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Artificial Neural Network for Diagnose Autism Spectrum Disorder

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Abstract: *In this paper an Artificial Neural Network (ANN) model, was developed and tested for diagnosing Autism Spectrum Disorder (ASD).*
A dataset collected from ASD screening app was used in this paper, it contains ASD tests results based upon questions answers from users. Test data evaluation shows that the ANN model is able to correctly diagnose ASD with 100% accuracy.

Keywords: Data Mining, Classification, Predictive Analysis, Artificial Neural Networks, Autism

1. INTRODUCTION

An artificial neural network (ANN) is a mathematical model which is almost motivated by the human brain as it consists of a connected network of simple processing units (artificial neurons) that learns from practice by adjusting its connections (weights) . The ability of brains to act adaptively depends on their ability to adjust their own behavior based on changing situations. Neural networks simulate human brains and this learning behavior in an efficient manner by updating network parameters Θ based on available data D = {z (1) . . . z (N)}, allowing the building of large models that are talented for solve complex cognitive tasks. Learning continues by making modifications to the network parameters Θ so that its output starts to increasingly match the objectives of the agent at hand. This is formalized by the cost function J (Θ) which measures the degree to which an agent move away from its objectives. J is calculated by running a neural network in forward mode (from input to output) and comparing the predicted output with the desired one. During its lifetime, the agent attains data from its environment by gathering from a data generating distribution p_{data} [1].

In Training, connections (weights) are assigned. Most training algorithms begin by assigning random numbers to the weight matrix. Then the validity of the neural network is examined. Next, the weights are adjusted based on how valid the neural network performed. This process is repeated until the validation error is within an acceptable limit [2].

Artificial Neurons are grouped into layers as seen in figure (1). Each Layer contains a group of neurons that implement alike functions. There are three types of layers. The input layer, which responsible for receiving input from the user program, the output Layer, which sends data to the user program, and the hidden layer(s) between the input and output layer. Hidden layer neurons never directly interact with the user program. Not every neural network has this many layers. The hidden layer is optional. The input and output layers are obligatory, but it is possible to have one layer that act as both an input and output layer [3].

Model Validation is done after a neural network has been trained to evaluate the model if it is ready for actual use. To correctly validate a neural network, validation data must be different from the training data [14]. In this paper, we used about 80% of the total sample data for network training, and 20% for network validation.

Our study main purpose is to develop a neural network as prediction technique to diagnose the autism presence.
A dataset from an application for autism-screening called "ASD Tests" was used for this purpose.

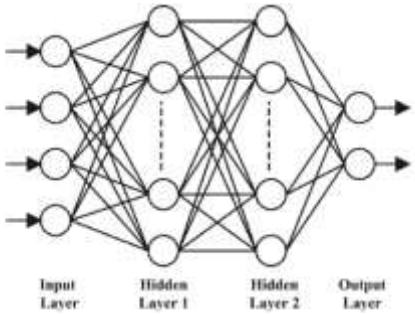

Figure 1: ANN Architecture

2. ASD

Autism, or autism spectrum disorder (ASD), refers to a broad range of conditions characterized by difficulties in social skills, repetitive behaviors, speech and nonverbal communication. Signs of autism usually appear by age 2 or 3. Some related growth delays can appear earlier, it can be diagnosed as early as 18 months.

Research tells that early intrusion results in positive outcomes later in life for people with autism [4]. Autism can be caused by genetics or environmental factors [5]. Globally, autism is expected to affect 24.8 million people as of 2015 [6], the number of people diagnosed has increased dramatically since the 1960s, but because of changes in diagnostic practice; the question of whether actual rates have increased is unanswered [7].

3. ASD TESTS APP

ASD Tests is a mobile application designed for all user age classes; it permits different types of user to measure ASD behaviors using four different modules [8]. The Autism Spectrum Quotient (AQ) is one of the early autism screening tools that was designed to enable adults detect autistic traits in a self-administered questionnaire [9]. In the beginning, the AQ test comprised of 50 questions that belonged to areas related to autism's cognitive strength. Each question is associated with four possible options: definitely agree, slightly agree, slightly disagree and definitely disagree, and each question has its scored point [8].

Allison et al. [10] suggested a shortened version of the original AQ test called AQ-10-Adult (10 questions).

The AQ-10-Adult test uses the same four choices per question that the user should select during the screening process. Then, a diagnostic rule is applied to compute the score. Any individual who scores more than 6 is then considered as a full Autistic. Each question will have either 0 or 1 point; a point is assigned if the answer is either 'Slightly Agree' or 'Definitely Agree' for questions 1, 7, 8 and 10. As well, a point is assigned to questions 2, 3, 4, 5, 6 and 9 if the response either was slightly or definitely disagree [8].

4. LITERATURE REVIEW

There are many studies involving Artificial Neural Network (ANN) for example : Artificial Neural Networks and expert systems were employed to obtain knowledge for the learner model in the Linear Programming Intelligent Tutoring System (LP-ITS) to be able to determine the academic performance level of the learners in order to offer him/her the proper difficulty level of linear programming problems to solve[8-12,15,18,21-23]; for predicting the performance of a sophomore student enrolled in engineering majors in the Faculty of Engineering and Information Technology in Al-Azhar University of Gaza was developed and tested [37,45]; ANN model was developed and tested to predict temperature in the surrounding environment [20]; for predicting critical cloud computing security issues by using Artificial Neural Network (ANNs) algorithms. However, they proposed the Levenberg–Marquardt based Back Propagation (LMBP) Algorithms to predict the performance for cloud security level [32]; for predicating the MPG rate for the forthcoming automobiles in the foremost relatively accurate evaluation for the approximated number which foresight the actual number to help through later design and manufacturing of later automobile [17,36]; to predict efficiency of antibiotics in treating various bacteria types [40]; to predict the rate of treatment expenditure on an individual or family in a country [46], for detecting early-stage non-small cell lung cancer (NSCLC) [38]; for the diagnosis of hepatitis virus [34,41]; for predicting the Letters from twenty dissimilar fonts for each letter [35], for Email Classification Using Artificial Neural Network [14]; Classification Prediction of SBRCTs Cancers Using Artificial Neural Network [16, 25]; for Diabetes Prediction Using Artificial Neural Network [29]; to predict Birth Weight [19]; to help cars dealers recognize the many characteristics of cars, including manufacturers, their location and classification of cars according to several categories including: Buying, Maint, Doors, Persons, Lug_boot, Safety, and Overall [13]; for Parkinson's Disease Prediction Using Artificial Neural Network[39,42,44]; for desktop PC Troubleshooting[27]; for Tomato Leaves Diseases Detection Using Deep Learning[26]; Plant Seedlings Classification Using Deep Learning [24,43]; for predicating software analysis and risk management [30,31].

5. METHODOLOGY

We got an Autistic Spectrum Disorder Screening Dataset that created by *Fadi Fayez Thabtah* [13]. Therefore, we used this dataset which is collected from tests history to build our ANN model and then validate it, so the results are compared.

5.1 Dataset Description

Table 1: Original Dataset attributes description

#	Attribute	Type	Description
1.	ID	Number	Id Number
2.	Age	Number	Age in years
3.	Gender	String(f, m)	Male or Female
4.	Ethnicity	String	List of common ethnicities in text format
5.	Jaundice	Boolean (yes or no)	Whether the case was born with jaundice
6.	Autism	Boolean (yes or no)	Whether any immediate family member has a PDD
7.	Relation	String	Who is completing the test? Parent, self, caregiver, medical staff, clinician ,etc.
8.	Country of residence	String	List of countries in text format
9.	Used app	Boolean (yes	Whether the user has used

	before	or no)	a screening app before
10.	Question 1 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
11.	Question 2 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
12.	Question 3 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
13.	Question 4 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
14.	Question 5 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
15.	Question 6 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
16.	Question 7 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
17.	Question 8 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
18.	Question 9 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
19.	Question 10 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
20.	Age description	Text	Age category
21.	Screening Score	Integer	The final score obtained based on the scoring algorithm of the screening method used. This was computed in an automated manner
22.	Class/ASD	Boolean (Yes, No)	The result that will be showed after the test

5.2 Dataset Preprocessing

We did some preprocessing and transformation so the data is fit for predictive analysis. We used the 10 questions answers, age, gender, and jaundice attributes as inputs for our model. In addition, the class attribute was the class to be predicted based on the input attributes. The resulted dataset description is shown in table (2).

Table 2: Data Preprocessing and Transformation

#	**Attribute**	**Type**
1.	Age	Number
2.	Gender	Boolean(f (1) , m (0))
3.	Jaundice	Boolean (0, 1)
4.	Question 1 Answer	Boolean (0, 1)
5.	Question 2 Answer	Boolean (0, 1)
6.	Question 3 Answer	Boolean (0, 1)
7.	Question 4 Answer	Boolean (0, 1)
8.	Question 5 Answer	Boolean (0, 1)
9.	Question 6 Answer	Boolean (0, 1)
10.	Question 7 Answer	Boolean (0, 1)
11.	Question 8 Answer	Boolean (0, 1)
12.	Question 9 Answer	Boolean (0, 1)
13.	Question 10 Answer	Boolean (0, 1)
14.	Class/ASD	Boolean (0, 1)

5.3 The Neural Network

The resulted ANN Model is shown in figure (2).

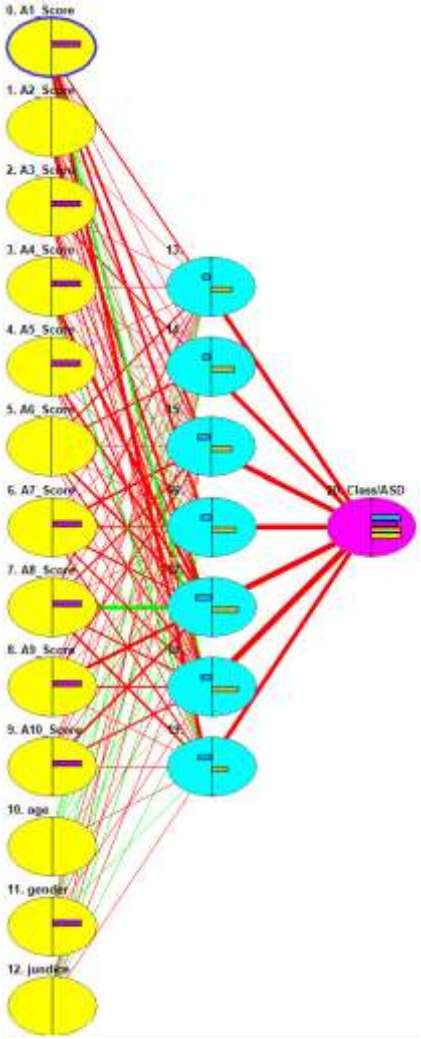

Figure 2: Our ANN Model

5.4 Results

Our ANN model was able to predict the class 100% accurately, with 0% for average error rate as seen in figure (3). In addition, Our Model discovered that the most attribute that has effect on the classification was the question number 8. More details are shown in figure (4).

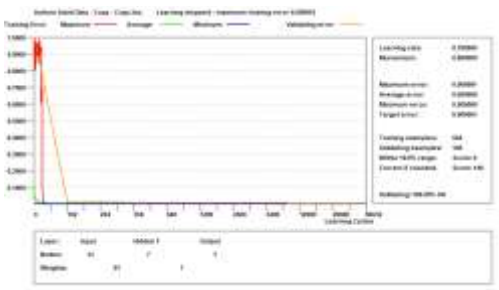

Figure 3: Validation and error rates

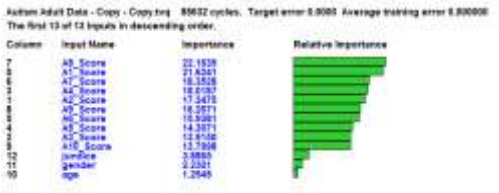

Figure 4: Attributes Importance

6. CONCLUSION

An artificial Neural Network for diagnosing autism was proposed. The input factors were obtained from an autism screening app data set represents users' autism-screening detailed results. The model was tested and the total result was 100% accuracy. This study showed the ability of the artificial neural network to diagnose ASD.

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