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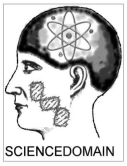

Comparative Analysis of Post University Matriculation Examination in Nigerian Universities Using Fuzzy Logic

Peter Ayuba[1*]

[1]*Department of Mathematical Sciences, Kaduna State University, Kaduna, Nigeria.*

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Abstract

The poor performance of students in Mathematical Science based programmes in Nigerian Universities is partly as a result of the tools and data used in the admission process into tertiary institutions. In this paper, a comparative analysis on three rule base cases using fuzzy logic was made on the Post University Matriculation Examination (PUME) results of the current 400 Level students in Mathematical Sciences programmes of Kaduna State University, Kaduna. The results reveal that the CGPA of students that had very good performance in Mathematics and Physics in their PUME are higher as compared to those that score fail in either Physics or Mathematics but were offered admissions into Mathematical Sciences programmes. The percentage pass from the aggregate method is 41% while that for fuzzy logic approach is 59%.

Keywords: Fuzzy logic; fuzzy set; membership function; aggregate method; neural network; PUME; JAMB; UTME and CGPA.

1 Introduction

The need for tertiary education is increasing on a daily basis due to the increase in population of graduates from secondary schools [1]. Therefore the process of selecting qualified candidates becomes more significant than necessary. The number of students that are being offered admissions into tertiary institutions and their academic performance still fall below the expectation of the society [2]. Several institutions utilized different techniques during the process of admitting students. The universally accepted method of

**Corresponding author: E-mail: ayubng@kasu.edu.ng;*

examination into tertiary institutions in Nigeria is the Unified Tertiary Matriculation Examination (UTME) conducted by Joint Admissions Matriculation Board (JAMB). While most universities use the aggregate scores in UTME and Post University Matriculation Examinations (PUME), others use slightly different rules [3]. The use of PUME screening is to ensure merit is considered in admitting students void of cheating [2].

[4] conducted a survey and reported that there exists a negative correlation between scores obtained by candidates in university matriculation examination (UME) and their respective scores (cumulative grade point average (CGPA)) in the first year of their programme in the University. Nevertheless, a positive correlation existed between their PUME and CGPA.

The need to evaluate candidates based on the scores obtained in PUME is very important. However, the tool used is of paramount importance in this respect. When a wrong or inadequate tool is employed for this exercise, wrong or poor results become inevitable. One of the excellent tools that can be applied is fuzzy set (FS) theory and fuzzy logic (FL) presented in [5].

The correlations that exist amongst members of a set are easily determined by FS theory [6]. In the conventional set theory, an element belongs to a set or it is not a member of the set in question. In FS, an element is a member of a set in degree, called the degree of membership in the closed interval [0, 1]. The ideology in FS theory is applicable in considering the strength of a candidate in order to offer him or her admission into any tertiary institution in Nigeria and elsewhere in the world with similar challenges like Nigerian universities. The ability to formulate different sets in FL and the membership function (MF) of each score allows for proper identification of the strength of a candidate in the various subjects written in PUME, which translates to making the right decision.

The various approaches used in offering admission to candidates into tertiary institutions play very significant role in the performance of students during the period of their studies. The poor performance of students in mathematical science programmes such as Mathematics, Physics and Computer Science is on the increase in Nigerian Universities. This affects scientific and technological advancement in the country as these programmes constitutes essential elements in the improvement of technology in any society. In order to address this predicament, a comparative approach is needed to ascertained the right rule base in implementing FL. In this paper, the need to evaluate candidates based on PUME using FL model was suggested in section one. In section two, part of the problems of very poor performance by students in mathematical sciences courses like Mathematics, Computer Science and Physics were discussed. Literature that discussed the used of FS theory and FL in decision making were reviewed in section three. The development of FL model for the different criteria to be considered in offering admission to candidates that sat for PUME is discussed in section four. In section five, the 2010/2011 PUME conducted in Kaduna State University, Kaduna for admission into Bachelor of Science (B.Sc.) degree programmes in Computer Science and Mathematics programmes of Kaduna State University, Kaduna and the data and tool used for the purpose of this research are presented. The analysis of data and discussions are done in Section six. Conclusion drawn on the basis of the results obtained and fuzzy neural network (FNN) was proposed as a new direction in the evaluation of PUME. This tool has the potential to give a valuable result [7].

2 The Problem Statement

The poor performance of students in mathematical sciences based programme such as B.Sc. in Mathematics, Physics and Computer Science has been on the increase. These subjects are vital for an energetic technological society. The weak performance of students in these subjects is partially due to the wrong admission criteria used in offering admissions to candidates. The use of aggregate performance of candidates in UTME and PUME does not reflect a significant strength of the candidates. This has lead to 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 capacity of the Nigerian tertiary institutions cannot accommodate the number of candidates seeking for admissions [1]. The need to consider the strength of candidates in offering admission into any field of studies is therefore very significant. The production of competent applicants with specialization in their various fields of study leads to economical growth and development in any society. To achieve this goal, there is a pressing need to review the current approach used in admitting students into tertiary institutions in Nigeria. The legitimacy of UME scores is low [8].

The use of FL to assess PUME based on the strength of a candidate's performance would really improve performance of students. This would translate to a commensurate growth and development in science and technology.

3 Review of Related Literature

The idea of fuzzy parameterized fuzzy soft set (FPFSS) was utilized in making decision concerning the assessment of several experts in comparison to the aggregate approach in use. The results showed that the FPFSS minimized the control of extreme values over the aggregate approach [9]. [10] reported that the Japanese were the initial people to use FL in their high speed train. FL was able to enhance the financial system, comfort and accuracy of the ride. Other notable applications are the detection of hand written sign in Sony pocket devices, flight assistance for Helicopters, control of subway system to enhance comfort. A FL model was built in [11,12] for decision making. The model shows that FS theory is appropriate for personal, economical and public applications.

FL was used in evaluating the correlation in students' performance before admission into the university and during the course of their programme [13]. The Ordinary level grades, UME scores and the PUME were the pre-admission criteria, while, CGPA of students at the end of a particular session were used.

The classical scoring approach was compared in [14] with FL to find out the contestants' graduation of educator's certification based on requirement fulfilled. In comparing the methods, five decisive factors were used as inputs. Each factor was divided into three FSs: Low, Medium and High. The classical scoring method was on the scale of one to five (1-5) for each factor. FL was reported to have been superior in making decision and in determining ranks of teachers.

In [15] FL was applied in the admission of students into tertiary institutions and it was reported that the average scores obtained from FL is 3.35 as compared to 2.38 obtained by using the aggregate method.

4 Fuzzy Logic Model Development

The development of FL is for the provision of mathematical rules and functions that allows the query of usual verbal communication. This gives a way of mathematically stating the uncertainty of information. In brief the conversion of control information into mathematical control information for the reason of decision making can be done by FL control [5,16].

The knowledge base of a fuzzy rule (FR) based reasoning system comprises of FSs and FRs. There are three components in a fuzzy logic controller (FLC). Each of these components plays a significant role in the reasoning process. These components are fuzzification, inference engine and defuzzification [16-18].

4.1 Fuzzification

This is the process of changing discrete input into a FS and for each discrete value transformed there is a corresponding MF. MFs are within a universe of discourse or universal set. In Fig. 1, an illustration of this is made.

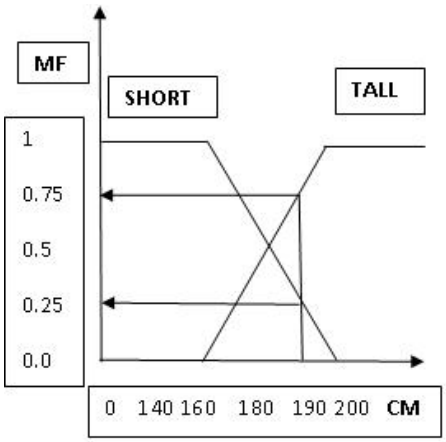

Fig. 1. Variable membership function graph

Two inputs, Mathematics and Physics variables are divided into three FSs, Fail, Average and Good. The step functions below depict the range for each these FSs.

$$\mu_{fail}(x)=\begin{cases}1 & x\le 22\\ \dfrac{26-x}{4} & 22\le x<26\\ 0 & x=26\end{cases}$$

$$\mu_{average}(x)=\begin{cases}0 & x\le 22\\ \dfrac{x-22}{4} & 22<x\le 26\\ \dfrac{30-x}{4} & 26<x\le 30\end{cases}$$

$$\mu_{good}(x)=\begin{cases}0 & x\le 26\\ \dfrac{x-26}{4} & 26<x\le 30\\ 1 & 30<x\le 50\end{cases}$$

4.2 Inference Engine

This maps the fuzzified inputs to the rule base; which produce a fuzzified output for each rule. The mamdani's fuzzy inference approach for the fuzzy maximum aggregate operator combines the outputs for each rule into a single FS.

4.2.1 Rule determination

In this research work, three cases were considered for the rule base constituting of nine rules each. In case I, fail in any subject is not granted admission into any of the mathematical sciences programme. In case II, if Good is obtained in any of the subjects it is considered. Finally, in case III, a minimum of average grade is considered in at least a subject. There are two inputs with each divided into three fuzzy sets, the following nine rules of If Then form were applied as follows:

Case I

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

Case II

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 Physics
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 Mathematics
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

Case III

Rule 1: If Mathematics is fail and Physics is fail then Others
Rule 2: If Mathematics is fail and Physics is average then Physics
Rule 3: If Mathematics is fail and Physics is good then Physics
Rule 4: If Mathematics is average and Physics is fail then Mathematics
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 Mathematics
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

The FLC of the FL inference (FLI) system from MATLAB is depicted in Fig. 2.

4.3 Defuzzification

The activated rules and their respective firing strengths are converted into a discrete value. The centre of the area under FS obtained from the inference engine was generated by the centroid Defuzzifier as given below.

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

where $u(x_i)$ are the firing strengths of the activated rules and f_i. is the centroid of the composite area evaluated and their corresponding horizontal coordinates used as the output. The compound area extracted from MATLAB is Fig. 3 in the scale of 0 to 50.

The range of scores in the PUME for Other programme is from 0 to 20, the range for Physics programme is 20 to 30; Mathematics ranges from 30 to 40, and Computer Science programme ranges from 40 to 50. The defuzzification process generates a crisp value and the highest score obtained by a candidate become the programme of study.

5 Data and Tools

The data of 143 students of the Mathematical Sciences programme in Kaduna State University, Kaduna who sat for the 2010 PUME were obtained for this research. The PUME consist of English Language, Mathematics, Physics and any other subject.

The CGPA of 300 Level students in Mathematical Sciences programmes that wrote the 2010 PUME were the additional data used for this research work. MATLAB R2010a was the tool utilized in this research.

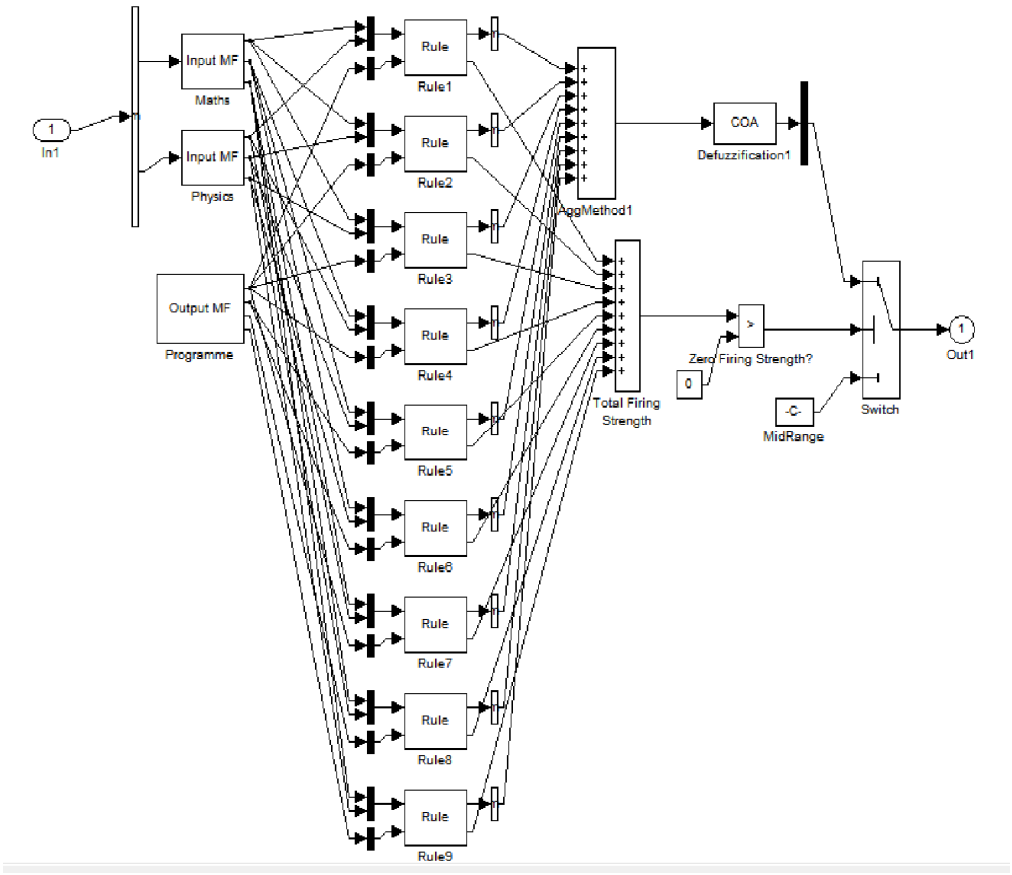

Fig. 2. Fuzzy logic controller of the inference system

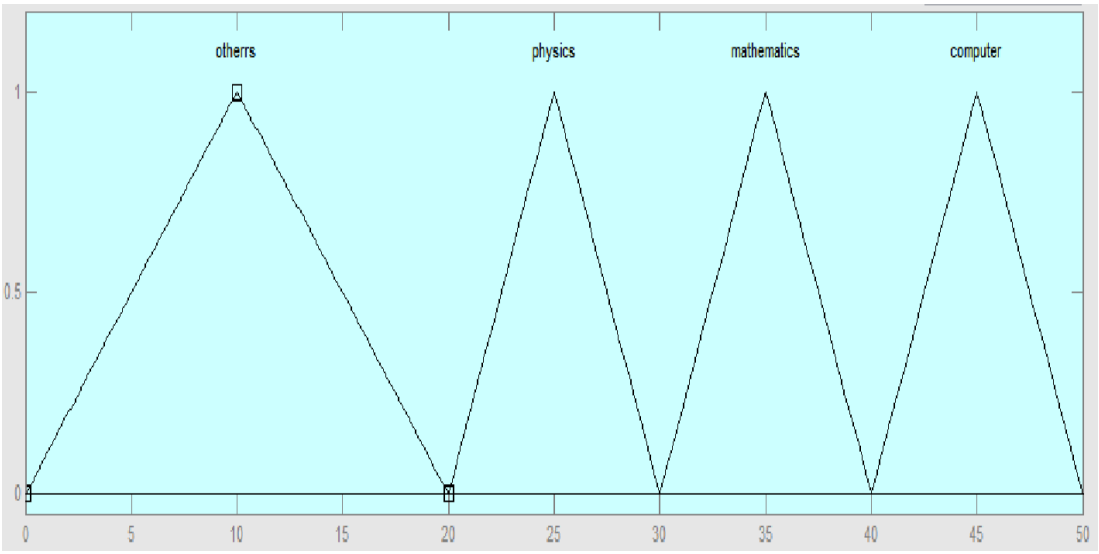

Fig. 3. Compound area of the output graph for Others, Physics, Mathematics and Computer Science

6 Analysis of Results and Discussion

The implementation of FL was done using MATLAB R2012a. In case I, 143 candidates were evaluated. The results showed that only a candidate each was really qualified for the B.Sc. in Mathematics and Physics. These constitute 0.7% each of the total number. 12 candidates were qualified for B.Sc. in Computer Science. This number constitutes 8.4%. The remaining 129 were qualified for Other programmes that make 90.2%. The control surface of the rule base for case I is shown in Fig. 4 for the 143 candidates.

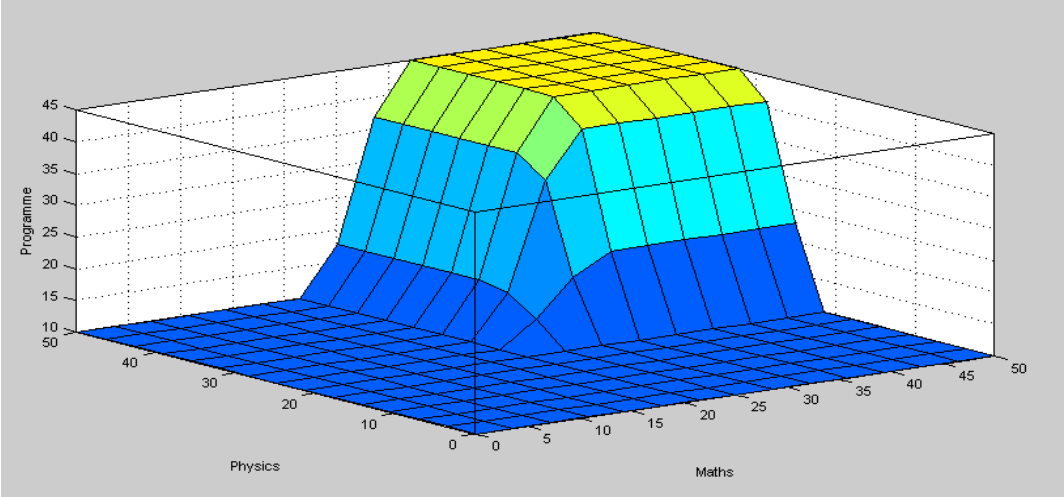

Fig. 4. Control surface of the rules base for case I

Based on the rule base above for case II, it shows that only 17 candidates were qualified for the B.Sc. in Mathematics, which makes 11.9%. 13 candidates were qualified for B.Sc. in Physics that constitutes 9.1%. 12 candidates were qualified for the B.Sc. in Computer Science that makes 8.4%. The Other programmes take 101, which constitutes 70.6% of the total number. The control surface for case II is shown in Fig. 5.

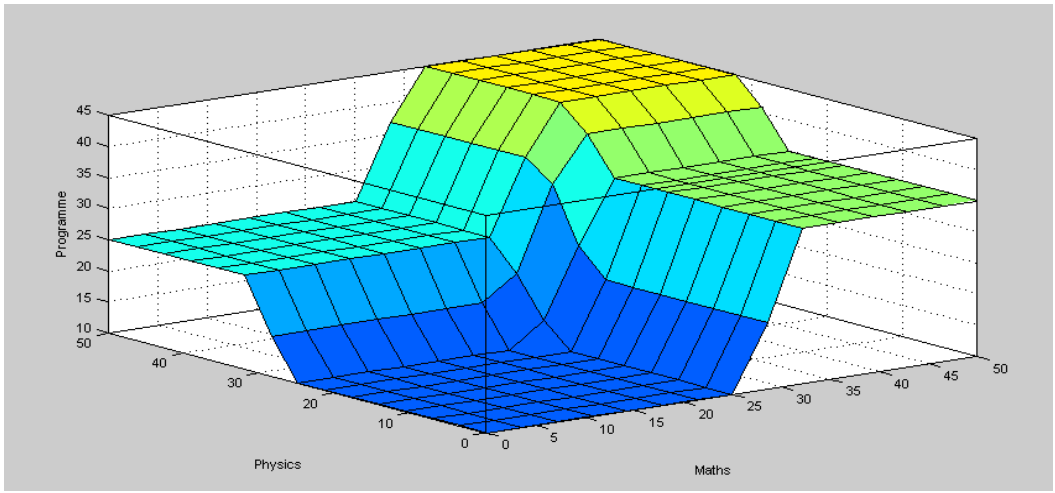

Fig. 5. Control surface of the rules base for case II

In case III, the results showed that 36 candidates were qualified for B.Sc. in Mathematics, this makes 25.2%. 18 candidates were qualified for B.Sc. in Physics, which constitutes 12.6%. 12 candidates were qualified for B.Sc. in Computer Science, which makes 8.4%. The remaining 77 candidates were qualified for Other programmes, which make up 53.8%. The control surface for case III is shown in Fig. 6.

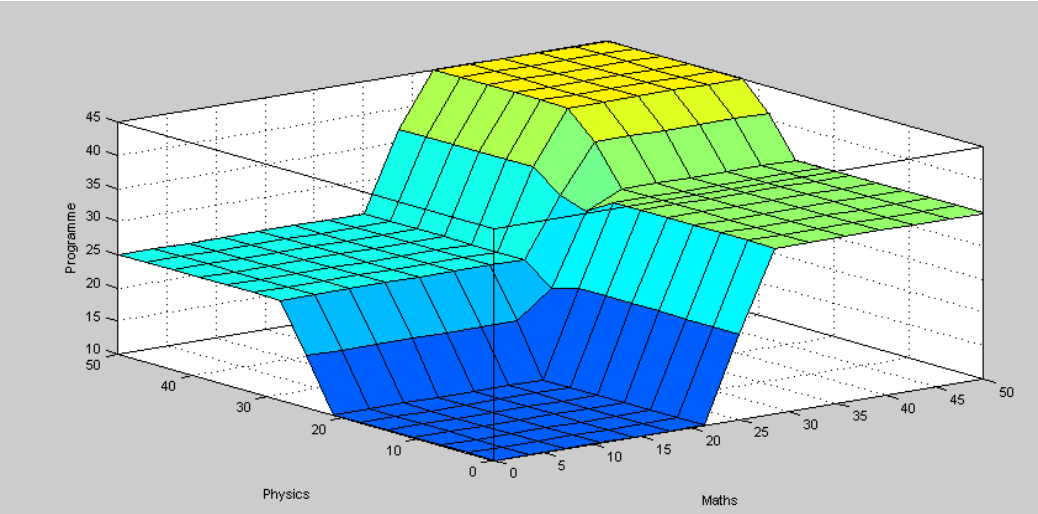

Fig. 6. Control surface of the rule base for case III

In case I, the average CGPA for students with matched programmes was found to be 3.57 and a standard deviation of 0.9. However, the average CGPA for students that their programmes do not match the suggested programmes was found to be 2.39 and a standard deviation of 1.03.

In Case II, the average CGPA for students with matched programmes was 3.53 with standard deviation of 0.92. Nevertheless, the average CGPA for students that their programmes do not match the suggested programmes was 2.37 and a standard deviation of 1.02.

In case III, the average CGPA for students with matched programmes was found to be 2.94 and a standard deviation of 1.17. Nonetheless, the average CGPA for students that their programmes do not match the suggested programmes was found to be 2.38 and a standard deviation of 1.02.

Finally, it was computed and the result shows that the average CGPA for the aggregate approach is 2.38 as compared to 3.35 if FL approaches where used.

7 Future Direction

The future direction of the paper is to admit students based on their strength in PUME rather than their aggregate performance.

8 Primary Source

Departments of Mathematical Sciences and Academic Planning of Kaduna State University, Kaduna, Nigeria.

9 Conclusion

Out of the three cases considered, case I is the most suitable in terms of the rule base to be considered for admitting candidates. Case I gives the highest performance by the students whose programmes of study matched the suggested programmes in comparison to Case II and Case III. Even in situations where there is no match in programmes of study and suggested programmes, Case I is still better compared to the other two cases in terms of the students CGPA. These results strongly suggests that a candidate with fail in either Mathematics or Physics or both Mathematics and Physics in PUME should not be given admission into any of the Mathematical Sciences programmes (Mathematics, Physics and Computer Science).

The effects on the society for the students whose programmes of study do not match the suggested programmes can only be imagined. FL is a very good tool for making decisions; nonetheless, combining FL and neural network will give better enlightening information.

Competing Interests

Author has declared that no competing interests exist.

References

[1] Judith EA, Yusuf L. Admission into Tertiary Institutions in Nigeria. A paper presentation at 33rd Annual Conference of the International Association of Educational Assessments (IAEA) Baku, Azerbaijan; 2007.

[2] Patrick AO. Three years of post UME screening: Influence on science education students' achievement in Delta State University, Abraka. International Journal of Educational Science. 2010;2: 29-40.

[3] Nkechi P. Assessment of access to University Education in Nigeria. Research Journal in Organizational Psychology & Educational Studies. 2012;1(5):303-306.

[4] Tosanwumi O. Relationship between Post-UME scores and performance in the first year of study in Nigeria. Alpha Education Foundation Educational Monograph Series. 2011;5:1-10.

[5] Zadeh LA. Fuzzy sets. Information and Control. 1965;8(3):338-353.

[6] Molodtsov D. Soft set theory: First results. Computers and Mathematics with Applications. 1999;37: 19-31.

[7] Hüllermeier E, Kruse R, Hoffmann F. Computational intelligence for knowledge-based systems design. Springer-Verlag, Berlin/Heidelberg, Germany; 2010 (Eds.).

[8] Obioma G. The predictive validity of public examination; a case study of Nigeria. A Paper Presented at the 33rd Annual Conference of International Association for Educational Assessment (IAEA) Baku, Azerbaran; 2007.

[9] Tella Y, Peter A, Hosea SB. Fuzzy parameterized fuzzy soft set for multiple criteria decision process under multiple expert assessments. International Journal of Engineering Sciences & Management. 2015;5(1):180-185.

[10] Kosko B. Fuzzy thinking, the new science of fuzzy logic. Hyperion; 1993.

[11] Kalaichelvi A, Malini PH. Application of fuzzy soft sets to investment decision making problem. Internal Journal of Mathematical Sciences and Applications. 2011;1(3):1583-1586.

[12] Peter A. Fuzzy goal programming model for optimal electricity allocation. British Journal of Mathematics & Computer Science. 2015;9(2):174-184.

[13] Oladipupo O. Application of fuzzy association rule mining for analyzing students academic performance. International Journal of Computer Science. 2012;9(6):3.

[14] Purnama D. Comparing scoring and fuzzy logic method for teacher certification DSS in Indonesia. International Journal of Computer Science. 2012;9(6):2.

[15] Peter A, Tella Y, Abdulkadir S, Najib KL. The application of fuzzy logic in admitting students into Tertiary Institutions of Learning. International Journal of Engineering Sciences and Research Technology. 2015;4(6):859-864.

[16] Zadeh LA. Fuzzy algorithms. Information and Control. 1968;12:94-102.

[17] Zadeh LA. The concept of a linguistic variable and its application to approximate reasoning. Part 1 & 2, Information Sciences. 1975;338-353.

[18] Zadeh LA. Soft computing and fuzzy logic. IEEE Software. 1994;11(6):48-56.

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