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AN IMPROVED AUTISM PREDICTIVE MECHANISM AMONG CHILDREN USING FUZZY COGNITIVE MAP AND FEATURE EXTRACTION METHODS (FEAST)

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ABSTRACT

Autism Spectrum Disorder (ASD) comprises over multiple range of developmental disabilities which includes Autism, Asperser Syndrome, and Pervasive Developmental Disorders. Individuals suffering from Autism Spectrum Disorders often struggle with significant issues over Communication, Social and Behavioral challenges. The need for the early identification of Autism Spectrum Disorder and proper treatment which is crucial for the children as well to family affected due to Autism. To support in early identification of Autism among children and optimize treatment this paper adopts Fuzzy Cognitive Map and feature extraction method. Fuzzy Cognitive Map works on dynamic weight assignment over Autism Spectrum Disorder variables, which is demonstrated using Rapid Miner tool.

Keywords: ASD, autism prediction, FCM, rapid miner.

1. INTRODUCTION

The phenomenon of inherent heterogeneity in Autism disease represents multiple challenges for research community, but not much evidence has been proved across brain dis-orders or motor disorders among Autism spectrum Disorder affected patients. Such disabilities helps to converge, implicate aberrant connectivity patterns thus involving functional networks [1]. Most recent survey reports had considered intelligence quotient (IQ) of children below age 8 years as a major metric to identify Autism Spectrum Disorder (ASD). Data set were available analyzed by age, gender, education, IQ level from various Autism and Developmental Disabilities Monitoring Network, US [14].

A spur in increase was seen among children whose average or above average intellectual ability, according to the CDC. The study and analysis carried out have identified nearly half of children affected with Autism Spectrum Disorder (ASD) for children average or above-average intellectual ability an IQ above 85. The diagnosis also considers parent-reported diagnoses noticed over symptoms such as intellectual disability, attention deficit hyperactivity disorder, cerebral palsy, seizures, Autism, stuttering or stammering of words, moderate to profound hearing loss, blindness of children, noticeable learning disorders and/or other developmental delays. Complexities in existing research [4] and inconsistencies in ASD literature [7] support the survey to involve multiple data-driven techniques to support uncover connectivity patterns [2].

Research has embraced different heuristic and statistical models to understand the theory behind treating Autism. Need for machine learning is considered as a natural fit for discovering complex patterns [11, 13] and its adoption are felt, but rare implementation or modelingapproach been reported in ASD literature. Machine Learning algorithms are implemented to perform a binary classification task of identifying features to detect Autism detection data. This research work explores the stochastic nature of detecting Autism among children based on weighted decision tree/ search algorithm along with Fuzzy Cognitive Map to predict chances of Autism. Survey has shown few works incorporated over Particle Swarm Optimization (PSO), along with Support Vector Machines (SVM) [10] for Feature Selection, termed as PSO-SVM. Much better development had utilized Support Vector Machine methods based on Recursive Feature Elimination (RFE-SVM) for feature ranking which explores Autism classification based on disabilities.

FEAST algorithm adopts feature-ranking approach [5] which identifies the fixed number of Autism top ranking feature descriptors. The feature ranking coefficients are assigned classifier weights, the inputs that are weighted by the largest value, influence the major classification decision. This multivariate classifier can be optimized during training to handle multiple variables, or features, simultaneously along with Fuzzy Cognitive Map. The research work works on the following objectives:

(a) To identify the challenges of Autism among children between 5 to 12 years.
(b) To predict the factors lying behind learning issues among Autism children.

The research challenges [10] encompass various approaches to classify and categorize Autism Spectrum Disorder affected children based on their intensity of learning skills and knowledge of understanding a subject. Classification is also based on their intensity of learning and adapting to the situation. The research work being

carried out applies Data Mining algorithms and classification models, which works along with computational methods for consistent and adaptive decisive making approaches. Fuzzy Cognitive Map [11] provides an adaptive learning frame work which identifies Autism Spectrum Disorder children based on their intensity of learning and adaptive skills. Various training models are suggested and evaluated at each step to identify the learning capability of children. To understand the factors which affect the Autism Spectrum Disorder, Recurrent Multivariate Analysis approach is being adopted.

2. SURVEY AND ANALYSIS

Autism Spectrum disorder (ASD) comprises over a range of developmental disabilities which includes Asperser Syndrome, Autism, Multiple Pervasive Developmental Disorders. Individuals suffering from Autism Spectrum Disorder encounter struggle with significant issues over Communication, Social, and Behavioral challenges. Such children also experience difficulty towards recognizing and comprehending non-verbal clues such as facial expressions [3] or maintaining eye contact or behavioral attitudes. Such difficulties often result in a reduced ability to easily and effectively engage in social and communication interactions. It is also understood that lack of attention to the facial region may account for a decreased ability to recognize emotions [6]. However, face processing abilities can be improved though effective training as discussed [8].

When a child or grown adult demonstrates deficit in brain or neuro motor planning and sequencing, such problems are also accompanied with learning aspects, coordination, or behavioral control.Existing research works suggest on need for improved prediction and characterization of social disorder in Autism which underlies the broadspectrum of human syndrome which has been suggested by genetic and neuro-functional research. Hence Autism is identified as a brain-based disorder with Genetic basis.

3. FEAST

Autism Spectrum Disorder affected children are found to be lagging in identifying key words for increased understanding, organizing time or considering their belongings for increased efficiency, listening, or following directions and self-advocacy skills. ASD (Autism Spectrum disorder) requires support in three major areas of development and functioning, to be designated as Social Interaction, Communication among people/friends, close relatives, understanding / showing interests, responsiveness to behaviors / attitudes related to normal routines. Common well known attributes found among Autism Spectrum Disorder affected children are shown in Figure-1. The mapping between various attributes affecting Autism Spectrum Disorder and its relation among children behavior may combine multiple attributes related to ignorance of common phenomenal aspects of behaviour, social relevance, emotional intelligence among social activities and its aspects.

FEAST adopts ABC [9] check list approach, where the activities of Autism Spectrum Disorder affected children are classified and weighted against activities and behaviors. This checklist explains behavioral aspects such as non-adaptive behaviors, understanding individual face looks or complexion in comparison to others. This checklist reflects a normal person challenges who responds to any daily life situation.

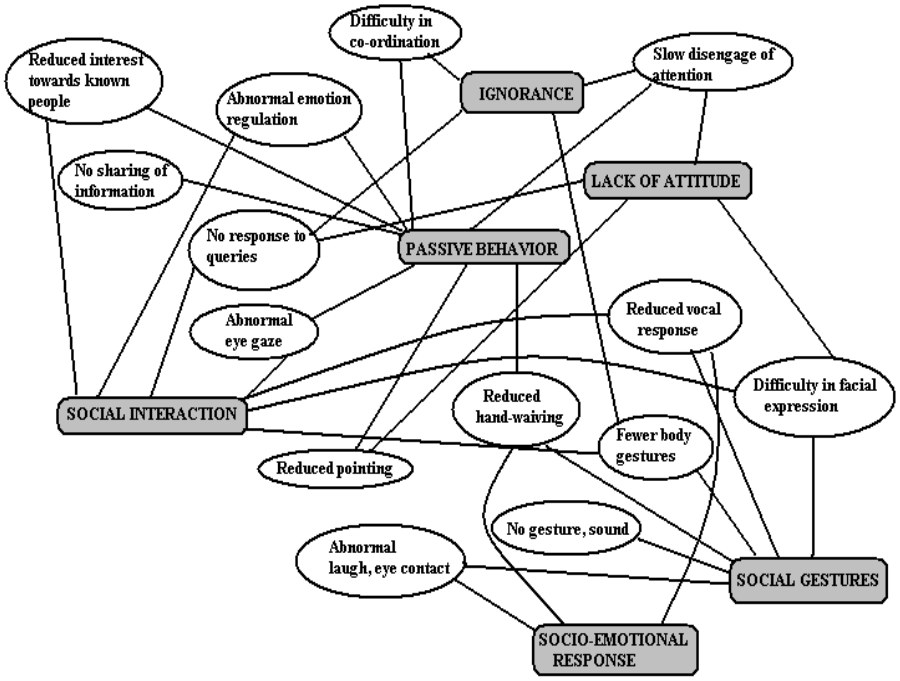

Figure-1. Feature set selection and decision tree.

Primary approaches of classification approach follows prediction of unknown class label using training data set. Classification approaches are categorized into Decision Tree, Back propagation Neural Network, Support Vector Machine (SVM), Rule based Classification and Bayesian Classification. In the present scenario, Autism analysis study was done by using Neural Network and Bayesian but these approaches are difficult to understand and tricky to predict. In this paper, Weighted Decision Tree [10] Prediction Model is proposed for Autism Risk Analysis. The performance of the proposed approach is measured with various parameters.

Table-1. Rank and weight assignment for autism spectrum disorder behaviour.

Autism spectrum disorder behavior metric	Decision tree rank	Weight	Total weight
Face recognition	6	2	12
Speech/Voice recognition	6	2	12
Gestures recognition	6	1	6
Object recognition	6	3	18
Avoid eye contact	6	3	18
Forgets letters, numbers	6	3	18
No face emotions	6	4	24
No society linkages	6	3	18
Unexpected attitude	6	5	30
Dis ambiguity	6	5	30
Faints/frowns at people	6	2	12
Does not mingle with others	6	1	6

3.1 Fuzzy cognitive map

Fuzzy Cognitive Maps (FCM) [5] defines it as a qualitative alternative approach to formulate dynamic systems. This approach can be considered to represent formal method to represent predictions and taking decisions.

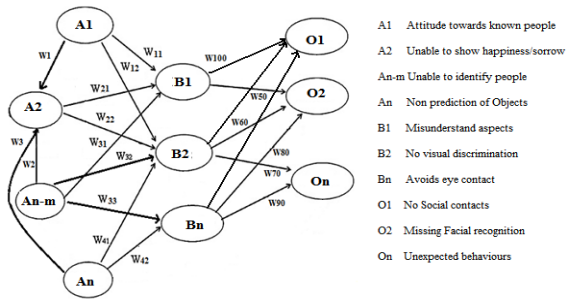

Figure-2.ASDbehavioral mapping using FCM.

Various behavioral attitude of ASD children related to personal and inter-personal aspects is shown in Figure-2. A1, A2…An. indicates the basic behavioral parameters which contribute to issues behind ASD, similarly B1, B2…Bn and intermediate nodes indicate the fuzzy weights assigned. Table-2 shows the fuzzy weight of behavior metrics and its relational ranking. The phenomenon of ranking is based on usage values and its relevance [ ] to Autism Spectrum Disorder affected children.

4. EXPERIMENTAL APPROACH

The need for the early identification of Autism Spectrum Disorder and proper treatment is crucial to the children as well to family affected with Autism. Proper assessment and treatment of children with Autism Spectrum Disorder involves a team of professionals which includes medical specialists (pediatricians and child psychiatrists) and allied health professionals (psychologists, speech pathologists, and occupational therapists). Each professional plays an important but different role in the assessment and differential diagnosis of Autism Spectrum Disorder. Even though each specialist have specific responsibility to help Autism Spectrum Disorder affected children, issues related to method of treatment, children being adaptive to environment, and applying the right method of diagnosis stresses on need from computational methodologies.

4.1 Dataset

The dataset required for this research work is gathered from multiple questionnaires, interviews carried out by experts from observations on ASD affected children. Multiple parents, teachers, psychologist, ASD treatment experts have contributed.

4.2 Performance analysis

Rapid Miner [15] software supports methodology to store, represent, filter and analyze the acquired ASD data collected from different children of age groups 3 years to 15 years. All the collected data were interpolated in order to produce a relational mapping for multiple Autism Spectrum Disorder behavioral metrics. The Data Set obtained is based on sampled years varying from 2010 to 2012, as can be observed from Table-2 that an average predicted ASD value is 87.42% for ASD patients affected.

Table-2. Predicted autism spectrum disorder value.

Sample year	Age	Predicted metric using FEAST	Actual / Observed autism spectrum disorder value	Residual autism spectrum disorder	Fuzzy prediction rate
2010	3-5 years	120.8	119.5419	5.2581	Low
2010	6-8 years	87.112	83.7547	5.3573	Low
2010	9-11 years	126.13	120.6428	4.4872	Average
2011	3-5 years	139.130	138.4765	3.6535	Average
2011	6-8 years	134.118	133.1821	3.0059	Average
2011	9-11 years	126 117	125.7217	2.3953	Fair
2012	3-5 years	99.462	98.5832	1.8788	Fair
2012	6-8 years	124.138	123.8340	0.3040	High
2012	9-11 years	138.145	137.5609	0.5841	High

The category of Autism Spectrum Disorder affected children are classified into four groups, whose gender may be 'M' for male and 'F' for female. Category I, where each patient belongs to age group of 11 to 15 years, and IQ level being greater than 50 and less than 60. Category II, belonging to age group of 8 to 10 years and IQ level being less than 50. Category III, belonging to age group of 5 to 7 years and IQ level being less than 50. Category IV, belonging to age group of 2 to 4 years and IQ level being less than 40. Figure-3 shows the active interaction of Autism Spectrum Disorder affected patients for four categories over a social interaction test. The

interviewers observed the behavior of children when playing with other normal children of different age groups and interaction during social gathering.

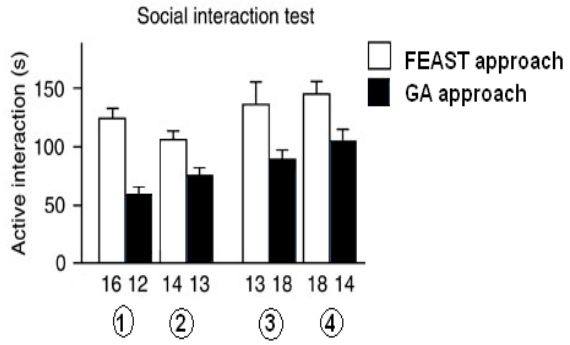

Figure-3. Active performance of autism spectrum disorder children for social interaction.

The observed results are analyzed using FEAST approach and Genetic Algorithm approach, where the predictions using FEAST nearly matches the observed values. Genetic Algorithm also performs near to the traditional analysis but differs by an average rate. It concludes that FEAST shows a better performance than a Genetic Algorithm approach.

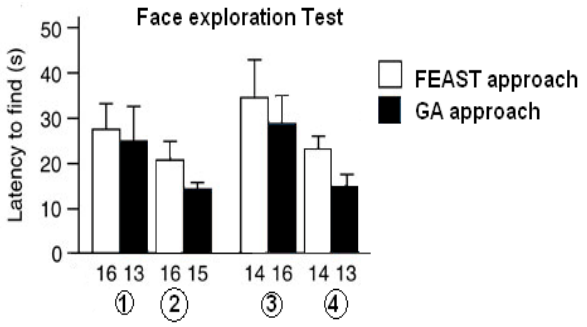

Figure-4. Latency (secs) performance measure for face exploration.

Figure-4 explains the latency of time observed by FEAST compared to Genetic Algorithm approach for face identification by ASD affected children of variable age groups and IQ level. FEAST shows and average of 32.49% better performance than Genetic Algorithm.

Figure-5 demonstrates the performance of FEAST with other contemporary approaches as Genetic Algorithm and Artificial Neural Network. FEAST is able to show a better performance due to improved classification based on weighted decision tree analysis over Fuzzy Cognitive Map. Fuzzy Cognitive Map supports varied mapping of Autism Spectrum Disorder reliable metrics which are influential in prediction of Autism. It can be noticed that early prediction of Autism Spectrum Disorder is required, so that early care could be provided. Hence FEAST overtakes other method.

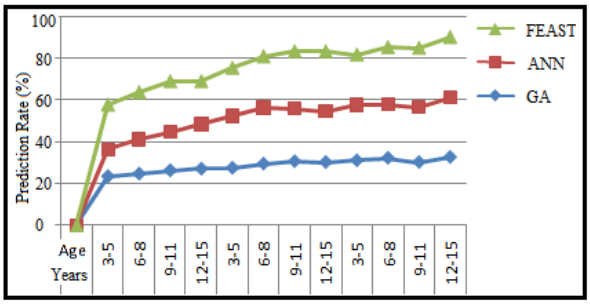

Figure-5. Performance of FEAST with other approaches in autism spectrum Disorder prediction rate.

5. CONCLUSIONS

The research work is carried out based on Data Set of various techniques applied for Autism Spectrum Disorder affected children and their consistent outcomes. This approach also adopts the findings from a virtual reality platform which is suggested to improve social skills, cognitive methods and functioning in Autism. The tests are carried out using Autism Spectrum Quotient as a metric to identify the intensity of affection and treatment provided.

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[14] http://www.cdc.gov.

[15] https://rapidminer.com/

Appendix

Based on Observations:		
Will child make eye contact with you?	☐	☐
Is child able to have shared attention on the same object with you when showing him/her the object?	☐	☐
Get child's attention, then point across the room at an interesting object and say "Look over there! There's a (toy name)!" Look at the child's face. Does the child follow your finger to the object you are pointing at? (make sure actually looked at object)	☐	☐
Get child's attention, say "I'm going to get you!" run over and tickle them. Do a couple of times. Does child seem interested in playing? Does he/she run away or laugh?	☐	☐
Get child's attention, then give the child a toy cup and teapot and say "Can you pour a cup of tea?" Imitate pouring and drinking the tea. Does child pretend to pour out the tea, drink it etc? (pretending in some other way would also mean yes)	☐	☐
Show the child an object and then hide it while he/she is watching. Then say, "Where's the _____?" Do they try to look for it?	☐	☐
Can the child stack blocks on top of each other? (If so, how many? _____)	☐	☐
* Indicates critical question most indicative of autistic characteristics		
This form has been modified from: Baron-Cohen, S. et. al., "Can autism be detected at 18 months? The needle, the haystack, and the CHAT," The British Journal of Psychiatry, 161, pp. 839-843, 1992.		