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THE APPLICATION OF FUZZY LOGIC IN ADMITTING STUDENTS INTO TERTIARY INSTITUTIONS OF LEARNING

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ABSTRACT

In this paper an attempt has been made to unveil part of the reasons for poor performances in Mathematics, Computer Science and Physics. This is partly due to the aggregate method used in offering admission into these programmes of study. Fuzzy logic approach was used to determine the best programme of study for each student based on the strength of students in their 2010/2011 Post-University Matriculation Examination test results. The mean scores from the aggregate method of admission is 2.38 while that for fuzzy logic approach is 3.35.

KEYWORDS: fuzzy logic, fuzzy set, aggregate method, UME, PUME, JAMB, UTME, CGPA.

INTRODUCTION

The demand for university education is on the increase than ever before [1]. The selection of qualified candidates becomes more important than necessary. Students are being offered admission but still there is a wide gap in the number being admitted, the expectation of the society and performance of university graduates [2]. Various methods have been employed by various institutions in admitting new students. Some institutions admit students based on high aggregate scores in Joint admission matriculation board examinations (JAMB) and post university matriculation examinations (PUME). Others admit candidates based on their individual institutional policies [3]. In all of these approaches, the required result is to admit the candidate who satisfies basic requirements for entry into the university. PUME was introduced into most Nigerian universities in the year 2005 as a result of serious cases of examination misconduct during the university matriculation examination (UME) screening test [3].

PUME screening test ensures that candidates gain admission based on merit [2]. This would ensure qualified graduates and equally reduced incidences of examination malpractice and sex for marks.

Research conducted in [4] showed that a negative correlation in the scores obtained by candidates during their UME and first year cumulative grade point average (CGPA). However, in the same research, a strong positive correlation was observed between PUME and CGPA.

Admitting students by evaluating their PUME scores on the basis of their strengths in the various scores obtained from the subjects they sat for exams will play a great role on the academic performance of students as better measures are being taken by universities to ensure that candidates that scored the cut off marks in unified tertiary matriculation examinations (UTME) write a PUME in a well invigilated and supervised conditions. A logical decision should be made in evaluating the PUME scores on the basis of strength. One of the renowned tools in making logical decision is the idea of using the concept of fuzzy set theory that was first proposed in [5].

Fuzzy set theory is a theory that determines the relationship that exists amongst certain objects located in a set [6]. In classical set theory, element(s) is/are either member(s) of a set or is/are excluded from the set. However, in fuzzy set an element belongs to a set in degrees which is referred to as the degree of membership within the unit interval [0, 1]. This concept of fuzzy set (FS) and fuzzy logic (FL) would greatly help in resolving the intrinsic involve in admission

into universities in Nigeria and elsewhere as the membership function (MF) of each score obtained by a candidate can easily be determined and the appropriate set (subject(s) of strength) is/are identified for correct decision making.

In this paper, FL model is presented for decision making process involving admitting students into various programme of studies based on the strength of their performance in PUME. Accordingly, problem description is discussed in section 2. In section 3, relevant literatures were reviewed. This was followed by the development of the FL model in section 4. In section five, the source of data which was 2010/2011 PUME of Kaduna State University (KASU), Kaduna due to its authenticity and reliability than UTME for the admission into B.Sc. Mathematics, Physics and Computer Science programmes of KASU, Kaduna and tools utilized for the research were presented. Section six contains the analysis of data and discussions. Finally, conclusion was drawn based on the research results obtained and propose a future research direction by the use of an hybrid approach like fuzzy neural network (FNN) in the process of evaluating PUME to make decision as the combination of such tools have proven to be extremely valuable [7].

PROBLEM DESCRIPTION

The poor performance of students in mathematical sciences based programme such as Bachelor of Science in mathematics, physics and computer science is on the increase and course great deal of concern as these courses constitute part of the corner stone for a vibrant technological society. This is partly due to wrong admission system which is based only on the aggregate performance of candidates in UTME and PUME. This has lead to very poor performance by these students, several cases of examination misconduct, withdrawal from the programme of study and generally, very low academic standards are being maintained in tertiary institutions of learning in Nigeria.

The number of candidates applying for admissions into tertiary institutions is more than the capacity of Nigeria's tertiary institutions, the need to admit students' not just on aggregate scores obtained, but also considering the strength of each candidate before offering admission into any field of study is very vital. This allows for qualified graduates with specialization in their various fields of study. The far reaching effect is economical growth and development in any society. In achieving this objective, there is an urgent need to review the system of admitting student into tertiary institutions in Nigeria due to the fact that the validity of UME scores is low [8].

The need to review the approach in admitting students into degree programmes should be taken with utmost importance. The use of FL in evaluating PUME based on strength of performance would greatly improve the academic performance of students and thereby bring about the needed change in the university system.

REVIEW OF RELATED LITERATURE

[9] used the concept of fuzzy parameterized fuzzy soft set in making decision regarding the assessment of multiple expert as compared to the classical method used and they claimed that the fuzzy method minimizes the influence of extreme values which is not easily handled by the classical approach. Fuzzy Logic (FL) is a strong tool in decision making that involves human reasoning. The Japanese were the first to utilize FL for practical applications. The first notable application was on the high speed train in Sendai, in which FL was able to improve the economy, comfort and precision of the ride [10]. It also been used in recognition of hand written symbols in Sony pocket computers, flight aid for helicopters, controlling of subway system in order to improve driving comfort. [11] build a model based on FL for solving decision making problem, and that the model proved thriving and concluded that the concept of FS has a prosperous opportunity for developing decision making models suitable for private, profitable and administrative application.

In [12] FL was applied in examining the correlation between students' pre-admission into university profile and their academic performance. Ordinary level grade, University Matriculation Examination (UME) scores and PUME scores were considered as the preadmission into university profile and the grade point average (GPA) at the end of a particular semester was used to define the academic performance of a candidate.

[13] compared the classical scoring method used to determine the participants' graduation of teacher's certification based on requirements fulfilled with FL method. Five criteria were used as inputs for the comparison of the system. In the FL approach, each criterion was divided into three FS: Low, medium and high; while the classical scoring approach was on the scale of 1-5 for each requirement fulfill. Different ranks and results were observed from the two different approaches. However, FL was more equitable in presenting decision and in determining the ranks.

FUZZY LOGIC MODEL DEVELOPMENT

FL was developed in order to provide mathematical rules and functions which permit natural language queries that attempts to provide a way of mathematically expressing the uncertainty of information. In a nutshell, FL control can convert linguistic control information to mathematical control information for the purpose of decision making [5], [14].

FSs and fuzzy rules (FRs) together form the knowledge base of a FR-based reasoning system which consists of three components, each performing specific task in the reasoning process. The components are fuzzification, inferencing and defuzzification [14-16].

Fuzzification: is concerned with finding a fuzzy representation of non-fuzzy input values. This was achieved through application of the membership functions associated with each fuzzy set in the rule input space (universe of discourse). Two input variables; Mathematics and Physics scores of the 2010/2011 PUME were used. Below is the MATLAB view of the input variable description used for both Mathematics and Physics.

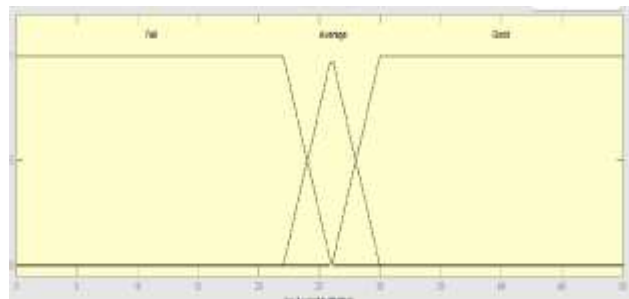


Fig 1. Variable membership function graph

Mathematics and physics variables are divided into three FSs, Fail, Average and Good.

On the graph, Fail set is on a scale of 0 to 26. The scale of the Average set is 22 to 30, while the Good set ranges from 30 to 50.

Inference Engine: is to map the fuzzified inputs (as received from the fuzzification process) to the rule base, and produce a fuzzified output for each rule. The inference system combined the outputs obtained for each rule into a single FS, using a fuzzy maximum aggregate operator of the mamdani's fuzzy inference (FI) method.

Rule Determination: In this research the rule base constitutes of nine rules of If then form as follows:

- Rule 1: If Mathematics is Fail and Physics is Fail then Others
- Rule 2: If Mathematics is Fail and Physics is Average then others
- Rule 3: If Mathematics is Fail and Physics is Good then others
- Rule 4: If Mathematics is Average and Physics is Fail then others
- Rule 5: If Mathematics is Average and Physics is Average then Physics
- Rule 6: If Mathematics is Average and Physics is Good then Physics
- Rule 7: If Mathematics is Good and Physics is Fail then others
- Rule 8: If Mathematics is Good and Physics is Average then Mathematics
- Rule 9: If Mathematics is Good and Physics is Good then Computer Science

Defuzzification: Given a set of activated rules and their corresponding firing strengths, the task of the defuzzification process is to convert the output of the FRs into a scalar, or non-fuzzy value. The centroid Defuzzifier was utilized in this respect which returns the center of the area under FS obtained in the inference engine. The defuzzification process utilized the formula

$$g = \frac{\sum_{i=1}^9 f_i \cdot u(x_i)}{\sum_{i=1}^9 u(x_i)}$$

Where $u(x_i)$ are the firing strengths of the activated rules and f_i is the centroid of the composite area calculated and its horizontal coordinate used as the output. The composite area under the scale of 0 to 50 is figure 2 below which was extracted from MATLAB.

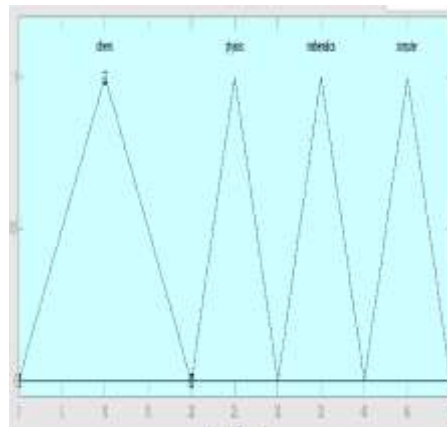


Fig. 2 Composite Area for the output graph for Others, Physics, Mathematics and Computer Science

In the graph, Others range from 0 to 20, Physics is from 20 to 30, Mathematics is from 30 to 40 and 40 to 50 for Computer Science. After defuzzification the course with the highest crisp value will be allocated to a candidate.

DATA AND TOOLS

The result of 2010 PUME test for 143 students in Mathematical Sciences department that were granted admission based on their aggregate performance in both UTME and PUME were obtained from the academic planning department of Kaduna state university (KASU), Kaduna. The subjects in the PUME include English language, Mathematics, Physics and any other subject.

The second semester’s CGPA of the students in 300 level of the department of Mathematical Sciences Programme who sat for the 2010 PUME were obtained from the department at the time of this research. The tools used in this research included, MATLAB R2012a and VISUAL BASIC 2010.

DATA ANALYSIS AND DISCUSSIONS

In implementing the FL model, two programs were written using VISUAL BASIC 2010 and MATLAB R2012a. After evaluate the PUME result of all 143 candidates offered admission it shows that only 1(0.7%) candidate should have been offered admission for B.Sc. in Mathematics, 1(0.7%) candidate should have been offered admission for B.Sc. Physics, 12(8.4%) should have been offered admission for B.Sc. Computer Science and 129(90.2%) should have been offered admission for B.Sc. in Other programmes. The output of the result in VISUAL BASIC 2010 is presented in figure 3 below.

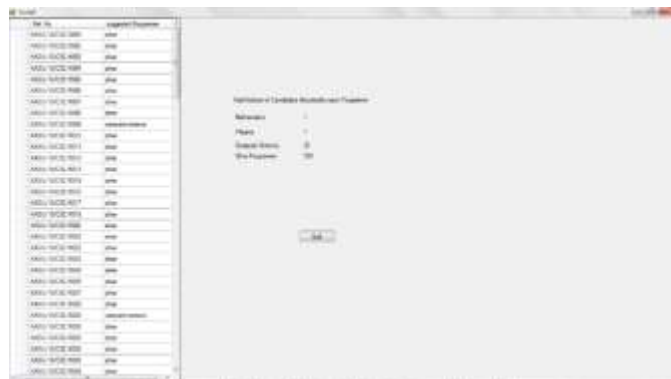


Fig.3 System view of the result

The rule view in MATLAB for a candidate that scored 31 in Mathematics and 17 in Physics had 10 for programme of study is illustrated in figure 4 below.

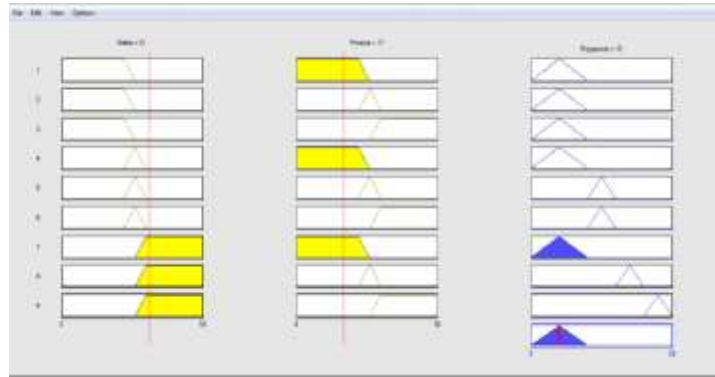


Fig. 4 Rule view of input mathematics = 31 and Physics = 17

The control surface for the rule base is depicted in figure 5; it displays the surface of the entire rule base for the 143 candidates.

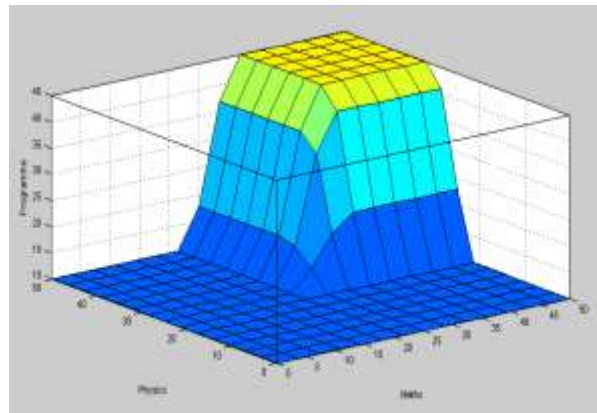


Fig 5 control surface of the rules base

In this study it was discovered that 6 students current programme matched their suggested programme and 3(50%) of them are having a CPGA ranging from 3.91 and above. The average CGPA for this group was found to be 3.57 with a standard deviation of 0.9.

The correlation coefficient between performance in Mathematics and CGPA for the students whose current programme matched their suggested programme is 0.31; and the coefficient of correlation between their performance in Physics and their CGPA is 0.6.

While for those that there was no match between their programme of study and the suggested programme had a correlation coefficient of 0.42 between Mathematics and CGPA and a correlation coefficient of 0.04 between Physics and CGPA. The average CGPA for this group was found to be 2.39 with a standard deviation of 1.03.

CONCLUSION

The results obtained from this research has clearly shown why the very poor performance by students offering Mathematical bias courses in Nigerian university as a result of the wrong use of tools in admitting students. This also shows why the very poor level of technological growth and development in Nigeria as the bedrock of scientific and technological development is lacking.

The performance of those students whose current programme matches the suggested programme is higher than those that there is no match. However, the results obtained from the calculations of correlation coefficients showed that for

those students that there is a match between their programme and the suggested programme the relationship is averagely strong in Physics than in Mathematics. While for those with no match, the correlation coefficient shows a weak relationship in Mathematics and a very weak relationship in Physics. We could imagine the multiplying effect of these students whose current programme did not matched their suggested programme to the society as they are expected to transfer their knowledge to the younger generation. Fuzzy logic is simple and easy to implement. However, hybridizing FL with neural network will produce more revealing information.

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