

Analyzing the Social Awareness in Autistic Children Trained through Multimedia Intervention Tool using Data Mining

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Abstract—This study focuses on creating a guideline for the ASD children by simulating the situation and analyzing the understanding of ASD (Asperger Syndrome) children over social skills by using a multimedia intervention tool designed for this purpose. 84 ASD individuals belonging to NGOs and clinics were selected for studying their social and cultural awareness. Autistic kids were taught social skills using specially designed multimedia intervention tool, in a controlled environment under the supervision of special educators or parents. Data mining technique was used to extract knowledge from the data collected after intervention. The results were analyzed to understand the impact of the designed multimedia intervention tool and share with special educators and parents of autistic children. The proposed multimedia intervention tool is inexpensive and user friendly. Integration of this tool has been observed to improve the quality of training an individual with autism traits. The overall growth in social communication of the ASD children under observation was observed to be 26.19%. There were substantial variances between age groups, training set and behavior parameters on any of the measures at follow-up. It was considered that an intervention starts at early age and proves beneficiary to ASD children. The study is establishing the remarkable benefits of designed multimedia intervention tool to train the ASD children.

Keywords—Asperger Syndrome (ASD); multimedia intervention tool; social skills; autism; computer aided training; autistic children

I. INTRODUCTION

Autism spectrum disorder is one of the most thought-provoking application of technology in the study, diagnosis, and treatment of disease [1]. As is the case with other psychological illnesses, the condition of autism is particularly incorporeal and complicated, providing no obvious, direct way of utilizing technology or conducting technological study to improve the condition of a patient with autism [2].

Autism is illustrated by insufficiencies in social communication and interaction, and abnormal and recurring behavior. Reasoning abilities in people with autism diverge between those with standard to above standard intelligence, to marginal and minor mental retardation, and others those function within the reasonable to extremely mentally retarded range [3].

Furthermore, the social aspect of the disease does not impart itself to treatment using any physical apparatus or

trivial scientific methods. Still, significant effort has gone into the exploration of technological aid in diagnosis and treatment of the disease, of improving the everyday life of an autistic person [4].

Computer technology plays an important role in the treatment of ailments, illness and disabilities. We continually seek and explore new ways of improving the health to empower those with disabilities to lead a life close to the normal. Multimedia Game or computer aided game helps in increasing Empathy Spectrum Quotient, Systemizing spectrum Quotient [5], [6].

Importance is also placed on present changes, with previous methods serving more or less successful strategies for managing with autism through multimedia technology [7]. The Study considered the detail analysis of autistic children on by using data mining as decision making tool [8]-[10] and multimedia intervention tool [11]-[13].

This study focuses on measuring social skills and analyzing the impact of multimedia intervention tool on the social behavior of ASD children.

II. RELATED WORK

1) A number of interventions have provided home-deliverable software or DVD packages that use photos, multimedia tool and document to teach face recognition and the recognition of emotion from faces. The majorities have found that subjects improve within the trained environment, but that these improvements do not generalize to performance of the same task in a ‘real-world’ environment. The purposes for this are discussed. One recent study [14] provided DVD packages to younger children (aged 4 to 7) and reported surprisingly strong generalization in a number of areas.

2) Other work here involves cameras or webcams than can be used to recognize emotion based on a combination of visual (facial) cues and top-down predictive emotional models. The wearable camera can either be pointed outwards, allowing a user to receive the computerized predictions about the emotional states of the person he or she is talking to, or pointed inwards [15] thus allowing the wearer to receive automatized predictions of what they are communicating about their own mental states.

3) Other projects use different media to explore interactive plays in ASD. The Reactive Colours project [16] is a digital play environment in which children with autism stand in front of a screen and explore different sorts of touch interface. Touching the screen evokes different combinations of auditory and visual cues – in one activity, dragging your finger across the screen creates a trail of bubbles and an ethereal sound; in another, hitting the screen results in cymbal crashes and huge splurges of colour.

The appeal of such a playful environment is intuitively understandable. It is a highly predictable, beautifully realized environment that rewards the kinds of repetitive, perfectly contingent interactions that some people with autism have been reported to prefer [17]. Although there is no direct training component, such endeavours are important as assistive technologies [18].

III. METHODOLOGY

In an attempt to collect the data about ASD individuals, few clinics and NGO's of Gujarat and Mumbai were visited. Special educators and parents were contacted to collect information on ASD children, and provide training on the multimedia intervention tool designed for this purpose. Medical history, responses of ASD children to prompts, and the observations before and after intervention were recorded.

The ASD children were pre conditioned to use mobile application in a controlled environment in the presence of parents and therapists, all were instructed to use commercially available apps to make ASD children familiar and acquainted with touch screen of tablets and mobile screens before starting the interventions.

A. Data Collection

Data, that are collected between January 2015 to March 2017; from a NGOs and clinics for the total sample of age groups by child's gender, to train or to improve quality life of autistic children. However study focuses on particularly assigned interventions. Data Mining is used to examine a range of parameters while sessions like competence, positive and negative likelihood ratios were reported.

B. Participants

The ASD groups comprised four groups aged from 3-30 for the experimental setup. The control group comprised NV (novice), BG (beginner), AD (adolescent) and AL (adulthood). After screening for ASD and other disability like PDD-NOS, PDD, ADHD conditions, 7 participants were excluded as they belonged to other disability. Fig. 1 shows relation of age groups and sex in regard of different behaviours of ASD children. The remaining 54 males and 23 females were matched on high guidance & teaching. In Table 1, the detail of participant's for discrete trials is shown. Data Mining is used to see the performance with respect to age group and gender, Study revealed significant differences between the age groups.

C. Dataset

a) Data collected for study

TABLE I. THE DETAILS OF PARTICIPANTS' FOR DISCRETE TRIALS

Baseline Characteristics	Clinic based treatment model			Special Educator managed treatment model		
	Total	Male	Female	Total	Male	Female
Age group & sex						
(0-3) NV	1	1	0	9	7	2
(4-11) BG	26	19	7	10	5	5
(12-19) AD	19	13	6	4	2	2
(20+) AL	8	7	1	0	0	0

Certain apprehension has been communicated, though, that the extrinsic provocation provided by the computer game might undermine any intrinsic interest a student might have in the subject matter.

By taking into due consideration of medical history and other recorded parameters the duration of sessions are decided for each individual ASD children. In Table 2, the details of participant's Dataset collected on mentioned parameters by using multimedia intervention tool are shown.

b) Attribute identification

TABLE II. ATTRIBUTES TO CALCULATE THE GROWTH IN ASD CHILD

Attributes	Description
AQ	Autism spectrum Quotient
EQ	Empathy Spectrum Quotient
SQ	Systemizing spectrum Quotient
FQ	Friendship Questionnaire
RQ	Relatives Questionnaire

D. Intervention

The multimedia intervention tool and exploration on computer-aided training (CAT) for the ASD child assesses the degree to which individualization has been addressed. This type of CAT includes short video clips or educational games which gives the student an ambition to reach or a problem to solve and requires the student to learn concepts through trial and error. For example, the ongoing simulation "Society" tells about Indian society followed by a game play consisting of multiple-choice questions (MCQs), to know the understanding of ASD kids based on video clips. Multimedia intervention tool based CAT is to provide individualized instruction, then it benefit from what is known about one-to-one teaching, an customized form of training which is the most effective form of instruction.

Assessments were done flexibly as per mood and nature of each child for study of FSCQ (Final score of social communication questionnaire), which includes scores of AQ,

EQ, FQ, RQ and SQ of ASD children. In Table 3, detailed explanation of the terms for calculating the growth of ASD children is shown.

TABLE III. TERMS USED TO EVALUATE THE PERFORMANCE OF ASD CHILDREN

S.no.	Terms	Explanation
1	FSCQ	Final score of social communication questionnaire FSCQ=(EQ'-EQ) + (SQ'-SQ) + (FQ'-FQ) + (RQ'-RQ) (If score greater than 15 then 2 otherwise 1) then converted into H and L
2	FS1	Final score of level 1 (ASD children plays MCQ by using designed multimedia intervention tool and score accordingly)
3	FS2	Final score of level 2 (ASD children has to type the answer and submit to score so at this level writing skills are also playing a considerate part)
4	EQ EQ'	Pre score of Empathy Spectrum Quotient Post score of Empathy Spectrum Quotient
5	SQ SQ'	Pre score of Systemizing spectrum Quotient Post score of Systemizing spectrum Quotient
6	FQ FQ'	Pre score of Friendship Questionnaire Post score of Friendship Questionnaire
7	RQ RQ'	Pre score of Relatives Questionnaire Post score of Relatives Questionnaire

$$\begin{aligned} \text{Rise in EQ} &= (EQ' - EQ) & (1) \\ \text{Rise in SQ} &= (SQ' - SQ) & (2) \\ \text{Rise in FQ} &= (FQ' - FQ) & (3) \\ \text{Rise in RQ} &= (RQ' - RQ) & (4) \end{aligned}$$

$$\begin{aligned} \text{FSCQ} &= (EQ' - EQ) + (SQ' - SQ) + (FQ' - FQ) + \\ & (RQ' - RQ) & (5) \\ \text{FSCQ} &\text{ is termed as Growth for the experimental setup.} \end{aligned}$$

Pre and post scores of discrete trials conducted through the designed multimedia intervention tool were taken into consideration.

E. Classification

Classification is a two-step process in which classification algorithms were applied on training and test data to classify the performance of ASD children. Various evaluation parameters were studied to find the accuracy of the classifiers.

The algorithms used in the study for classification are J48, SVM, JRip, Voted perceptron and Multilayer perceptron.

F. Experimental Setup

Weka is open source data mining tool and it is broadly used in data mining applications. From the above dataset of ASD children result.csv file was created. The file was then loaded in Weka explorer. Sample of 84 ASD children were taken for the implementation. The classify console permits to use classification algorithms to the selected dataset, to estimate accuracy and allow to visualize the model. The decision tree, SVM, Voted and multilayer perceptron were

applied in Weka. Under the test options, the 10-fold cross validation is chosen to classify.

IV. RESULTS

The result obtained for Final score of social communication questionnaire, i.e., FSCQ was obtained as under:

The improvement of 3.17% was observed in Empathy Spectrum Quotient EQ.

The improvement of 53 % was observed in Systemizing Spectrum Quotient SQ.

The improvement of 19% was observed in Friendship Questionnaire FQ.

The improvement of 28% was observed in Relatives Questionnaire RQ.

The growth in social communication skills of the observed ASD individuals was measured as 26.19%.

Social communication and cognitive skills tasks has shown significant improvement by depicting from the scores of FS1, FS2 and FSCQ. There is enough evidence to show that multimedia intervention tool for autistic children are independent of gender but impacts of age groups exist.

In Fig. 2, the knowledge represented by decision tree can be extracted in the form of IF-THEN rules to predict the growth in FSCQ by J48 (Final score of social communication questionnaire).

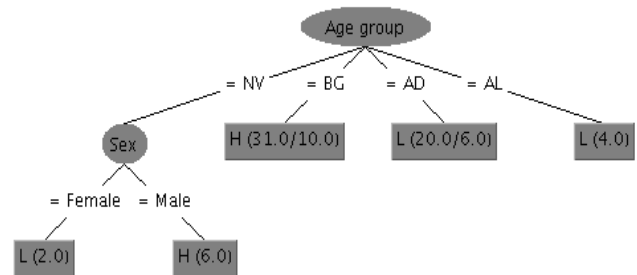


Fig. 1. Decision tree (Class attribute: Child Growth, L: Low and H: High).

The classification rules are as under:

1. If Age group = NV AND Sex=Female THEN Growth=L
2. If Age group = NV AND Sex= Male THEN Growth= H
3. If Age group = BG THEN Growth= H
4. If Age group = AD THEN Growth= L
5. If Age group = AL THEN Growth= L

From the above set of rules a conclusion emerges the ASD children of age group BG and female of NV group learns by using multimedia intervention tool and shows remarkable growth in performance of FSCQ. Table 4 presents the results

of evaluation parameters for various Classifiers. Hence voted perceptron stated as more accurate than other classifiers.

TABLE IV. EVALUATION PARAMETERS OF VARIOUS CLASSIFIERS

Evaluation Criteria	J48	Multilayer Perceptron	SVM	Voted
Accuracy	58.73%	79.37%	82.54%	88.89%
Kappa statistic	0.1727	0.5882	0.6516	0.7769
Mean absolute error	0.4597	0.195	0.1746	0.1077
Root mean squared error (RMSE)	0.5457	0.4013	0.4179	0.3168

Fig. 2 shows that the graphical representation of accuracy results of ASD children performance based on dataset. It

clearly reveals that Voted is the best classifier for analyzing the ASD children performance.

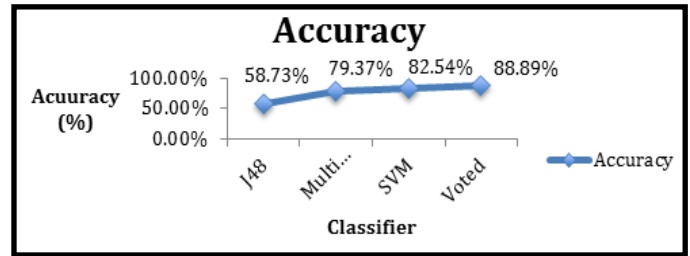


Fig. 2. Accuracy of the classifiers.

Table 5 shows the accuracy by Class. The Voted algorithm outperforms all other classifiers.

TABLE V. ACCURACY BY CLASS FOR VARIOUS CLASSIFIERS

Classifier	TP Rate	FP Rate	Precision	Recall	F-Measure	ROC Area	Class
J48	0.833	0.000	1.000	0.833	0.909	0.844	Low
	1.000	0.167	0.868	1.000	0.930	0.844	High
	0.921	0.087	0.931	0.921	0.920	0.844	Average
SVM	0.867	0.212	0.788	0.867	0.825	0.827	Low
	0.788	0.133	0.867	0.788	0.825	0.827	High
	0.825	0.171	0.829	0.825	0.825	0.827	Average
Voted	0.867	0.091	0.897	0.867	0.881	0.927	Low
	0.909	0.133	0.882	0.909	0.896	0.927	High
	0.889	0.113	0.889	0.889	0.889	0.927	Average
Multilayer Perceptron	0.833	0.242	0.758	0.833	0.794	0.884	Low
	0.758	0.167	0.833	0.758	0.794	0.884	High
	0.794	0.203	0.797	0.794	0.794	0.884	Average

Fig. 3 presents ROC obtained for different classifiers.

Voted has highest area curve compared to different classifiers. Therefore, the Voted is the efficient classification technique.

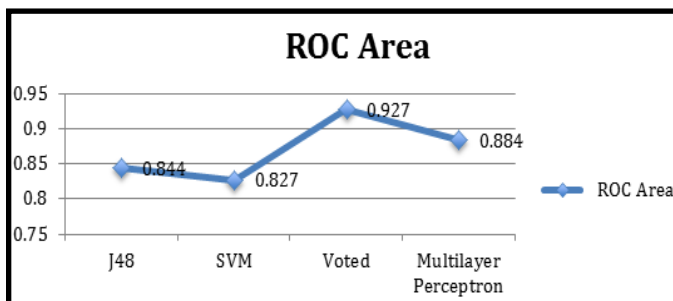


Fig. 3. ROC area of classifiers.

V. CONCLUSION

The study evaluated the expediency of machine learning algorithms in classifying the performance of ASD children. It was also discovered that Voted Perceptron performs best when employed in the study. This study is quite helpful for the

analysis of the behaviour of ASD children and providing timely suggestions to special educators and parents. The multimedia intervention tool designed for this study is inexpensive and affordable. Integration of the tools will enhance the quality of Personal attention to an individual with autism. The Improvement of 3.17% was observed in Empathy Spectrum Quotient, the Improvement of 53 % was observed in Systemizing spectrum Quotient, the Improvement of 19% was observed in Friendship Questionnaire and the Improvement of 28% was observed in Relatives Questionnaire thus total growth in terms of Final score of social communication questionnaire was observed as 26.19% in ASD children.

Multimedia intervention tool intrusion is found to be greatly successful in treating disorders like anxiety and autism as parents of NGOs and clinical associates in India found multimedia a good tool for increasing concentration and eye contact and observed the rise in mood constancy in ASD children. The study is establishing the remarkable benefits of designed multimedia intervention tool to train the ASD children.

Currently intervention tool is on android platform further can be developed on iOS platform.

In future we plan to focus on developing a mechanism to read brain waves of autistic children so that we can have a comparative study between collected data through mobile intervention tool and measured brain waves of individual child. Certainly we will do utmost to achieve the goal of giving a tool to monitor the behaviour of autistic children. Creating video chat forum for autistic children from where they can build their active social life.

We look forward to have customized products like books, CD's and counselling sessions via mobile intervention tool thus will help parents and special educators to deal with autistic children efficiently.

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