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Implementation of the breadth-first search method on forward-chaining inferences to diagnose autism disorders in children

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Abstract

Autism is a type of mental disorder that can affect children as young as three years old, but can affect children from birth. This mental disorder is characterized by social relationships, culture, verbal and non-verbal communication, imagination, and a single attractive object. By using the Autism Disorder Diagnostic Expert System, we hope that most people will be able to attempt an autism diagnosis without an expert. This system works by answering all system questions. The "forward chaining" method is a way of drawing conclusions that starts with facts and tests hypotheses toward conclusions. To test the hypothesis, begin matching facts or statements with IF. The forward chaining method searches for a solution to a problem. The forward chaining inference and breadth first search methods were used to design this system, as well as Microsoft Access for database management systems and Visual Basic Language Programming. The expected outcome is that all users, particularly parents, will be able to easily assess the possibility of their child developing autism symptoms from an early age. The output of the system is whether there is a possibility of autism in a child based on the facts and symptoms given to the system.

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1. Introduction

Autism is a disorder of brain function suffered by someone whose symptoms appear before the child is 3 years old, and in some cases, this disorder has been seen since birth [1]. This disorder includes social relations with the surrounding environment, verbal and non-verbal communication, imagination, and attention to something [2][3][4]. In some cases, autistic disorder can be cured by following a regular therapy program, and in some cases, autistic disorder can be cured if it is detected early. Unfortunately, some parents do not have enough knowledge about these symptoms. early symptoms of this autism disorder, so that early detection is ignored [5][6][7]. The American Psychiatric Association creates the Diagnostic and Statistical Manual of Mental Disorders as a standard reference that can be used universally to identify different types of mental developmental disorders [8][9][10], so that with this reference, there is already a standard value that will be obtained from the test results to determine whether a person has autism or not [11][12][13].

The diagnosis of Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) is generally used in the United States to explain the existence of several characteristics of autism in a person [14][15][16]. The National Information Center for Children and Youth with Disabilities (NICHCY) in the United States states that autism and PDD-NOS are developmental disorders that tend to have similar characteristics and whose symptoms appear before the age of 3 years [17]. Both are neurological disorders that affect the ability to communicate, understand language, play, and relate to others. The inability to adapt to change and the presence of abnormal responses to sensory experiences are often associated with autism symptoms.

The inference engine is the part that contains the thinking function mechanisms and system reasoning patterns that will analyze a particular problem and then look for the best answer or conclusion [18]. Deductively, the inference engine selects relevant knowledge in order to reach a conclusion. Thus, this system can answer user questions even though these answers are not stored explicitly in the knowledge base. The inference engine starts its tracking by matching the rules in the knowledge base with the facts in the database [19]. There are two types of inference techniques: (a). backward chaining, which starts its reasoning from a set of hypotheses to facts that support these hypotheses [20]; and b. forward chaining, which starts its reasoning from a set of hypotheses to facts that support these hypotheses[21]. (b). Forward tracking (forward chaining), which is the opposite of backward tracking, namely starting from a set of data and drawing conclusions [22].

The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), defines autism as one of five pervasive developmental disorders. Pervasive Developmental Disorders refers to a group of developmental disorders that affect children [23][24][25]. Expert systems as part of artificial intelligence can be applied to help parents detect autism in their children as early as possible because the decoy system is a computer program that mimics the reasoning of an expert who is an expert in a particular field of knowledge. Diagnosing autism disorder must be supported by forward chain tracking and the breath-first search method to obtain the desired diagnostic results [26][27][28], and [29]. With the application of this method, it is hoped that later it will be possible to complete research to detect autistic disorders in children as early as possible, and with this research, it is hoped that parents who do not have sufficient knowledge about autism can find out about autistic disorders in their children as early as possible, so that it is possible to be cured. The severity of this autism disorder can be even worse [30][31].

2. Research Method

2.1. Framework.

In the research methodology, there is a sequence of frameworks that must be followed; this framework sequence is an illustration of the steps to be followed so that this research can run smoothly. The following framework is used:

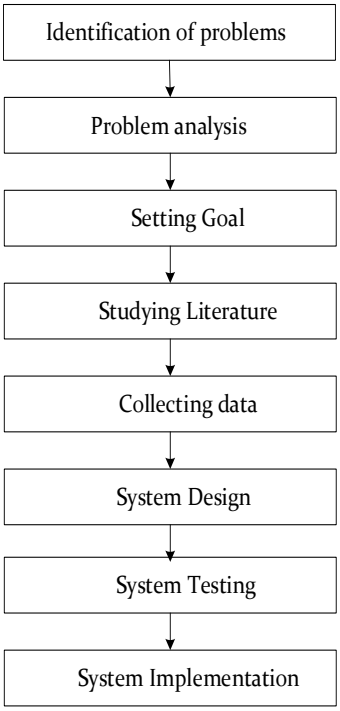

Figure 1. Research Framework

2.2. Framework description.

Based on figure 1, the above sequence of work steps can be described as follows:

a. Identification of problems
   The problem identified in this study is identifying signs related to autism in children as early as possible, while the exponential comparison method is used to make decisions based on some of the symptoms detected.
b. Problem analysis
   Problem analysis in this thesis was carried out using two methods, namely the descriptive method and the comparative method.
   1) Descriptive method In this method, the existing data is collected, compiled, grouped, and analyzed in order to obtain some clear descriptions of the problems discussed.
   2) Comparative Method In this method, the analysis is carried out by comparing theory and practice in order to obtain a clear picture of the similarities and differences between the two.
c. Setting Goals
   Based on the description above, the objectives to be achieved from this research are:
   1) Obtain accurate diagnostic results regarding the possibility of autism in children, in accordance with the Statistical Manual for Mental Disorder (DSM-IV) rules
   2) Providing knowledge to parents about autism disorders in children
d. Studying Literature
   The goal of reading the literature is to gain a better understanding of the knowledge or knowledge that will be used in this expert system. The literature to be studied comes from books written by experts in their fields, scientific journals published on the internet, magazines, and newspapers.
e. Collecting data Data is collected from various existing sources. Data collection in this thesis was carried out using three methods, namely literature study, observation, and interview methods.
   1) Literature review Studying theories or literature from scientific books and references related to the object of the thesis as the problem domain in this thesis constitutes literature study. The literature studied here is related to the basic concepts of expert systems, expert system applications, and books related to autism.

2) Observation Observations were made to see firsthand how the conditions and behavior of children with autistic disorders vary.

f. System Design
At this stage, the system design process will be carried out, starting from designing a database to accommodate statistical data obtained from the Diagnostic and Statistical Manual (DSM-IV) using Microsoft Access 2003, designing an interface to display questions and alternative answers, writing program codes, and designing the interface for process output.

g. System Testing
System testing is carried out according to the rules that have been established in the Statistical Diagnostics Manual for Mental Disorders (DSM-IV).

h. System Implementation
At this stage, a review of the feasibility of the system that has been designed is carried out to determine whether the system is appropriate or still needs to be reviewed or refined.

2.3. System overview.

This expert system for diagnosing autism disorders in children uses the advanced inference method (forward chaining). The choice of this method is based on the fact that this method is suitable to be applied to obtain diagnostic results from several groups of symptoms that are present. diagnosis of autism According to the DSM-IV, there are 3 groups that are characteristic of autistic disorders in children at this early age, namely: a qualitative disturbance in reciprocal social interaction; a qualitative disturbance in the field of communication; and a sustained and repeated pattern of behavior, interests, and activities.

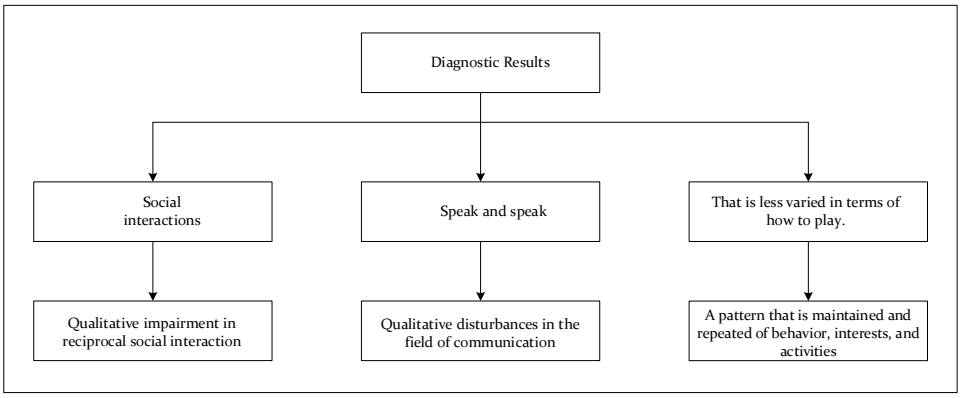

Figure 2. Factors Influencing Autistic Disorder Diagnosis

If there are signs of at least two symptoms of qualitative disturbance in social interaction, one symptom of qualitative disorder in communication, and one symptom of a pattern that is maintained repeatedly from behavior, interests, and activities from the three groups, the child is diagnosed with autism.

2.4. System architecture.

In accordance with the form of expert system architecture that has been defined, by simplifying several components, the expert system architecture for diagnosing autism in children can be designed as follows:

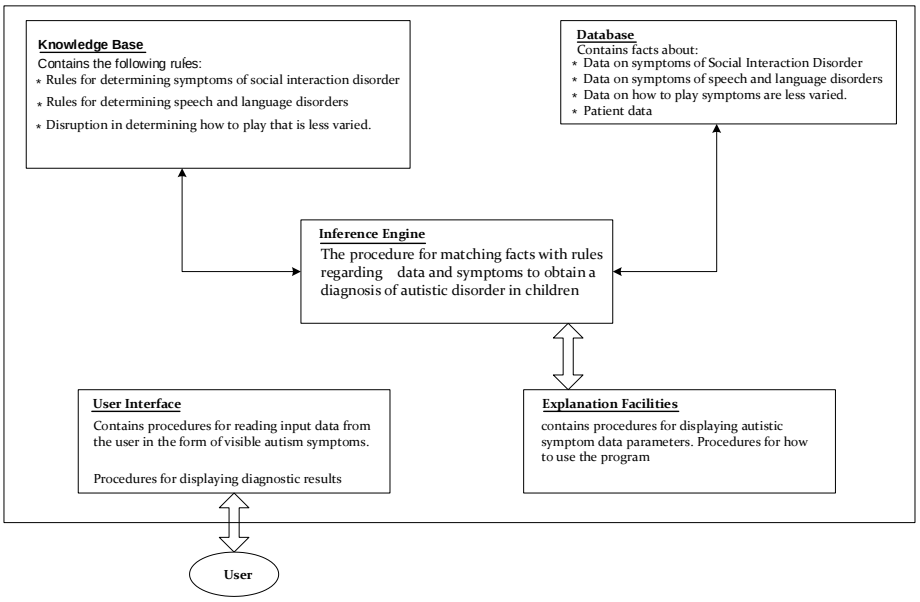

Figure 3. System Architecture Design

2.5. System activity design.

Activity diagrams describe the various activity flows in general in the system being designed, how each flow starts, how the process is carried out, and how the process ends. Activity diagrams do not describe the internal behavior of a system. From figure 4 below, it can be seen how the flow of system activity goes from the user to finally being able to display the results of the diagnostic conclusions that will be received by the user.

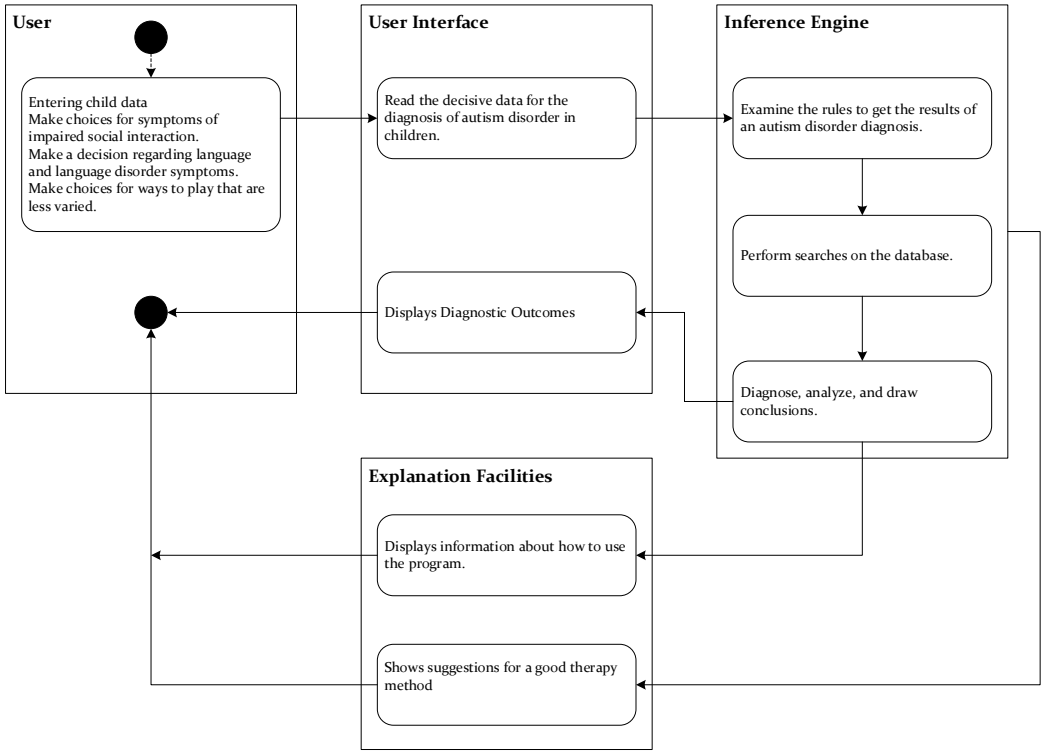

Figure 4. Autistic Disorder: Diagnostic Activity Design

There are three entities that are directly involved in the use of this system; the three entities are experts who will enter knowledge related to the diagnosis of autism into the knowledge base. admin who will manage the access rights of each user as well as users or general people who will use this system to diagnose autism in children.

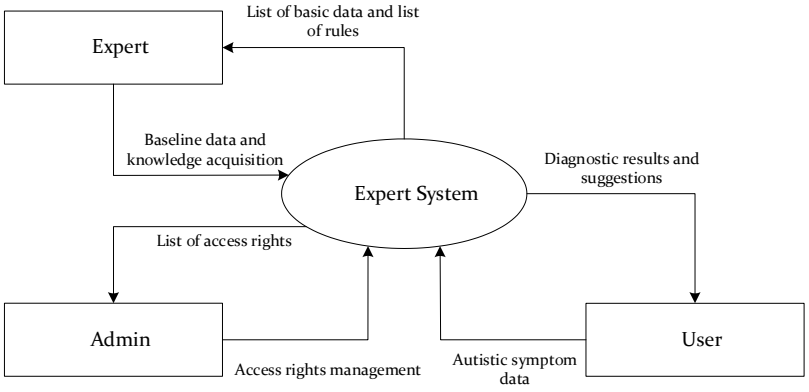

Figure 5. System Relations with Users

2.6. Knowledge representation.

To support reasoning in diagnosing autistic disorders in children [32][33], the knowledge obtained from experts can be represented in the form of a decision tree [34][35], as shown in figure 6 [36].

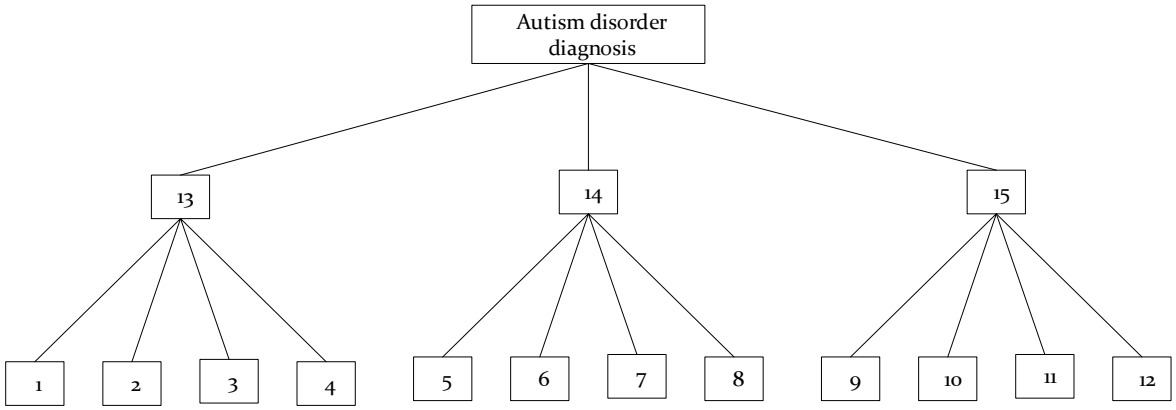

Figure 6. Reasoning for the Autism Diagnosis Decision [37][38]

Information:

1 = Unable to establish adequate social interaction: very little eye contact, less lively facial expressions, less focused movements.
2 = Unable to play with peers.
3 = Inability to empathize with others.
4 = Lack of mutual social and emotional connection.
5 = Talking late or not even progressing at all (and no attempt to compensate for communication in other ways without talking).
6 = If you can talk, you can't talk for communication.
7 = Often uses strange and repetitive language.
8 = How to play is less varied, less imaginative, and less able to imitate.
9 = Defending one or more interests in a very distinctive and exaggerated manner.
10 = Fixation on a ritualistic activity or routine that is useless.
11 = There are peculiar, repetitive movements.
12 = I am often fascinated by parts of things.
13 = Qualitative impairment in reciprocal social interaction.

14 = Qualitative disturbances in the field of communication.
15 = A pattern that is maintained and repeated through behavior, interests, and activities.

From Figure 6 above, it can be seen that each factor that influences the outcome of the diagnosis of autistic disorder has several criteria, for example, the quality disorder factor and reciprocal social interaction (no. 13), influenced by not being able to establish adequate social interaction: very little eye contact, lack of lively facial expressions, less focused movements (no. 1), inability to play with peers (no. 2), inability to feel what others feel (no. 3), lack of social and emotional reciprocal relationships (no. 4). If two symptoms of the four criteria are found, then the child can be suspected of having autism. For the qualitative disorder factor in the field of language (no. 14), it is influenced by the criteria. Speech is delayed or non-existent (and there is no attempt to compensate for communication in other ways other than speaking) (no. 5); if you can talk, you can't communicate (no. 6); frequently uses strange and repetitive language (no. 7); the way of playing is less varied, less imaginative, and less able to imitate (no. 8); if there is one sign from these four criteria, the child can be suspected of having autism.For factors A pattern that is maintained and repeated from behavior, interests, and activities (No. 15) is influenced by the following criteria: maintains one or more interests in a very characteristic and exaggerated way (#9), fixates on a ritualistic activity or a meaningless routine (#10), makes peculiar and repetitive odd movements (No. 11), and is often fascinated by parts of objects (No. 12).If, for example, factor No. 13 has a sign greater than or equal to 2, factor No. 14 has a sign greater than or equal to 1, and factor No. If there are 15 signs greater than or equal to 1, then the child is declared to be suffering from an autism disorder. To simplify the process, each factor and criterion is represented by a certain symbol: qualitative disturbance factors in reciprocal social interaction are symbolized by A; qualitative disturbance factors in the field of communication are symbolized by B; factors of a pattern that is maintained and repeated from behavior, interests, and activities are denoted by C; then the criterion values for each factor are denoted sequentially by numbers 1, 2, and so on.
As an example of a qualitative disturbance factor in reciprocal social interaction denoted by A, each criterion of this factor is implemented as follows:

A1 = Unable to establish adequate social interaction: very little eye contact, less lively facial expressions, Less focused movements.
A2 = Unable to play with peers.
A3 = Unable to feel what other people feel.
A4 = Lack of mutual social and emotional relationships.
B1 = Speech is delayed or does not progress at all (and no attempt is made to compensate for communication by other means without speaking)
B2 = If he can speak, he cannot speak for communication.
B3 = Often uses strange and repeated language.
B4 = Less varied way of playing, less imaginative and less able to imitate.
C1 = Maintains one or more interests, in a very distinctive and exaggerated way.
C2 = Fixation on a ritualistic activity or a useless routine.
C3 = There are peculiar and repetitive movements.
C4 = Often very fascinated by parts of objects
D1 = Qualitative impairment in reciprocal social interaction.
D2 = Qualitative disturbances in communication.
D3 = A pattern that is maintained and repeated from behavior, interests and activities.

2.7. Presentation of facts and rules.

A list of rules is compiled based on the representation of knowledge for diagnosing autistic disorders in children, as follows:

Tabel 1.
Rule

No	Rule
1	IF there is very little eye contact AND facial expressions and gestures are less animated and purposeful, then A1 = 1
2	IF the child cannot play with peers, then A2 = 1
3	IF the child cannot feel what others feel, then A3=1

No	Rule
4	IF there is no reciprocal social or emotional connection, then $A_4 = 1$
5	IF speech is delayed or does not progress at all, and no attempt is made to compensate for communication by means other than speaking, then $B_1 = 1$
6	IF the conversation cannot be used for communication, then $B_2 = 1$
7	IF often uses strange and repetitive language, then $B_3 = 1$
8	IF the way of playing is less varied, less imaginative, and less capable of imitation, then $B_4 = 1$
9	IF the student maintains one or more interests in an unusual and exaggerated manner, then $C_1 = 1$
10	IF the child is fixated on a ritualistic activity or routine, that is useless, then $C_2 = 1$
11	IF the child makes peculiar and repetitive movements, then $C_3 = 1$
12	IF the child is frequently fixated on specific parts of objects, then $C_4 = 1$

2.8. Inference mechanism.

The expert system algorithm for diagnosing autistic disorders in children can be seen in figure 7. In this algorithm, it can be seen that the search process begins by entering the child's age, if the child is more than 3 years old, the system will reject it, then continue by entering preferred data for social interaction and the system will conduct a search on the rule, after the search is carried out, a score will be obtained for the factor in question. The process of tracing the rules and the process of calculating the score for each factor occurs in the three factors that affect the diagnosis results until finally each score on each factor will be accumulated to obtain a diagnosis result.

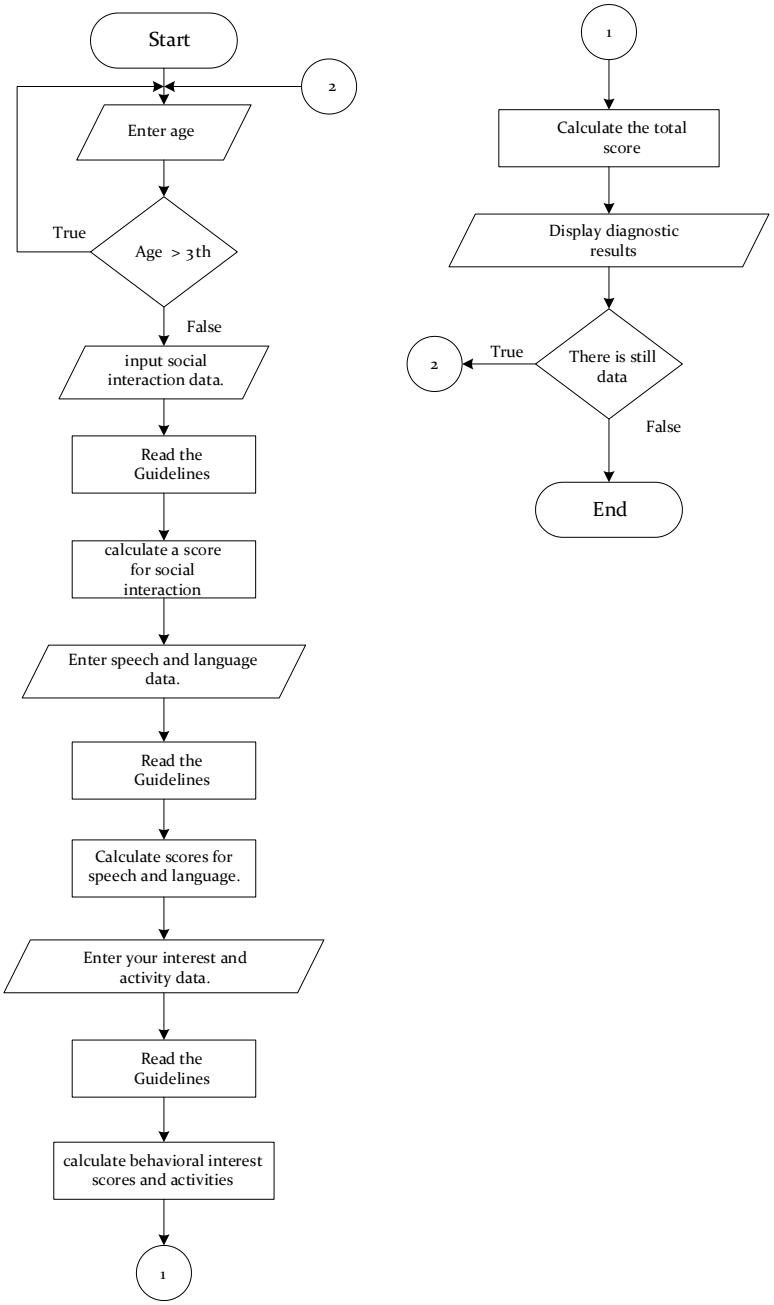

Figure 7. Inference Engine Algorithm

3. Results and Discussion

To facilitate the operation of this system, the interface design is divided into several types, which are adapted to their respective functions, namely:

3.1. Form of login.

This form is the initial appearance of the program, which also functions as system security, because in this form user access rights are distinguished between expert-level users, admin-level users, and user- or parent-level users. The appearance of the Sepseti login form is shown in figure 8.

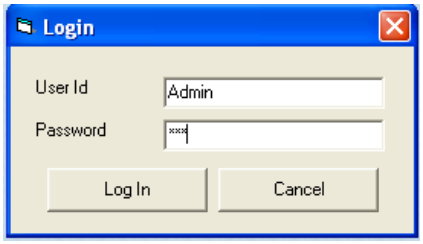

Figure 8. Form User Login

3.2. Main menu.

Form The main menu form is a form that contains all menus to activate sub-programs or other forms. The menus on this form are tailored to the permissions settings. Administrators have the most comprehensive menu options because all menus are activated with Admin access rights. Access rights for experts and users are not as extensive as those for administrators; active experts have access to only the factor data form and the criteria data form, while active users have access to the patient data form and the criteria data form.

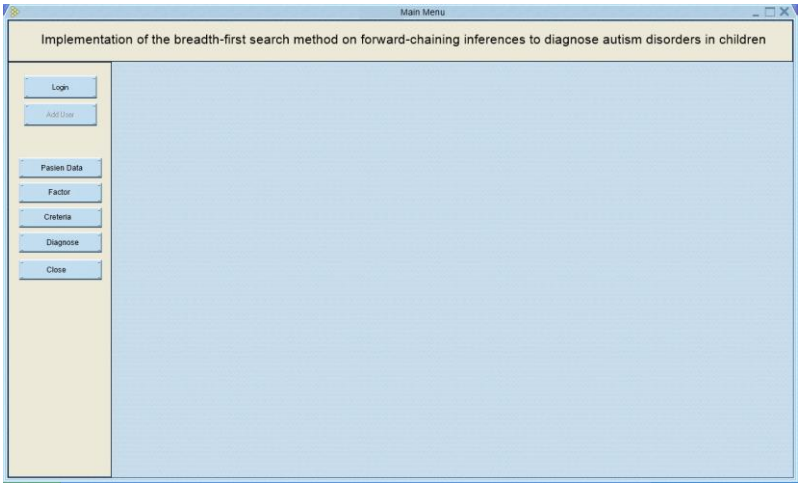

Figure 9. Main Menu

In the initial appearance of the main menu, most of the buttons that will be used to open parts of the program are inactive. The only active buttons are the Close and Login buttons. In order for the other buttons to be active, we first carry out the login process. If the login process has been carried out, the buttons that match the access rights settings will be active by themselves.

3.3. Include a user form.

This Add User Form is useful for adding user data for experts or admins who are allowed to use the system. This form is only active if the access right that is activated is admin. To activate this form, click the Add User button below the Login button.

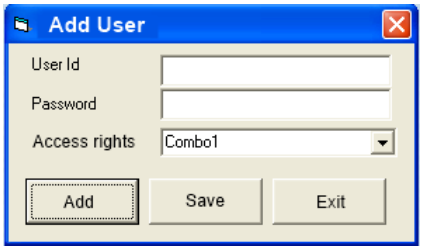

Figure 10. Form New User

3.4. Patient data forms.

The Patient Data Form is used to enter the data of children who will be tested with this system.

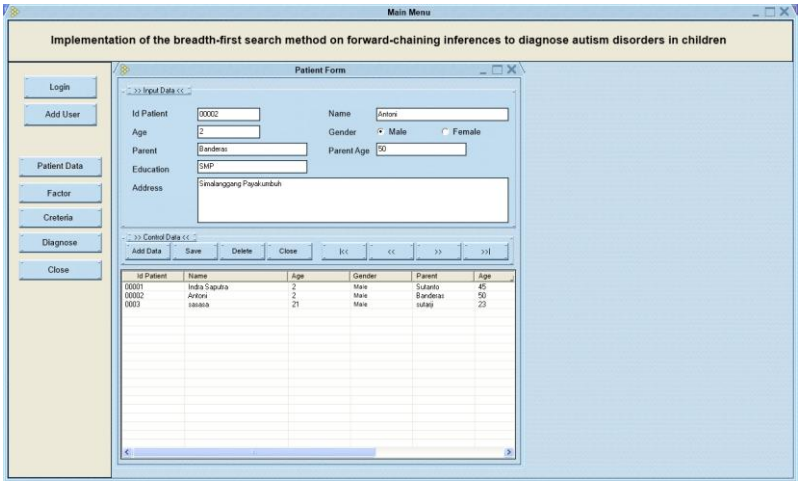

Figure 11. Patient Information Forms

In this patient data form, we will find several buttons, including Add Data. This button is used to clear all existing text boxes to make it easier to add the next set of data. The Save button is useful for saving all the data that has been typed into each textbox into the patient data table. The delete button is useful for deleting records in the patient data table if the patient code matches what is in the Patient Id textbox. In another section, the deepest command button is described with the captions |<<, <<, >>, >>|.The Command Button is useful for managing the navigation of moving from one record to another, whether to the first record, the previous record, the next record, or the last record.

3.5. Factor data form.

The factor data form is a form that is part of the expert, so the expert can enter factors that are the main data for diagnosing this autism disorder.

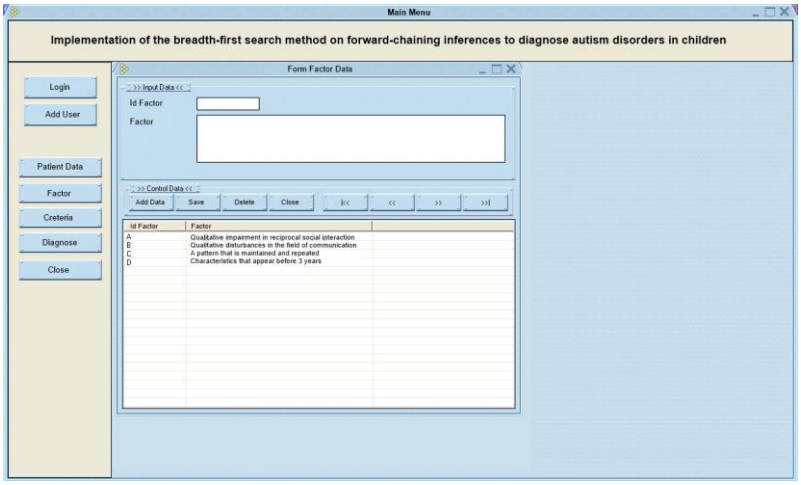

Figure 12. Factor Data Form

To enter new factor data, type the Factor Id in the Factor Id textbox and write the factor in the factor textbox. The data that has been stored in the factor table is displayed in the ListView which is at the bottom of the form.

3.6. Criteria data form.

Criteria data is a more detailed description of factor data. Each data entered into this form has its own Factor Id.

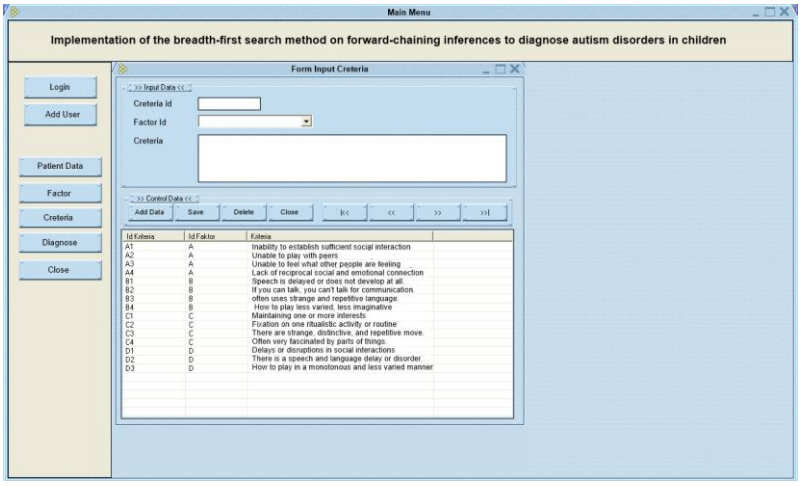

Figure 13. Criteria Input Form

3.7. Diagnosis form.

The diagnostic form is the core form for processing data to produce a diagnosis.

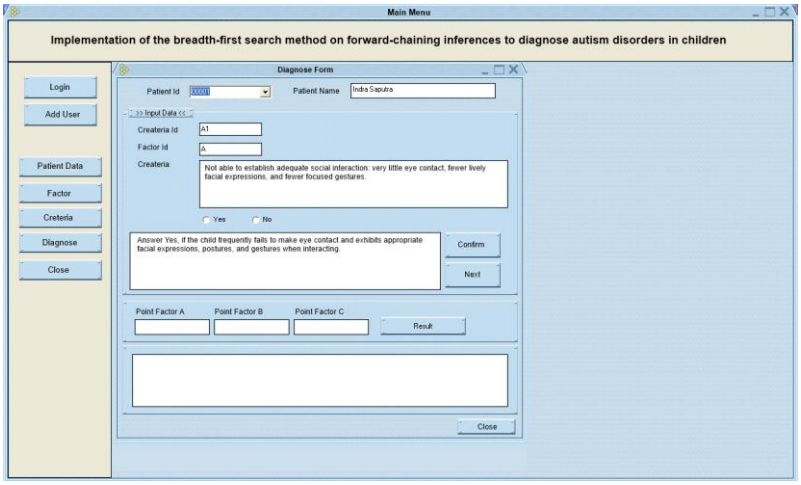

Figure 14. Diagnosis Form

The first step to implementing this diagnostic form is to enter the patient ID in the patient ID combo box. If the code has been registered in the patient data table, the patient name will automatically appear in the patient name textbox. In the Data Input Frame, Criteria Id, Factor Id, and Criteria will appear, and below that there are 2 option buttons to determine Yes or No. If the Yes or No options have been determined, press the Confirm button to confirm the selected answer, then click the Continue button and follow the same steps as in the previous question. There is another text box under the Yes and No Option Buttons; this text box contains questions that users of this system must consider before confirming the answer is Yes or No. The Result button is used to display the final diagnosis of the system after all questions have been answered.

3.8. System testing.

System testing is carried out by answering Yes or No questions submitted by the system through the

Diagnostics Form interface. The results of the question and answer process can be seen in the following table:

Tabel 2.
FAQ Data

Questions	Answer
Are children frequently found in Failure to make eye contact and show facial expressions, postures, and gestures to interact properly	Yes
Is it often found in children's failure to foster social relationships with peers, where they can share emotions, activities, and interests together?	Yes
Are children often found to be unable to empathize with and read other people's emotions?	Yes
Are children often found to be unable to spontaneously find friends to share fun and do things together?	No
Is speech development delayed or not developed at all, and is there no attempt to communicate with gestures or facial expressions to overcome deficiencies in speech ability?	Yes
Is the child unable to initiate a conversation or maintain a good two-way conversation?	No
Does the child often use unusual language that is repeated or stereotyped?	No
Is the child unable to play imaginatively? Usually, the game is less varied.	No
Is there a preoccupation that is very limited to an abnormal pattern of behavior, for example, sitting in a corner while scattering sand like rainwater for hours on end?	No
The existence of an attachment to a routine or ritual that is not useful For example, if a child wants to go to sleep, he has to wash his feet, brush his teeth, put on his pajamas, rub his feet on the mat, and then climb into bed. If one is missed or the order is reversed, he will be very upset, crying and screaming for it to be repeated.	No
Are children often found to have strange motor movements that are repeated, for example, flapping arms, moving fingers in a certain way, and tapping something?	Yes
Is there a preoccupation with non-useful parts of objects or toys, such as a bicycle wheel being rotated, objects with specific shapes and feels that they continue to seek, and certain sounds?	Yes

From the results of the question and answer process as shown in the table above, the Diagnostic Form will display the following results:

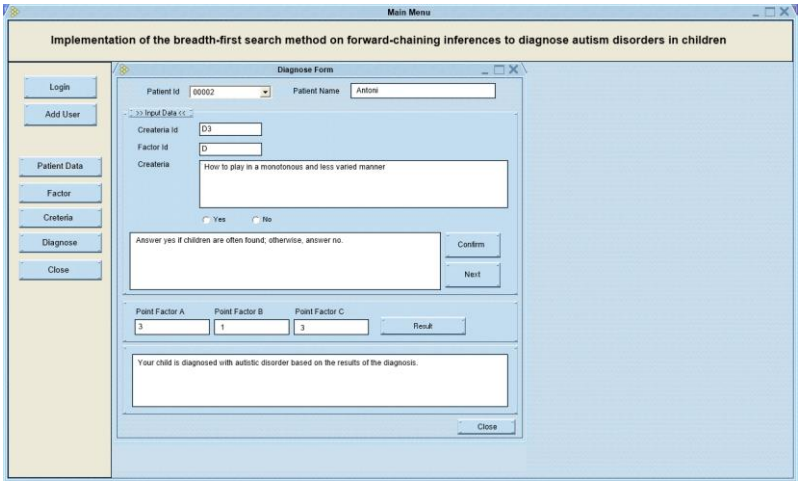

Figure 15. Diagnostic Results

4. Conclusion

Based on the research and discussion conducted, several things can be concluded, as follows: The outcome of an autistic disorder diagnosis is determined by three factors and several criteria for each factor. To diagnose social development disorder, at least two signs of the first factor must be found. Impaired verbal development is influenced by the second factor, and at least one criterion must be found for this factor. The third factor is used to determine the existence of behavioral deviations and must have at least one criterion. An expert system is designed to diagnose autism in children based on the question and answer data entered. Fordward chaining reasoning with the Breadth First Search

method can be used to trace the factors and criteria needed to get a diagnosis of autism disorder. The output of this system is information about whether a child has autism or not. As the end of this research approaches, we would like to provide some suggestions that may be useful for anyone who is interested in using this system; The design of an expert system for diagnosing autistic disorders in children, the writer feels, is still far from being perfect. For this reason, the authors hope that there are other parties or researchers who are willing to develop and continue this research. This research can be developed by creating mobile or Android-based applications that can be accessed and downloaded widely by the public as a form of early detection of children with autism. can be added in more detail about various questions and answers for the decision-making system by consulting several specialists who are experts in their fields. Then, to get more accurate and closer to the truth of the diagnosis, it is better to apply statistical methods or other decision-making system methods, and we recommend that every public service place, such as sub-district offices, health centers, sub-district offices, and others, provide computer facilities. which is supported by expert system applications for various fields that can be easily accessed by the public.

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