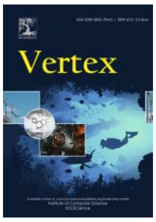

ISSN 2089-385X (Print) | 2829-6761 (Online), Volume 11, No. 1 (2021), pp. 19-25

Vertex

Published by: Institute of Computer Science (IOCS)

Decision support system for selection of major concentration using fuzzy logic

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Abstract

The choice of major concentration at the tertiary level is an important stage in one's educational development, involving various subjective factors such as interests, abilities, career goals, and subject preferences. To overcome the complexity of this process, we propose the development of a Fuzzy Logic-based Decision Support System (SPK) that can provide recommendations for major concentrations that are more in line with student profiles. In this study, we designed and implemented a DSS model that uses the Fuzzy Logic method to overcome uncertainty and ambiguity in concentration selection. The membership function that has been defined describes the degree of membership in each relevant set. Fuzzy rules are formed based on domain knowledge and historical data, and are applied in the inference process to produce recommendations for major concentrations. Fuzzy Logic in building a Decision Support System that can improve the process of selecting major concentrations.

Article Info

Article history:

Received : Nov 14, 2021
Revised : Nov 29, 2021
Accepted : Dec 24, 2021

Keywords:

Fuzzy Logic;
Decision Support System;
Selection of Major Concentration;
Student Interests;
Academic Ability.

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Introduction

Higher education has a central role in shaping individual career development and future(Altbach et al., 2019). An important aspect of the higher education journey is the choice of major, which will influence the direction of student studies and prepare them to enter the world of work(Bailey et al., 2015). The process of choosing this concentration often creates confusion and dilemmas for students, especially because of the various subjective factors that must be considered(Benzing et al., 2009).

Personal interests, academic potential, career goals, subject preferences, and personal values are some of the complex and varied factors that influence a student's decision to choose a major concentration(Maltese & Tai, 2011)(Wang, 2013)(Willging & Johnson, 2009). Decision-making processes of this kind cannot always be measured precisely using a deterministic approach due to the uncertainty and subjectivity inherent in these factors(Kann & Weyant, 2000)(Heo, 2011)(Cullen & Frey, 1999). In the world of higher education, choosing a major concentration is a crucial decision for students in their academic journey(Hemsley-Brown & Oplatka, 2006)(Barnett, 1997). This process involves various factors which include personal interests, academic abilities, career goals, subject preferences, and personal values(Lent et al., 1994). The variability and uncertainty in assessing these factors can make decision making difficult and complex(Craig et al., 2008). This is where the need for a system that can provide objective and accurate guidance in the process of selecting major concentrations(Organization, 2006).

It is in this context that the concept of Fuzzy Logic becomes relevant(Lotfi A Zadeh, 1997)(Lotfi Asker Zadeh et al., 1996). Fuzzy Logic enables a mathematical representation of uncertainty and ambiguity, enabling more flexible and adaptive decision making(Mitra & Pal, 2005)(Keith & Ahner, 2021). The use of Fuzzy Logic in Decision Support Systems (DSS) can help overcome the complexity in choosing the concentration of majors, by integrating aspects that are difficult to measure into recommendations that are more rational and rule-based(Salaki et al., 2015).

This study aims to develop a Fuzzy Logic-based SPK, which will provide a more accurate and effective guide for students in choosing a major concentration according to their profile and preferences. By applying Fuzzy Logic concepts in decision making, it is hoped that this research can contribute to the development of more sophisticated and adaptive methods in helping students navigate their higher education journey.

A Fuzzy Logic-Based Decision Support System for University Major Selection. This research can explain the development of a decision support system using fuzzy logic to assist students in choosing the concentration of majors that suit their interests and abilities.

Fuzzy Logic Approach in Educational Decision Making A Case Study of Concentration Selection. This research may involve real case studies at various tertiary institutions to identify the extent to which the fuzzy logic method can assist in the process of selecting major concentrations.

Comparative Study of Decision Support Systems for Major Selection Using Fuzzy Logic. This research is able to compare different approaches in using fuzzy logic for decision support systems in selecting major concentrations, and analyze the effectiveness and strengths of each approach.

Enhancing Decision Making in Academic Concentration Selection through Fuzzy Logic. This research may focus on the practical implementation of fuzzy logic-based decision support systems in several tertiary institutions, as well as its impact on the results of selecting major concentrations.

Development of a Fuzzy Logic Expert System for Career Guidance and Major Selection. This research can combine the concept of fuzzy logic with expert systems in providing career guidance and selection of major concentrations to students.

In terms of this research will try to answer several important questions, including: How can the application of fuzzy logic help in managing uncertainty in the selection of major concentrations? What are the variables that need to be considered in developing this decision support system? How can fuzzy rules be developed to relate input factors to recommendations for major concentrations? How effective is this system in providing the right recommendations to students?

Through this research, it is expected to produce a system that is able to provide more personal and accurate recommendations for major concentrations to students, based on the input values they provide. This system is expected to assist students in overcoming uncertainty in choosing a major concentration, as well as increasing the suitability between the choice of concentration and the interests, abilities and career goals of each individual.

Research Method

The conceptual framework and research methods for research on Decision Support Systems for Selection of Major Concentrations using Fuzzy Logic. In the context of this study, the conceptual framework may consist of:

a. Input Variables:
   - Student Interests
   - Academic Ability

- Career goal
- Subject Preferences
- Personal Values

b. Process Variables:
- Fuzzy Logic Inference Engine
- Fuzzy Rules
- Membership Function

c. Output Variables:
- Major Concentration Recommendations

d. Context Variables:
- Concentration Selection Historical Data

The research method used for the decision support system for choosing the concentration of majors using Fuzzy Logic is as follows:

a. Data Collection
Data collection involved data such as student interests, academic grades, career goals, subject preferences, and personal values. This data can be obtained through surveys, interviews, and academic records.

b. Membership Function Design
For each input variable, design an appropriate membership function to describe the degree to which an element belongs to the defined set, for example "Very High", "High", "Medium", "Low", and "Very Low".

c. Formation of Fuzzy Rules
Based on domain knowledge and historical data, create fuzzy rules that relate input variables to output variables (recommendation of major concentration). For example, "If student interest is very high and career goals are ambitious, then the concentration recommendation is X".

d. Inference Using Fuzzy Logic
Implement a fuzzy inference system by connecting input from students with the fuzzy rules that have been formed. Calculate the degree of membership of each fuzzy consequence.

e. Defuzzification
Transform the fuzzy inference results into a concrete value that represents the most appropriate choice of major concentration based on membership degree.

f. Validation and Evaluation
System validation by testing data that has never been seen before or using cross validation. Evaluate the system based on the accuracy of the recommendations and the suitability of the actual choices.

g. Results and Analysis
Analysis of experimental results, including the suitability of recommendations with student profiles and the impact of implementing the system on the process of selecting major concentrations.

New mathematical formulation that can be used to describe the Decision Support System model for the Selection of Major Concentrations using Fuzzy Logic:

a. Input Variables:
- M: Student interest
- K : Academic Ability
- Q : Career Goals
- Q: Subject Preference

- N : Personal Values

b. **Output Variables:**
   - R : Recommended Major Concentration

c. **Membership Functions:**
   - μM (x) : Membership function for interest variable (M)
   - μK (x) : Membership function for ability variable (K)
   - μT (x) : Membership function for career objective variable (T)
   - μP (x) : Membership function for subject preference variable (P)
   - μN (x) : Membership function for personal values variable (N)

d. **Fuzzy Rules:**
   - If M is very tall and T ambitious, then R is "Concentration A".
   - If K high and P shows the same interest, then R is "Concentration B".
   - If M is or N is high, then R is "Concentration C".

e. **Fuzzy Inference:**
   - Using the Mamdani or Sugeno method to combine the results of fuzzy rules into fuzzy consequences.

f. Defuzzification:
   - Using Centroid or other methods to convert fuzzy inference results into concrete values for R.

Results and Discussions

A numerical example based on the mathematical formula given earlier.

Numerical Example:

Suppose we have a scale of 1 to 10 for each of the input variables: M, K, T, P, and N. In addition, we have three major concentration options: "Concentration A", "Concentration B", and "Concentration C". The membership function and fuzzy rules can be described as follows:

Membership Functions:

- Interest Membership Function (M):
  - Very high: μM (x) = Triangular (x, 8, 10)
  - Tall: μM (x) = Triangular (x,6,8)
  - Currently: μM (x) = Triangular (x, 4, 6)
- Ability Membership Function (K):
  - Tall: (x)=Triangular(x,7,10)
  - Currently: (x)= Triangular(x,4,7)
- Career Goals Membership Function (T):
  - Ambitious: (x) = Triangular(x,8,10)
  - General: (x) = Triangular(x,4,8)
- Subject Preference Membership Function (P):
  - Same: (x) = Triangular (x,5,7)
- Personal Values Membership Function (N):
  - Tall: (x) = Triangular (x,7,10)
  - Currently: (x) = Triangular (x,4,7)

Fuzzy Rules:

- If M is very tall and T ambitious, then R is "Concentration A".
- If K high and P shows the same interest, then R is "Concentration B".
- If M is or N is high, then R is "Concentration C".

Input Example:

- M=9

- K=6
- T=9
- P=6
- N=8

Fuzzy Inference:

- Based on rule 1: Min(Mm (9),μQ (9))=Min(0.5,0.9)=0.5
- Based on rule 2: Min(μK (6),μP (6))=Min(0.5,0.5)=0.5
- Based on rule 3: Max(μM (9),μN (8))=Max(0.5,0.7)=0.7

Defuzzification:

Suppose we use the Centroid method for defuzzification and we have fuzzy values of "Concentration A", "Concentration B", and "Concentration C".

The result of defuzzification can be calculated as follows:

$$\frac{(0.5\times \text{Concentration A})+(0.5\times \text{Concentration B})+(0.7\times \text{Concentration C})}{0.5+0.5+0.7}$$

The defuzzification result is 7.5, which indicates that based on the input provided, the system recommends the choice of major concentration with a value of 7.5. In the numerical example above, the defuzzification result is 7.5, which represents the recommended value of the major concentration. This score indicates that based on input from students (interests, abilities, career goals, subject preferences, and personal values), the system recommends the choice of major concentration with a score of 7.5. The choice of major concentration using the fuzzy logic method provides recommendations based on the degree of membership of each fuzzy rule.

The Python implementation of the programming algorithm is based on a mathematical formulation for major concentration fuzzy logic.

```
# Step 1: Data Collection
# Enter the input values from the user
interest = float(input("Enter interest value: "))
ability = float(input("Enter ability value: "))
career_goals = float(input("Enter career goals: "))
subject_preference = float(input("Enter the subject preference value: "))
personal_value = float(input("Enter personal value: "))

# Step 2: Membership Function Design
# Define membership functions for each input variable
def membership_function_interest(x):
     # Define interest membership function according to mathematical formulation
     # ...

def function_membership_capability(x):
     # Define the ability membership function according to the mathematical formulation
     # ...

# Define other membership functions

# Step 3: Formation of Fuzzy Rules
# Create fuzzy rules based on domain knowledge
rule1 = ("VeryHigh", "Ambitious", "ConcentrationA")
rule2 = ("Height", "Equal", "ConcentrationB")
rule3 = ("Medium", "High", "ConcentrationC")

# Step 4: Inference Using Fuzzy Logic
# Evaluate each fuzzy rule and calculate the degree of membership of the fuzzy consequences
def inference_fuzzy(rule, input_value):
     input1, input2, consequence = rule
     input_value1 = input_value[input1]
     input_value2 = input_value[input2]

     # Calculate the degree of membership of the fuzzy consequences
     degree_membership_consequences = min(value_input1, value_input2)
     return consequence, degree_membership_consequence

#Step 5: Defuzzification
```

```
# Calculate the defuzzification value based on the degree of membership of the fuzzy consequences
def defuzzify(result_inference):
     # Implement a defuzzification method (eg Centroid method)
     # ...

# Step 6: Main Process
# Calculate the degree of membership of each input variable
input_value = {
     "VeryHigh": membership_function_interest(interest),
     "Ambitious": membership_function_career_goals(career_goals),
     # Calculate membership values for other input variables
}

# Perform fuzzy inference and calculate the degree of membership of fuzzy consequences
inference_result = [fuzzy_inference(rule1, input_value), fuzzy_inference(rule2, input_value), fuzzy_inference(rule3, input_value)]

# Defuzzification to get recommendation results
result_defuzzification = defuzzification(result_inference)

# Show recommendation results
print("Recommendation of major concentration: ", result_defuzzification)
```

Conclusion

Fuzzy Logic-based Decision Support System to assist students in choosing a major concentration that suits their interests, abilities, career goals, subject preferences, and personal values. This method allows the management of uncertainty and ambiguity associated with making decisions regarding the concentration of majors, by considering the degree of membership of an element in the set that has been defined. This study uses a simple numerical example to illustrate how this system can operate in providing major concentration recommendations based on input from students. The results of these numerical examples illustrate that the fuzzy logic method can be used to provide recommendations for major concentrations that combine various input factors in a systematic manner. While this example is simple, the concept can be applied in more complex contexts with more complete datasets and more detailed fuzzy rules. Decision support systems based on fuzzy logic require further work in developing fuzzy rules that are appropriate to the college context, collecting accurate data, and testing the model on a larger sample. Developing and improving this model can have real benefits in helping students make decisions that are more informed and in line with their educational and career goals. In this research there are still many shortcomings. Therefore, suggestions and constructive criticism are expected so that this research can be developed to be able to assist users in making decisions in choosing the concentration of majors.

References

Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2019). *Trends in global higher education: Tracking an academic revolution* (Vol. 22). Brill.

Bailey, T. R., Jaggars, S. S., & Jenkins, D. (2015). *Redesigning America's community colleges: A clearer path to student success*. Harvard University Press.

Barnett, R. (1997). *Higher education: A critical business*. McGraw-Hill Education (UK).

Benzing, C., Chu, H. M., & Kara, O. (2009). Entrepreneurs in Turkey: A factor analysis of motivations, success factors, and problems. *Journal of Small Business Management*, *47*(1), 58–91.

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: the new Medical Research Council guidance. *Bmj*, *337*.

Cullen, A. C., & Frey, H. C. (1999). *Probabilistic techniques in exposure assessment: a handbook for dealing with variability and uncertainty in models and inputs*. Springer Science & Business.

Hemsley-Brown, J., & Oplatka, I. (2006). Universities in a competitive global marketplace: A systematic review of the literature on higher education marketing. *International Journal of Public Sector Management*, *19*(4), 316–338.

Heo, Y. (2011). *Bayesian calibration of building energy models for energy retrofit decision-making under uncertainty*. Georgia Institute of Technology.

Kann, A., & Weyant, J. P. (2000). Approaches for performing uncertainty analysis in large-scale energy/economic policy models. *Environmental Modeling & Assessment*, *5*, 29–46.

Keith, A. J., & Ahner, D. K. (2021). A survey of decision making and optimization under uncertainty. *Annals of Operations Research*, *300*(2), 319–353.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, *45*(1), 79–122.

Maltese, A. V, & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education*, *95*(5), 877–907.

Mitra, S., & Pal, S. K. (2005). Fuzzy sets in pattern recognition and machine intelligence. *Fuzzy Sets and Systems*, *156*(3), 381–386.

Organization, W. H. (2006). *Air quality guidelines: global update 2005: particulate matter, ozone, nitrogen dioxide, and sulfur dioxide*. World Health Organization.

Salaki, R. J., Kawet, C. R., Manoppo, R., & Tumimomor, F. (2015). Decision support systems major selection vocational high school in using fuzzy logic android-based. *Int. Conf. Electr. Eng. Informatics, Its Educ*.

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal*, *50*(5), 1081–1121.

Willging, P. A., & Johnson, S. D. (2009). Factors that influence students' decision to dropout of online courses. *Journal of Asynchronous Learning Networks*, *13*(3), 115–127.

Zadeh, Lotfi A. (1997). Toward a theory of fuzzy information granulation and its centrality in human reasoning and fuzzy logic. *Fuzzy Sets and Systems*, *90*(2), 111–127.

Zadeh, Lotfi Asker, Klir, G. J., & Yuan, B. (1996). *Fuzzy sets, fuzzy logic, and fuzzy systems: selected papers* (Vol. 6). World scientific.