

# Fuzzy Logic for Academic Orientation and Its Impact on Success: Content Analysis

Harraki Youssef<sup>a</sup>, Aniss Moumen<sup>b</sup> and Driss Gretete<sup>c</sup>  
*Laboratory of Engineering Sciences, ENSA Kenitra, IbnTofail University. Morocco*

**Keywords:** Education, Orientation, Fuzzy Logic, Data Analysis and Forecasting.

**Abstract:** This paper will present an exploratory literature review and content analysis of fuzzy set theory for risk management in education, including the impact of academic orientation on success. The study is developed using textual analysis techniques, to situate our topic about a similar project on a corpus of references (reference library Analyzing with the Zotero tool) from the most available databases: Springer Link, Scopus, IEEE Xplore, Web of Science, Jstor. The interest of this work is to analyze our library by type of reference by year of publication and by topic, which offers an overview and a critical evaluation of a set of articles related to our research problem with a degree of similarity. Finally, compare the different models used and discuss the results.

## 1 INTRODUCTION

Real-life is too complicated for one to get precise explanations; an approximation (or fuzzy) must therefore be introduced to obtain a realistic but traceable model. As we move into the information age, human knowledge is becoming more and more critical. We need a theory to formulate human expertise and integrate it into engineering systems and other information such as mathematical models and sensory measurements.

In other words, the critical question is how to transform a human knowledge base into a mathematical formula. For this purpose, a fuzzy logic system is used to model cause-and-effect relationships, assess the degree of risk exposure and consistently classify key risks, taking into account available data and expert opinions.

## 2 THE FOUNDATIONS OF FUZZY SET THEORY AND ITS APPLICATION IN EDUCATION

Fuzzy logic is a type of modelling that focuses on predicting a "subjective" categorical variable: it depends on the observer. This framework goes beyond the classical statistics in which the variable's value can be objectivist (J. Klir, 2006).

The application of fuzzy logic (F. Martin and T. Ellen, 1994) amounts to Attempting to apply to reason close to human thought; it, therefore, allows expert systems to be integrated into automated processes.

The theory of fuzzy sets (J. Klir, 2006) Developed in 1965 by Professor Lotfi Zadeh of the University of Berkeley in a founding paper, which defines the principles (ZADEH, 1965); it constitutes a generalization of sets classics. It began to be used in industry, medicine, the establishment of expert systems in the mid-1970s and will see its widespread use in the 1990s: autofocus, pressure cookers, autonomous mobile systems, decision systems, diagnosis, recognition, education, etc.

Its operation can be summarized in three main steps (see Figure 1).

<sup>a</sup> <https://orcid.org/0000-0003-2437-9695>

<sup>b</sup> <https://orcid.org/0000-0001-5330-0136>

<sup>c</sup> <https://orcid.org/0000-0001-6155-3969>

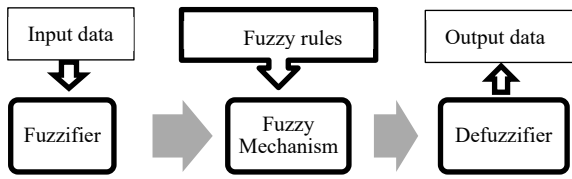


Figure 1: Mamdani fuzzy logic model.

**Fuzzifier:** this first step consists in transforming the variables (input and output) into linguistic variables, is mainly carried out based on statistical observations (or by learning, supervised or not, to group the values of a variable into homogeneous categories) or expert opinion.

**Inference Mechanism:** construction of rules (and results) based on linguistic variables, assigning a truthfulness to each direction, and then aggregating the regulations to obtain a result single (linguistic).

**Defuzzifier:** the last step of the fuzzy logic aims at transforming the final activation curve obtained during the aggregation step into an actual value.

### 2.1 Operation of Fuzzy Sets

As in classical set theory, fuzzy sets (C. Servin, 2018) have their operations, including union, intersection, and complement. Unlike the process on classical sets, the methods specific to fuzzy sets rely on the membership function. (Figure 2) shows the operation relating to conventional assemblies. (Figure 3) indicates a possible type of operation dealing with fuzzy sets.

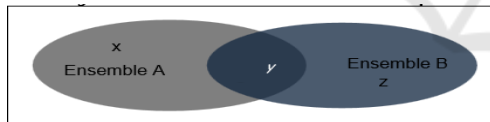


Figure 2: Classical sets,  $A \cup B = \{x, y, z\}$ ;  $A \cap B = \{y\}$ ;  $\bar{A} = \{z\}$



Figure 3: Fuzzy sets.

1. If A and B, then C. The maximum degree of certainty of C is the lesser of the degree of certainty of A « $\mu_A$ » and the degree of certainty of B « $\mu_B$ »:

$$C = A \cap B = \min(\mu_A, \mu_B) \quad (1)$$

2. If A or B, then C. The maximum degree of certainty of C is the highest of the degree of certainty of A and the degree of certainty of B:

$$A \cup B = \max(\mu_A, \mu_B) \quad (2)$$

3. If it is not A, then C. The maximum degree of certainty of C is that which is deduced from the degree of certainty of A:

$$\bar{A} = 1 - \mu_A \quad (3)$$

### 2.2 Logic and Education

History teaches us that education systems have changed a great deal over time, and we must now manage these systems to ensure the success of as many people as possible.

The evaluation of students' academic performance is the most important for the higher education institution to have a high reputation and ranking (Ishak, 2015).

A priority task is to make a model, by the expert system more than an academic diagnosis, to provide career guidance.

Therefore, it is necessary to evaluate different psychological factors such as intelligence, patience and perseverance, learning ability and speed of problem-solving (J. Sasi Bhanu, 2019).

The model where the traditional diagnosis we obtained with the only parameter of the cut-off score remains incomplete to determine the student's career guidance. The fuzzy set theory illustrates its advantages in this situation by adding human parameters to the model.

## 3 METHODOLOGY

The working method is developed using textual analysis techniques, to locate our topic about a similar project on a corpus of references (run on Zotero library), from the most known: Springer Link, Scopus, IEEE Xplore, Web of Science, Jstor (see Figure 3).

The interest of this work is analyzed in our library by type of reference by year of publication and by theme (occurrence of words). Finally, compare the different models used and discuss the results.

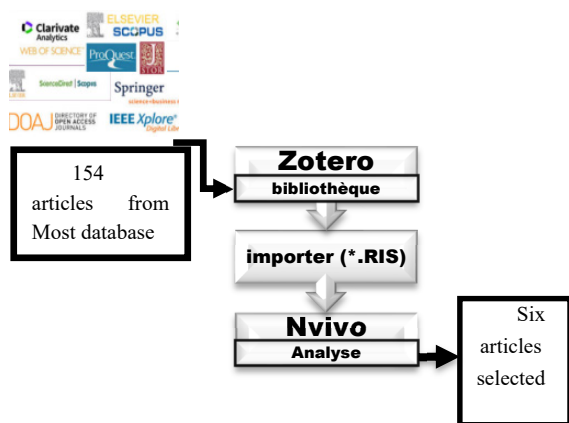


Figure 3: The working method.

After the analysis, most of the articles selected from the corpus are under the theme of education and vocational guidance (see Table1). We will descend the problem of each work, the theoretical model used with its different parameters; thus, the results obtained.

Table 1: List articles on career guidance and career paths.

year	Author
2018	Tarashev, Alexandr A.; Agarkov, Gavriil A.; Ospina Acosta, Camilo A.; Koksharov, Viktor A.
2017	Peker, Musa; Guruler, Huseyin; Sen, Baha; Istanbulu, Ayhan
2019	Tajul Rosli Razak, Iman Hazwam Abd. Halim, Muhammad Nabil Fikri Jamaluddin, Mohammad Hafiz mypapat Ismail.
2019	Sulaiman, M.S., Tamizi, A.A., Shamsudin, M.R., Azmi, A.
2019	J. Sasi Bhanu, V. Chandra Prakash, and J. Sastry
2017	D. Calvo, L. Quesada, G. López, and L. A. Guerrero

#### 4 RESULTS AND DISCUSSIONS

The objective of the work (A. Tarashev, 2018) is to analyze a set of economic factors, which influence the student's decision to change his educational path. To estimate the possibility for each student to change their educational path, they developed an approach based on the fuzzy logic model of the Mamdani type (see Figure 4).

Fuzzy logic model for Educational Path Change Probability based on three variables in input:

- Direction: Variable that affects a student's decision to change programs.
- Budget Support Possibility: Variable represents the demand that these students obtain budgetary support from the government or the university to pay for their studies.
- Expected Salary: Variable who estimate the number of money students earns upon graduation from their current program.

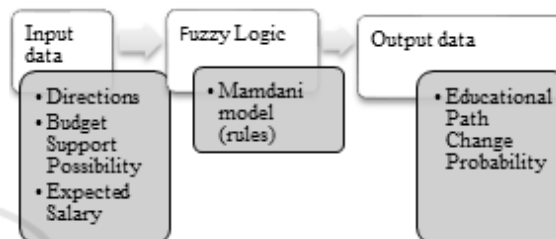


Figure 4: Fuzzy logic model of the Mamdani type to estimate the possibility for each student to change his educational path.

Career guidance requires taking into account country-specific variables. Therefore, this study (M. Peker, 2017) aims to develop an automated system for career guidance activities that can be applied to students in the final year of secondary school. By introducing an artificial intelligence approach, using a fuzzy logic model of the Mamdani type (see Figure 5).

Fuzzy logic model for the prediction of vocational guidance based on three variables in input:

- GPAs (MB, SSB): this is the average of the annual average values of Grade 9 students in classes based on mathematics (physics, chemistry, biology and math) and social studies (history, geography and language arts).
- Teacher views (TV): the variable that shows students' disposition towards specific careers. The value assigned to the variable, obtained through individual interviews with students and by collecting the opinions of parents and other teachers who knew the student.
- Interest values: Career guidance variable estimated from a questionnaire with 150 questions whose answers are in the form of << yes, no, and sometimes >>.

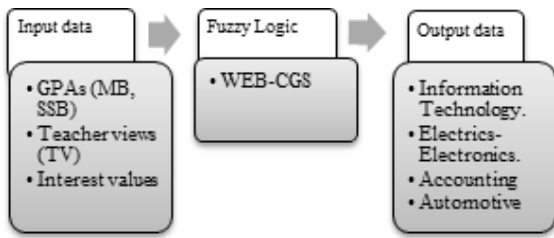


Figure 5: Model fuzzy logic, Mamdani type using WEB-CGS, for the prediction of vocational guidance.

This document (R. Tajul Rosli, 2019) aims to explore the HFS model (Figure 6) for the career path recommendation system (CPRS), particularly for a recommendation of the web programmer career.

The CPRS is a recommendation system that provides direction in choosing their career via skills assessment based on the multiple-choice question technique.

Questions Skills Scale (Input Variable)

- Q1 Design and develop a web base.
- Q2 Handle the whole web project from start to rollout.
- Q3 Skill and knowledge in PHP, HTML, CSS, Javascript and MySQL.
- Q4 Good in problem-solving, communication, interpersonal and organization skills.
- Q5 Up to date with the latest web technology trends and programming techniques.

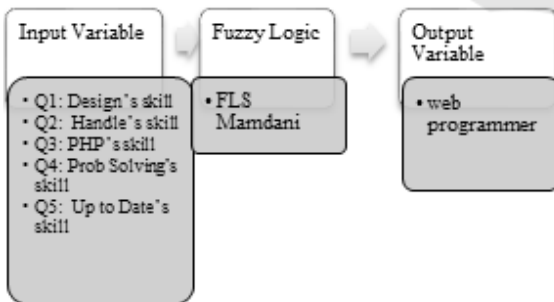


Figure 6: Career Path Recommendation System (CPRS) – FLS topology.

The main objective of this study (M. S. Sulaiman, 2019) is to help students who often face a dilemma and confusion in choosing the right path. It is essential to choose the right course and the proper education in the training years. Therefore, a course recommendation system using Fuzzy Logic is to make the right choice (see Fig9).

The model for recommending courses using fuzzy sets is based on two characteristics, which are competence and interest. Skills are contributed from the eight courses based on the diploma results, classified as programming, problem-solving, and computer and data analysis skills. The exciting part is based on a questionnaire with twelve questions which can be classified according to Programming, Critical thinking, Organizing information, Practical work, Data processing, networking.

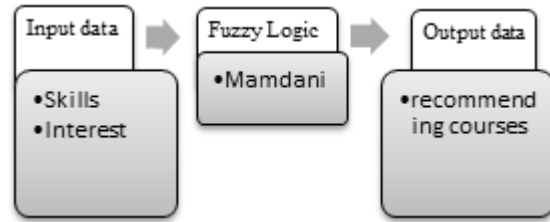


Figure 7: The model for recommending courses using fuzzy sets.

A thorough reading of each work allowed us to determine the problem, the model (sample, variable and rules), the tool used, the results obtained and the limits of each model (see table 2):

Table 2: Reading of each work.

Authors	Method and variable	implement	Sample	Limit
Tarashev, Alexandr A.; Agarkov, Gavriil A.; Ospina Acosta, Camilo A.; Koksharov, Viktor A. (2018).	Mamdani type Three variable in input and one variable in output (see Fig5)	python	5300 students	Descriptive model.
Peker, Musa; Guruler, Huseyin; Sen, Baha; Istanbulu, Ayhan (2017).	Mamdani type using WEB-CGS: Three variables in input and three variables in output (see Fig6)	Matlab	Twenty students to predict and 300 students for modelling.	In this study, the overall results were determined just about four occupational areas. It would therefore be helpful to carry out a more comprehensive analysis applied to all occupational areas.

Table 2: Reading of each work (cont.).

Authors	Method and variable	implement	Sample	Limit
Tajul Rosli Razak, Iman Hazwam Abd. Halim, Muhammad Nabil Fikri Jamaluddin, Mohammad Hafiz mypapit Ismail 2019.	Mamdani type Explore and compare HFS and FLS for the career path recommendation system (CPRS)	Matlab	Comparative model.	This exploratory study has shown that HFS is more interpretable than FLS. Still, it does not cover all aspects of interpretability, such as the semantic meaning of fuzzy sets and intermediate variables.
Sulaiman, M.S., Tamizi, A.A., Shamsudin, M.R., Azmi, A.	Mamdani type	Matlab	A positive achievement among a sample of 50 students which are based on vigour	-
J. Sasi Bhanu, V. Chandra Prakash, and J. Sastry (2019)	TTT-GP-CGS	Java	Students of our K L University.	-
D. Calvo, L. Quesada G. López, and L. A. Guerrero (2017)	System Using, Google Home and Telegram.	The proxy service (API.AI) used for communication and dialogue computation, and the personality evaluator (IBM Watson).	72 Freshmen.	One of the most disliked attributes of the system was the extent of the conversation, as the users perceived it as a long process. And 27.78% of the participants expressed that they did not like the personality analysis.

The first model is a descriptive economic model of the Mamdani type: modelled on a sample of 5300 students, it estimates the probability that a student can change their careers.

The second model is a Mamdani type prediction model (three input variables and three output variables), modelled on a sample of 300 students. It is used to predict the academic guidance of the 9th year of vocational high school.

The third model is a model that compares two FLS and HFS architectures of the Mamdani type for the prediction of guidance to the web programmer profile.

The fourth model helps students for an optimal orientation, based on two axes: a recommendation of the courses, more the competence and the student's interests.

The outcome of this research work (J. Sasi Bhanu, 2019) is an expert system called Tic-Tac-Toe Game Playing Career Guidance System (TTT- GP-CGS) that is useful to assess the psychological factors of the student through Tic-Tac-Toe Game Playing, build the cognitive model of the student and predict the appropriate career(s) for the student.

Finally, in this article (D. Calvo, 2017) the model presents a new and different approach to career guidance systems. it uses Google home as a voice interface and Telegram as a text interface to generate conversation between users and a bot for career guidance.

## 5 CONCLUSIONS

The fuzzy set theory aims at dealing with qualitative situations and takes into account human variables. However, it appears that this theory is the best approach to realize a model for predicting academic orientation. The model will help the student make the right choice of direction and succeed in his career.

In the previous section, we could compare four models of the Mamdani type, which were realized in this way. This comparison aimed to situate our problem in relation to the existing work and to choose the model close to our case, on which it is based.

This comparison allowed us to see that we could opt for a recommended course system and academic path for the engineering cycle at the National School of Applied Sciences (NSAS), Ibn Tofail University (ITU) kenitra.

The system can be classified into three parts: the competencies, the student interest, and the professors' recommendations (See Figure 8).

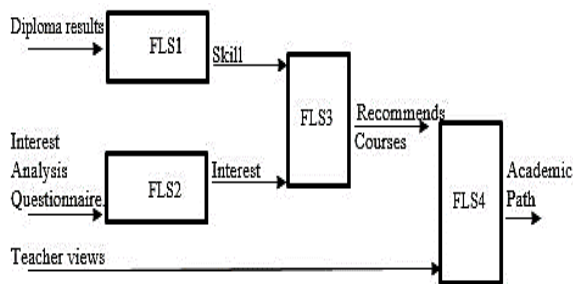


Figure 8: System of recommended academic paths.

## REFERENCES

- L. A. Zadeh, 1965 "Fuzzy sets," *Information and Control*, vol. 8, no. 3, pp. 338–353, Jun, DOI: 10.1016/S0019-9958(65)90241-X.
- I. Ishak, 2015« Application of fuzzy logic to student performance in calculation subjects ».
- C. Servin, O. Kosheleva, and V. Kreinovich, 2018, "In Fuzzy Decision Making, General Fuzzy Sets Can Be Replaced by Fuzzy Numbers," p. 7.
- G. J. Klir, 2006. « Fuzzy Set Theory », in *Uncertainty and Information: Foundations of Generalized Information Theory*, IEEE,
- M. F. Martin and T. Ellen, 1994 *Fuzzy Logic A Practical Approach*. Elsevier. DOI: 10.1016/C2013-0-11164-6.
- A. Tarasyev, G. A. Agarkov, C. A. Ospina Acosta, and V. A. Koksharov, 2018: Fuzzy Logic and Optimization of Educational Paths. In *IFAC*, vol. 51, no. 2, pp. 511–516, Jan. DOI: 10.1016/j.ifacol.2018.03.086.
- M. Peker, H. Guruler, B. Sen, and A. Istanbulu 2017: A New Fuzzy Logic Based Career Guidance System: Web-Cgs. In *The. Vjesn*. Vol. 24, no. 6, pp. 1863–1868, Dec. DOI: 10.17559/TV-20151105201325.
- R. Tajul Rosli and I, Hazwam Abd. Halim May 27, 2019, "An Exploratory Study of Hierarchical Fuzzy Systems Approach in A Recommendation System,"
- M. S. Sulaiman, A. A. Tamizi, M. R. Shamsudin, and A. Azmi, "Course recommendation system using the fuzzy logic approach," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 17, no. 1, pp. 365–371, 2019, DOI: 10.11591/ijeecs.v17.i1.pp365-371.
- J. Sasi Bhanu, V. Chandra Prakash, and J. Sastry, "Assessing the intelligence of a student through TIC-TAC-TOE game for career guidance," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 9, no. 6, Art. no. 6, Dec. 2019, doi: 10.11591/ijece.v9i6.pp5545-5551.
- D. Calvo, L. Quesada, G. López, and L. A. Guerrero, "Multiplatform Career Guidance System Using IBM Watson, Google Home and Telegram," in *Ubiquitous Computing and Ambient Intelligence*, Cham, 2017, pp. 689–700. doi: 10.1007/978-3-319-67585-5\_67.