THE DESIGN OF THE FUZZY SYSTEMS IN SELECTING THE STUDENTS' CONCENTRATION IN TERMS OF DETERMINING THE TOPIC OF THE THESIS

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ABSTRACT

The Graduate Program of Information Technology Department of IBI Darmajaya has some concentrations. They are Software Engineering and Information Systems. During this time, the decision made by the students to choose the topic of their thesis is based on their interest on the provided concentration, not based on their expertise. Beside the scores of the course that the students take, there are other factors that influence in selecting the concentration. They are interest and motivation possessed by the students. These factors can early help the students develop the skills that they have so that they can be more focus on developing capabilities. The objective of this research was to produce a design of the fuzzy systems which could help the students in determining the concentration and the topic of the thesis by using the fuzzy logic. The method used in this research was the intelligent system method which was called the fuzzy logic. The reason why the fuzzy logic was used was that the fuzzy logic could tolerate the uncertain values. Moreover, the fuzzy logic was based on the reasoning which used the approach to the uncertainty which combined the numeric variable, the linguistic variable, and rule.

KEY WORDS
Concentrations, Interests, Motivation, Courses Scores, Fuzzy

1. Introduction

Selecting the concentration enables students to develop their capabilities by studying deeply on the particular course in accordance with their respective interests. This affects the topic of the thesis which the students take.

Yulmaini (2011) states that selecting the interest which has been done during this time by the the students is based on the number of students who take their particular interest. Moreover, Luke, Meiliayana, and Samson, (2009) explain that the knowledge in selecting the students' interest actually is known by the head of the department and the adviser of the students but the knowledge is not known by the students so that there is the possibility of the students not to determine their interest. The input variables of the research which were conducted by Yulmaini (2011) and of the research which were conducted by Luke, Meiliayana, and Samson, (2009) use the scores of the course so that the further research must be done by adding the input variables. They are interest and motivation.

According to Djamarah and Bahri (2008), interest is the tendency within the individu which creates sense of interest and pleasure on objects. Interest is basically the acceptance of the relationship between oneself internally and something or someone externally. The stronger or closer the relationship is, the greater their interest raises. Furthermore,

motivation is internal and external processes on individuals which create enthusiasm and persistence from which certain activities are carried out (Winardi, 2002).

Yaqin (2013) writes that there are several factors which affect the students' motivation in selecting a concentration in faculty of management of economics of University of Jember. The affecting factors are (1) friends, (2) professors, (3) interest, and (4) capability.

The Graduate Program of Information Technology Department of IBI Darmajaya has some concentrations. They are Software Engineering and Information Systems. During this time, the decision made by the students to determine the topic of their thesis was based on their interest on the provided concentration, not based on their expertise.

According to the explanation from the background of the research above, the problem formulation was how the implementation of the fuzzy logic is in selecting the students' concentration to determine the topic of the thesis.

The objective of this research was to produce the system design which could help the students in selecting the concentration to determine the topic of the thesis by using the fuzzy logic.

2. Reviews Of The Related Theories

Fuzzy Logic

Fuzzy logic is a proper way to map an input into an output (Kusumadewi & Purnomo, 2010). According to Bojadziev (2007), the fuzzy logic is an extension of the number of logic values within the meaning of the formation of *the fuzzy set* and *the fuzzy relation* as the tool which turns into the system which consists of many logical values.

The Universe of Discourse

The universe of discourse is the whole problems from the smallest values to the largest values. The universe of discourse has monotonous upsurge.

Crisp Set

Crisp set is the set which distinguishes the members and non members with clear boundaries (Suyanto, 2007). Crisp set has two values of membership (μ). They are: one (1), which means that an item is a member in a set, or; and zero (0), which means that an item is not a member in a set (Kusumadewi & Purnomo, 2010)

Fuzzy Variable

Fuzzy variable is the variables which are discussed in a fuzzy system.

Fuzzy Set

Fuzzy set is the sets which are discussed in a variable within a fuzzy system. The fuzzy set has two attributes. They are that:

a. Linguistics is the naming of a group which represents a particular state or condition by using natural language.
b. Numeric is the value (number) which indicates the size of a variable.

Fuzzy Set Domain

Fuzzy set domain is the overall value which exists in the universe of discourse. Domain is a set of real numbers which are increasing monotonically from left to right. The value of the domain can be in the form of positive or negative numbers.

Membership Functions

The membership functions are the curve which shows the mapping of the input points into the membership values (often called the degree of membership) which has the interval from 0 to 1. One of the ways which can be used to obtain the membership values is through the function approach (Kusumadewi & Purnomo, 2010). Suyanto (2007) says that some of the membership functions which are frequently used in the real world are:

a. Triangle Functions

This function has one value of x which has the degree of membership which is equal to 1 when x = b. However, the values around b have a degree of membership which decreases sharply (stretching away

by 1). The membership functions can be described below:

The Membership Functions:

$$\mu(x) = \begin{cases} 0; & x \leq a \text{ atau } x \geq c \\ (x-a)/(b-a); & a \leq x \leq b \\ (c-x)/(c-b); & b \leq x \leq c \end{cases} \quad (1)$$

From which x is the variable which is to be searched, a is the lower limit, b is the middle limit, and c is the upper limit.

b. Trapezoid functions

This function has some of the values x which have the degree of membership which is equal to 1 when b ≤ x ≤ c. However, the degree of membership for a <x <b and c <x ≤ d has the same characteristics as the triangle functions. The membership functions can be described below:

The membership functions:

$$\mu(x) = \begin{cases} 0; & x \leq a \text{ atau } x \geq d \\ (x-a)/(b-a); & a < x < b \\ 1; & b \leq x \leq c \\ (d-x)/(d-c); & c < x \leq d \end{cases}$$

From which x is the variable which is to be searched, a is the lower limit, b and c are middle limit, and d is the upper limit.

Zadeh's Basic Operation for Operation

There are some basic operators created by Zadeh but the operator which are used in this research is AND. The AND corresponds with the operation of the intersection on the set. α- the predicate which is regarded as a result of the operations with the AND is obtained by taking the value of the smallest membership among the elements on the involved sets.

$\mu_{A\cap B}(x,y) = \min[\mu_{A(x)},\mu_{B(y)}]$

Fuzzy Inference System (FIS)

The mapping is carried out by Fuzzy Inference System (FIS). Moreover, FIS is also called fuzzy inference engine. Furthermore, FIS is also the system which can evaluate all rules simultaneously to yield conclusions. The sequence of rule is random (Naba, 2009). The complete fuzzy-based system consists of three main components: fuzzification, inference, and defuzzification.

Tsukamoto Method

Each consequence on the rule which is in the form of IF-THEN must be represented by the fuzzy set with the monotonous membership function. As a result, the output of the inference result of each rule is given explicitly (crisp) based on α-predicate (fire strength). The end of the result is obtained by using the weighted average. Besides, the output of the final result (Z value) is obtained with the formula as follows: (Kusumadewi & Purnomo, 2010).

$$Z = \frac{\alpha_1 Z_1 + \alpha_1 Z_1}{\alpha_1 + \alpha_2}$$

There are a few steps needed to obtain the output, including:

a. The formation of input variables
b. The degree of the membership
c. The application of Fuzzy Operator
d. d. Assertions (defuzzy)

Interest

According to Djamarah & Bahri (2008), interest is a persistent tendency to notice and recall some activities. Someone who is interested in an activity will consistently notice the activity with a sense of pleasure because it comes from within oneself which is based on s sense of love and an absence of coercion from outsiders. According to Yaqin (2013), interest is a tendency of individuals to focus on a sense of more pleasure and a sense of interest on objects or specific situations from which selecting the individuals' concentration is the main matter in this case.

Still, Yaqin (2013) says that there are some indicators of the interest in learning. They are pleasure, students' interest, students' attention, and students' involvement.

Motivation

According to Winardi (2002), motivation is internal and external processes on individuals which create enthusiasm and persistence by which certain

activities are carried out. Another definition is proposed by James O Wotittaker.

Yaqin (2013) explains that there are five common characteristics. They are: the driven motivation, the motivation boosters are the basic coincidence or the learned coincidence; direction-giving motivation; action-raising motivation; and effective motivation. The motivation is the key for need satisfaction due to a person's deficiencies so that it affectsthe person to be motivated to fulfill the need.

3. Research Method

This research was conducted in five phases as follows:

a. Phases 1

This phase is explaining the identification of the existing problems in the Graduate Program of Information Technology Department. The identification of the existing problems was related to selecting the students' concentration in terms of determining the topic of the thesis. Selecting the students' concentration was based on the number of students who took the concentration during that time. In addition, the particular methods had also not been used in the selecting the students' concentration in term of determining the topic of the thesis.

b. Phase 2

There were a few things to do in this phase. They were the literary research, the search for solutions, the identification of the need of the data, and the data collection.The literary research was based on the previous researches. They were in the form of the previous research journals relating to this research. The other literary research was the theoretical basis on the questionnaire data processing and the theoretical basis on the fuzzy logic which contained definitions and theories on the fuzzy logic by using Tsukamoto-FIS method. The identification of the need of the data was the process of determining the data which was needed in selecting the students' concentration on the topic of the thesis. The required data was (1) the lists of the course of The Graduate Program of Information Technology Department, (2) the scores of the students on the subjects which were taken by the students, the students' existing concentration, (3) the rules of the assessment of the subjects, and (4) the data on the results of questionnaires on the interest and motivation. The data collection was implemented by doing direct observation to The Graduate Program of Information Technology Department of IBI Darmajaya.

c. Phase 3

This phase described about the parameter determinant in selecting the students' concentration in terms of determining the topic of the thesis. Afterwards, the distribution of questionnaires was carried out to obtain data on the students' interest and motivation in selecting their concentration.

d. Phase 4

This phase involved the processing data on the questionnaires which were based on the interest and motivation. The result of the data on questionnaires was processed as the input variables in the fuzzy method. This phase also involved the implementation on the system requirements and the system design. The system requirements consisted of the input requirements, the process needs of FIS-Tsukamoto method, and the output needs. The system design included the design of the membership functions, the design of the fuzzy rule, the design of the system process, and the interface design.

e. Phase 5

This phase is the conclusion. This phase outlined the conclusions of the research, the compatibility of the objective of the research, and the reporting of the result of the research.

4. The Result Of This Research And The Discussion

Technique of the Implementation of the Method

The technique of the implementation of the method which was used in constructing the fuzzy system was Fuzzy Inference System (FIS)–Tsukamoto method. This method could be described in the fuzzy system architecture. The Tsukamoto-FIS system design could be seen in Figure 1.

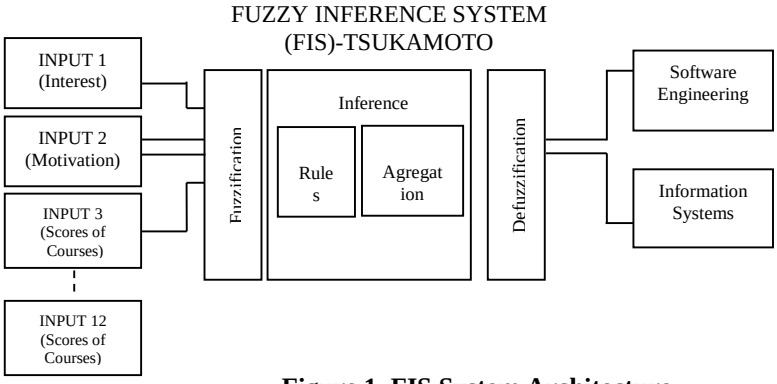

Figure 1. FIS System Architecture

Need Analysis

The need analysis was the process to yield the need of the specification. This specification was used to make a deal in constructing the system. The need analysis consisted of the analysis of the input needs, the process needs, and the output needs.

Input Need

There were 14 required input variables. They were that the scores of the courses relating to the students' concentration of the topic of the thesis, the scores of the interest, and the scores of the motivation. These variables could be seen in Table 1.

Table 1. Input Variable

Names of the Variabel	Annotation
CM	Computer Networks & Systems Management (CM)
SD	Software and Engineering Analysis System Design (SD)
DS	Database Management System (DS)
SP	Strategic Information Systems Planning (SP)
IM	Information Technology Project Management (IM)
TP	Text Image Processing (TP)
AI	Artifical Intelligent (AI)
IP	Internet and Web Programming (IP)
SA	Software Quality Assurance (SA)
AA	Analysis and Design of Algorithms (AA)
IA	Information Systems Audit (IA)
DS	Decision Support Systems (DS)
IS	Interest (IS)
MT	Motivation (MT)

The determinant of the variable and the universe of discourse from the result of the obtained data could be seen in Table 2.

Table 2. Variable Determinant and Universe of Discourse

Function	Variabel Determinant	Universe of Discourse	Annotation
Input	Scores of Basic Course [1:12]	[0 – 100]	Scores of Basic Course: [13]
	Scores of Interest		Scores of Motivation [14]
Output	Group of Concentration [1:2]	[0 – 100]	Concentration 1 (SEC) : Software Engineering Concentration Interest 2

			(ISC) : Information Systems Concentration

The fuzzy set was shown in the Table. 3

Table 3. Fuzzy Set

Function	Variable	Names of Fuzzy/Linguistics Sets	Abbreviation	Range	Domain
Input	Scores of Basic Course [1:12]	High	Hi	0 - 100	50 – 100
		Low	Lo		0 – 80
	Scores of Interest				
	Scores of Motivation [14]				
Output	Group of Concentration [1:3]	High	Hi	0 - 100	50 – 100
		Low	Lo		0 – 80

Process Need

The process need which was used in this research was the problem solving by using FIS-Tsukamoto method.

Output Need

This output of this research was in the form of the students' concentration of the topic of the thesis. The concentration of the topic of the thesis is the Engineering Software Concentration (ESC) and the Information Systems.

System Design

The designed method was the membership functions, the fuzzy rule design, the DFD design, and the display (interface) design.

Design of the Membership Functions

The membership functions are the curve which shows the mapping of the input points into the membership values (often called the degree of membership) which has the interval from 0 to 1.

The Membership Functions of the Variable Input of the scores of the course with the universe of discourse (0-100)

To represent the variable of the score of the subject was by using the left shoulder of the membership function representation for the LOW fuzzy and the right shoulder of the membership function representation for the HIGH fuzzy set. This function was to terminate an area and there were a few points which had 1 as the score membership.

The HIGH with the domain (50-100) and the right Trapezoid membership function were:

$$\mu_{High(x)} = \begin{cases} 1 & ; \ x \geq 80 \\ \frac{x-50}{30} & ; \ 50 < x \leq 80 \\ 0 & ; \ x \leq 50 \end{cases}$$

The LOW with the domain (0-80) and the left Trapezoid membership function were

$$\mu_{Low(x)} = \begin{cases} 1 & ; x \leq 50 \\ \frac{80-x}{30} & ; 50 < x \leq 80 \\ 0 & ; x \geq 80 \end{cases}$$

The Membership Functions of the Variable Input of the scores of the Interest with the universe of discourse (0-100)

To represent the variable of the score of the interest was by using the left shoulder of membership function representation for the LOW fuzzy and the right shoulder of membership function representation for the HIGH fuzzy set. This function was to terminate an area and there were a few points which had 1 as the score membership.

The HIGH with the domain (50-100) and the right Trapezoid membership function were.

$$\mu_{High(x)} = \begin{cases} 1 & ; \ x \geq 80 \\ \frac{x-50}{30} & ; \ 50 < x \leq 80 \\ 0 & ; \ x \leq 50 \end{cases}$$

The LOW with the domain (0-80) and the left Trapezoid membership function were.

$$\mu_{Low(x)} = \begin{cases} 1 & ; x \leq 50 \\ \frac{80-x}{30} & ; 50 < x \leq 80 \\ 0 & ; x \geq 80 \end{cases}$$

The Membership Functions of the Variable Input of the scores of the Interest with the universe of discourse (0-100)

To represent the variable of the scores of the motivation was by using the left shoulder of membership function representation for the LOW fuzzy and the right shoulder of membership function representation for the HIGH fuzzy set. This function was to terminate an area and there were a few points which had 1 as the score membership.

The HIGH with the domain (50-100) and the right Trapezoid membership function were:

$$\mu_{High\ (x)} = \begin{cases} 1 & ; \ x \geq 80 \\ \frac{x-50}{30} & ; \ 50 < x \leq 80 \\ 0 & ; \ x \leq 50 \end{cases}$$

The LOW with the domain (0-80) and the left Trapezoid membership function were:

$$\mu_{Low(x)} = \begin{cases} 1 & ; x \leq 50 \\ \frac{80-x}{30} & ; 50 < x \leq 80 \\ 0 & ; x \geq 80 \end{cases}$$

The Membership Functions of the Variable Input of the scores of the Interest with the universe of discourse (0-100)

To represent the variable of the group of the concentration was by using the left shoulder of membership function representation for the LOW fuzzy and the right shoulder of membership function representation for the HIGH fuzzy set. This function is to terminate an area and there are a few points which had 1 as the score membership.

The HIGH with the domain (50-100) and the right Trapezoid membership function were:

$$\mu_{High(x)} = \begin{cases} 1 & ; \ x \geq 80 \\ \frac{x-50}{30} & ; \ 50 < x \leq 80 \\ 0 & ; \ x \leq 50 \end{cases}$$

The LOW with the domain (0-80) and the left Trapezoid membership function were:

$$\mu_{Low(x)} = \begin{cases} 1 & ; x \leq 50 \\ \frac{80-x}{30} & ; 50 < x \leq 80 \\ 0 & ; x \geq 80 \end{cases}$$

Fuzzy Rule Design

To run the fuzzy system which was used in selecting the students' concentration in terms of determining the topic of the thesis, the rules representing the relationship behavior between the input variable and output variable were built. There were some cornerstones in the formation of the fuzzy rules as follows:

1. The basic course was a course which was in all the students' concentrations in terms of determining the topic of the thesis. They were CM, SD, DS, SP, IM, TP, AI, and IP. One of the basic courses could be in the form of the low scores so that one of the group concentrations was filled.
2. The core course was the core courses of each of the students' concentration in terms of determining the topic of the thesis. They were SA, AA, IA, and DS. The scores of the core course could not be low so that a group of high concentration was raised.

Data Flow Diagram (DFD) Design

In general, the design of the system of the fuzzy logic in selecting the interest for the final task was described in the DFD Level 0, as shown in Figure 2.

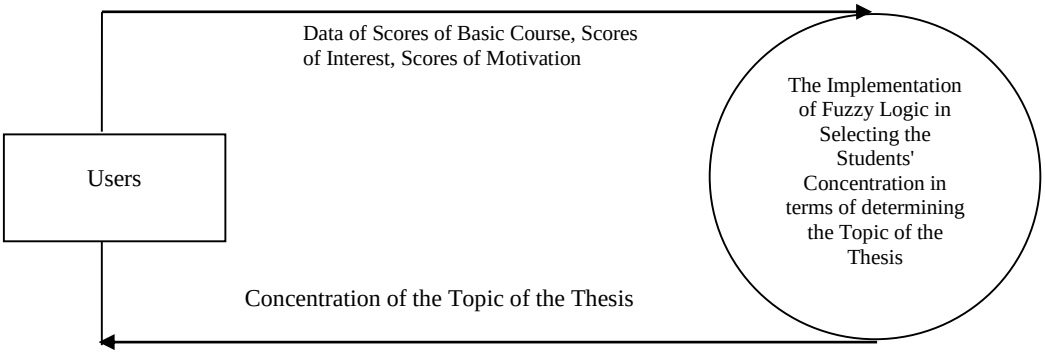

Figure 5. DFD Level 0 of Fuzzy System

At the end of selecting of the interest of the final tasks, there were 3 sub-processes. They were the design of the membership functions, the fuzzy process, and the fuzzy method.

a. The design of the membership function was used to design the membership function
b. The fuzzy process was used to make the process of the problem solving by using FIS-Tsukamoto method.
c. The fuzzy method is used to process the trial on new data input by using Tsukamoto FIS method.

5. Conclusions

According to the discussion which had been represented, there were some conclusions which was described that the design of the fuzzy system in selecting the students' concentration in terms of determining the topic of the thesis only reached the phase of the design of the method and system. The fuzzy system by using the FIS-Tsukamoto method produced an output based on the designed fuzzy rule.

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