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Artificial Intelligence–based Fuzzy Logic to Determine Admission of First- year Primary School Student

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***الملخص*- يتم قبول التلاميذ في الصف الأول الإبتدائي عند إتمام ستة أعوام، مما يؤدي إلى حرمان العديد من الأطفال الذين تنقصهم أسابيع قليلة لإتمام ستة أعوام بالرغم من توفر القدرات الذهنية والجسدية لديهم. لذلك يجب مراعاة هذه المعايير في عملية القبول، وفي هذه الورقة تم تصميم نموذج برمجي لحساب نسبة قبول التلاميذ وتستخدم هذه المعايير مع معيار العمر بواسطة المنطق الضبابي fuzzy logic والذكاء الإصطناعي عن طريق نموذج ماامداني (Mamdani) حيث يتم اعتبار المعايير الذهنية والجسدية بالإضافة للعمر كمدخلات للنظام المصمم حيث حُددت قيم لفظية تُعبر عن القيم الفعلية لكل مدخل وهذه المدخلات يتم وضعها عند تصميم النظام ويمكن الحصول عليها من الخبراء التربويين، ويقوم النظام بمعالجة المعايير المدخلة ومن ثَم يُتخذ قرار القبول بحسب النتائج المتحصل عليها.**

Abstract- Students are typically admitted to the first grade of primary school upon reaching the age of six years. This policy, however, often results in the exclusion of children who are just a few weeks shy of turning six, despite possessing the mental and physical capabilities required for admission. Hence, it is crucial to reconsider these criteria during the admission process. This paper introduces a software model designed to calculate the acceptance rate of students. The model incorporates fuzzy logic and artificial intelligence, employing the Mamdani model to consider age along with mental and physical criteria as inputs to the system. Specific threshold values, indicative of actual values for each input, have been established and incorporated during the system's design. These values, derived from insights provided by educational experts, are then used by the system to process criteria entered by end-users. Subsequently, the system determines the acceptance decision based on the processed criteria.

Keywords— *FUZYY LOGIC, ARTIFICIAL INTELLIGENCE; MAMDANI.*

I. Introduction

The integration of Artificial Intelligence (AI) in education is undeniably ushering in a new paradigm, revolutionizing the methods, manners, and approaches through which knowledge is imparted and transferred. Education stands as an indispensable tool for individual, societal, and national development, playing a pivotal role in shaping the growth of any nation. Individuals must acquire the accepted norms, cultural values, and societal expectations, fostering an understanding of rules and conduct for future behavior.

In the 21st century, the forefront of educational innovation lies in the application of Artificial Intelligence, particularly in the realm of smart learning. Smart learning heavily relies on technology

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and related devices within intelligent educational environments. The introduction of smart learning and associated technologies has been identified through research as a highly efficient means of enhancing learning in the present century.

However, the effectiveness of learning is contingent upon various considerations. has identified several factors that hinder effective learning, and addressing these factors can significantly impact the extent to which learning is achieved. Another crucial aspect emphasized in this paper is the educational system adopted by the learner's country of residence. Different countries worldwide operate under distinct educational systems, shaped by their educational goals and envisioned levels of national development.
As per the educational glossary's online summary, the educational system encompasses "everything that goes into educating public-school students at the federal, state, or community levels." This comprehensive term includes laws, policies, regulations, funding, infrastructure, human resources, and teaching resources (such as books, computers, and other materials), all stipulated by the governing body responsible for educational inclusion in various countries. [1]

Technological development and the expansion of various programs and applications, especially those used by children, like smartphones and video games, etc. have contributed to increasing mental abilities and higher IQ rates than children of the same age for decades, and this is known to everyone.

This fact was not implemented in the process of accepting students in the first grade of primary school, and admission was limited to traditional methods of completing Six years until the student is accepted to study in the first year of primary school.

The growth of the economy in the modern world is provided by scientific and technological progress in all areas of production. Modern technologies allow systems not only to develop the quality and to enlarge the range of products but also significantly reduce the cost of production and services by delegating human functions such as decisions to equipment and automatic devices. using artificial intelligence (AI) systems to help humans make decisions here Mamdani can be used to help make decisions where imprecise or uncertain information is involved. It allows for the incorporation of fuzzy sets and rules, which can capture the complexities and ambiguities of real-world decision-making problems. It is possible to effectively apply fuzzy logic in this situation in which there is no exact mathematical description of management, in which the source of data input is determined with real values [2].

Fuzzy Logic was first introduced by a professor from the University of California of Berkeley, He introduced the theory that objects of fuzzy sets, have no precise boundaries and membership in the fuzzy set and logic rather than right or wrong, but is expressed in degrees. Fuzzy logic is an increase of Boolean logic dealing with the concept of truth in part. Where is the logic of classical (crisp) states that all things can be expressed in terms of binary [3].

Some of the reasons why many people using fuzzy logic is that concept of fuzzy logic is easy to understand. Underlying mathematical concepts of fuzzy reasoning are very simple, flexible, and easy to understand and tolerate data. Can be used to model complex nonlinear functions and can be integrated with convolutional control. Finally, it is primarily based on natural language.[4]

In this paper, the role of Artificial Intelligence was channeled toward education by developing a rule-based Fuzzy Logic System to aid school administrators in accepting grade-one students based on a certain criterion that will be set by each student's requirements and give a recommendation for whether to accept the student or not. A high accuracy of 95.87 % generated by the fuzzy system depicts it as a very accurate and reliable tool for students' acceptance.

II. Literature Review

Traditionally, the admission process for first grade in primary schools has been rigidly tied to age requirements, typically requiring students to have completed six years of age before being accepted. However, this approach often overlooks individual differences in readiness and development among young learners. Recent research has explored the potential benefits of integrating fuzzy logic into the admission process, allowing for a more nuanced and comprehensive assessment of students' readiness for first-grade education.
Holistic Assessment:
Fuzzy logic systems enable a holistic assessment of students by considering multiple dimensions of readiness, such as cognitive abilities, socio-emotional development, and prior educational experiences [5].This contrasts with traditional methods that

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primarily focus on chronological age as the sole criterion for admission.

Adaptive Criteria:

Researchers such as Lee and Kim [6]. have highlighted the adaptability of fuzzy logic systems in setting admission criteria. These systems can dynamically adjust criteria based on real-time data, allowing for more flexible decision-making that takes into account individual variations in readiness.

Reduced Bias:

Fuzzy logic models offer the potential to reduce bias in the admission process by considering a wide range of factors without rigid cutoffs based solely on age [7]. This promotes fairness and inclusivity by mitigating the impact of arbitrary age requirements.

Parental Involvement:

Garcia and Lopez emphasize the role of fuzzy logic systems in enhancing parental involvement in the admission process. Transparent explanations provided by these systems help parents understand how various factors contribute to the decision-making process, fostering collaboration between parents and educators [8].

Multi-Criteria Decision Making:

Fuzzy logic enables multi-criteria decision making, as demonstrated by Chen and Wang [9]. By assigning different degrees of relevance to various admission criteria, fuzzy logic systems can weigh factors such as academic readiness, social skills, and maturity levels comprehensively.

In conclusion, the integration of fuzzy logic into the admission process for first grade in primary schools offers numerous advantages over traditional methods. These include holistic assessment, adaptive criteria, reduced bias, enhanced parental involvement, and multi-criteria decision making. Further research and practical implementations can refine these fuzzy logic-based systems to better serve the diverse needs of young learners

III. Methodology

A. *Fuzzy Sets Theory*

This paper uses an interwoven concept approach that applies fuzzy logic to each acceptance rule criterion. This knowledge of expertise sets this caritas Fig. 1. below blocks a diagram of a fuzzy logic system.

Although the degree between 0 and 1 in FL variables can have truth values within the range, conventional binary logic (crisp logic) displays either 1 or 0 representing truth or false, respectively. The membership function (MF) truth values are described in terms of degree rather than absolute yes or no. By breaking up the discourse universe into smaller subregions—also known as linguistic variables—fuzzy sets are produced for each input and output variable. A linguistic variable is one whose values are expressed as natural language phrases or words and are specified by a recognized MF [10,11].

To be more precise, MF is a curve that shows how each point in the input field is mapped by the membership value between 0 and 1. In this case, 0 denotes falsehood, 1 absolute truth, and the degree of truth falls within the given range. Beyond just knowing probability theory, modeling uncertainties, vagueness, and subjective attributes requires other knowledge as well. Arithmetically, an element x is defined as follows: x∈A for an element that belongs to set A, and x not∈A for an element that does not belong in A. Equation (1) defines the characteristics function, also known as the membership function, μ_A (x), as an entity with a crisp value of 1 or 0 in the universe.

U. For every $x \in U$,

$$\mu_A(x) = \begin{cases} & for \ x \in A, \\ & for \ x \ not \in A, \end{cases} \quad (1)$$

which additionally has the expression μ_A (x)∈{0,1}. The MF will accept a value of 1 or 0 for the crisp or classical set, but it may accept values in the [0,1] range for fuzzy sets. The membership grade, also known as the degree of membership, is defined as the interval between 0 and 1 Equation (2) defines a fuzzy set A.

$$A = \{(x, \mu_A(x))| \ x \in A, \ \mu_A(x) \in [0,1]\} \quad (2)$$

where μ_A (x) represents a membership function in the 0–1 range. Two operations that are frequently utilized in set theory are the union and intersection, which are Mathematical Problems in Engineering 3. The definitions of the union and intersection of sets A and B are provided by equations (3) and (4), respectively.

$$\mu_{A \cup B} = max\{\mu_A, \mu_B\} \quad (3)$$

$$\mu_{A \cap B} = min\{\mu_A, \mu_B\} \quad (4)$$

B. *.Fuzzy Inference Systems*

Based on fuzzy logic, a few stages are involved in the development and use of fuzzy inference systems

- Rule-Base Generation**.**

An expression of a rule is of the format «IF A THEN B», where A denotes the condition (or antecedent) and B is the conclusion (or consequent). Fuzzy logic expressions like A and B are typically represented as fuzzy statements of the type «β IS α». One term of the

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linguistic variable α, represented by a fuzzy set, is included in a fuzzy statement along with a linguistic variable β. Words in a natural language serve as the values of linguistic variables. The definition of this tuple is T(β), X, G, and M, where β is the name of the linguistic variable, T(β) is the collection of linguistic values of β, each of which is a fuzzy variable on the set X, X is a discourse universe, G is a syntactic rule that creates the terms in T(β), and M is a semantic rule that assigns a meaning to each linguistic value β. If they are available, G and M are noted. A tuple <α, X, A>, where α is the fuzzy variable's name, X is a discourse universe, and A is a fuzzy set on the X universe, which is a fuzzy variable. The preceding and following can [12].

- Fuzzification of the input variables.

Using the data from the knowledge base, the process of fuzzification converts the input variables—which are sharp numerical values—into fuzzy sets. Values of each input variable are linked to membership function values of the corresponding linguistic terms used in the rule antecedents at the fuzzification stage.

- Defuzzification.

The process of mapping a membership function for the output linguistic variable to a clear, numerical value is called defuzzification. Either of the following techniques is used to convert the output linguistic variable's membership function μ(x) into its crisp value y: The fuzzy set's center of gravity along the x-axis is returned by the center of gravity method Equation (5):

$$y = \frac{\int_{min}^{max} x.\mu(x)dx}{\int_{min}^{max} \mu(x)dx} \quad (5)$$

The fuzzy set is divided into two equal-sized sub-regions by a vertical line that is found using the center of area method Equation (6):

$$\int_{min}^{u} \mu(x)dx = \int_{u}^{max} \mu(x)dx \quad (6)$$

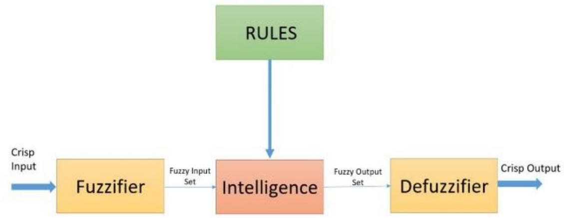

Fig.1 Block diagram of a fuzzy logic system.

IV. System implementation

Firstly, we fuzzified all the crisp inputs and classified the degree of the related fuzzy sets of which the inputs age, smart, and children's body growth these inputs are described in Table I. The proposed system is implemented using the same fuzzy logic system illustrated in Fig. 1.

Table. I. input variables.

Input	Linguistic value	
Age 55-75	Reject	55-60 months
	Medium	60-70 months
	Pass	68-75 months
Smart degree 0-25	Low	0-7
	Medium	7-18
	High	18-25
body growth. 95-120	Short	95 cm -100 cm
	Medium	100 cm -112cm
	Tall	112cm-120cm

1. Rule Base:

Rule Base contains all rules and the if-then conditions offered by the experts to control the decision-making system regarding student acceptance and admission to year one. There are various methods for the design and tuning of fuzzy controllers. These updates significantly reduce the number of the fuzzy set of rules.

2. Fuzzification:

The Fuzzification step is important as it helps to convert the crisp inputs into a fuzzy set. In this case, the crisp inputs represented in Table 1, will be

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converted into the control system as fuzzy sets for further processing.

3. Inference Engine (Intelligence):

At this stage, the system will determine the degree of match between fuzzy input and the generated rules. Based on the % match, it determines which rule needs to be implemented according to the given input field. The applied rules are combined to develop the control action accordingly.

4. Defuzzification:

The final stage of the defuzzification process converts fuzzy sets into clear outputs using various techniques. Linguistic value refers to the variables that are difficult to quantify precisely or where subjective interpretation is required, in table1 3 linguistic values for each input low, medium, and high describe the membership levels of a fuzzy set. membership functions to determine the degree of membership of a value in each fuzzy set as shown in Fig.2. A, B, C.

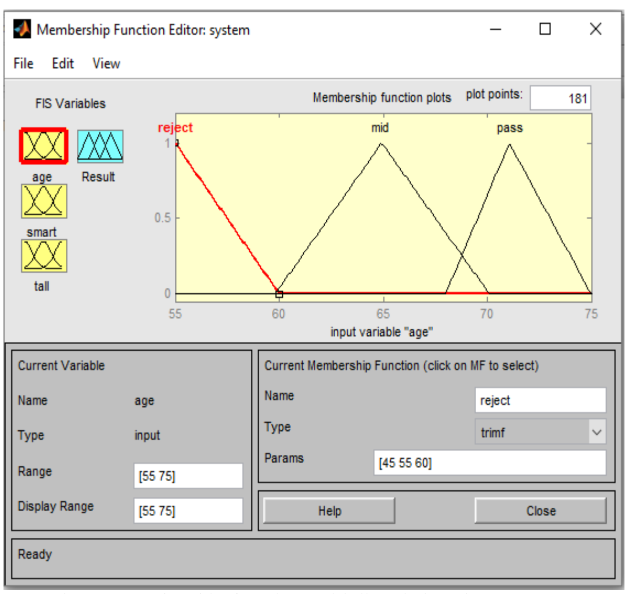

Fig.2.A membership functions with linguistic values age

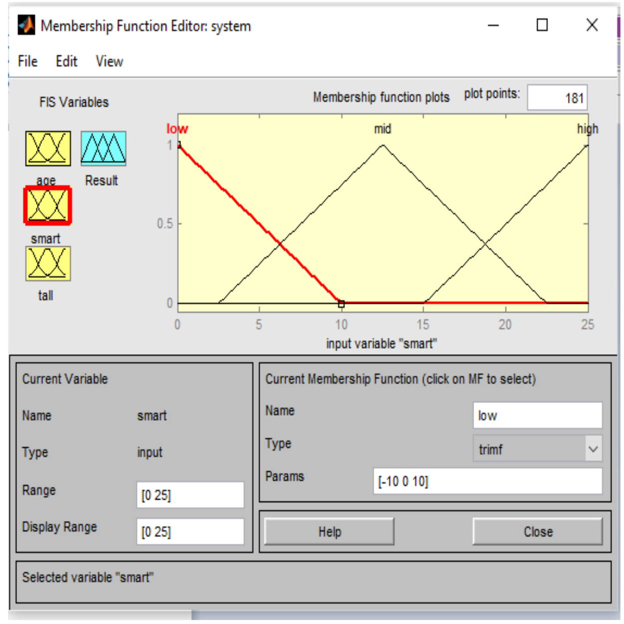

Fig.2.B membership functions with linguistic values smart.

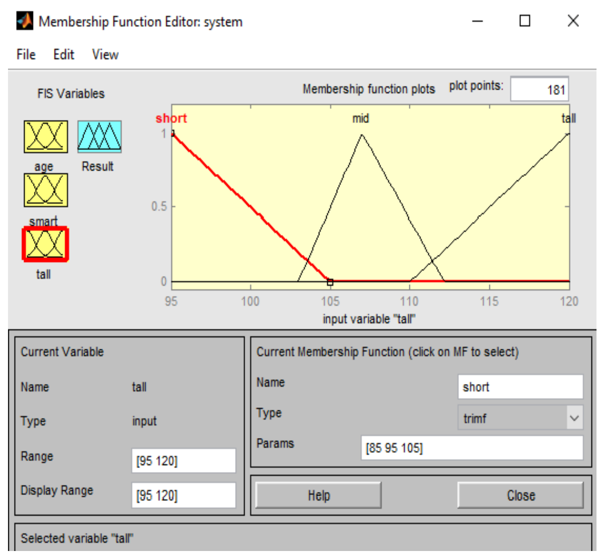

Fig.2.C membership functions with linguistic values tall.

The input membership functions define the fuzzy sets for each input variable of three inputs. These functions assign a membership grade to each value of the input variable, indicating the degree to which that value belongs to a particular fuzzy set. Here Triangular membership functions are used. In the system case, it is proposed to create additional software based on the integrated MATLAB Fuzzy Logic Toolbox. For fuzzy inference, it is suggested to use the Mamdani algorithm. For the fuzzy inference system that was used the input linguistic variables were. After the input

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values convert to a fuzzy set the Mamdani system process [13].

The Mamdani output refers to the method of defuzzification used to obtain a crisp output value from the fuzzy output set, The Mamdani method calculates a weighted average of the output values based on their degree of membership in the fuzzy output set. The degree of membership represents the strength of the association between the input and the output. The value of each membership function is determined by rules where the value is shown in Fig.3. here the if-then rules were expressed in Mamdani rules.

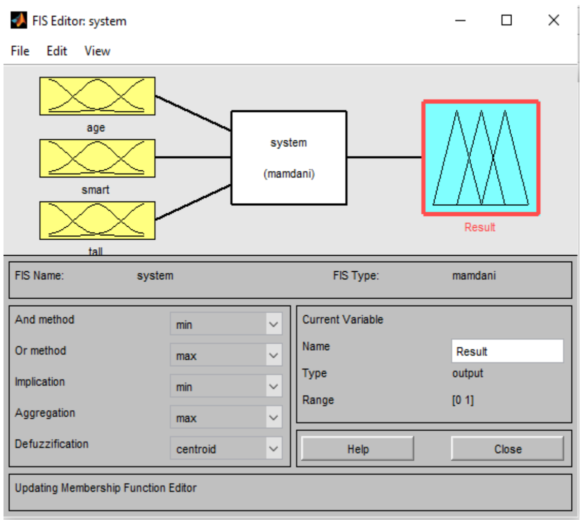

Fig.3. Fuzzy Inference System.

V. Results and Discussion

After simulating and implementing the required datasets, the proposed fuzzy-based intelligent system for deciding on the acceptance of the year-one student was performed with the aid of the MATLAB platform and FIS toolbox. For each student, Student choice, Parent choice, Class teacher's Assessment, student age, and school factors obtained by the students were fuzzified using the Gaussian and Tingler membership functions, and the set of fuzzy rules was placed to determine the relationships between the inputs and output aiding for the decision making as illustrated in Fig.4.

The implementation of the aforementioned steps grants the understanding of how the fuzzy logic system was evaluated and trained in the context of predicting student acceptance into year-one primary, and it is the reason behind achieving the accuracy score of 95.87%.

The proposed system was tested and evaluated by splitting the dataset into training and testing sets as 70% for training, and 30% for testing. Train the fuzzy logic model is used the training data, which involves adjusting parameters and fine-tuning the fuzzy rules to improve accuracy. Test the trained model on the testing/validation data and compare the predicted outcomes with the actual outcomes to evaluate its performance. At this stage, the system accuracy can be calculated by comparing the predicted outcomes (the proposed system's outputs) with the actual outcomes in the testing/validation set (labeled data).

Accuracy (%) = (Number of Correct Predictions / Total Predictions) * 100

For example, after training and testing the fuzzy logic model with a dataset of new students, it correctly predicted 100 out of 104 outcomes in the testing set (e.g., 96 Accepted, 8 Rejected). The accuracy would be calculated as follows: Accuracy = (100 / 104) * 100 = 96.15%

This hypothetical scenario demonstrates how an accuracy score of 95.87% or higher could be obtained through the training, testing, and evaluating process of a fuzzy logic system designed to predict student acceptance into year-one primary based on the given linguistic values and criteria. It's important to note that actual implementation may involve more complex data, rules, and optimization techniques to achieve such high accuracy levels.

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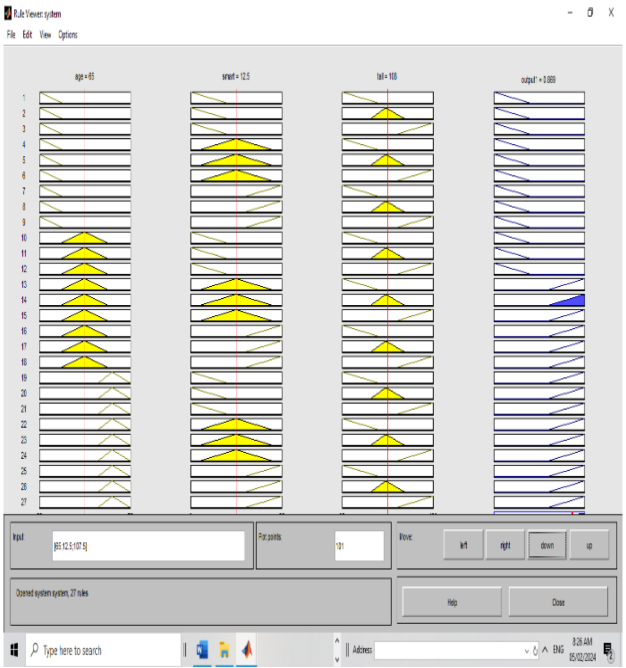

Fig.4.show result

VI. Conclusions

This paper has addressed the use of Fuzzy logic to prediction for deciding whether the new student will be accepted and admitted to the year-one primary, or need to wait until the next year. The prediction criteria adopted is a novel type combining Student choice, Parent choice Class teacher's Assessment, student age, and school factors.

The algorithm describes the processes performed by modeling the selection and prediction of student acceptance. Furthermore, the framework and architecture of the system presented depict the variables deployed in the robust system. Output generated with an accuracy level of 95.87% by the system is a true replica of the action the expert (school registrar) would perform to admit a student into year one.

Conclusively, the data set for testing and validation was limited but can be extended to an appreciably large number depending on the available number of students to be placed in year one. However, the fuzzy intelligent system for students' acceptance has been noted to enhance and efficiently solve the rigorously task-consuming mental power and enormous time of the registrar during student admission into year one. Significantly noticeable in this research are the relationships that exist between the adopted variables and the computational time required for the system to generate the output for each student input.

VII. Future work.

The work presented in this research proposed an Artificial Intelligence – based Fuzzy Logic to Determine Admission to First- year Primary School Student. The system was designed and implemented to ensure it fulfilled the aims of this research. Once the system is implemented using MATLAB based on Mamdani Fuzzy theory. The system has been tested and evaluated based on some different inputs that were considering the possible scenarios of acceptance of the year-one students. The achieved results are very promising so far.

For future work, the system needs to include some self-learning capability to generate the fuzzy rules automatically based on the inputs instead of generating them manually. This could be achieved by combining the system with Neural Networks (NNs) which will enhance the callability of the system to perform much better even once it is dealing with a higher volume of input data.

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