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Smart Admission Filtering for Actuarial Science Using Fuzzy-Based Decision Support

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Abstract: *This study focuses on developing a Fuzzy Inference System (FIS) to ensure the selection of qualified students for UiTM Actuarial Science Diploma program. The FIS simplifies the process for applicants by providing clear and immediate feedback on whether they meet the requirements for the program. This helps prospective students understand their eligibility, reduces uncertainty and streamlines the application process by offering a more transparent and efficient evaluation system. This project starts with developing a primary screening that utilizes Google Forms, followed by a final extensive evaluation in the MATLAB Fuzzy Logic Designer App (FLDA). The initiation phase started with a tailor-made Google Form intended to streamline the process of preliminary screening candidates based on the necessary admission requirements set by UiTM. This further reduces the practice of manual errors, ensures efficiency, and gives immediate feedback to the applicants. The second phase involved development and implementation of the FIS to comprehensively evaluate candidates on several criteria including academic performance and co-curricular achievements. Thorough tests and manual calculations have validated the accuracy of the system and showed its reliability in determining the eligibility of candidates. The results confirm that the FIS is effective in accurately evaluating and identifying qualified candidates for UiTM Actuarial Science Diploma program. This study highlighted the potential of fuzzy logic in addressing ambiguities in educational assessments and suggested extending this to other academic programs at UiTM to promote inclusiveness and improve decision making.*

Keywords: Fuzzy Inference System, MATLAB Fuzzy Logic Designer App, selection

1. Introduction

Universiti Teknologi MARA (UiTM) offers a comprehensive array of academic programs, spanning from pre-diploma to postgraduate studies, with the Diploma in Actuarial Science being one of its most competitive and sought-after offerings. As demand for this program increases, so does the need for a more robust, transparent, and equitable selection process. Currently, the admission mechanism relies heavily on rigid eligibility criteria and manual evaluation procedures, which often fail to accommodate the complexity and diversity of applicant profiles. Consequently, this approach may lead to inconsistencies in candidate

selection and overlook students with significant academic and non-academic potential (Stojanovic et al., 2021). Furthermore, the direct application method through the Unit Pusat Universiti (UPU) system does not provide applicants with a pre-evaluation stage, increasing the risk of misaligned applications and reducing the chances of students securing a place in their preferred programs.

To mitigate these issues, this study proposes the implementation of a Fuzzy Inference System (FIS) to enhance the student selection process for the Actuarial Science program. Unlike traditional binary logic systems, FIS is designed to manage vagueness and uncertainty by modeling decision-making in a manner similar to human reasoning. It allows for the consideration of both precise and imprecise input data, making it especially suitable for evaluating diverse academic backgrounds and qualitative attributes (Jang, 1993; Zadeh, 2019). This includes elements such as critical thinking, creativity, and leadership potential, which are often essential for success in actuarial science but are not captured by conventional metrics alone (Cao et al., 2024; Goyal et al., 2022).

The proposed framework integrates two key components: an automated eligibility screening using Google Forms and a detailed fuzzy logic-based evaluation using MATLAB's Fuzzy Logic Designer App (FLDA). In the first phase, prospective students submit their Sijil Pelajaran Malaysia (SPM) or Pre-Diploma results into an online Google Form, which applies UiTM's entry requirements to instantly assess basic eligibility. This immediate feedback mechanism not only empowers students to make informed choices about their program applications but also reduces the administrative burden on admissions staff by filtering out ineligible candidates early in the process.

The second phase utilizes the FLDA to implement a FIS model tailored to UiTM's criteria. Academic performance data are translated into fuzzy linguistic variables and evaluated against a comprehensive rule base developed in alignment with institutional standards. This system enables more nuanced and flexible decision-making, especially in cases where applicants' profiles fall between clear-cut admission thresholds. Through the combination of fuzzification, rule inference, and defuzzification, the FIS provides a final eligibility score that indicates whether a student qualifies for the program.

The implementation of this two-tiered system offers several advantages. It promotes fairness by standardizing assessments across applicants, enhances accuracy by minimizing manual error, and supports inclusivity by recognizing a broader range of student capabilities. Ultimately, this initiative aligns with UiTM's strategic goals of academic excellence, innovation, and accessibility by modernizing the admissions process and ensuring that the most suitable and well-rounded candidates are selected for the Actuarial Science program (Razak et al., 2021).

2. Literature Review

Fuzzy Inference System (FIS) are the computational models developed particularly to imitate human decision-making processes through handling uncertainty and imprecision in the data by means of fuzzy logic. It is a methodology to cope with uncertainty through degrees of truth between 0 and 1, unlike the conventional binary logic systems dealing with severe values of either true or false. It accommodates more sophisticated reasoning in challenging real-world situations according to (Jang, 1993). A fuzzy FIS represents one of the most important computational frameworks under which the incorporation of fuzzy logic and fuzzy set theory

for modeling complex nonlinear systems with uncertainty and imprecision is achieved. This becomes very useful in many real applications due to its handling of imprecise and ambiguous information, mostly in those cases where binary logic cannot properly represent. A FIS basically comprises fuzzification, a rule base, an inference engine, and defuzzification (Kaur & Kaur, 2019).

In this recent years, application of fuzzy logic has been gradually accepted as a decision-making tool in model student selection evaluation (Khalid et al., 2016; Pujiharsono et al., 2023). Khalid et al (2016) introduces a fuzzy logic approach to model student selection, which helps in mimicking human analytical thinking. This is particularly useful in evaluating multiple criteria for selecting a model student, such as CGPA, co-curricular involvement, and soft skills. The use of fuzzy logic allows for handling ambiguous and incomplete information, which is common in educational assessments. The two most popular methodologies for building intelligent decision support systems through fuzzy logic based processes into FIS are those based on the Mamdani proposed by Ebrahim Mamdani and Assilian in 1975 and Sugeno (Takagi & Sugeno, 1985). The application of FIS in the student selection model have been implemented in Oladokun & Oyewole (2015), Nursikuwagus (2017), and Pujiharsono et al. (2023).

In general, selection at Universiti Teknologi MARA (UiTM) is rigorous to ensure that only the cream of students gets admitted and only those students most likely to succeed academically and contribute positively towards the campus community. For a start, new applicants apply online through the Unit Pusat Universiti, UPU system, which manages the intake of Malaysia's public universities (Kementerian Pendidikan Tinggi, 2025). For a student to be considered for admission, he or she has to meet specific academic requirements. Normally, diploma programs require a minimum of three credits in the Sijil Pelajaran Malaysia or its equivalent. In addition, the study conducted by Schumacher et al in 2010 identifies important factors that influence the success of actuarial students, such as mathematics SAT scores, placement test scores, and class rank. This information can guide academic departments in recruiting and advising students.

3. Methodology

This study employed a hybrid methodological framework combining automated filtration with fuzzy logic modeling to assess the eligibility of candidates for the UiTM Diploma in Actuarial Science. The process comprised two main stages: an initial eligibility screening and a final evaluation via a Fuzzy Inference System (FIS).

3.1 Phase 1: Preliminary Filtering via Google Form

A Google Form was developed as a structured data intake tool to screen candidates based on UiTM's official admission requirements. The form captured key attributes including academic qualification level (SPM or Pre-Diploma), subject grades (Mathematics, Additional Mathematics, English, Sejarah, and others), and demographic criteria (Bumiputera status). Embedded logical conditions automated the filtering process: applicants who failed to meet the minimum program prerequisites were immediately informed of ineligibility, ensuring only qualified data proceeded to the next phase.

3.2 Phase 2: FIS Construction Using MATLAB FLDA

The Fuzzy Inference System was modeled using the MATLAB Fuzzy Logic Designer App (FLDA). Input variables were categorized using triangular membership functions into linguistic terms—*Lulus* (Pass), *Kepujian* (Credit), and *Cemerlang* (Excellent)—with

overlapping ranges based on UiTM grading standards. Each candidate's subject scores were fuzzified into these terms.

A rule base was constructed using Mamdani-type inference, comprising 243 rules for SPM and 81 rules for Pre-Diploma pathways. Rules were structured using logical operators (e.g., IF–AND–THEN) to simulate expert judgment in admissions decisions. The inference engine aggregated outputs using the max–min method, and final defuzzification was performed using the Centroid of Area (COA) technique, producing a crisp eligibility score.

3.3 Validation and Reliability Assessment

To validate the FIS, manual calculations were performed using the same membership functions and rules. The results were compared with FLDA-generated outcomes. Both methods yielded consistent classifications, with minor numerical deviations but identical eligibility determinations, confirming the reliability and precision of the system.

This methodological approach demonstrated the viability of integrating fuzzy logic into academic selection processes, providing a nuanced, scalable, and data-driven alternative to rigid rule-based systems.

4. Data Analysis and Implementation

4.1 Introduction

The analysis began with manual computations, where the eligibility of students was being appraised. Then, a FIS was designed to evaluate students' eligibility for UiTM's Diploma in Actuarial Science in the MATLAB FLDA environment. Finally, the results of both the manual calculations and those from MATLAB FLDA were compared in order to validate the accuracy and reliability of the developed tool. Two groups of students were created to be compared that is SPM and Pre-Diploma students.

4.2 Manual Calculation

The academic performance metrics, such as scores in Mathematics, English, and Science, alongside other relevant subjects, were used as inputs in the manual calculation. These inputs were classified into linguistic variables, each representing a range of performance levels. The inputs used are "Lulus" (Pass), "Kepujian" (Credit) and "Cemerlang" (Excellent). Besides, each linguistic variable was divided based on specific score ranges. The categories are "Cemerlang" with range 70–100, "Kepujian" with range 50–69 and "Lulus" with range 40–49.

Therefore, membership ranges for input of each linguistic term are Lulus [40,52], Kepujian [47,72] and Cemerlang [68,100]. Meanwhile, the eligibility score was categorized into two ranges that do not overlap which Eligible [0.4, 1.0] and Not Eligible [0, 0.6].

Based on the defuzification process, we are looking on the value obtained whether it lies within the Eligible range [0.4,1] or Not Eligible range [0, 0.6]. The conclusion for the student is made based on the output values obtained.

The table below shows the data and analysis for students at SPM level.

Step 1 Calculates the membership values for each subject using a formula.

Table 1: Calculations membership value for student 1 SPM

Subjects	Data given	Membership value for each linguistic			Maximum
		Lulus	Kepujian	Cemerlang	
Sejarah	69	$\mu_L = 0$	$\mu_K = \left(1, \frac{72-69}{3}\right) = (1,1)$ Max = 1	$\mu_C = \frac{69-68}{2} = 0.5$	1
BM	79	$\mu_L = 0$	$\mu_K = 0$	$\mu_C = 1$	1
BI	59	$\mu_L = 0$	$\mu_K = 1$	$\mu_C = 0$	1
Mathematics	69	$\mu_L = 0$	$\mu_K = (1, \frac{72-69}{3}) = (1,1)$ Max = 1	$\mu_C = \frac{69-68}{2} = 0.5$	1
Others	89	$\mu_L = 0$	$\mu_K = 0$	$\mu_C = 1$	1

Step 2 is applying the rules.
Rules in the FIS system are applied using the AND operator, which takes the minimum membership value of the involved terms. Rule used is IF Sejarah is Kepujian AND BM is Cemerlang AND BI is Kepujian AND Mathematics is Kepujian AND Others is Cemerlang, THEN Result is Eligible. The minimum membership value is:

$$\mu\text{Eligible} = \min(1,1,1,1,1) = 1 \quad (4.1)$$

Step 3 is defuzzification using centroid method which the formula: $z = \frac{\int z \cdot \mu(z) dz}{\int \mu(z) dz}$
Since the minimum membership value for "Eligible" is 1, the aggregated membership function for "Eligible" is simplified as μE(x)=1 over its range [0.4,1].

$$z = \frac{\int_{0.4}^{1} z \cdot 1 \, dz}{\int_{0.4}^{1} 1 \, dz} = \frac{\left[\frac{x^2}{2}\right]_{0.4}^{1}}{[x]_{0.4}^{1}} = \frac{\frac{1^2}{2} - \frac{0.4^2}{2}}{1 - 0.4} = 0.7 \quad (4.2)$$

Equation (4.2) shows the defuzzified crisp output is 0.7. This indicates the classification output based on the given data and membership values. Based on the defuzzification process, the value lies within the Eligible range [0.4,1]. Since the output value is within the Eligible range, the conclusion is the candidate is classified as Eligible.

4.3 Implementation of the FIS Using Matlab FLDA

For evaluating the eligibility of candidates applying for UiTM's Diploma in Actuarial Science program, the FLDA was utilized to design and implement a FIS. This application provided a graphical interface that facilitated the creation of membership functions, fuzzy rules, and output variables. The system was customized to accommodate the unique eligibility criteria for both SPM and Pre-Diploma candidates.

The same fuzzy rules and membership functions used in manual calculations were applied. The FIS output was the Eligibility Score, which indicated whether a candidate was Eligible or Not Eligible for the program. The eligibility score was Eligible [0.4, 1.0] and Not Eligible [0, 0.6]. The system was designed to accommodate the differing eligibility requirements for SPM and Pre-Diploma candidates. As a result, 243 rules were implemented for the SPM group and 81 rules for the Pre-Diploma group. These rules ensured that each candidate's eligibility was evaluated comprehensively and fairly.

Separate FIS models were developed for SPM and Pre-Diploma candidates to address their distinct eligibility criteria. These tailored systems allowed for a focused evaluation of each group, ensuring the FIS was optimized for the specific requirements of UiTM's selection process.

The table below shows the data and analysis from MATLAB for pre-diploma students.

Table 2: Sample of students that apply the program for Pre Diploma Level

Students	Input variables				Output variable
	Bahasa Melayu	Sejarah	Bahasa Inggeris	Others	Result
1	79	100	100	89	0.749
2	69	69	59	89	0.749
3	49	59	49	49	0.449
4	49	69	69	49	0.449
5	59	59	49	49	0.449

4.4 Comparison Manual Calculation and MATLAB FLDA

The result from the manual calculation and MATLAB is shown in the table below.

Table 3: The comparison result of manual calculation and MATLAB FLDA

Students		Manual calculation result	Matlab FLDA tools result
SPM			
	1	0.7 = eligible	0.749 = eligible
	2	0.7 = eligible	0.749 = eligible
	3	0.7 = eligible	0.749 = eligible
	4	0.3 = not eligible	0.449 = not eligible
	5	0.3 = not eligible	0.449 = not eligible
Pre-Diploma			
	1	0.7 = eligible	0.749 = eligible
	2	0.7 = eligible	0.749 = eligible
	3	0.3 = not eligible	0.449 = not eligible
	4	0.3 = not eligible	0.449 = not eligible
	5	0.3 = not eligible	0.449 = not eligible

The table 3 presents a comparison between the manual calculation results and the MATLAB FLDA tool results for evaluating the eligibility of students for UiTM's Diploma in Actuarial Science program. The comparison is made for two groups of students: those with SPM qualifications and those with Pre-Diploma qualifications.

Comparing the results, it shows that although there are slight differences in the exact values, manual calculations and the MATLAB FLDA tool give largely similar results. The

two methods identify students in the same sets of eligibility. Hence the results hereby prove the accuracy and reliability of MATLAB FLDA tool for candidate eligibility evaluation.

5. Conclusion and Recommendations

5.1 Conclusion

This study successfully demonstrated the development and application of a Fuzzy Inference System (FIS) to enhance the selection process for the Diploma in Actuarial Science program at Universiti Teknologi MARA (UiTM). By integrating fuzzy logic principles with institutional admission criteria, the proposed system addressed key limitations of traditional binary decision-making methods—namely, inflexibility, inefficiency, and the inability to accommodate borderline or nuanced applicant profiles.

The dual-phase methodology—initial eligibility filtering via Google Forms followed by final evaluation through MATLAB's Fuzzy Logic Designer App (FLDA)—proved effective in streamlining admissions. The automated filtration reduced manual workload while providing immediate feedback to applicants, and the FIS model facilitated a holistic assessment using linguistic variables and fuzzy rule sets tailored to UiTM's program requirements.

Validation through manual calculations confirmed the consistency and accuracy of the FIS model, indicating its potential as a reliable tool for academic decision-making. The system's adaptability allows for customization to other academic programs, supporting a more inclusive and transparent admissions framework. Future work could involve expanding the input variables to include qualitative measures, implementing adaptive rule learning, and integrating the system directly into UiTM's online application infrastructure to support real-time decision support.

5.2 Recommendation

The successful implementation of the FIS for the Actuarial Science program at UiTM shows a higher potential increase in the student selection process by many folds. It is highly advisable that FIS are expanded to other academic programs in the university. This will enable UiTM to have a uniform efficient selection process at all faculties. With the FIS able to react to a lot of different applicant-profiles and the integration of various selection criteria, its validity branched out into different fields. This will enable UiTM to have a preliminary screening process before students apply through the University Central Unit (UPU) system. By applying this process, it will ensure that only students who are eligible will apply for the program, increasing their chances of security a spot in the program.

To keep the FIS relevant and accurate, there is a dire need to pursue a continuous improvement approach. This includes updating the system regularly based on the feedback of the admission committee and performance of the selected students. From analyzing the outcome and effectiveness of FIS, UiTM will be able to establish areas for enhancement and make necessary adjustments to the membership functions and fuzzy rules. This would keep the FIS abreast of ever-evolving academic standards and requirements at the university for admissions. Besides, this would help the system learn and become robust over time with new data coming into the system, thereby enhancing the predictive capabilities. This would hopefully lead to attaining the goal of academic excellence with inclusivity by the institution through an iterative process

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