

ABDA: An Automated Behavioral Disorder Assessment Framework

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Abstract. In this paper, we investigate the problem of manual behavioral disorder assessments completion for the purposes of determining the early warning signs for patients with behavioral disorder symptoms. This study resides in the application domain of Autism Spectrum Disorder (ASD) as a motivating example. With the automation of behavioral disorder assessment, we seek to decrease the amount of time required for each diagnostic test and therefore increase the efficiency of diagnostic and number of diagnosed patient. We have evaluated our system with sufficient number of diagnostic tests and found that our system can perform almost quick and accurate Autism Spectrum Disorder diagnostic. In this work, we present the proposed framework and take advantages of the automation of the proposed solution in order to facilitate diagnostics.

Keywords: Behavioral disorder · Diagnostic tests · Automation · Assessment tool

1 Introduction

In this paper, we approach the problem of manual diagnoses intellectual and developmental children's disabilities to determine children with autistic disorder. This approach is based in particular on the collection of subjective data by means of a questionnaire as Gilliam Autism Rating Scale [1].

In the electronic world of today, we are moving towards fast adaptation of technology in every field of life including healthcare, financial, transportation and communication. This adaptation has allowed us to move from registers to computers and from offline systems to real time systems. Electronic data is not only timely and precise, it is also easy to store and access [2]. In healthcare field and especially Behavioral Disorder diagnostics, such adaptation is required to diagnoses intellectual and developmental disabilities [3]. The problem studied is a real-life problem occurring at the children department at Al Amal Mental Health center in AL Madinah Al Mounawara. Psychologists perform those assessments manually based on printed documents. The actual manual method is time consuming because they need special math calculations

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O. Gervasi et al. (Eds.): ICCSA 2020, LNCS 12254, pp. 1003–1012, 2020.
https://doi.org/10.1007/978-3-030-58817-5_71

to get the result, which is difficult to process due to the lack of automated process tools for such type of documents. Moreover, it may sometimes lead to some error when calculating results. These behavioral tests are mostly proposed as printed documents and are normally processed by hand by psychologist. Manual assessments completion is extremely time-consuming. The time required to complete an assessment can range anywhere from one hour to two hour per survey, per child. The use of tests in diagnosing psychiatric diseases is an effective technique that was able to withstand the test of time. Gilliam Autism Rating Scale (GARE) aims to determine individuals with autistic disorder from 3 to 22 years. It can be used either by regular individuals at home, school environment or by professionals [5] or as Asperger Syndrome Test [4].

Automatically estimate person disabilities based on predefined standard scales can overcome those limitations [6]. The prevention of behavioral disorders requires an ergonomic approach, which aims to a quick diagnostic. In our proposed system, a psychologist can conduct a diagnostic test for a particular patient (child) electronically.

This automatization will save an immense amount of time. After accounting for many assessments completed by many psychologists, the number of diagnosis children will be improved. By decreasing the amount of time required to complete these assessments through eliminating the need to re-enter basic information each time, more assessments can be completed, and more children can be diagnosed. Our proposed system process the electronic document for answer evaluation. In the evaluation process, answers are detected and counted, for a result generation; the output of the diagnostic test will be shown as a percentage number and as average.

The organization of the paper is summarized as follows: Sect. 2 represents a brief review of related work. In Sect. 3, we gave a detail sketch of the computation framework of our proposed approach. Experimental results are presented in Sect. 4. In Sect. 3.2, we will present an evaluation study. Finally, Sect. 6 conclude this work and present future research directions.

2 Related Works

There are several applications, which are used to automate BDA. Those systems are not based on standard scale but we have found no such system, which automate DBA from manual pages to statistical results. In [7] authors proposes to automate the collection of quality of life data and a comparison of paper and computer touch screen questionnaires. This comparison was made between the paper test and the electronic test. The electronic tests got high scores and results. The data was better confidentially, were healthier and did not include spelling errors.

In [8] authors propose an automated system to handle and analyze surveys and convert them into electronic documents. The main advantage of the proposed approach was the high accuracy and the rapid analysis of documents. In [9], electronic surveys were used instead of manual surveys and making comparisons between them. It was

concluded that transfer helps in efficient collection of the market by reducing time. The Asperger's Syndrome Test described in [10] is an application for self-diagnosis that can be used by anyone who suspects they may have Asperger's Syndrome. The test gives a standard of autistic properties in grownups. On the other hand, the Autism-Spectrum Quotient (AQ) [11] is a questionnaire designed by Baron Cohen to assess the attributes of the autism spectrum in mentally qualified adults in both the general population and the community and is designed to evaluate 5 different areas of performance: social skills, attention transfer, and attention to detail, communication and imagination.

In another work, [12] authors propose a tool named Q-global. The proposed tool is a web-based system for psychological assessment management. It provide above 50 assessments in different area of performances. It generate many sub-accounts, which is helpful in departments and examiners management. In addition, it Create comprehensive reports from the assessment records.

Based on the same principle as the previous work, PARiConnect [13] is an online assessment management platform that provides standardized assessments in deferent categories. It provide assigning assessment and generating reports following many assessments categories.

In [14] authors investigate how Machine Learning (ML) has been introduced into the medical field as a means to provide diagnostic tools capable of enhancing accuracy and precision while minimizing laborious tasks that require human intervention.

Regarding personality analysis, [15] propose a tool named Personality Match that conducts a free test of the personality by asking questions to the user to discover the type of personality and can invite friends to take this test.

Personality Test presented in [16] is another interesting automated survey that propose many questions to determine the type of personality once you have completed the test. Results obtained after the competition if the survey were very accurate.

Our research intends to propose an efficient framework in Arabic language to automate manual assessments of behavioral disorder by allowing a psychologist to conduct a diagnostic test for a particular patient electronically. Our proposed system estimate automatically patient disabilities based on predefined standard scales. This system makes diagnoses intellectual and developmental disabilities fast, easy and more accuracy and it may overcome the limitations of the existing manual diagnostics.

3 System Architecture and Design

The aim of this work is to develop an automated diagnostic test framework that involves carrying out the diagnostic test and producing diagnostic results. Using this framework diagnostic assessment can be done easily, quickly and accurately.

The proposed Automated Behavioral Disorder Assessment (ABDA) framework requires a sequential workflow of serval components. The combination of the components of the system constructs the system architecture (see Fig. 1).

In a first stage, data is received from the system. Once the data is received, it is associated with the appropriate process it belongs to. This is done by extracting the patient ID field from the data block. Once data is associated with the correct patient, the appropriate test that will be generated populated and associated with each process data block. Weights or predefined standard scales, used from the weighting schema proposed in this model are associated to different individual steps of processes, this aims to estimate automatically patient disabilities. Especially for each diagnostic test dimension. Then the data is transmitted to the evaluation module to generate results and reports. The flowchart of activities performed in this model is shown in Fig. 1.

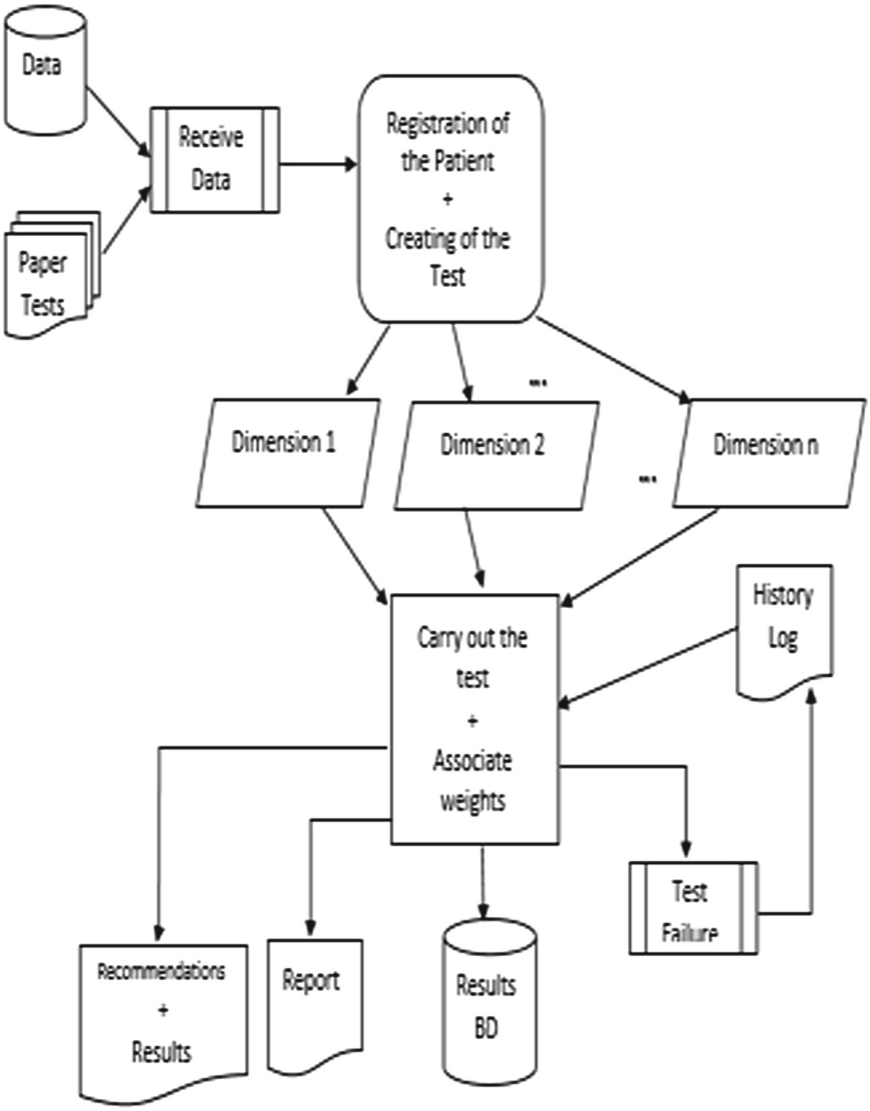


Fig. 1. Overall architecture of the automated BDA framework

3.1 Creating ABDA Test Module

At the beginning of the session, psychologist needs to create a Behavioral Disorder Assessment. So, it creates a unique identifier for a patient and store the test and dimension of each one into the corresponding tables in database tables. Figure 2 Shows the algorithm for dimension selection.

Algorithm: Select Dimension
Input: Patient Registration

1. **Begin**
2. **For** each Patient **do**
3. Count the number of dimensions the user had chosen
4. Insert the dimensions the user chosen according to their number
5. Compare the selection with stored data in data base
6. **If** section match **do**
7. display the dimension selection
8. **Else** return error ;
9. **End**

Fig. 2. Algorithm of selecting dimesion

3.2 Answer Evaluation and Weight Association Module

Answers given by the psychologiste that matches with the option stored with the database are counted in this phase. This count and evaluation will be used to generate results. The used algorithm todo that is given in Fig. 3.

Algorithm: Calculate Autism Coefficient

Input: Psychologist Test answers

1. **Begin**
2. **Table** is a predefined standard table used to convert the total sum to an equivalent autism coefficient value depending on the number of dimension the user had chosen
3. Use Counter
4. Calculate total sum of each dimension
5. Generate autism coefficient
6. Call autismMeaning function giving autism coefficient as parameter
7. **End**

Fig. 3. Algorithm of calculating autism coefficient

The algorithm presented in Fig. 4 will generate the result of the test for the diagnostic patient.

```
Algorithm: autismMeaning
Input: autism coefficient
    Begin
    If coefficient >131 do
    Print autism coefficient is " very high "
    Else if 121 <= coefficient <= 130 do
    Print autism coefficient is " high "
    Else if 111 <= coefficient <= 120 do
    Print autism coefficient is " above average "
    Else if 90 <= coefficient <= 110 do
    Print autism coefficient is " average "
    Else if 80 <= coefficient <= 89 do
    Print autism coefficient is " below average "
    Else if 70 <= coefficient <= 79 do
    Print autism coefficient is " low "
    Else if coefficient <= 69 do
    Print autism coefficient is " very low "
    End
```

Fig. 4. Algorithm to give meaning for the autism coefficient

All algorithms described above that we used in our proposed framework are used for simplicity of coding and calculations and for acquiring a higher accuracy of the system. The flowchart of activities performed to generate a report and diagnostic for patient are shown in Fig. 5.

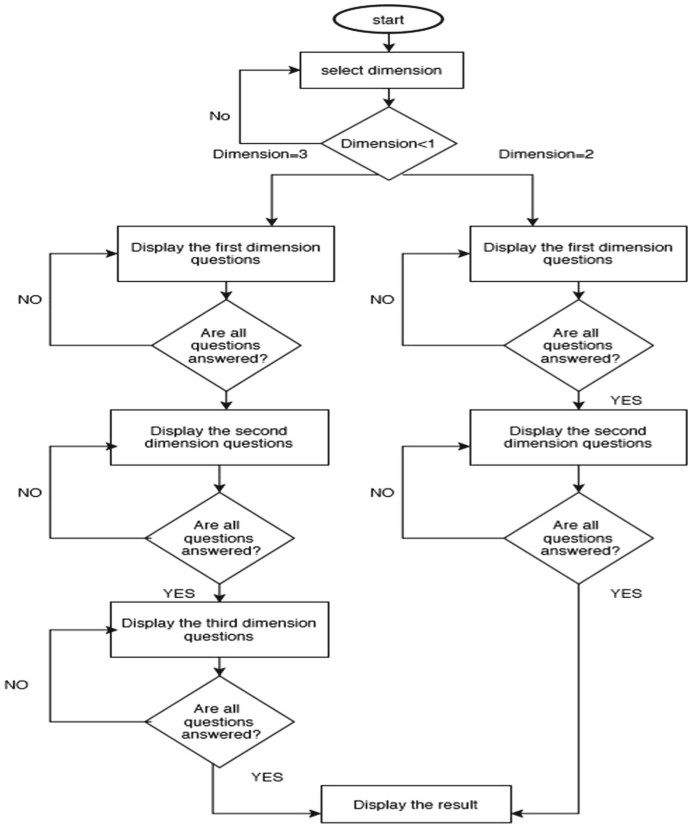


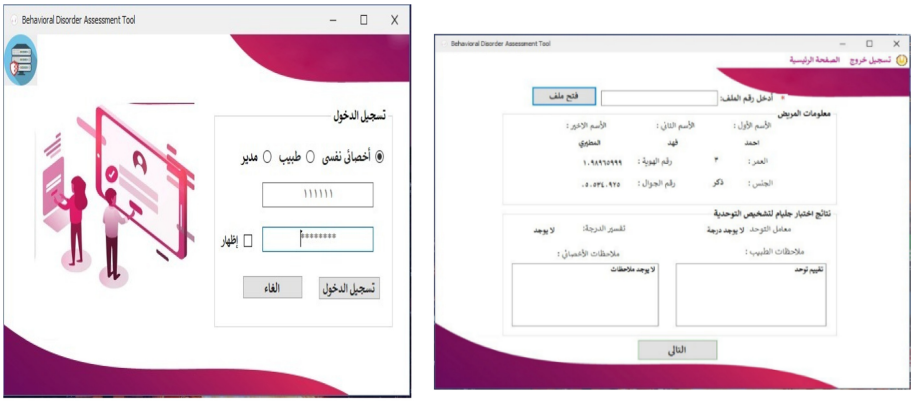
Fig. 5. Flowchart of the proposed system

4 Implementations and Experiments

In this section, we have provided the implementation procedure with necessary explanation that clearly describe the outcome of the system. We have also provided the experimental setup of our developed system.

The proposed framework has been developed with Visual studio was chosen using C# as a tool to achieve the required goals.

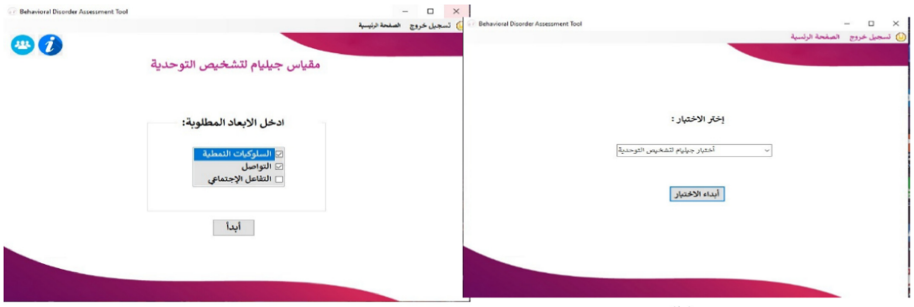
At the beginning of proposed system the psychologist provide patient's file number and then display the patient's information if the patient is already registered. In this interface, we show that if the patient is not registered in the system, the doctor will register a new patient as shown in Fig. 6.



(a) (b)

Fig. 6. (a) Start the BDA, (b) Display patient information

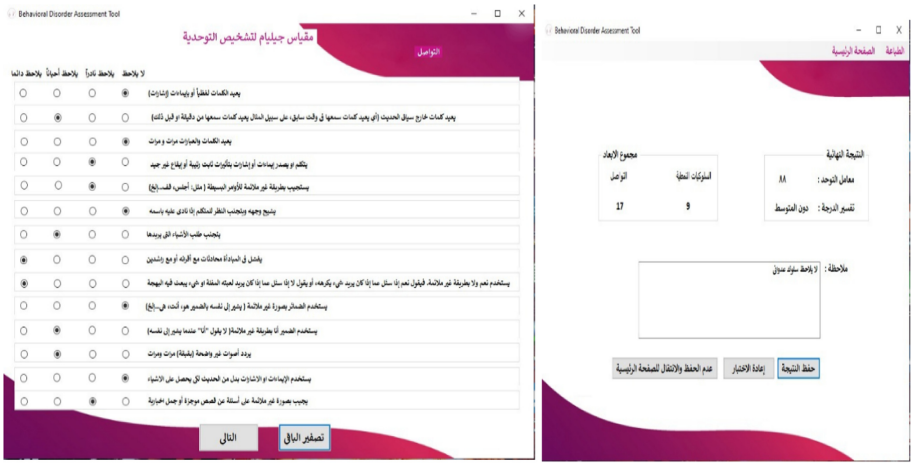
Here and in order to carry out the diagnostic test, the psychologist selects the test that he wants to perform on the patient. Here as an example the user choose Gilliam test. As we mentioned earlier that we convert the paper Gilliam test into an electronic test here showing the dimensions used in the Gilliam test the psychologist determines the dimensions that he wants to perform on the patient and then starts the test Fig. 7 (a).



(a) (b)

Fig. 7. (a) Perform the test for a patient. (b) Choose Gilliam test

In this step, after selecting the appropriate dimensions, the dimensions questions are presented to the psychologist and answers the appropriate way that suits the patient's condition (see Fig. 8.a). In this step, after the psychological specialist finishes answering all the dimensional questions, the test result will appear for the psychological specialist, and the psychologist can save the result or not to save it and return the home page and he can repeat the test for the patient. As shown by Fig. 8.b.



(a) (b)

Fig. 8. (a) List of dimensions questions. (b) Generate test result

5 Empirical Result and Discussion

In order to validate the proposed framework, we compare results proposed by the ABDA developed tool and the actual approach based on a manual performing and calculation of Guillum Test as example of behavior disorder Assessment to diagnose children Autism. Both methods use the same data as input. The comparison will be based on: 1) Number of patient to be diagnostic, 2) The paper waste generated by those manual tests and 3) The time required to determine the result and recommendation for a patient. Actually an example trial run consisting of twenty manual survey completions and twenty automated survey completions.

The time required is taken to be the mean of: firstly, the times required fill out the test and secondly, the time required to calculate the result, the recommendation and generate report to print. This computation time represent a very important parameter in a diagnostic process. Actually, it tacks from one to two hours using a manual method and also the manual calculation can lead to diagnostic errors. Using ABDA tool the process is instantly done. The research resulted in a large decrease in the amount of time required to complete each behavioral disorder Assessment. For the sample used of Gillum Test for Autism diagnostic used, the average amount of time required to complete the test was reduced. This trend is predicted to continue for all other behavior

disorder tests, perhaps even reducing the percentage of time required by even more. The proposed technique save at least 90% of the time spent manually and reduces the number of steps by more than 50%.

In addition, the number of patient diagnostic per day is very important because it facilitate and anticipate treatment of the behavior disorder of the child. As the time required for each patient decreased the number of patient diagnoses per day decreased also and the total number of patient decrease. In the other hand, paper waste is a crucial point because it need storage strategies to facilitate patient record searching and finding. Using the proposed method.

6 Conclusion and Future Work

In this paper, we study the problem of manual completion of printed test documents for the aim of diagnoses the intellectual and developmental disabilities for patients. In many cases, child's behaviors are assessed manually using paper tests, which is costly in time, effort and sometimes lead to errors. These motivated us to develop a computational methodology for translating well-known BD tests into automated ones. The proposition could bridge domains like psychology and social science with computer science. Our work is to develop an automated diagnostic framework that completes tests and generates diagnostic results that will save time, get more accurate results and easily used and perform data analysis to show statistics. In the proposed system, we used documents with multiple-choice questions (MCQ) for Gillum Test as sample.

In the future, the proposed automation process can be improved in several ways. Currently, the phycologist can carry out one BDA has to begin the process themselves and click a button to automatically complete the test. This could be improved with further automation. The availability of tests' results to evaluate the program performance was a limitation because the limited number of patients with the time passing, more results will made available for estimation. Due to lake of time many other manual tests automation is left to the future. In addition, it could be more interesting if our future work also contains deeper data analysis and verity of statistics. These improvements would further increase the gains of automating surveys versus manual completion.

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