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E-BOOK OF EXTENDED ABSTRACTS

SCHOLARSHIP SELECTION REINVENTED: A FUZZY INFERENCE APPROACH TO ASSESSING OVERSEAS STUDY CANDIDATES

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ABSTRACT

Scholarship selection is a critical process that determines access to higher education opportunities, yet conventional methods often suffer from subjectivity, rigidity, and bias. This project introduces a fuzzy inference system (FIS) as an innovative approach to assessing overseas scholarship candidates. The system integrates four key criteria—CGPA, parents' income, co-curricular activeness, and number of siblings—using trapezoidal membership functions and a rule base of 81 fuzzy rules. By applying MATLAB's Fuzzy Logic Toolbox, the model transforms crisp input values into fuzzy sets, evaluates them through inference rules, and defuzzifies the results into clear eligibility outcomes. This method captures uncertainties in candidate profiles and provides nuanced decisions beyond binary acceptance or rejection. The novelty lies in its fairness, transparency, and flexibility in handling borderline cases, offering a scalable framework adaptable to diverse scholarship schemes. Ultimately, the system ensures more equitable opportunities for students pursuing overseas education.

Keywords: Fuzzy Inference System, Scholarship Selection, MATLAB, Decision-Making

INTRODUCTION

Scholarship programs play a vital role in ensuring equitable access to higher education, especially for students aspiring to pursue studies abroad. Traditionally, scholarship selection processes rely heavily on fixed eligibility criteria or subjective evaluations by committees. While such approaches are widely used, they often face challenges including ambiguity in requirements, inconsistency in candidate evaluation, and susceptibility to bias (Pamučar et al., 2018). These limitations may result in deserving candidates being overlooked or resources distributed inequitably.

The complexity of scholarship selection arises from the multi-criteria nature of the problem, where factors such as academic performance, socio-economic background, and extracurricular participation must be simultaneously considered. Rigid cut-off points—for instance, a specific CGPA threshold or strict income brackets—fail to capture the nuanced realities of students' circumstances. In some cases, students with slightly lower academic scores but significant financial need or strong leadership potential may be unfairly excluded (Chen & Hwang, 1992; Pérez et al., 2013).

To address these issues, this project proposes the development of a Fuzzy Inference System (FIS) for scholarship eligibility assessment. Fuzzy logic provides a powerful tool to model uncertainty and vagueness inherent in human decision-making (Mendel, 2017). By incorporating linguistic variables such as "active," "middle active," or "less active," and translating them into quantitative fuzzy sets, the system evaluates candidates more holistically.

The primary motivation behind this product is to enhance fairness, transparency, and inclusivity in scholarship selection. Objectives include: (1) analysing scholarship eligibility based on multiple academic and socio-economic criteria, (2) minimising subjective bias in evaluations, and (3) providing a scalable, adaptable framework for diverse scholarship schemes. In doing so, this innovation aims not only to improve decision-making accuracy but also to promote educational equity.

METHODOLOGY

The development of the fuzzy inference system (FIS) for scholarship selection followed a structured process (see Figure 1), beginning with the identification of key eligibility criteria and ending with the implementation and testing of the system in MATLAB's Fuzzy Logic Toolbox. Four input variables were selected based on their relevance and frequent use in real scholarship assessments: CGPA, parents' income, co-curricular activeness, and number of siblings. These inputs were linguistically categorised into membership functions (e.g., CGPA: first-class, upper second-class, lower second-class; Parents' income: B40, M40, T20).

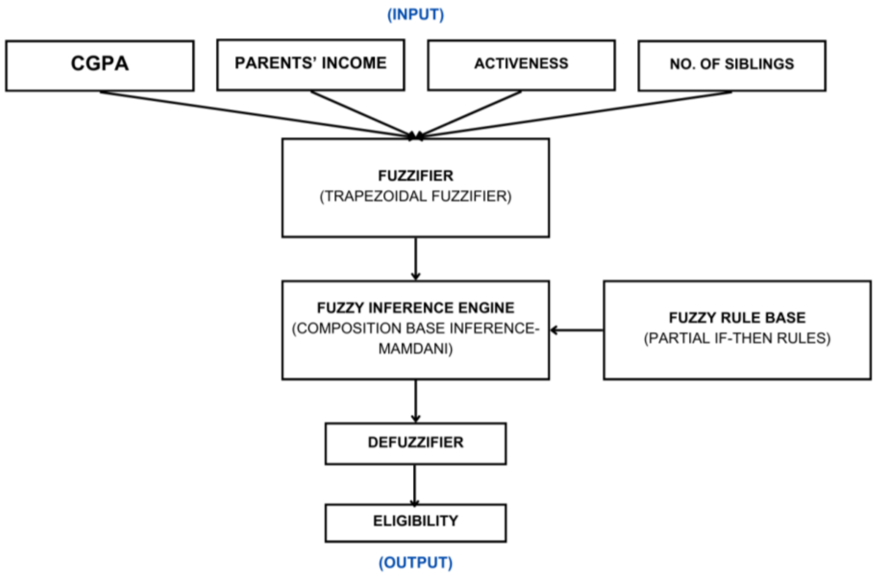

Figure 1: Framework of scholarship selection system

A trapezoidal fuzzifier was applied for each input variable due to its flexibility in modeling ranges with uncertain boundaries. The system output was defined as scholarship eligibility with two categories: accept or reject.

The rule base was constructed using expert knowledge and logical reasoning, resulting in 81 fuzzy IF–THEN rules. For instance: IF CGPA is first-class AND income is B40 AND activeness is active THEN eligibility is accepted. These rules were encoded in MATLAB to form the decision-making backbone of the system.

The fuzzy inference engine applied the Mamdani method, using the minimum operator for the "AND" condition to evaluate the truth values of input combinations. The aggregated results were then converted into crisp outputs through the centroid defuzzification method, yielding a membership value between 0 and 1.

Finally, the model was tested using real-world inspired input cases to validate its ability to handle diverse scenarios. Results demonstrated the system's robustness in capturing uncertainty, ensuring fairness, and producing transparent scholarship eligibility outcomes.

RESULTS AND DISCUSSION

The fuzzy inference system (FIS) developed for scholarship eligibility assessment was tested using various input scenarios to evaluate its effectiveness in handling diverse candidate profiles. The system produced outputs in the form of crisp eligibility values ranging between 0 (reject) and 1 (accept), with higher values indicating stronger eligibility.

Five representative cases were analysed as shown in Table 1. For instance, a student with CGPA 3.80, parents' income RM2,000, high co-curricular activity, and six siblings achieved a membership value of 0.605, resulting in acceptance. In contrast, a student with CGPA 3.00, parents' income RM1,000, moderate activeness, and three siblings obtained a membership degree of 0.227, leading to rejection. These results highlight how the system effectively balances academic, financial, and social dimensions in its decision-making.

Table 1: Scholarship Selection FIS Results

Case	CGPA	Parents' Income (RM)	Activeness (Certificates)	No. of Siblings	Eligibility Score	Decision
1	3	1000	8	3	0.227	Reject
2	3.8	2000	7	6	0.605	Accept
3	2.3	900	13	10	0.75	Accept
4	4	1000	14	8	0.786	Accept
5	3.5	1500	5	2	0.5	Borderline

Interestingly, borderline cases emerged, such as a student with CGPA 3.50, parents' income RM1,500, low activeness, and two siblings, who scored exactly 0.5. In such scenarios, the system demonstrates flexibility, allowing final decisions to be guided by scholarship quotas or policy considerations. This reflects the practical adaptability of fuzzy logic in addressing real-world ambiguities.

The discussion of results indicates three key findings. First, the system enhances fairness by prioritising candidates from disadvantaged socio-economic backgrounds without ignoring academic merit. Second, it improves transparency through explainable rules, reducing reliance on subjective judgment. Third, the model accommodates uncertainty, particularly in cases where candidates exhibit mixed profiles.

Overall, the fuzzy inference approach proves to be a promising solution to the limitations of traditional scholarship selection processes. By integrating multiple criteria into a holistic framework, the system ensures that opportunities are distributed more equitably, providing a robust foundation for policy implementation and potential expansion to larger-scale educational funding programs.

CONCLUSION

This project demonstrates the potential of fuzzy inference systems (FIS) to transform scholarship selection into a fairer, more transparent, and inclusive process. By integrating multiple factors such as academic performance, socio-economic background, co-curricular activeness, and family responsibilities—the system captures the complex realities of candidate profiles that traditional rigid criteria often overlook.

The results validate the system's ability to handle diverse scenarios, including strong candidates from disadvantaged backgrounds and borderline cases requiring flexible decision-making. Unlike conventional methods prone to bias or oversimplification, the fuzzy logic approach accommodates uncertainty and ensures that selection outcomes reflect both merit and equity.

The novelty of this work lies in its holistic evaluation framework, supported by rule-based transparency and adaptability. Beyond its immediate application in scholarship selection, the methodology can be scaled and extended to other decision-making contexts, such as grant allocations, admission processes, and social welfare distribution.

In essence, the fuzzy inference approach not only enhances the credibility of scholarship distribution but also contributes to broader educational equity by ensuring opportunities are allocated more justly and effectively. This innovation highlights the value of computational intelligence in addressing complex human-centered decision-making challenges.

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