Autism and its Classification Techniques -A Review

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Abstract— **Autism is a Neurobehavioral disorder which includes the person communication, social interaction and behaviour. Autism Children are less able to interact with world than others. Autism is called a "spectrum" disorder because children's covers large spectrum of symptoms and severity. Autism spectrum disorder (ASD) is a highly heterogeneous neuro-developmental condition with multiple causes and courses that wide range in symptom severity and several associated comorbid disorders. Autism is lifelong disorder associated with other medical disorders like ADHD. This paper will describe about the problem Autism and describe about various techniques that are applied for Autism.**

Keywords— **Autism Spectrum Disorder, Autistic Disorder, RETT's, Asperger's Disorder, Pervasive Developmental Disorder- Not.**

I. INTRODUCTION

Autism-Spectrum Disorders (ASD) is a set of neurological developmental disabilities with features that includes social as well as communication challenges. In additions, individuals produce stereotyped patterns of behaviour and experience unusual responses to mental stimulation. ASD is believed to be a   lifelong disorder with no reliable cure. It is also known Pervasive Developmental Disorders (PDD) [1]. Autism as defined in IDEA 1997 means a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age 3 that adversely affects a child's educational performance. Various characteristics related with autism are engagement in repetitive activities and resistance to environmental change and unusual responses to sensory experiences [2].
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Autism Spectrum Conditions (ASC) are characterized by developmental disabilities in communication, emotional functioning, alongside restricted or repetitive behaviors. Individuals with Asperger syndrome have broadly entire verbal language development though speech production may still be unusual in terms of prosody, pragmatics, rate, volume and frequency [3]. They express distributive difficulties in social-communication and characterized by

interpersonal awkwardness with conceptual learning abilities [4].

A. Causes of Autism-Spectrum Disorders
Autism-spectrum disorders represent an irregularity of brain development and functions appearing within the first three years of life. However the brief steps are not known, autism is likely to have multiple aetiologies, including genetic factors. A range of studies have found in 10 - 37% of cases, there may be an associated medical condition (e.g. tuberous sclerosis) [5].

B. Categories of Autism Spectrum Disorder
ASD is a vivid umbrella term that comprises five different symptomatic categories. Despite some similarities in areas of disability, each category does have unique characteristics and symptomatic criteria. The diagnostic categories within ASD are [1]:
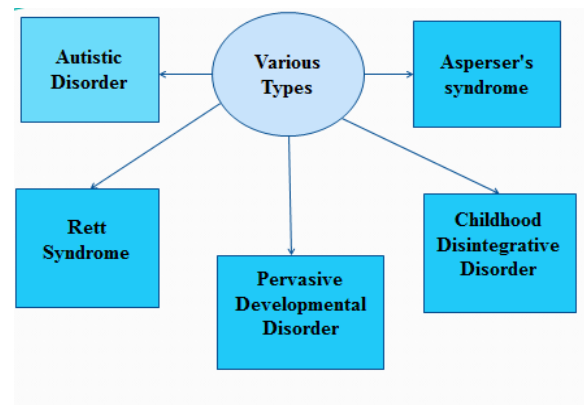

Figure 1: Various types of Autism

C. Autistic Disorder
In Autistic Disorder, the abnormalities in the social and communication areas are sustained and present before the age of three years. The patient is likely to perform a limited type of activities. Speech deferment is a main characteristic of Autism. Individuals with Autism may also have an intellectual disability [6].

Typical Characteristics of autistic are as [5]:
- Aloofness and failure to develop friendships.
- Seeking people's company but lacking ability to engage in two-way social interactions.
- Stilted, one-sided or repetitive social interactions.

- Being socially passive while tolerating social approaches.
- Awkward, avoidant or indifferent eye contact.
- Impaired understanding of other people's motivations, perspectives or feelings.
- Markedly impaired use of non-verbal behaviours to regulate social interaction eg gestures.
- A delay in or lack of development of speech without any compensatory forms of communication e.g. gesture or mime.

D. Asperger's Disorder

There can be sustained social disabilities, but impairments are not as severe in the communication area and language generally develops at the typical age. However, individuals may still have difficulties with the unwritten rules of communication like literal

interpretations. The abnormalities seem less obvious in the very young child, and become more apparent when the individual is in school. Individuals with Asperger's Syndrome may have an average or above-average IQ [6]. This disorder is more common in males (13:1) but may be under diagnosed in females [5].

Typical Characteristics of Asperger's are as:
- Normal or borderline intellectual ability.
- Clumsiness.
- Concrete, pedantic speech.
- Lack of common sense.
- Normal or even precocious speech development.
- Better verbal than non-verbal skills on psychological assessments.
- Intolerance of change.
- Anxiety.

E. Pervasive Development Disorder- Not Otherwise Specified

It is referred to as a typical autism; the identification of PP-NOS may be built when a child does not meet the criteria for a specific diagnosis but reveal a severe and universal impairment in particular behaviors [2]. The PDD-NOS is also called as Atypical Autism.

Diagnosis

Accurate diagnosis of ASD (autism spectrum disorder) is important for a number of reasons [5]:
- The parents can guess that their child is "different," along with assessment; the parents can understand their child's needs and strengths better.
- In advance the involvement and appropriate educational schedule can be planned.
- Consult with specialist and other support services can be facilitated.
- The undiagnosed adults without significant intellectual disability often find a diagnostic assessment is helpful in explaining their experience and enabling access to supports.
- The person who support are able to better understand the management process.

F. RETT's

This is not consistently placed under the umbrella of ASD. Yet it is identified as an ASD in the DSM-IV-TR. This has not always been examining the part of autism spectrum by the CDC. It has inconsistency of largely for two reasons. The first reason is that a specific gene has been identified that causes Rett's Disorder, yet no single gene has been identified for the other ASDs. Secondly, progression of Rett's Disorder is different than the previously discussed ASDs [7].

G. Childhood Disintegrative Disorder

Childhood Disintegrative Disorder (CDD) is also sometimes placed under the umbrella of ASD. It is sometime associated with other medical brain disorders, yet nothing has been recognize that accounts for all symptoms of Childhood Disintegrative Disorder (CDD) and all cases. The CDD is extremely rare in boys being affected more than girls. The children who are diagnosed with CDD start losing skills and exhibiting signs of ASD after an average of 2-4 years of normal development but typically before age 10 [7]. The children with Childhood Disintegrative Disorder may be unable to start conversations with other people or use nonverbal forms of communication like as gestures, smiles, or nodding. And they may lose interest in engaging in other interactive situations with peers and playing games and may also lose interest in relationships with other people. The children may engage in repetitive behaviors like as hand flapping, spinning, body rocking, or other types of repeated motor movement or in repetitive vocalizations like as phrases, sounds, or repeating passages from books, movies, and websites [7].

After discussing about various types of disorder of autism, Asperger's Disorder, and PDD-NOS are the most common. Although Rett's Disorder and Childhood Disintegrative Disorder (CDD) present differently than the other ASDs.

II. SEX DIFFERENCES AND AUTISM

ASC (Autism spectrum conditions) is more commonly diagnosed in males than females. This observed that coupled with widely documented sex differences in brain structure, neurotransmission in the normative population and function [8]. In various pathological conditions have motivated research into a possible relationship between the mechanisms underlying sexual differentiation and autism [3].

The sex differences in the general population are noticeable in both these domains like as females on average show higher levels of empathy compared to systemizing and on the other hand males typically show opposite profile [9]. The second known as the (EMB) 'extreme male brain theory' that can extend E–S theory to autism. Initially based on the observation of exaggerated male-typical systemizing /empathizing patterns in autism it has subsequently led to the proposal that some of the mechanisms causing autism may be linked to those related to typical sex differences [3].

III. WHAT CAN BE DONE FOR AUTISM?

Autism is a lifelong disorder and there is currently no known cure for autism. Besides many children with autism can develop significantly with early, well-planned and individually tailored educational efforts in specially adapted settings. The primary objectives are to help the child develop functional communication. The academic approaches must focus on knowledge about the unique ways that children with autism learn. Many (Applied behaviour analysis) ABA strategies as well as the structured teaching method in the (Treatment and Education of Autistic and related Communication Handicapped Children) TEACCH-model are examples of such specially-tailored academic strategies for persons with autism [10].

The first are early identification, diagnosis and assessment and next step is to present correct information for parents. Specially adapted nursery school and subsequent schooling are important requirement for the child; furthermore an adapted home environment and the daily actions are equally important for the adults. Adults and adolescents may need continued access to academic measures to further develop skills that aim to increase independence and participation [10].

IV. SOME TECHNIQUES USED FOR AUTISM

The feature framework is used for implementing the machine learning algorithms. Assume that $\{w1, \ldots, wn\}$ be a dictionary containing the n lexical features which can occur in one record **d.** Various examples of features include an unigram "communication" or a bigram "eye contact." The data can be shown as a feature vector: $d=<f_1, \ldots, f_n>$, where $f_i (i = 1 \ldots n)$ is a variable that representing the weight of the ith feature. Three classification methods are outlined as follows:

A. *Naïve Bayes*

This technique uses the concept of probability distribution of features to estimate the label of an instance by assuming independency between features. Assume that y^* be the estimated class. In a given, the document vector d, the Naïve Bayes assigns the document to a class by Bayes' theorem:

$$y^* = argmax_y P(y \mid d) \propto P(c) \prod_{i=1}^{n} P(f_i \mid c) \quad (1)$$

In above equation, y stands for positive and negative classes of the document d, P(c) for the prior probability of class c, and $P(f_i \mid c)$ for the independent probability distributions over a set of features given the class c.

B. *Bayesian Logistic Regression*

It is extended using a logistic regression model by adding a prior probability distribution like as Gaussian prior that favours sparseness in the fitted model [15]. It can be defined as:

$$P(y \mid \theta, d) = \frac{1}{1 + exp\left(-\sum_{i=1}^{n} \theta_i . f_i\right)} \quad (2)$$

In above equation, $\theta = \theta = <\theta_0, \ldots \theta_n>$ represents the parameter vector and $y \in \{1, 0\}$ represents the positive and negative classes, respectively. For a text categorization problem $P(y = 1 \mid \theta, d)$ will be an estimate of the probability that a document **d** is allocate to the positive class. Document **d** will be allocated to the positive class whenever probability is above a cut-off value.

C. *Support Vector Machine*

An effective model for text classification is SVM (Support Vector Machine) [16]. Basic idea is to find a maximum marginal hyper plane, which gives the largest separation between classes. The linear hyper plane is written as:

$$W = \sum_{i=1}^{m} a^{(i)} c^{(i)} d^{(i)}, a^{(i)} \geq 0 \quad (3)$$

In above, a^i are the Lagrangian multiples. $c^i \in \{1, -1\}$ defines for positive and negative classes of the ith document d^i and m for the number of training examples. Documents of which the corresponding a^i is non-zero are called support vectors. Let a test example $d^{(t)}$, estimated class y^t is decided by the sign of the function:

$$y^{(t)} = sign(W. d^{(t)} + b) \quad (4)$$

In this equation, b is the bias parameter. Although, sign is positive, the test data will fall on or above the hyper plane, and will be classify into the positive class.

D. *Artificial Neural Network[11]*

ANN is to return output of correct ASD diagnoses when given input microarray data collected from toddlers with ASD or typically developing (TD) toddlers. ANN is used by using Matlab's Neural Network Toolbox [12] with the specific approach of applying the feed-forward resilient back propagation learning algorithm to a multilayer perceptron. Multilayer perceptrons were chosen under the assumption that subjects with ASD and those without ASD are not linearly separable. Feed forward multilayer perceptron architecture used that had one hidden layer between the input and output layer, for a total of 2 layers of neurons (Figure 2). First layer had 5 neurons for receiving input, and the second layer had 2 neurons for producing output. That one output neuron classifies TD (typically developing) subjects as 0 and ASD 72 subjects as 1, and the other neuron classifies ASD subjects as 0 and TD subjects as 1. ASD/TD classification is 2-bit information that can be explained with only one 74 neuron, and 2 output neurons were used to observe training discrepancies between the 2 output neurons when they did not always perform equally [11].
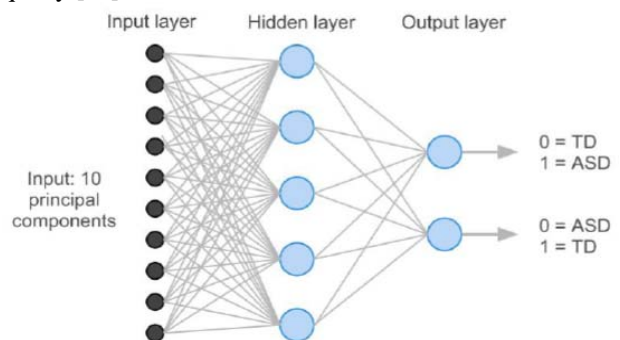

Figure 2: Network Architecture [11]

Information flow from input to output first occurs by multiplying each input into each neuron of the hidden layer by a weight value. Output (a_1) of the hidden layer is calculated by using multiplying a matrix of weights (W_1) by each input to each neuron in the hidden layer by the matrix of input values (b_1) for one subject from plus a matrix of bias values (p) for each neuron in the hidden layer:

$$a_1 = tansig(W_1 p + b_1)$$
$$tansig(n) = \frac{e^n - e^{-n}}{e^n + e^{-n}}$$

The output layer is calculated by multiplying (W_2) a matrix of weights from each output of the hidden layer to each neuron in the output layer by the matrix of output values from the hidden layer (a_1) for one subject from plus a matrix of (b_2) bias values for each neuron in the output layer:

$$a_2 = purelin(W_2 a_1 + b_2)$$
$$purelin(n) = n$$

It is differentiable so transfer function $tansig$ was chosen for the hidden layer and it has 95 inputs and outputs and these can be any real number.

E. ϵ -radial Anatomical Connectivity[13]

Without parcellations of the grey or white matter, ϵ -radial is used to construct a connectivity matrix using streamlines. The technique uses the end points of the tracts to specify the nodes by the clustering neighbouring tract end points into a set of spheres of ϵ −radius. And these spheres can make the nodes for constructing a connectivity matrix. Then call it as ϵ-radial connectivity. Although the nodes that can sphere shaped useful in localizing important regions of the brain. All these ϵ −radial nodes are typically near the grey matter/white matter interface [14] where the FA drops below 0.15, tractography stopping criterion.

V.   RELATED WORK

Prud'hommeaux et al. [15] examines the difficulties for classification of non standardized text of machine learning techniques. Kathleen T Quach [16] said that problem through the classification problem is that ASD is a very heterogeneous disorder that may have subgroups with drastically different genetic expression signatures. To improve classification, it may be useful to stratify the ASD class into subgroups and enrich the input set with clinical measures. Alexander Genkin et al. [17] presented a simple Bayesian logistic regression approach that uses a Laplace prior to avoid over fitting and produces sparse predictive models for text data. They applied this approach to a range of document classification problems and show that it produces compact predictive models at least as effective as those produced by support vector machine classifiers or ridge logistic regression combined with feature selection.

VI.   CONCLUSION

Autism spectrum disorders (ASDs) are characterized by impairments in social functioning and language, and by the presence of restricted interests and repetitive behaviors. In order to be diagnosed with autism, the behavioral symptoms in all of the above-named areas must be present by age 3. Even if the parents often notice that something is wrong during infancy, it is very difficult to diagnose autism before the age of eighteen months. This is because the behavioural symptoms used to establish the diagnosis have not clearly emerged developmentally until that age. The majority of children with autism also have a learning disability (mental retardation), although a few have average intelligence. Many also have epilepsy, and visual and hearing impairment are over-represented in this group. Persons with Asperger's syndrome, which is a condition resembling autism, have average or above average intelligence. This paper discussed about the problem of autism, various types of disorder autism and compare the effectiveness of popular machine learning methods - Naïve Bayes, Bayesian Logistic Regression and Support Vector Machine, Artificial Neural Network and ϵ-radial Anatomical Connectivity -techniques that are used to handle the autism. In future, new technique can be proposed for Autism Disorder classification by using neural network and fuzzy rules.

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