

Fuzzy Logic in Decision Support Systems Using Linear Equations in Construct 3 Game Engine

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Abstract: The current use of Construct 3 is not only used as a tool for developing games but can also be developed to create applications that can run on platforms that support HTML5. However, the superiority of construct 3, which only requires logic without using program code, sometimes its rather difficult to develop when we need construct 3 to calculate mathematical algorithms such as Dijkstra or fuzzy. The problem that I found in this study is how to make Construct 3 can do some calculations using logic without program code to produce the required mathematical algorithm. The main purpose of this research is to find out the best way to be able to run Non-Linear equations into game engine Construct 3. The conclusion in this study is by using linear equations we can calculate the formula into the logic board in Construct 3, so the development of applications that require algorithms can be done in construct 3 without using programming code. Another conclusion is, the application development time is getting faster and more effective. This is proven by the fact that there is no need for program codes which are usually long and have different forms from the formulas that have been prepared.

Keywords: fuzzy; decision support system; construct 3; linear equation; non-linear equation

1. INTRODUCING

Construct 3 is a game engine that does not require program code to make a game. We can replace programming code, using logic that is arranged systematically to produce 2D games[1]. The current use of Construct 3 is not only used as a tool for developing games but can also be developed to create applications that can run on platforms that support HTML5. With simple logic that is provided by developer educational applications such as edutainment can also be developed easily using construct 3[2], [3]. However, the superiority of construct 3, which only requires logic without using program code, sometimes its rather difficult to develop when we need construct 3 for calculate mathematical algorithms such as Dijkstra or fuzzy. The problem that I found in this study is how to make Construct 3 can do some calculation using logic without program code to produce the required mathematical algorithm. One of the algorithms that require calculations and high accuracy of results is a decision support system, which can help users to determine an existing decision[4], [5]. The assistance provided by decision support systems can determine humans to make crucial choices that require a lot of consideration[6], [7]. Another use in decision support systems is in the medical world

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where one of them is an application to support decisions whether a child has autism symptoms or not[8], [9]. With a system that helps humans to make decisions, humans can reduce the risk of being wrong when determining something. Another thing that can be solved by using a decision support system is knowing a disease, a disease that is common in humans often recurs with the same pattern[10], this can be used as a variable that can help make the system such as symptoms of fever accompanied by coughing and sneezing, we can collect that data so decision support system can produce enough information to the humans[11]. So, the system will help us to determine how to treat the disease. This also applies if there are diseases suffered by animals[12], in this study I am using prawns as research objects, using the forward chaining algorithm to determined the code of the symptoms, then calculations would be carried out using Sugeno's fuzzy logic to determine the appropriate handling solution. This study uses prawns' illnesses as an object to calculate between non-linear and linear equation[13], [14]. but the main purpose of this research is to find out the best way to be able to run Non-Linear equations into game engine Construct 3.

2. RESEARCH METHODOLOGY

This research was developed using MDLC (Multimedia Development Life Cycle) which has 6 stages, Concept, Design, material collecting, assembly, testing and distribution[15]. The initial development of this research was carried out with the first stage, namely concept.

Concept: The initial step taken is to determine the existing problems, in this research there is a main problem to be solved, how to use the logic in construct 3 to be able to answer the needs of the fuzzy algorithm.

Design: At this stage, the requirements are carried out which will later need to be collected. At this stage, the crew design of the application to be developed is also carried out.

Material Collecting: data collection is done first is to collect data on symptoms and disease data. The data that was collected for the first time was the name of the disease and how to handle it, as can be seen in Table 1. This was done so that the research could run well and be completed.

Table 1. Nama Penyakit dan Penanganan

Disease	treatment
White Spot Syndrome Viruses	Ponds were immediately treated with 30 ppm chlorine to kill shrimp and potential carriers in the pond. Shrimp and other dead animals are taken and buried or burned. The chlorinated water is left for 4 days.
white feces diseases	Immediately reduce the amount of feed or temporarily stop feeding, increase aeration using a wheel, add garlic powder with feed, and use probiotics with a dose of 3x the normal use.
Infectious Necrosis Virus	Myo There is no effective vaccination for IMNV. At the beginning of the infection phase when mortality is still low: stabilization of water quality, especially temperature, salinity and pH; increase aeration; provide additional feed containing vitamin C; giving molasses (25% of FR/day) or given

Disease	treatment
	probiotics; and reduce the amount of feed or stop feeding temporarily.
Infectious Hypodermal And Haematopoietic Necrosis Virus	There is no treatment for this disease. The best control is prevention by choosing fry that are free of IHNV or specific Pathogen Free (SPF). In addition, maintaining pond water quality during cultivation is an important factor in preventing this virus.

Table 1 describes the name of the disease and how to treat the disease. After knowing the kinds of disease and how to do a treatment, we now find the symptoms that can cause the disease, you can see all existing symptoms of prawn disease that can be seen in Table 2.

Table 2. Symptom

Number	Gejala	Symptom code
1	White spots on prawn shells	S1
2	Prawn swimming on the surface	S2
3	Dead prawns stuck to the pond wall	S3
4	The food pipe is empty and white	S4
5	Loss of appetite	S5
6	Prawn poops floating on water has a white color	S6
7	The body segments has a little spot like a white clouds	S7
8	In our perspective prawn experience cramps in muscle tissue	S8
9	There are a few dead prawn at the bottom of the pond	S9
10	Its has a defects on the belly and snout of the shrimp	S10
11	Not moving and then spinning, and sinking to the bottom of the pond	S11

Table 2 describes the symptoms found in prawns, then a symptom code is determined which will later be used to determine the disease in prawns. After collecting symptom data, it's time to collect disease data which can be categorized based on the prawn's symptoms, we can get a disease code according to the symptoms and the name of the disease. You can see diseases table below:

Table 3. Disease

Symptom Code	Disease	Disease code
S1, S2, S3	White Spot Syndrome Viruses	D1
S4, S5, S6	white feces diseases	D2
S3, S7, S8	Infectious Myo Necrosis Virus	D3

Symptom Code	Disease	Disease code
S9, S10, S11	Infectious Hypodermal And Haematopoietic Virus Necrosis	D4

By looking at Table 3, we can determine the suitable algorithm to determine the existing disease. In the symptom code section, there are three symptoms that the prawn has, then the disease can be seen in the disease column. After knowing the rules above, it's time to determine the level of measurement of the severity, we can get it using the Sugeno fuzzy logic. Before informing the expert about the weight of the existing disease, the fuzzy set table is determined as follows:

Table 4. Fuzzy Set

Input/output	Range	Category
Input / Symptom	$0 \leq a \leq 0.4$	Low
	$0.3 \leq a \leq 0.7$	Mid
	$0.6 \leq a \leq 1$	High
Output / Disease severity	$0 \leq a \leq 0.25$	Low
	$0.26 \leq a \leq 0.5$	Mid
	$0.51 \leq a \leq 0.75$	High
	$0.75 \leq a \leq 1$	Very High

Table 4 describes the categories that will be generated, both for input and output. The basic difference is that for input we use symptoms while the output will be in the form of disease severity. After getting the existing range of values, then the categories and weights obtained from the experts are obtained which can be seen in Table 5:

Table 5. Bobot Gejala

Symptom code	Category	Weight Value
S1	High	0.8
S2	Low	0.15
S3	High	0.8
S4	Mid	0.5
S5	Low	0.15
S6	High	0.8
S7	Mid	0.5
S8	High	0.8
S9	High	0.8
S10	High	0.8
S11	High	0.8

In table 5, the expert determines the appropriate weight value for each of the symptoms found in prawns. After determining the weights, the next step is to calculate the value and carry out the fuzzification process using the Sugeno fuzzy logic formula (1):

$$\mu[x, a, b, c] \begin{cases} 0; x \leq a \text{ or } x \geq c \\ \frac{x-a}{b-a}; a \leq x \leq b \\ \frac{c-x}{c-b}; b \leq x \leq c \end{cases} \quad (1)$$

x = Weight Value

a = Minimum Value

b = Median Value

c = Maximim Value

We need the Median value of each category to determine the fuzzification. Equation (2) is use for searching nilai tengah (b):

$$b = \frac{\sum_{i=a}^c a^i}{n} \quad (2)$$

n = banyaknya himpunan a sampai c

a = Minimum Value

b = Median Value

c = Maximum Value

After all the values are obtained, the next process fuzzification can be carried out. Equation (3) is use for searching fuzzification:

$$F = \frac{(x-a)}{(b-a)} \quad (3)$$

x = Weight Value

a = Minimum Value

b = Median Value

F = fuzzification

After knowing the value of the fuzzification, we need to determine the severity of the disease, the value obtained is based on the rule obtained based on any symptoms of the disease that the prawns are suffering from. Equation (4) is use for searching defuzzification:

$$WA = \frac{\sum_{i=1}^n (F(i) * weight(i))}{\sum_{i=1}^n F(i)} \quad (4)$$

Calculation example, we want to calculate the severity of the first disease (White Spot Syndrome Viruses), the first step we need to find the median value.

We know that there are three ranges of the symptoms in Table 4 (low, mid and high), so we need three median values for each range. By using the previous formula, the median value for low category is 0.2, the median value for mid category is 0.5 and the median value for high category is 0.8. After that we determine the fuzzification of each symptom in Table 3. With the fuzzification formula, Fuzzification S1 produces a value of 1, Fuzzification S2 produces a value of 0.75 and fuzzification S3 produces a value of 1. Finally, we defuzzify with the existing formula and get the result, the level of disease in White Spot Syndrome Viruses is 0.622, so the severity of White Spot Syndrome Viruses is High with a value of 62.2%.

3. RESULT AND DISCUSSIONS

The next stage is assembly, at this stage the formula is written using game engine construct 3. Due to the limitations of the program code in construct 3, the results obtained in this study are as follows:

1. The formula that has been obtained is a Non-Linear Equation while construct 3 cannot calculate the formula with that format.
2. Limitations of construct 3 are the creation and calling of variables

Answering the two limitations above, this study has the following results:

1. Non-Linear Equation must be converted into a formula with a linear equation format.

2. We use global variables provided by Construct 3.

The use of linear equations in construct 3 can be seen in Table 6 below:

Table 6. Equation comparison

Formula/Non-Linear	Construct 3/ Linear
$b = \frac{\sum_{i=a}^c i}{n}$	
$F = \frac{(x - a)}{(b - a)}$	

Formula/Non-Linear

Construct 3/ Linear

$$\frac{\sum_{i=1}^n (F(i) * weight(i))}{\sum_{i=1}^n F(i)}$$

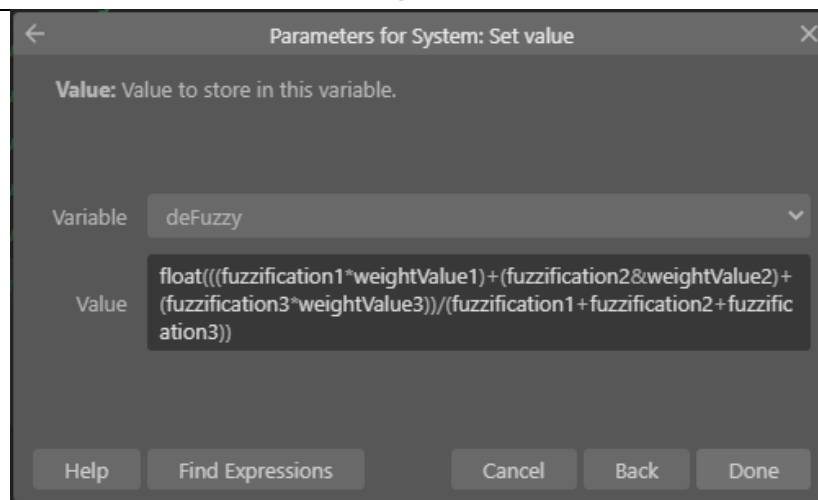


Table 6 explains that the existing formula in the form of a non-linear equation can be used in Construct 3 (right column), the method is to change the non-linear form to a linear equation form. Next is the testing stage which is proving the results obtained from the calculations in construct 3.

Table 7. Result comparison

Rumus	Linear at Construct 3
Variable: Min value: 0 Max value: 0.4 Formula: $b = \frac{\sum_{i=a}^c i}{n}$ Answer: $b = \frac{0 + 0.1 + 0.2 + 0.3 + 0.4}{5}$ $b = \frac{1}{5}$ $b = 0.2$	

Rumus

Linear at Construct 3

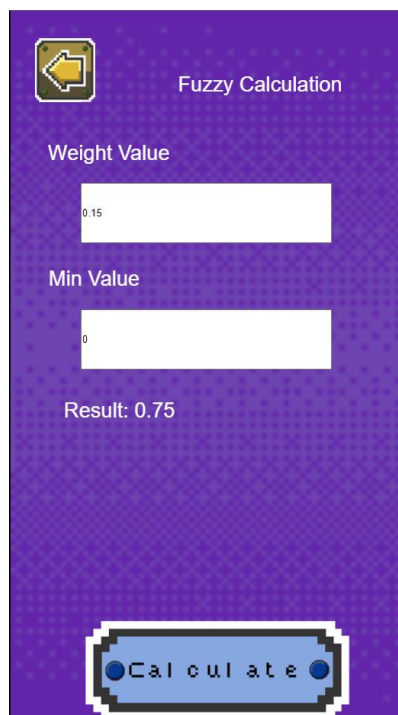
Variable:
Weight Value: 0.15
Min Value: 0

Formula:
$$F = \frac{(x - a)}{(b - a)}$$

Answer:
$$F = \frac{(0.15 - 0)}{(0.2 - 0)}$$

$$F = \frac{0.15}{0.2}$$

$$F = 0.75$$



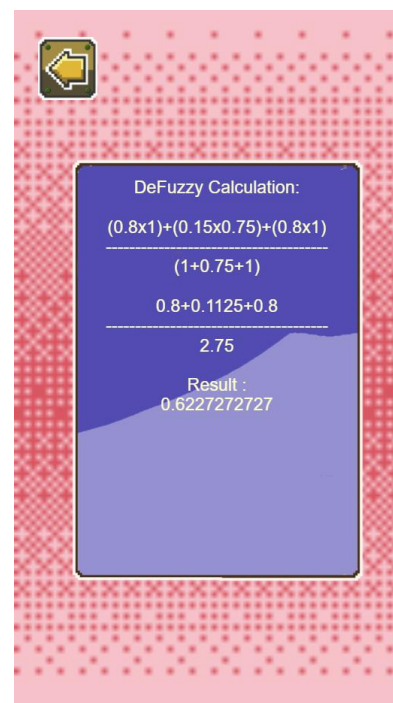
Variable:
Weight Value 1: 0.8
Fuzzification 1: 1
Weight Value 2: 0.15
Fuzzification 2: 0.75
Weight Value 3: 0.8
Fuzzification 3: 1

Formula:
$$\frac{\sum_{i=1}^n (F(i) * weight(i))}{\sum_{i=1}^n F(i)}$$

Answer:
$$WA = \frac{(0.8 * 1) + (0.15 * 0.75) + (0.8 * 1)}{(1 + 0.75 + 1)}$$

$$WA = \frac{(0.8) + (0.1125) + (0.8)}{2.75}$$

$$WA = 0.62$$



In Table 7, it is proven that the linear formula in construct 3 can produce the same value as calculations with Non-Linear equations. The next stage is distribution where the

results of the calculations will issue a solution to the disease suffered by the prawns. The results described are the results obtained in Table 1.

4. CONCLUSION

The development of decision support systems can be done using various methods, one of which is by using the game engine construct 3. The conclusion in this study is by using linear equations we can calculate the formula into the logic board in construct 3, so that the development of applications that require algorithms can be done in construct 3. Another conclusion is, application development time is getting faster and more effective. This is proven by the fact that there is no need for program codes which are usually long and have different forms from the formulas that have been prepared. Further work in this study is to develop other complex algorithms or to compare memory effectiveness and processing time between program code and the linear equation.

5. ACKNOWLEDGMENT

Thanks are given to Mr. Agus from Darmajaya who has helped in calculating the fuzzy algorithm so that this research can be done.

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