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# Autism Spectrum Disorder Classification Using Machine Learning and Deep Learning- A Survey

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## Abstract

Modern, highly developed technology has impacted reputable procedures in the medical and healthcare industries. Smart healthcare prediction to the senior sick patient is not only for quick access to data but also to get dependable treatment in an accurate prediction by healthcare service provider. smart health prediction helps in the identification of numerous diseases. Based on patient experience, Deep learning technology provides a robust application space in the medical sector for health disease prediction problems by applying deep learning techniques to analyze various symptoms. In order to classify things and make precise predictions about diseases, deep learning techniques are utilized. people's health will be more secure, medical care will be of a higher caliber, and personal information will be kept more secret. As deep learning algorithms become more widely used to construct an interactive smart healthcare prediction and evaluation model on the basis of the deep learning model, CNN is upgraded. Advanced deep learning algorithms combined with multi-mode approaches and resting-state functional magnetic resonance represent an innovative approach that researchers have taken. A DL structure for the programmed ID ASD using highlights separated from the corpus callosum and cerebrum volume from the Stand dataset is proposed. Imaging is used to reveal hidden diseased brain connectome patterns to find diagnostic and prognostic indicators.

**Keywords:** ASD, CNN, Machine Learning, DBN

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## 1. Introduction

ASD is a formative problem that influences connection, correspondence, and conduct. A screening process is used to identify autism spectrum disorder for the first time. At this early stage, screening instruments are preferable over clinical observations since routine behaviors can be accentuated in busy outpatient clinics, making it more difficult to discover an ASD [1]. A novel autism screening technique that uses deep learning algorithms to replace the traditional score formulas used in traditional screening methods [2]. According to the author, deep learning techniques should be used to analyze genetic data from Numerous uncomplicated households that are at threat of developing ASD in order to recognize causal transformations and develop a sophisticated indicative system for mental imbalance mutations [3]. The architecture and functioning of the brain resemble complicated networks. Fig1 shows the affected parts of the brain by autism. The cerebral cortex is responsible for the complex mental processes that make humans unique. The basal ganglia are involved in the control of movement, motor learning, and various aspects of behaviour. The amygdala plays a key role in emotional processing and social behaviour. The hippocampus is a part of the limbic system and has connections with various other brain regions. The brainstem is a vital region of the brain located at the base of the skull, connecting the spinal cord to the rest of the brain. The brain's left and right hemispheres are joined by a substantial bundle of nerve fibers called the corpus callosum. The cerebellum is a distinct structure positioned in the rear of the brain, below the cerebral hemispheres.

The main investigation determines the prevalence of ASD in youngsters with NF-1[4]. A deep-generative paradigm that integrates diffusion tensor imaging tractography with rs_fMRI connectivity to model complementary data and derives disease-predictive markers [5]. A method using machine learning to categorize neurological illnesses while offering a framework that is comprehensible. The majority of current approaches frequently fail to deliver sufficient performance. The combination of EEG and eye-following information has been presented as a new multimodal determination approach for diagnosing ASD in youngsters [6][7]. Side effects of ASD are shown by being lessened through fecal microbiota transplantation. More treatment sessions are taken, and the outcome is better, in addition to reducing systemic inflammation, WMT dramatically improved GI symptoms, sleep issues, and ASD symptoms in children with ASD [8]. A generic uniform framework was used to assess the effectiveness of five prominent GNN architectures in the diagnosis of major depressive illness and autistic spectrum disorder in two multi-site diagnostic datasets using functional brain scans [9]. To identify ASD sufferers from usual controls using fMRI data, the author [10] fostered a system called a geometry-transient converter.

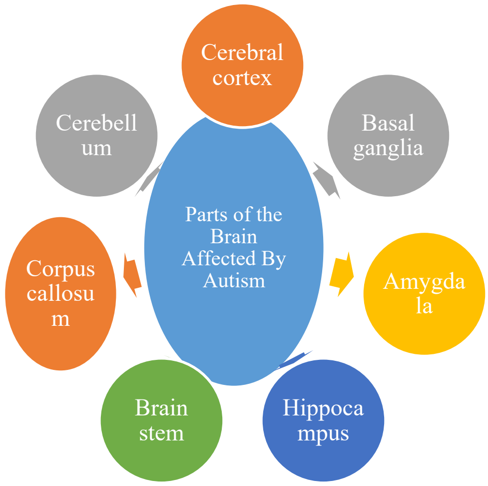


**Figure 1.** Parts of the brain affected by autism.

## 2. Machine Learning-Based Models

To help with the advancement of illness-explicit designated therapeutics, computational techniques to recognize ASD caused by genetic abnormalities are essential. The author [12] states that by categorizing the mutations that underlie these phenotypes managed AI strategies can be used to build a framework to recognize syndromic ASD. The significance of early diagnosis attracted scientists to several machine learning-based approaches. On the autism spectrum, it is common to see deficiencies in social language skills, particularly storytelling abilities. Provided its ability to help decisions about the finding and management of mental sicknesses and problems, advancements in machine-learning technologies may have an impact on clinical psychology and psychiatry. To test the effectiveness of deep neural networks in recognizing text-based utterances that may be indicative of autism spectrum disorder (ASD), particularly narratives written by people with ASD. Table 1 shows the accuracy of the ABIDE-I collaboration is responsible for providing the data for these parcellations.

The author [14] uses the information from rsFmri Site-specific information to categorize ASD from non-ASD. The author [15] uses visual behavior to recognize those who are on autistic spectrum disorders. A model for using visual data to detect the existence of autism spectrum disorder is created. The author [16] presents A novel way of indicators retrieval for ASD that focuses on the application of chart hypothetical metrics Table 2: Shows the analysis of various classifiers in machine learning-based models. In Table 2 DNN showed the highest performance rate with the augmented dataset. This dataset includes 547 visually interpreted Eye-

Tracking Scan Path (ETSP) pictures made from the eye-tracking data of 59 people who took part in a test employing a variety of autistic-precise visual stimuli delivered by an SMI RED eye tracker.

Table 1. Classification accuracy using ABIDE-1 consortium.

| Method | Accuracy | Sensitivity | Specificity |
|---|---|---|---|
| ASD-DiagNet[13] | 67.5 | 63.4 | 71.5 |
| SVM[13] | 67.5 | 63.9 | 70.9 |
| Random forest[13] | 65 | 56.8 | 72.7 |

Table 2. Analysis of classifier performance.

| Classifier | Sensitivity % | specificity% | PPV% | NPV % | AUC % |
|---|---|---|---|---|---|
| DSVM[11] | 44.06 | 55.55 | 52.0 | 47.61 | 51.50 |
| DNN[11] | 78.57 | 75.47 | 87.12 | 62.50 | 78.00 |
| **DNN-Augmented dataset[11]** | **93.28** | **91.38** | **94.46** | **90.06** | **97.00** |

## 3. Deep Learning-Based Models

According to sophisticated MRI techniques, a significant rise in neuropsychiatric illnesses has been observed recently. In applications involving Clinical Picture Examination, deep learning, a machine learning subfield, is increasingly being employed. Using a mix of information, the author claims that a Deep Belief Network was used to categorize and represent learning activities [17]. The DBN was used in order to concentrate on the fusion of rsfMRI, grey matter, and white matter information. The author [18] presented a DBN for ASD classification. Based on fMRI the author [19] recommended a powerful federated multi-task learning system to mutually diagnose many linked mental diseases. To reduce the optimization of personalized conflicts caused by modifying shared parameters in MTL. Additionally, the suggested system offers useful modules like federated biomarker interpretation, personalized model learning, and privacy protection. The author [20] applies deep learning about how to hereditary information from a huge number of simplex families in danger of ASD to recognize contributing changes and to make a high-level symptomatic classifier for mental imbalance screening. Profound brain networks outflank shallow AI models on perplexing and high-layered information. The author [21] suggests that face recognition with a transferable acquiring system has been enhanced to find autistic children early on. To more accurately recognize kids with ASD in the beginning phases.

The deep belief network was used by the author [19] to develop a unique graph-based categorization model. A diagram expansion of K-nearest neighbors is used to pick the notable connectedness capabilities. In order to locate patients with ASD considering a sizable cerebral scan sample, the author [20] employed graph representation learning methods. Brain functional connectivity patterns are primarily used to diagnose ASD since it is characterized by social difficulties and recurrent behavioral symptoms. The core of ASD categorization consists of efforts to identify the brain patterns that resulted from ASD. Here it is asserted that learning techniques using graph representations are suitable for taking into account the brain's connection patterns. These techniques are capable of capturing both the regional and global aspects of the entire brain structure. The intricacy and worldwide aspects of the cerebrum organization have been disregarded in several conventional methods that have been put out in recent years. The majority of deep learning-based techniques typically require numerous parameter adjustments throughout the learning process.

The Author [21] presented a Deep-broad learning technique to learn the computational interconnectivity architecture of the more advanced neural properties to aid in the findings of ASD in order to get around the issues discussed prior. Table 3 shows the performance of different classifiers using deep learning techniques. There are 3,014 faces in this dataset, including 1,507 autistic children and 1,507 typically developing youngsters. The structure of this study is based on the VGG16 and Xception models. The VGG16 model showed the highest rate of performance. The Xception classifier showed the most noteworthy rate of specificity. One of the most well-known deep learning techniques is CNN. Prioritizing learnable weights and biases, it uses the information picture to determine the class of the picture. The connection and communication between cells inside the mathematical decrease in the number of parameters through the maximum amount of pooling and average pooling techniques. In their study presented at the 13th International Conference on Computing Communication and Networking Technologies, Vikas et al. (2022) examined the classification of agricultural land using machine learning algorithms. The research, illustrated using Zhashui County as an example, established a Rating Factor System through methods like the Delphi method and straight-line method. They assessed various factors related to the land, calculating a classification index and achieving preliminary land classification. Furthermore, the study emphasized the role of weather and soil characteristics in agricultural decision-making, highlighting the potential for more accurate and cost-effective land classification through satellite images and machine learning algorithms [22].In their book "Decision Making And Problem Solving," Shetkar and Mohanty (2021) explore the need for robust information processing and decision-making strategies in today's complex economic landscape. They emphasize the potential for enhancing decision-making abilities by tapping into the innate capacities of the brain. The authors introduce the concept of the mid-brain connective, proposing a model that focuses on optimizing the connections and integrations between the mind, brain, and body. This approach aims to empower individuals for more effective decision-making, ultimately contributing to their overall well-being [23].

## 3.1. Xception Model

A deep CNN called Xception offers new inception layers. A pointwise convolution layer is added after the inception layers, which are constructed from depth-wise convolution layers with 71 layers. The size of the Xception model is 88MB and 22.8 million parameters. The 299x299 input image size is the standard for this model. Convolutions that are Depth Wise Separable are alternatives to traditional convolutions that are ostensibly significantly faster to compute.

## 3.2. Visual Geometry Group Network Model

This algorithm, which depends on the CNN method and is frequently used on ImageNet, is advantageous for its simplicity. In VGG19, max-pooling is used as an assigner to minimize the input volume size. Neurons adopted the VGG19 framework to connect each layer to the others. The 138 million parameters that makeup VGGNet-16 can be a little difficult to manage. VGG is possible with transfer learning. In which the parameters are updated for improved accuracy, and you can use the parameter values once the model has been trained on a dataset.

## 3.3. MobileNet

In order to filter images, MobileNet uses the same convolution technique as CNN, but with a different method than how CNN did it before. In contrast to the standard convolution carried out by conventional CNNs, it makes use of the concepts of depth convolution and point convolution. As a result, CNN is better able to predict images, enabling them to compete in mobile systems equally.

Table 3. Testing results for the deep learning models.

| Classifiers | Performance | | | |
|---|---|---|---|---|
| Deep Belief Network[20] | Accuracy-65% | | | |
| Multitask learning framework[19] | Accuracy-83.29% | | | |
| CNN –Genotype-based Deep learning[21] | Accuracy-88.56% | | | |
| KNN-MobileNet | Accuracy-92.10% | | | |
| CNN[18] | Model | | Accuracy | |
| | NASNET | | 78% | |
| | VGG19 | | 80% | |
| | InceptionV3 | | 89% | |
| | Xception | | 91% | |
| | MobileNet | | 95% | |
| **CNN-Flask framework[21][18]** | **Model** | **Accuracy** | **Specificity** | **Sensitivity** |
| | **Xception** | **94%** | **95%** | **89%** |
| | **VGG16** | **95%** | **80%** | **78%** |

## 4. Conclusion

Numerous speculations of ASD center around a solitary framework or component as an illustrative instrument for mental imbalance side effects and conduct. Nonetheless, there is developing acknowledgment that ASD is a convoluted, multisystem neurodevelopmental condition with beginnings in pre-birth origins. Multiple cognitive domains and brain systems are impacted by autism, a complicated neurodevelopmental condition. According to the above-mentioned literature, children with autism have different facial characteristics than those typically developing's who are of a similar age and gender. Using Machine Learning techniques DNN showed the highest performance rate with the augmented dataset but when working with a small dataset, using a Deep Neural Network (DNN) algorithm in machine learning can present challenges. Furthermore, CNN's capacity for visual recognition may help assist in the early detection of ASD in children using Deep learning techniques with more samples. In light of the aforementioned findings, we set out to construct a perfect CNN framework that can identify the characteristics of children with autism with the highest degree of sensitivity and specificity using face images.

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