American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-10, Issue-03, pp-121-126
www.ajer.org
Research Paper Open Access

A Comparative Analysis of Autistic Spectrum Disorder (ASD) Disease for Children using ML Approaches

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ABSTRACT : *Autistic Spectrum Disorder (ASD) is a neuro developmental disorder that is associated with significant treatment costs and can significantly decrease these early diagnoses. Unfortunately, time delay is occurred and procedures are not economically efficient for an ASD diagnosis. The economic effects of autism and the rise in the number of ASD cases worldwide indicate an urgent need to create reliable screening approaches.*

A time efficient and affordable ASD screening is now in the process of assisting health providers and advising people whether they can be officially diagnosed. Nowadays machine learning plays a vital role in medical science and this field can detect more complex disease at a very early stage. However the proposed dataset in this study the ASD performance analyzes using some machine learning algorithms to find out the risk factor of ASD disease. In this article precision, recall, f measure are found using machine learning models. Moreover the applied algorithms are sequential minimal optimization (SMO), stochastic gradient descent (SGD), random forest (RF), multilayer perceptron (MLP), j48 and logistic regression. The MLP algorithm shows the best outcome approximately 100% accuracy.

KEYWORDS: *Autistic spectrum disorder, Confusion metrics, F measure, False Positive (FP), Precision, True Positive (TP), Recall, Receiver Operating Characteristic (ROC)*

Date of Submission: 27-02-2021 Date of acceptance: 12-03-2021

I. INTRODUCTION

Autism Spectrum Disorder (ASD) is a situation concerned with mental health that impacts how an individual sees and associates with others, messing up social interconnection and communication. It is an exceptionally heterogeneous neuro developmental disorder with numerous causes, courses, and a wide range of syndrome rigor [1]. The cause of the disease is still indistinct. However, there is the evidence that it is due to genetics. At the age of one or two years, the symptoms of the disease begin to appear in the behavior of the child. According to modern research, 6 out of every 1,000 people are infected with ASD [2]. However, advanced diagnostic methods and awareness raising are considered to be the main reasons behind this [2]. The core features of ASD such poor eye contact, lack of facial expression, speak abnormal tune and, cannot understand simple questions and so more. It is probable that between 64% and 91% of the danger is due to family [2]. Recently, the detonation rate of autism around the world is innumerable and it is increasing at a very high rate. According to WHO about 1 out of every 160 children has ASD [3]. A few people with this issue can live autonomously, while others require long lasting consideration and backing. In 2013, the Diagnostic and Statistical Manual of Mental Disorders version 5 (DSM-5) replaced the prior subgroups of autistic disorder, Asperger Syndrome (AS), Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS), and childhood dis integrative disorder with the single term ”autism spectrum disorder[3]. An expected 1% of the population (62.2 million around the world) is on the autism spectrum as of 2015[4]. In the US it is estimated to affect more than 2% children (out of 1.5 million people) as of 2016 [4]. Diagnosis of autism requires a lot of time and cost. Prior recognition of autism can go to extraordinary assistance by recommending patients with an appropriate prescription at the beginning phase. Previously various works have been done on this topic like identify autistic children on their motor abnormalities [16], Predict Autism Spectrum Disorder (ASD) using

machine learning [17], mobile detection of autism through machine learning on home video [18], for the surveillance of autism disorder children developed a machine learning algorithm [19].

II. LITERATURE REVIEW

Qandeel Tariq et al. proposed the work to reduce time and test ASD [20] .They analyzed video on machine learning and taken the test applied this on ASD children's and non ASD Children's and the outcome accuracy result was 90% [20]. Zhou et al. tried to improved characterization and prediction in autism spectrum disorders (ASD) with graph theory and machine learning analysis of multi-parametric MRI data [21].They released MRI data of over 500 ASD patients. Wenbo Liuet al. tried to find out Autism Spectrum Disorder (ASD) by scanning human face and eyes movement and their outcome accuracy was 88.51% [22]. For limited access of ADI-R and ADOS in China, they confirmed the diagnosis using the Chinese version of Autism Spectrum Quotient. They used three group members of 29 and their age 4 to 11 years and they used ASD classification framework. Demirhan, Ays¸ et al. worked for identify Autism spectrum disorder most accurately and reduced time for identify ASD (Autism Spectrum Disorder).k-nearest neighbor (kNN) algorithm used and 104 instances and 10 parameters in dataset for analysis [23]. Their accuracy rate was 95%, 89%, and 100% were achieved using SVM, kNN and RF methods [23]. Kazi Shahrukh Omar et al. tried to make an effective prediction based on Machine Learning technique and developed a mobile application for ASD [24]. They used merging Random Forest-CART (Classification and Regression Trees) and Random Forest-ID3 (Iterative Dichotomiser 3) and developed a mobile application based on the proposed prediction model. Domenico Bertoncelli et al. prior studies have developed and tested a predictive learning model to identify factors associated with ASD (Autism Spectrum Disorder) in adolescents with CP (Cerebral Palsy)[25]. This was a multicenter controlled cohort study of 102 adolescents with CP and 11 parameters were collected between 2005 and 2015[25].

III. PROPOSED MODEL

3.1 Algorithms Description

Logistic regression: Logistic Regression is a prescient investigation algorithm and dependent on the idea of probability. It is utilized for anticipating the straight out ward variable utilizing a given arrangement of autonomous variables. Logistic relapse predicts the yield of a clear cut ward variable. Accordingly the result must be a clear cut or discrete worth. It tends to be either Yes or No, 0 or 1, valid or False, etc. However as opposed to giving the specific incentive as 0 and 1, it gives the probabilistic qualities which lies somewhere in the range of 0 and 1. Logistic Regression is a lot like the Linear Regression aside from how they are utilized. Direct Regression is utilized for taking care of Regression issues, while Logistic relapse is utilized for taking care of the arrangement issues. In Logistic relapse, rather than fitting a relapse line, we fit an "S" formed strategic capacity, which predicts two greatest qualities (0 or 1). The bend from the strategic capacity demonstrates the probability of something. Logistic Regression is a critical AI calculation since it can give probabilities and group new information utilizing ceaseless and discrete datasets.

Random Forest: Random forests have almost similar hyper-parameters as a choice tree or a stowing classifier. Working of random forest algorithm it is appreciated the working of random forest count with the help of the advances initially, start with the determination of arbitrary examples from a given dataset. Next one is the count will build up a decision tree for every model. At that point it will get the forecast result from each choice tree. In this progression, casting a ballot will be performed for each anticipated outcome. At last, select the most casted ballot forecast result as the last expectation result. When utilizing the random forest algorithm to tackle relapse issues, there is utilizing the mean squared blunder (MSE) to how the information branches from every hub.

MLP: A multilayer perceptron (MLP) is a class of feed forward counterfeit neural organization. A MLP comprises at any rate three layers of hubs: an information layer, a concealed layer and a yield layer. Aside from the information hubs, every hub is a neuron that utilizes a nonlinear initiation work. MLP uses a managed learning strategy called back propagation for preparation. Its various layers and non-straight actuation recognize MLP from a direct perceptron. It can recognize information that is not straightly distinct.

SGD: Stochastic Gradient Descent (SGD) is a crucial yet fit way to deal with overseeing fitting straight classifiers and regressors under twisted episode limits, in instant support vector machines and logistic regression. Dismissing the way that utilizing the entire dataset is truly significant for getting to the minima in a less disorderly and less emotional way, at any rate the issue emerges when our datasets get massive. Acknowledge, there have 1,000,000 models in your dataset, hence in the event that there utilize an ordinary Gradient Descent streamlining system, it should utilize the all out of the 1,000,000 models for finishing one cycle while playing out the Gradient Descent, and it should be developed for each complement until the minima is reached. Thus, it winds up being computationally over the top expensive to perform. This issue is explained

by Stochastic Gradient Descent. In SGD, it utilizes essentially a solitary model, i.e., a pack size of one, to play out each cycle. The model is haphazardly altered and selected for playing the cycle. In SGD, since just one model from the dataset is picked randomly for every complement, the course taken by the assessment to go to the minima is customarily noisier than your standard Gradient Descent tally.

Naive Bayes: Naive Bayes algorithm is a supervised learning algorithm, which depends on Bayes hypothesis and utilized for taking care of grouping issues. Credulous Bayes Classifier is one of the straightforward and best Classification algorithms which helps in building the quick AI models that can make brisk forecasts. At the point when supposition of freedom holds, a Naive Bayes classifier performs better contrast with different models like calculated relapse and you need less preparing information. It performs well if there should be an occurrence of clear cut information factors contrasted with mathematical variable(s). For mathematical variables, ordinary dissemination is accepted. On the off chance that downright factor has a class (in test informational collection), which was not seen in preparing informational collection, at that point the model will allot a 0 (zero) likelihood and will be not able to make an expectation. This is regularly known as "Zero Frequency". To illuminate this, it can utilize the smoothing procedure. One of the least difficult smoothing strategies is called Laplace assessment.

SMO: Sequential Minimal Optimization (SMO) algorithm is exceptionally powerful when tackling a huge scope of vector machines. The current algorithms need to judge which quadrant the 4 Lagrange multipliers lie in, muddling its usage. Also, the current calculations all accept that the piece capacities are positive clear or positive semi-definite, restricting their applications. Having considered these inadequacies of the customary ones, a streamlined SMO algorithm dependent on SVR is proposed, and further applied in explaining SVR with non-positive Kernels. Contrasted and the current algorithms, the streamlined one is a lot simpler to be actualized without relinquishing reality effectiveness, and can accomplish an ideal relapse exactness under the reason of guaranteeing combination. In this manner, it has a specific hypothetical and functional hugeness. The Sequential Minimal Optimization (SMO) algorithm is inferred by taking the possibility of the disintegration technique to its outrageous and streamlining a negligible subset of only two focuses at each iteration. The intensity of this strategy lives in the way that the streamlining issue for two information focuses concedes a scientific arrangement, disposing of the need to utilize an iterative quadratic programming analyzer as a component of the algorithm [26-27].

3.2 Implementation Process

The step by step procedure are shown in figure 1 and also briefly described in this section

1. Input Data: In this article, 292 data has been collected to measure the analysis of Autistic Spectrum Disorder. In this dataset has 20 attributes and 1 attribute is decision class. In decision class 107 values are 0 and 185 are 1.
2. Replace Missing Value: Numerous real-world datasets may contain lost values for different reasons. They are regularly encoded as NaNs, spaces or any other placeholders. Preparing a show with a dataset that includes a part of lost values can definitely affect the machine learning model's quality. A few calculations such as scikit-learn estimators accept that all values are numerical and have and hold meaningful value. One way to handle this issue is to urge freed of the perceptions that have missing data. In any case, you'll chance losing information focuses with valuable information. An improved procedure would be to ascribe the lost values. In other words, we got to gather those lost values from the existing portion of the information. There are three fundamental sorts of lost information: Missing at random, missing completely at random, and not missing at random. In this research paper it uses imputation using mean values for replacing missing value. This way works by calculating the mean of the non-missing values in a column and then replacing the missing values within each column separately and independently from others. It can only be used with numeric data.
3. Split Data: After replacing missing values it is split the dataset into two parts. One of them is training data and another one is test data. In this work 65% data is used for training data and the other 35% data is used for test data.
4. Applying Classifier: In this work it uses 6 kinds of classifier to choose the best result for the research. The classifier are Sequential Minimal Optimization, Stochastic Gradient Descent, Random Forest, Naive Bayes, Multilayer Perception, and Logistic Regression. In this part after using all the classifier it can get the best classifier for performance.
5. Best Model: A matrix of uncertainty is a technique for summarizing the results of a classification algorithm. Assessing a confusion matrix will give a clearer under- standing of what the classification model is going to do and what kind of mistake it is going to make. In this research true positive, true negative, false positive and false negative are analyzed.
6. Classification Report: Classification consistent with the supervised learning class and the outcome has now been moved to input results. It is the most critical aspect to appreciate that the classifier witnesses its

importance after practicing the methods. The system of classification of the data points shall be used to predict the class.

7. Best Model: In this study some of the researches are based on the findings. Moreover which algorithm offers the best positive, misplace able and also the best consistency, remember, the calculations are the best algorithms in this study.

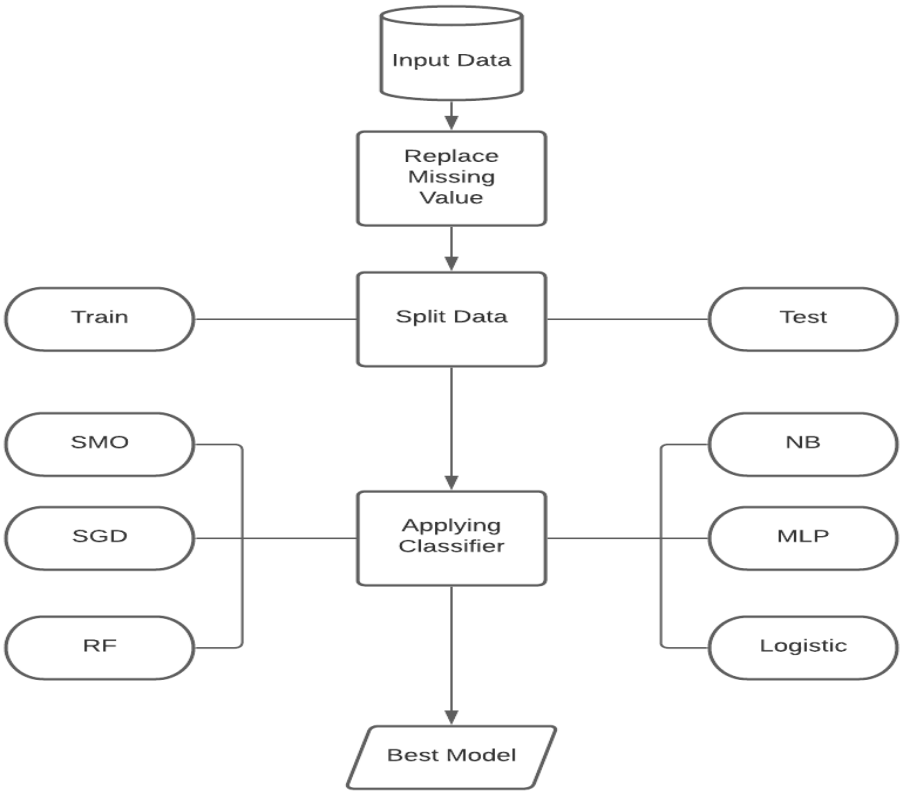

Fig.1. Proposed Model Step By Step Procedure

IV. RESULT DISCUSSION AND ANALYSIS

In this article the table 1 represents the classification report for all applied classifiers. However, sequential minimal optimization (SMO), stochastic gradient descent (SGD), random forest(RF), multilayer perceptron (MLP), j48 and logistic regression are analysis model and find out precision, recall, accuracy as well as. MLP classifier attains 100% accuracy and lowest accuracy is performed by SGD and logistic regression about 93%.

Table 1: Evaluation metrics analysis of our uses classifier

Model Name	Label	TP Rate(%)	FP Rate(%)	Precision(%)	Recall(%)	F-Measure(%)	ROC(%)
SMO	No	94	4	96	94	95	95
	Yes	95	5	93	95	93	95
SGD	No	94	8	93	94	94	92
	Yes	91	5	93	91	92	92
RF	No	98	0	100	98	99	100
	Yes	100	2	97	100	98	100
NB	No	98	0	100	98	99	100
	Yes	100	2	97	100	98	100
MLP	No	100	0	100	100	100	100
	Yes	100	0	100	100	100	100
Logistic	No	91	4	96	91	93	97
	Yes	95	8	89	95	92	97

In table 2 it represents the confusion metrics of all applying classifiers. Here also shows that MLP gives the best true positive and false negative value. For this reason MLP is the best from other applying classifiers.

Table 2: Confusion metrics analysis for applying classifier

Model Name	Accuracy (%)	Label	Predictive Positive	Predictive Negative
SMO	95	Actual Negative	54	3
		Actual Positive	2	43
SGD	93	Actual Negative	54	3
		Actual Positive	4	41
RF	99	Actual Negative	56	1
		Actual Positive	0	45
NB	99	Actual Negative	56	1
		Actual Positive	0	45
MLP	100	Actual Negative	57	0
		Actual Positive	0	45
Logistic	93	Actual Negative	57	5
		Actual Positive	2	43

In table 3, the comparison table of existing model are described also mention their accuracy. Random Forest-ID3 shows highest (97.10%) and SVM indicates lowest (88.5%) accuracy

Table 3: Comparison analysis of previous model and our model

Reference	Model	Accuracy
Wenbo Liuet al.[21]	Support Vector Machine (SVM)	88.5%
Omar et al.[22]	Decision Tree-CART, Random Forest-CART, and Random Forest-ID3	92.26%, 93.78%, and 97.10%
Bertoncelli et al.[25]	Logistic Regression	75%
Crippa et. al. [27]	Support Vector Machine (SVM)	96%
Thabtah et. al. [28]	Rules-Machine Learning	95%

V. CONCLUSION

In this research, comparative analysis has been shown for Autistic Spectrum Disorder (ASD) disease. Therefore six machine learning classifiers have been used to find out precision, recall, F1 score and so on. In this study, the proposed random forest classifier considered the best model because it achieved about 100% accuracy and also the highest from others. In future this study will use a deep learning model and more data from different area.

REFERENCES

[1]. Amaral, D. G., Schumann, C. M., & Nordahl, C. W. (2008). Neuroanatomy of autism. Trends in neurosciences, 31(3), 137-145.
[2]. Bangla wikipedia, available at https://bn.wikipedia.org/wiki/autism, last access on 09-11-2020 at 08.35am.
[3]. WHO available at https://www.who.int/news-room/fact- sheets/detail/autism-spectrum-disorders, last access on 09-11-2020 at 09.00am.
[4]. Wikipedia, available at https://en.wikipedia.org/wiki/Autism spectrum, last access on 10-11-2020 at 10.00pm.
[5]. Lord C, Rutter M, Le Couteur A. Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. J Autism Dev Disord. 1994;24(24):659–85.
[6]. Lord C, Risi S, Lambrecht L, Cook EH Jr, Lambrecht BL, DiLavore PC, Pickles A, Rutter M. et al. the autism diagnostic observation schedule-generic: a standard measure of social and communication deficits associated with the spectrum of autism. J Autism Dev Disord. 2000;30(30):205–23.
[7]. Baron-Cohen S, Wheelwright S, Skinner R, Martin J, Clubley E. The autism-spectrum quotient (AQ): evidence from Asperger syndrome/high- functioning autism, males and females, scientists and mathematicians. J Autism Dev Disord. 2001;31(31):5–17.
[8]. Berument SK, Rutter M, Lord C, Pickles A, Bailey A, MRC Child Psychiatry Unit, Social, Genetic and Developmental Psychiatry Re- search Centre. Autism screening questionnaire: diagnostic validity. Br J Psychiatry. 2000;(175):444–51.
[9]. Allison C, Auyeung B, Baron-Cohen S. Toward brief "red flags" for autism screening: the short Autism Spectrum Quotient and the short quantitative checklist for autism in toddlers in 1,000 cases and 3,000 controls. J Am Acad Adolesc Psychiatry. 2012;51(2):202–12Y.
[10]. Ruzich E, Allison C, Smith P, Watson P, Auyeung B, Ring H, Baron- Cohen S. Measuring autistic traits in the general population: a systematic review of the Autism-Spectrum Quotient (AQ) in a nonclinical popu- lation sample of 6,900 typical adult males and females. Mol Autism. 2015;6(2):1–12.
[11]. Mayer JL, Heaton PF. Age and sensory processing abnormalities predict declines in encoding and recall of temporally manipulated speech in high-functioning adults with ASD. Autism Res. 2014;7(7):40–49.
[12]. Mythili M, Shanavas Mohamed R. A study on Autism spectrum disor- ders using classification techniques. Ijcsit. 2014;5(6):7288–91.
[13]. Pancers K, Derkacz A (2015). Consistency-based pre-processing for classification of data coming from evaluation sheets of subjects with ASDS. Federated conference on Computer Science and Information Systems, 63–67.
[14]. Duda M, Ma R, Haber N, Wall DP. Use of machine learning for behav- ioral distinction of autism and ADHD. Transl Psychiatry. 2016;9(6):732.
[15]. Bone D, Goodwin MS, Black MP, Lee -C-C, Audhkhasi K, Narayan. Applying machine learning to facilitate autism diagnostics: pitfalls and promises. J Autism Dev Disord. 2014;45(5):1–16.
[16]. Crippa, Alessandro, et al. "Use of machine learning to identify children with autism and their motor abnormalities." Journal of autism and developmental disorders 45.7 (2015): 2146-2156.

[17]. Omar, K. S., Mondal, P., Khan, N. S., Rizvi, M. R. K., Islam, M.N. (2019, February). A machine learning approach to predict autism spectrum disorder. In 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE) (pp. 1-6). IEEE.
[18]. Tariq, Q., Daniels, J., Schwartz, J.N., Washington, P., Kalantarian, H. and Wall, D.P., 2018. Mobile detection of autism through machine learning on home video: A development and prospective validation study. PLoS medicine, 15(11), p.e1002705.
[19]. Maenner, M. J., Yeargin-Allsopp, M., Van Naarden Braun, K., Chris- tensen, D. L., & Schieve, L. A. (2016). Development of a machine learning algorithm for the surveillance of autism spectrum disorder. PloS one, 11(12), e0168224.
[20]. Zhou, Yongxia, Fang Yu, and Timothy Duong. "Multiparametric MRI characterization and prediction in autism spectrum disorder using graph theory and machine learning." PloS one 9.6 (2014): e90405.
[21]. Liu, Wenbo, Ming Li, and Li Yi. "Identifying children with autism spec- trum disorder based on their face processing abnormality: A machine learning framework." Autism Research 9.8 (2016): 888-898.
[22]. Omar, K. S., Mondal, P., Khan, N. S., Rizvi, M. R. K., & Islam, M. N. (2019, February). A machine learning approach to predict autism spectrum disorder. In 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE) (pp. 1-6). IEEE.
[23]. Demirhan, Ays¸e. "Performance of machine learning methods in deter- mining the autism spectrum disorder cases." Mugla Journal of Science and Technology 4, no. 1 (2018): 79-84.
[24]. Tariq, Q., Daniels, J., Schwartz, J. N., Washington, P., Kalantarian, H., & Wall, D. P. (2018). Mobile detection of autism through machine learning on home video: A development and prospective validation study. PLoS medicine, 15(11), e1002705.
[25]. Bertoncelli, Carlo M., et al. "Using artificial intelligence to identify factors associated with autism spectrum disorder in adolescents with cerebral palsy." Neuropediatrics 50.03 (2019): 178-187.
[26]. M. U. Emon, M. S. Keya, T. I. Meghla, M. M. Rahman, M. S. A. Mamun and M. S. Kaiser, "Performance Analysis of Machine Learning Approaches in Stroke Prediction," 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, 2020, pp. 1464-1469, doi: 10.1109/ICECA49313.2020.9297525.
[27]. M. A. Islam, M. S. Islam, M. S. Hossen, M. U. Emon, M. S. Keya and A. Habib, "Machine Learning based Image Classification of Papaya Disease Recognition," 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, 2020, pp. 1353-1360, doi: 10.1109/ICECA49313.2020.9297570.

Ohidujjaman, et. al. "A Comparative Analysis of Autistic Spectrum Disorder (ASD) Disease for Children using ML Approaches."*American Journal of Engineering Research (AJER)*, vol. 10(3), 2021, pp. 121-126.