

Tuition Reduction Determination Using Fuzzy Tsukamoto

Mochammad Iswan Perangin-angin¹, Wirda Fitriani², Nova Mayasari³,
Andysah Putera Utama Siahaan⁴

Faculty of Computer Science, Universitas Pembangunan Panca Budi, Jl. Jend. Gatot Subroto Km. 4,5 Sei
Sikambing, 20122, Medan, Sumatera Utara, Indonesia

Abstract: The process of determining cuts tuition for students are usually given with the same nominal. And in this paper is the determination of the pieces tuition for students who are less able to be different, depending on how much income parents and the number of children covered. For income parents who get discounted tuition fee of IDR Rp.1,500,000 and for the number of children in these families also determine the number of pieces obtained. Tsukamoto Fuzzy system is the model used in this paper. Each input variable is divided into three membership functions. In this paper, Nine Tsukamoto Fuzzy model rules have been applied. The system also provides a consequent change of parameters if the current parameter values to be changed. The smaller the parent's income, the greater the pieces obtained. The more children insured the greater the college acquired pieces.

Keywords: Fuzzy Logic, Membership Function, Tsukamoto

I. Introduction

Education is a knowledge that is transferred from one generation to future generations, or from one individual to the group by doing research and teaching. Education can be done by itself or any of the guidance of others. Education is often performed in educational institutions as an example: the University of North Sumatra, Bandung Institute of Technology, University of Indonesia, and others. Higher education affects the ability of the human individual, and also influential for countries to achieve economic growth rates in the country. Countries that are poor or developing highly required for the faster development of education so that they can adopt the technology that has been tested or tried by the rich countries.

The scholarship is a reduction, given a piece of fees previously deducted expenses for the purpose of reward or prize. Scholarships may be awarded by educational institutions, government agencies, companies, and foundations. The amount of the scholarship depends on how many prizes or rewards given. To support the ability of students in the learning process, the universities provide discounted tuition directly with applicable regulations. A student gets a scholarship based on GPA and the high economic level of the parents is low. The process of awarding scholarships that have been running in the universities still provided with the same nominal amount. This process is still not effective because there is also a student whose parents can afford and her high GPA, scholarship the same with parents whose ability is low but high GPA students. Therefore, this study will produce a system that will provide a total number of scholarship varies depending on the economic level of the parents and the students GPA. The purpose of this study, not to reduce the nominal tuition fee cuts or degrading students low economic level of the parents, but the goal of this research is to improve and support the development of the country of Indonesia's education. The method used for this research is to use the model method Tsukamoto FIS (Fuzzy Inference System).

A previous study using the model Tsukamoto FIS is the determination of the purchase price of a mobile phone, forecasting, study program and etc. [1][5][11].Electrical machines are also calculated by fuzzy system [9]. Determination of the risk of disease, and others. A researcher used Tsukamoto FIS models for each parameter consequent to the rules if then shaped and represented by a fuzzy set that as a stand-alone membership function (monotone) and the results of the inference to any rules which are defined as the crisp value.The research has two variables such as the economic level of parents and GPA. Each of them consists of two membership functions respectively. The taking of two variable and membership function will issue a nominal output cuts tuition fees to be received by the students.

II. Theories

Fuzzy logic is a proper way to map an input space into a space of output [3][4][6]. Fuzzy is used to adjust the solution or rank the problem into sequence [2]. The reasons for using fuzzy logic, among others; The concept of fuzzy logic is more easily understood and fuzzy logic, if there are incorrect data, have a tolerance. In general, fuzzy logic system has four elements:

1. The basic rule that contains the rules derived from the experts.
2. A decision-making mechanism in which the expert took the decision to apply the knowledge they have.

3. The process of fuzzification that changes the amount crisp into the magnitude fuzzy.
4. The process of defuzzification, is the reverse of the process that is changing the magnitude result of the fuzzy inference engine, be assertive magnitude (crisp).

In the implementation of the system, fuzzy has three parts, such as fuzzification, fuzzy inference, and defuzzification [7][8][10]. However, the process here is optimal defuzzification i.e., when the conclusion is already meeting or as expected, then no defuzzification process. However, if a conclusion has not met the defuzzification process is still being done. Fuzzy logic membership functions consisting of boundary value data input and data output values. The definition of the membership function is a graph that there are points of boundary value data input into a valuable membership value between 0 and 1.

In the graph membership functions, there are three sections, such as core, support, and boundary. The part cores or core part graph represent the complete area of the entire set of fuzzy, so if expressed in a function where x is a member of the set $\mu(x) = 1$. Furthermore, the second part is the support, the support or the support of a part graph representing the region with a membership value of the fuzzy set is not 0, then if expressed in a function where x is a member of the set $\mu(x) > 0$. And lastly, part of boundary or limit. Boundary in the graph membership functions declared the value of the minimum and maximum limits of the fuzzy set, then it if expressed in a function where x is a member of the set is $0 < \mu(x) < 1$.

Tsukamoto Fuzzy method is one method of Fuzzy Inference System, system decision makers. In the method of using the Tsukamoto fuzzy rules or rules shaped "causation" or "if-then". The calculation method of fuzzy Tsukamoto, the first rule is formed representing the fuzzy set, then calculate the degree of membership by the rules that have been created. After getting a degree of membership value, look for the value of the predicate alpha (α) by finding the minimum value of the value of the degree of membership. The final step, look for the value output is crisp values (z) called defuzzification process, which is expressed in the equation 1.

$$Z = \frac{\sum \alpha(i).z(i)}{\sum z(i)} \quad (1)$$

Where α = alpha predicate (the minimum value of the degree of membership is), Z_i = crisp values obtained from the formula degree of membership of fuzzy sets which is the value of output, and Z = defuzzification average centralized (Center Average Defuzzifier).

III. Design And Implementation

The method used is a model FIS Tsukamoto, membership functions used are linear, i.e., the triangle and trapezium. Every each of the variable input is divided into two membership functions. First to economic levels is divided into two functions both for GPA membership and is divided into two membership functions. Of each variable give each of the two membership functions are demonstrated in figure 1.

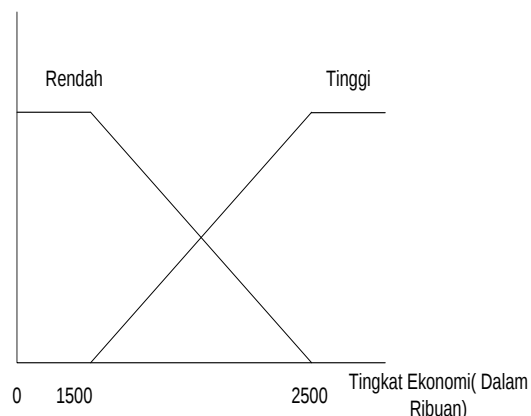


Fig. 1 Economics Level Membership Function

$$\text{Frendah (EL)} = \begin{cases} 1, & EL \leq 1500 \\ \frac{2500-EL}{2500-1500}, & 1500 < EL < 2500 \\ 0, & EL \geq 2500 \end{cases}$$

$$\text{Ftinggi (EL)} = \begin{cases} 0, & EL \leq 1500 \\ \frac{EL-1500}{2500-1500}, & 1500 < EL \leq 2500 \\ 1, & EL \geq 2500 \end{cases}$$

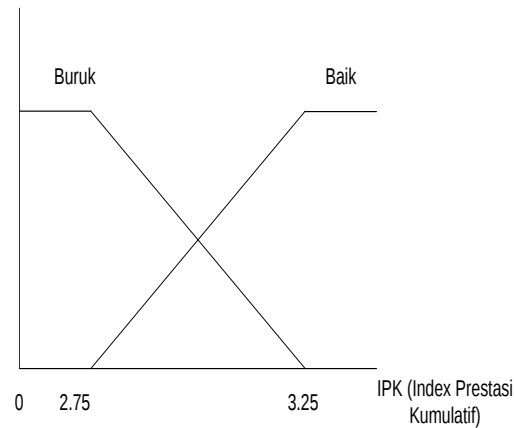


Fig.2 GPA Membership Function

$$F_{\text{buruk}}(\text{GPA}) = \begin{cases} 1, & \text{GPA} \leq 2.75 \\ \frac{3.25 - \text{GPA}}{3.25 - 2.75}, & 2.75 < \text{GPA} < 3.25 \\ 0, & \text{GPA} \geq 3.25 \end{cases}$$

$$F_{\text{baik}}(\text{GPA}) = \begin{cases} 0, & \text{GPA} \leq 2.75 \\ \frac{\text{GPA} - 2.75}{3.25 - 2.75}, & 2.75 < \text{GPA} < 3.25 \\ 1, & \text{GPA} \geq 3.25 \end{cases}$$

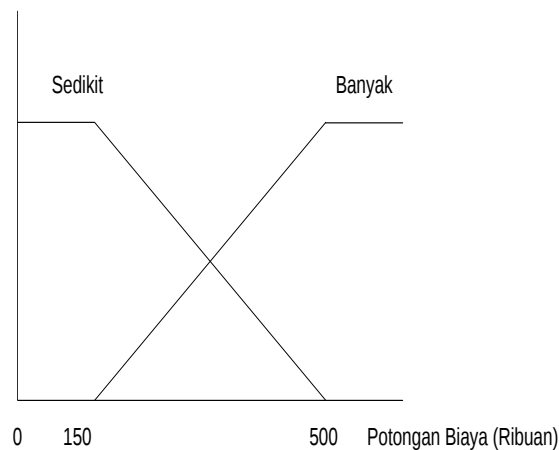


Fig. 3 Tuition Reduction Membership Function

$$F_{\text{sedikit}}(\text{TR}) = \begin{cases} 1, & \text{TR} \leq 150 \\ \frac{500 - \text{TR}}{500 - 150}, & 150 < \text{TR} \leq 500 \\ 0, & \text{TR} \geq 500 \end{cases}$$

$$F_{\text{banyak}}(\text{TR}) = \begin{cases} 0, & \text{TR} \leq 150 \\ \frac{\text{TR} - 150}{500 - 150}, & 150 < \text{TR} \leq 500 \\ 1, & \text{TR} \geq 500 \end{cases}$$

where:

EL : Economy Level
GPA : Grade Point Average
TR : Tuition Reduction

Table I Fuzzy Rules

Aturan ke-	Aturan		
	Tingkat Ekonomi	IPK	Potongan Biaya
1	Rendah	Tinggi	Banyak
2	Tinggi	Tinggi	Banyak
3	Tinggi	Rendah	Sedikit
4	Rendah	Rendah	Sedikit

From Table 1, it is already obtained the degree of membership of the output of each rule and to see the detail of the rules of fuzzy logic are described in Table 1.0. Having obtained the number of rules by using models Tsukamoto FIS acquired two (2) rule using the AND operator. After searching the degree of membership of the output of each rule created or generated from the combined level of parents and the GPA, then the next step is to look for the cost cuts output value of each rule listed in Table 1.0. In the search for cost cuts output value, using the following equation:

$$TR = \frac{\sum_{i=1}^4 w(i) \cdot z(i)}{\sum_{i=1}^4 z(i)} \quad (2)$$

where :

w : output of inference
z : degree of the output membership

The input limit of the economic level variable is Rp. 1,500,000 to Rp. 2,000,000 and variable GPA is 2.75 up to 3.25. If there are students, who are below the economic level of Rp. 1,500,000 then they are put into the lower limit value of the economic level, while if his economy rate of more than Rp. 2,500,000, the level of economic is added to upper limit economic level. Restrictions on variable input GPA, cannot be below the 2.75 because if below 2.75 there is no requirement to obtain a reduced fee. But if the GPA is more than 3.25, the value of its variable GPA entered the upper limit value of the GPA.

IV. Evaluation

The students get a discount on tuition fees this study assumed that get a piece of the fee is a student at a rating of the first five in class in every subject or area of expertise. So, to the value of the variable GPA below 2.75 will not appear because the GPA is ranked into the first five who is GPA > 3.00. From the system that researchers do, obtained GPA vary and economic level also vary from every student who was ranked top five in class expertise, and computer engineering is expected. The institution can provide discounted tuition fairly and spur directly to students to get a high GPA and rank in the class in their respective fields.

Table II Earlier Tuition Reduction

No.	Name	Economy Level	GPA	Tuition Reduction
1	Putri	1.700.000	3.23	500.000
2	Ayu	1.850.000	3.20	500.000
3	Sindi	1.850.000	3.17	500.000
4	Bobby	1.700.000	3.12	500.000
5	Marisa	2.250.00	3.08	500.000

Table III Fuzzy tuition reduction

No.	Name	Economy Level	GPA	Tuition Reduction	Fuzzy Tuition Reduction
1	Putri	1.700.000	3.23	500.000	397.750
2	Ayu	1.850.000	3.20	500.000	361.458
3	Sindi	1.850.000	3.17	500.000	365.780
4	Bobby	1.700.000	3.12	500.000	387.414
5	Marisa	2.250.000	3.08	500.000	386.955

Table 2 shows the cost cuts that have been made by instituion. The calculations are still the same for the distribution of flat and there is no difference in cost cuts obtained. With pieces such as tables, a bit difficult to encourage students economic level parents a little to study hard for their pieces acquired equal value and to the economic level of the parents a lot can be pushed higher again on the intention of learning for many students whose parents have high economic level lazy to learn.

In Table 3, showing different cuts costs because it is calculated using the FIS models Tsukamoto based on two variables, the level of economic and GPA that each variable has a lower limit and upper limit respectively. For the discounted cost also has an upper limit and a lower limit value in the process of formulating a reduced fee for students who get it.

V. Conclusion

By comparing the reduction between Table 2 and Table 3, it can be concluded that the method of determining the pieces of tuition fees already running before they are less fair and less clear on what students get discounted cost because the previous system already runs still use one variable to determine the cost cuts. Function FIS models Tsukamoto aims to provide value discounted cost varies according to the specified variable. If a student

has a high GPA and low economic level, he gains more reduction but for students who [1] have a high GPA and economic level high gets a reduction too but not as much as that obtained by the previous students.

Variable determination for cost cuts proposed by the researchers, there are two, namely: the level of economic and GPA (Grade Point Index), but can also be added for further variables to get the value discounted cost more focused. Previously, the determination of cost cuts, there is no comparison of variables and still determined by GPA (Grade Point Index) alone. For that study is done to determine the pieces that were not already have become variables, have variables and get a piece of good cost and fair. In this study may resolve the problem on cost cuts in several institutions by using two variables, but this research also has drawbacks.

In this study, there are also some disadvantages and advantages in the process of cutting costs. The disadvantage is not too noticeable difference cuts costs because of the difference of each student is still about IDR Rp.1,000 - 15,000. As for the advantages of this research is the value of the discounted cost of not using Tsukamoto is greater than the value that is generated by using Tsukamoto. Therefore, it is suggested to institution to add up the number of students who get a discounted cost of the previous five students to 10 students. So that students in institution have a good education because it encouraged the discounted cost of the course.

References

- [1]. F. Ariani and R. Y. Endra, "Implementation Of Fuzzy Inference System With Tsukamoto Method For Study Programme Selection," in *International Conference on Engineering and Technology Development*, Bandar Lampung, 2013.
- [2]. Z. Tharo and A. P. U. Siahaan, "Profile Matching in Solving Rank Problem," *IOSR Journal of Electronics and Communication Engineering*, vol. 11, no. 5, pp. 73-76, 2016.
- [3]. B. C. Arabacioglu, "Using Fuzzy Inference System For Architectural Space Analysis," *Applied Soft Computing*, vol. 10, p. 926–937, 2010.
- [4]. L. Biacino and G. Gerla, "Fuzzy Logic, Continuity and Effectiveness," *Mathematical Logic*, vol. 41, p. 643–667, 2002.
- [5]. G. Gerla, "Effectiveness and Multivalued Logics," *The Journal of Symbolic Logic*, vol. 71, pp. 137-162, 2006.
- [6]. S. S. Jamsandekar and R. R. Mudholkar, "Fuzzy Classification System by Self Generated Membership Function Using Clustering," *International Journal of Information Technology*, vol. 6, no. 1, pp. 697-704, 2014.
- [7]. P. Hájek, "Fuzzy Logic and Arithmetical Hierarchy," *Fuzzy Sets and Systems*, vol. 73, pp. 359-363, 1994.
- [8]. A. P. U. Siahaan, "Fuzzification of College Adviser Proficiency Based on Specific Knowledge," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 6, no. 7, pp. 164-168, 2016.
- [9]. A. Saepullah and R. S. Wahono, "Comparative Analysis of Mamdani, Sugeno And Tsukamoto Method of Fuzzy Inference System for Air Conditioner Energy Saving," *Journal of Intelligent Systems*, vol. 1, no. 2, pp. 143-147, 2015.
- [10]. I. Firmansyah and S. F. Utami, "Tsukamoto Fuzzy Logic Application in Production Planning at PT. Kimia Farma (Persero) Tbk. Plant Bandung Indonesia," in *International Conference On Global Optimization and Its Applications*, Melaka, 2013.
- [11]. R. Heshmati, M. J. Mahmoodabadi, A. Bagheri and B. Miripour-Fard, "An Improved Adaptive Neuro Fuzzy Inference for the Step Forward Forecasting of Time Series," *Journal of Advanced Computing*, vol. 2, no. 3, pp. 88-98, 2013.