of a machine learning model as well as its advantages and disadvantages. The most common metrics for measuring classification performance include accuracy, precision, and confusion matrix. The elements of a confusion matrix are

- True Positive (TP)
- True Negative (TN)
- False Positive (FP)
- False Negative (FN)

The accuracy can be obtained by the formula-

$$\text{Accuracy} = \frac{TP+TN}{TN+TP+FN+FP}$$

For the ASD data of adults, adolescents, and children, the accuracy of machine learning techniques before and after feature selection has been examined. The three data sets' performance measures are displayed below.

TABLE I.

Results of ASD screening in children			
Algorithms	***Accuracy***		***Feature***
	Before	***After***	
Logistic Regression	100	100	10/21
Random Forest	100	100	9/21
Support Vector Machine	98.30	100	12/21
Naïve Bayes	94.92	96.61	17/21
K-Nearest Neighbor	81.36	83.05	15/21

The results of the asd screening for children are shown in table 4. Before implementing feature selection, various machine learning models on the dataset for diagnosing ASD children found accuracy ranging from (81.36% - 100%). KNN produced the lowest accuracy, 81.36%, whereas random forest and logistic regression both produced 100% accuracy. The accuracy attained after feature selection and training machine learning models with these selected features is between (83.05% - 100%).

TABLE II.

Results of ASD screening in Adolescents			
Algorithms	***Accuracy***		***Feature***
	Before	***After***	
Logistic Regression	100	95	13/21
Random Forest	85	80	16/21
Support Vector Machine	95	90	15/21
Naïve Bayes	80	85	16/21
K-Nearest Neighbor	80	80	16/21

The results of the asd screening for adolescents are shown in table 5. Before implementing feature selection, various machine learning models on the dataset for diagnosing ASD children found accuracy ranging from (80% - 100%). KNN and Naïve Bayes produced the lowest accuracy, 80%, whereas logistic regression produced 100% accuracy. The accuracy attained after feature selection and training machine learning models with these selected features is between (80%- 95%).

TABLE III.

Results of ASD screening in Adults			
Algorithms	***Accuracy***		***Feature***
	Before	***After***	
Logistic Regression	100	100	16/21
Random Forest	79	98.58	10/21
Support Vector Machine	100	97.87	9/21
Naïve Bayes	98.58	98.58	15/21
K-Nearest Neighbor	98.58	97.87	16/21

The results of the asd screening for adults are shown in table 6. Before implementing feature selection, various machine learning models on the dataset for diagnosing ASD children found accuracy ranging from (79% - 100%). Random Forest produced the lowest accuracy, 79%, whereas Logistic Regression produced 100% accuracy. The accuracy attained after feature selection and training machine learning models with these selected features is between (97.87% - 100%).

VI. CONCLUSION

Several machine learning approaches were used in this study to try and detect autism spectrum disorder. The effectiveness of the models employed for ASD detection on non-clinical datasets from three sets of age groups, namely children, adolescents, and adults, was examined using performance assessment criteria. After applying feature selection to a dataset of children, Random Forest and SVM demonstrated 100% accuracy alongside Logistic Regression. Accuracy improvements were also seen with the other two approaches. But all other methods' accuracy decreased in adolescent ASD screenings, with the exception of Naive Bayes. After feature selection, adult ASD screening dataset accuracy increased. For all three data sets, Logistic Regression performs better both before and after the use of feature selection.

VII. REFERENCES

[1] S. Raj, S. Masood, "Analysis and Detection of Autism Spectrum Disorder Using Machine Learning Techniques", Procedia Computer Science, 167,994-1004, 2020.doi: 10.1016/j.procs.2020.03.399

[2] Vaishali R., and R. Sasikala, "A machine learning based approach to classify Autism with optimum behaviour sets", International Journal of Engineering & Technology 7(4): 18, 2018. doi: 10.14419/ijet.v7i3.18.14907Published

[3] J. A. Kosmicki, V. Sochat, M. Duda, and D. P. Wall, "Searching for a minimal set of behaviors for autism detection through feature selection-based machine learning," *Transl. Psychiatry*, vol. 5, no. 2, p. e514, 2015.

[4] A. S. Mohanty, P. Parida, K. C. Patra," Identification of Autism Spectrum Disorder using Deep Neural Network" *Journal of Physics: Conference Series*, Jan. 2006.

[5] B. R. Elshoky, O. A. Ibrahim, A. A. Ali, "Machine Learning Techniques Based on Feature Selection for Improving Autism Disease Classification*", International Journal of Intelligent Computing and Information Sciences*, July 2021.

[6] Md. Rahman ,O. L. Usman , R. C. Muniyandi,, S. Sahran, S. Mohamed and R. A. Razak ," A Review of Machine Learning Methods of Feature Selection and Classification for Autism Spectrum Disorder", *Brain Sciences*,10,949,2020.

[7] Md. Hossain, A. Anwar and Md. Zahidul Islam, "Detecting autism spectrum disorder using machine learning techniques", *Health Information Science and Systems* 9,17, 2021.

[8] Vakadkar K, Purkayastha D, Krishnan D, "Detection of Autism Spectrum Disorder in Children Using Machine Learning Techniques", *SN Computer Science*, 2(5): 386, 2021.

[9] K. K. Hyde, N. LaHaye, C. Parlett-Pelleriti, R. Anden, E. Linstead et al. "Applications of Supervised Machine Learning in Autism Spectrum Disorder Research: a Review". *Review Journal of Autism and Developmental Disorders* 6, 128–146, 2019.

[10] Tania Akter , Md. Shahriare Satu, Md. Imran Khan , Mohammad Hanif Ali , Shahadat Uddin , Pietro Lió , Julian M. W. Quinn, Mohammad Ali Moni, "Machine Learning-Based Models for Early Stage Detection of Autism Spectrum Disorders", *in IEEE Access*, vol. 7, pp. 166509-166527, 2019.

[11] Fadi Fayez Thabtah (2017), "Autistic Spectrum Disorder Screening Data for Children", https://archive.ics.uci.edu/ml/machine-learning-databases/00419/

[12] Fadi Fayez Thabtah (2017), "Autistic Spectrum Disorder Screening Data for Adolescent", https://archive.ics.uci.edu/ml/machine-learning-databases/00420/

[13] Fadi Fayez Thabtah (2017), "Autistic Spectrum Disorder Screening Data for Adult", https://archive.ics.uci.edu/ml/machine-learning-databases/00426/

[14] https://www.autism-society.org/what-is/facts-and-statistics/. Accessed 25 Dec 2019.

[15] T. W. Edgar, D. O. Manz, Chapter 4 - Exploratory Study, *Research Methods for Cyber Security*, pp. 95-130,2017.

[16] K. S. Omar, P. Mondal, N. S. Khan, M. R. K. Rizvi and M. N. Islam, "A Machine Learning Approach to Predict Autism Spectrum Disorder," *International Conference on Electrical, Computer and Communication Engineering (ECCE): IEEE*, pp. 1-6,2019.

[17] E. Weir, C. Allison, S. Baron-Cohen, "Identifying and managing autism in adults", vol. 31, pp.12-16,2020.

[18] E. Weir, C. Allison, S. Baron-Cohen, "Autism in children: improving screening, diagnosis and support", vol.31, pp.20-24,2020.

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