COMPUTER AIDED SYSTEM FOR THE ABILITY OF PRESCHOOLER USING FUZZY LOGIC

Nay Myo Say, Tin Mar Kyi
Computer University (Mandalay)
aaa439035@gmail.com, tinmarkyi@gmail.com

ABSTRACT

Computer controlled systems are greatest interest in today's world. Examination can be held not only the paper writing but also computer testing. This system is to classify the ability of the preschoolers. The child needs to test the exam. There are five kinds of type in test questions: ***choose the right alphabetic, color, shape, number and mathematical computing****. The exam mark is 75 marks. The teacher needs to give other 25 marks to the child depending* ***the child's attendance, cooperate with the other, interests in the class and activity in sport****. The total marks are 100 marks. As the result, the child will get the Grade of the test depending on their marks. The ability of the children will be determined using Fuzzy Logic. Fuzzy logic is one of the latest intelligent control techniques. The input is the mark of test and output is the result of test. Both input and output are analyzed by Fuzzy Decision Making. This system will be implemented by using C# programming language.*

Keywords: *Membership Function, Rule Base, Inference Mechanism, Fuzzification (Triangular Fuzzy Number), Defuzzification (COG)*

1. INTRODUCTION

Control systems are everywhere around us and within us. Fuzzy logic can offer several advantages over other problem-solving techniques, such as quicker development time, increased maintainability better performances less expensive hardware and more robustness [3].Fuzzy logic is one of the recent developing methods in control that are gaining more popularity.

The idea behind fuzzy logic is to write rules that will operate the controller in a heuristic manner, mainly in an (If A Then B) format. The arguments A and B are not exact numbers or equations, but they are descriptive words or phrases like small, pretty cold, and very high.

In general, fuzzy logic is most useful in handling complex problems not easily definable by practical mathematical models. Fuzzy is not limited to just complex control problems. In fact, fuzzy logic was originally thought to be better suited for "softer sciences" such as statistics, psychology, sociology, health care, factory controls, military affairs etc [9]. Any decision-making task, such as managing investment portfolios or circuit design layout may be a good candidate for fuzzy logic.

This system is a study and implementation of fuzzy set and fuzzy logic theorem for determining the ability of preschoolers.

2. RELATED WORKS

The significant progress has been made in the development of fuzzy sets and fuzzy logic theory and their use in a variety of applied topics in engineering and natural and socio-economic sciences involving uncertainty, vagueness and ambiguity. By using fuzzy control system, it can be implemented in another application as traffic signals. Fuzzy logic lies in its capability of simulating the decision making of a human, a process that is often difficult with traditional mathematical methods [8].

[3] is development of a Model-based Self-Learning Predictive Fuzzy Logic (MSPF) Controller for use in applications where the inherent uncertainty in the process model and/or data precludes the use of conventional discrete control algorithms. This work required not only a translation of the concepts of discrete model-based control systems into the fuzzy domain but also significant extensions to fuzzy logic theory.

3. BACKGROUND THEORY

Fuzzy logic was initiated in by Lotfi A.Zadeh, professor for computer science at the University of California in Berkeley; Fuzzy Logic (FL) is a multivalued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low [1].The fuzzy logic approach has three distinguishing features:

1. it uses linguistic variables in place of, or in addition to, numerical values
2. simple relations between the variables are characterized by conditional fuzzy statements
3. complete relations are characterized by fuzzy algorithms

Fuzzy logic controller

The fuzzy controller (Sometimes a fuzzy controller is called a “fuzzy logic controller” (FLC) or even a “fuzzy linguistic controller”) is composed of the following four elements [13].

1. Fuzzification Interface
2. Rule Base System
3. Inference Mechanism
4. Defuzzification Interface

3.1. Fuzzification interface

A fuzzification interface, which converts controller inputs into information that the interface mechanism can easily use to activate and apply rules. It interprets the crisp input as linguistic values [15].

Fuzzy numbers are fuzzy subsets of the real line. They have a peak of plateau with membership grade 1, over which the members of the universe are completely in the set. [6].

The membership function is increasing towards the peak and decreasing away from it. Fuzzy numbers are used very widely in fuzzy control applications. There are many fuzzy numbers.

3.1.1 Triangular fuzzy numbers

A triangular fuzzy number A is defined as by the membership function

$$\alpha = F(x) = \begin{cases} \dfrac{x - a_1}{a_M - a_1} & \text{for} \quad a_1 \le x \le a_M \\ \dfrac{x - a_2}{a_M - a_2} & \text{for} \quad a_M \le x \le a_2 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

Where $[a_1,a_2]$ is the supporting interval and the point$(a_M,1)$ is the peak.To find the α-level intervals, setting in $x^1=a_1^{(\alpha)}$ for $a_1 \le x \le a_M$ and$x^r=a_2^{(\alpha)}$ for $a_M \le x \le a_2$ gives

$$\alpha = \frac{a_1^{(\infty)} - a_1}{a_M - a_1} \quad and \quad \alpha = \frac{a_2^{(\infty)} - a}{a_M - a_1} \quad (2)$$

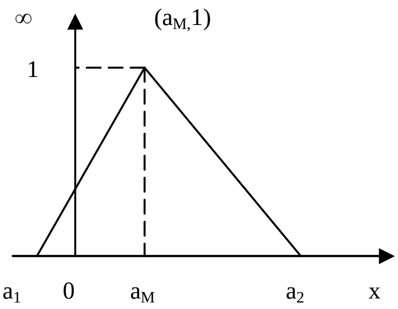


Figure 1. Triangular Fuzzy Number

3.1.2 Trapezoidal fuzzy number

A trapezoidal A (see Figure 2) is defined by

$$\alpha = F(x) = \begin{cases} \dfrac{x - a_1}{a_1^{(1)} - a_1} & \text{for} \quad a_1 \le x \le a_1^{(1)} \\ 1 \ \text{for} & a_1^{(1)} \le x \le a_2^{(1)} \\ \dfrac{x - a_2}{a_2^{(1)} - a_2} & \text{for} \quad a_2^{(1)} \le x \le a_2 \end{cases} \quad (3)$$

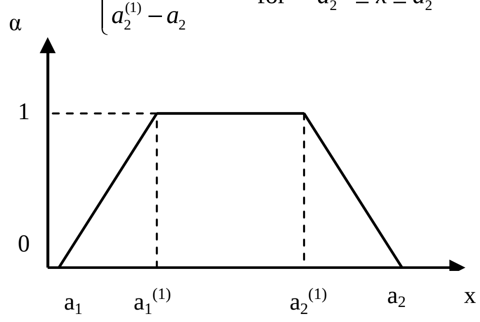


Figure 2. Trapezoidal Fuzzy Number

3.1.3 L function

A fuzzy number L with a flat of the type with membership function

$$\mu l(x) = \begin{cases} 1 & \text{for} \quad 0 \le x \le l_1 \\ \dfrac{x - l_1}{l_1 - l_2} & \text{for} \quad l_1 \le x \le l_2 \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

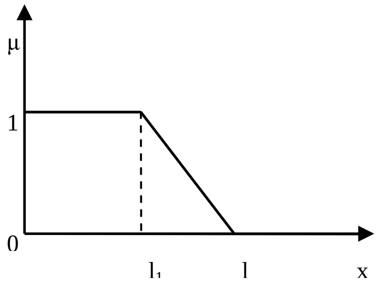


Figure 3. L Function

3.1.4 Membership function

U_1, denote a universe of discourse and $\hat{A}_i^j \in \hat{A}_i$ denote a specified linguistic values for linguistic variables $\hat{U}_i$. the function $\mu(u_1)$ associate with $\hat{A}_i^j$ that maps Ui to [0,1] is called a "membership function". This membership function describes the "certainty" that an element of U_i denoted u_1, with a linguistic description $\hat{u}_1$, may be classified linguistically as $\hat{A}_i^j$ [6].

3.2. Rule base system

A series of rules are developed that equate the fuzzy input membership functions to the fuzzy output membership functions. The rules can be formulated using the same *if ... then ... rules*, typical of expert systems, or by using *look-up-table*s, which consolidate all the *rule-base* information. *Rule-based systems* are most commonly used in applications of fuzzy control [8].

3.3. Inference mechanism

An inference mechanism which emulates the expert's decision making in interpreting and applying knowledge about how best to control the plant. Inference uses a knowledge base of rules to determine the output sets for the input linguistic values. It computes the actual control signal as a linguistic variable for each set of input single [14].

3.4. Defuzzification interface

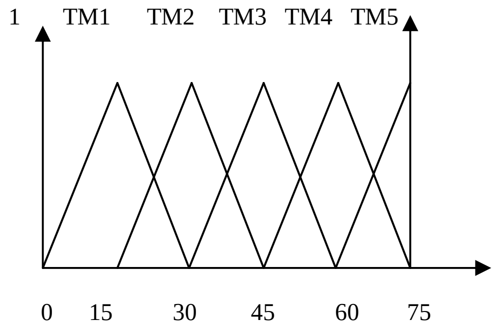
A defuzzification interface, which converts the conclusions of the inference mechanism into actual inputs for the process. Defuzzication process is the output of the interface process to derive a single "crisp" output value[11]. Typical defuzzification techniques are

Center of gravity (COG): A crisp output is chosen using the center of area and of each implied fuzzy set, and is given by

$$y_q^{crisp} = \frac{\sum_{i=1}^{R} b_i^q \int y_q \mu B_q^i (y_q) dy_q}{\sum_{i=1}^{R} \int y_q \mu B_q^i (y_q) dy_q} \quad (5)$$

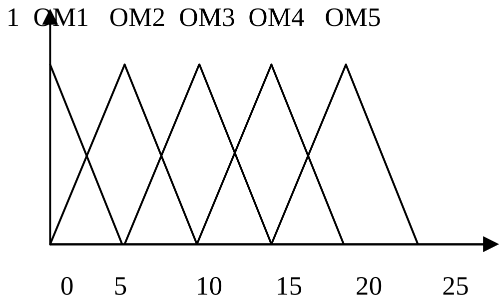
4. SYSTEM DESIGN

In this system, there are two main parts, training or tutorial. In training site, the child can choose the type of question that they want to train. In tutorial site, at first need to enter the name, roll-no, class and date of birth etc. And then, the child needs to test the exam for 75 marks. After that, the teacher needs to enter the corresponding 25 marks for attendance, interest in class, activity in sport and cooperate with others. Then the total marks are applied by fuzzy logic and determine the grade of the student.



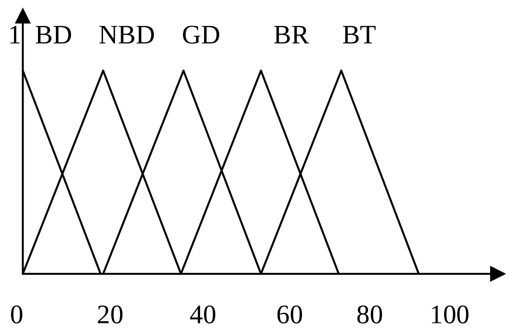
Tutorial Mark 1 - TM1 (0-30 Marks)
Tutorial Mark 2 - TM2 (15-45 Marks)
Tutorial Mark 3 - TM3 (30-60 Marks)
Tutorial Mark 4 - TM4 (45-75 Marks)
Tutorial Mark 5 - TM5 (60-75 Marks)

Figure 4. Membership Function of Tutorial Mark (T)



Other Mark 1 - OM1 (0-5Marks)
Other Mark 2 - OM2 (0-10 Marks)
Other Mark 3 - OM3 (5-15 Marks)
Other Mark 4 - OM4 (10-20 Marks)
Other Mark 5 - OM5 (15-25 Marks)

Figure 5. Membership Function of Other Marks (O)



Bad - BD (0-20 Marks)
Not Bad -NBD (20-40 Marks)
Good -GD (40-60 Marks)
Better -BR (60-80 Marks)
Best -BT (80-100 Marks)

Figure 6. Membership Function of Grade of the Student

Table 1. Rule-Base Table

	TM1	TM2	TM3	TM4	TM5
OM1	BD	NBD	GD	BR	BR
OM2	BD	NBD	GD	BR	BR
OM3	BD	GD	GD	BR	BT
OM4	NBD	GD	BR	BR	BT
OM5	NBD	GD	BR	BT	BT

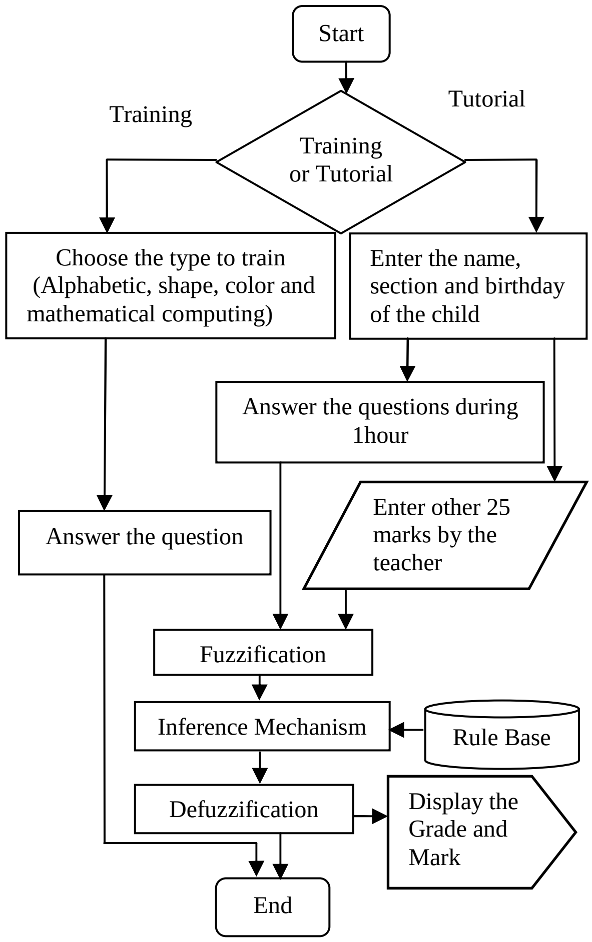


Figure 7. System Flow Diagram

5. IMPLEMENTATION AND CASE STUDY

5.1. Implementation of the system

In this system, there are two main parts: tutorial and training. In training side, the children can choose the type of the question that they want to train. In tutorial side, the child must sit the 25 questions within 1 hour.

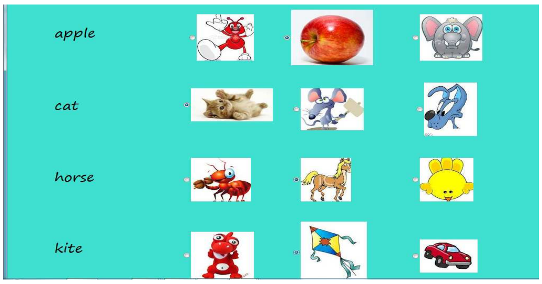


Figure 8. Tutorial Test in Alphabetic

Figure 8 shows the test of the tutorial in alphabetic type. If the children answer one question correctly, they will get 3 marks for 1 question.

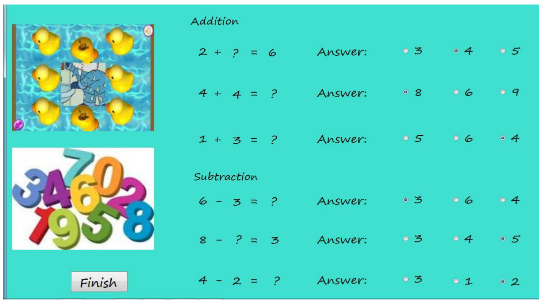


Figure 9. Tutorial Test in Math

Figure 9 represents in mathematical computing.

Figure 10. Tutorial and Other Marks

After the children test all the questions, the exam marks will be calculate and shown in Figure 10. In this Figure, the teacher has to fill the other 25 mark.

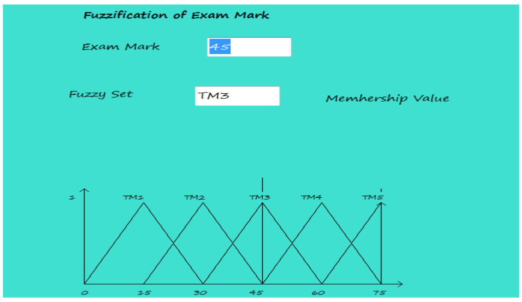


Figure 11. Membership Function of Tutorial Mark

Figure 11 describes fuzzification step using triangular fuzzy number..

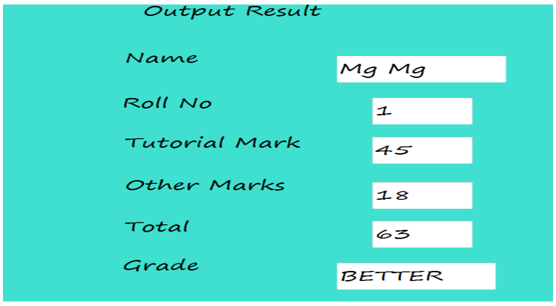


Figure 12. Final Output Result

The final defuzzification is calculated and gives the output result of the grade of the children as shown in Figure 12.

5.2. Case study

In this system, the child can test the exam directly or practice the training courses. If the child has to test the exam, the child needs to enter the name, birthday, section etc. The child needs to test 25 questions and 3 marks for 1 question. The total exam mark is 75 marks and the teacher need to give the other 25 marks. For example the child tests the exam and correct 15 questions. The exam mark is 45 marks and the teacher gives the attendance is 5, cooperate with other is 6, interests in the class is 4 marks and activity in sport is 3 marks. The other mark is 18 marks.

Fuzzification

Tutorial mark= 45 marks and other marks = 18 marks

μ_{TM3} (T) = 1
μ_{OM4} (O) = 0.4 and μ_{OM5} = O.6

Premise quantification via fuzzy logic

-If T is TM3 and O is OM4.
μTM3 (T) = 1 and μOM4 (O) =0.4
-If T is TM3 and O is OM5.
μTM3 (T) =1 and μOM5 (O) =0.6

Denote μpremise by using the minimum

μpremise = min {1, 0.4} = 0.4
μpremise = min {1, 0.6} = 0.6

Inference mechanism

Determining which rules are on
By using the rule-base table 4.1,
If T is TM3 and O is OM4 then Grade is Better.
If T is TM3 and O is OM5 then Grade is Better.

Inference setup

In the rule-base table 4.1,
If T is TM3 and O is OM4 then Grade is Better.
If T is TM3 and O is OM5 then Grade is Better.

Defuzzification

Implied area Ai = Wi (h-h2/2)

$$\mu crisp = \frac{(center1*A_1) +}{(center2*A_2)}$$

μcrisp = **63** marks and Grade is **Better**.

6. CONCLUSION

This system is intended to determine the ability of the children. To test this, there are two parts: First, test the exam for 75 marks. One question is 3 marks and only 1 hour is limited. In this system, others 25 marks are subdivided into four types. The attendance is 5 marks, cooperate with other is 10 marks, interests in the class is 5 marks and activity in sport is 5 marks. These marks can be determined by the teacher. Outputs are classified grade 1 to grade 5 and show the total marks of the children. This system is based on fuzzy logic and the output is determined by using fuzzy decision making.

An advantage of fuzzy system is easy to underlying functionality of the system. Basically, in fuzzy logic control there is a focus on the use of rules to represent how to make the decision rather than ordinary differential equations.

REFERENCES

[1] Abdel-Kader, M. G. and D. Dugdale, “Evaluating Investments in Advanced Manufacturing Technology: A Fuzzy Set Theory Approach”, British Accounting Review, Vol.33, page 455-489, 2001.

[2] Bojadziev, G, and M. Bojadziev, “Fuzzy sets and Fuzzy logic applications”, World Scientific, Singapore, 1998.

[3] Bourke, M.M, “Self-learning predictive control using relational based fuzzy logic”, University of Alberta, 1995.

[4] Chiou, H. K. and G. H. Tzeng, “Fuzzy Hierarchical Evaluation with Grey Relation Model of Green Engineering for Industry,” International of FuzzySystem, Vol.3, page 466-475, 2001.

[5] Cheng,C. H, “Evaluating Weapon SystemsUsing Ranking Fuzzy Numbers,” Fuzzy Sets and Systems, Vol.107, page 25-35, 1999.

[6] Dubois, D. and H. Prade, “Fundamentals of Fuzzy Sets-The Handbooks of Fuzzy Sets Series”, Kluwer Academic Publishers, 2000.

[7] Giachetti, R. and R. E. Young, “A Parametric Representation of Fuzzy Numbers and Their Arithmetic Operators”, Fuzzy Sets and Systems, Vol.91, page 185-202, 1997.

[8] Kaufmann, A. and Gupta, M. M, “Introduction to fuzzy arithmetic:Theory and

applications", New York: Van Nostrand Reinhold, 1991.

[9] Li, Q. D, "The Random Set and the Cutting of Random Fuzzy Sets", Fuzzy Sets and Systems, Vol.86, page 223-234. 1997.

[10] Laarhoven, P. J. M. and W. Pedrycz, "A Fuzzy Extension of Saaty's Priority Theory," Fuzzy Sets and Systems, Vol.11, page 229-241, 1983.

[11] Lee, A. H, "A fuzzy supplier selection model with the consideration of benefits, opportunities, costs and risks", Expert Systems with Applications, Vol.36, page 2879–2893.

[12] Mon, D. L, C. H. Cheng and J. L. Lin, Evaluating Weapon System Using Fuzzy Analytic Hierarchy Process Based on Entropy Weight", Fuzzy sets and Systems, Vol. 62, page 127-134, 1994.

[13] Van Laarhoven, P.J.M. and W.A. Pedrcyz, "Fuzzy extension of Saaty's priority theory", Fuzzy Sets Systems, Vol.11, page 229-241, 1983.

[14] Zimmermann, H.J, "Fuzzy set theory and its applications, In: Dunn JM, Epstein G Modern uses of multiple-valued logic", Kluwer, Boston, 1992.

[15] Zadeh, L.A, "Information and Control Fuzzy sets", Vol.8, page 338–353, 1965.