Synthesis of the application of fuzzy logic techniques to assess candidates in academic orientation

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Abstract: - The aim of this paper is to present a synthesis of an application of fuzzy logic in various researches particularly for decision-making. In fact, we present the problem to assess candidates in academic orientation in Tunisia. Our contribution in this work consists in proposing not only an approach for decision making based on the use of fuzzy logic techniques but also an application of the fuzzy logic techniques in the academic orientation in Tunisia. In fact, we have formulated criteria of assessment of candidates at the time of choosing of a path. The application presented was permit to institute a reflex of adoption of the method to academic orientation.

Key-Words: - Fuzzy logic, fuzzy operators, criteria of assessment, academic orientation.

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1 Introduction

The traditional approach to solve industrial problems has often adopted an analytic tendency. In spite of the computing advances that pushed calculations to unimaginable boundaries, analytic approach is believed to have arrived to a dead end in several complex problems. The idea to simulate human performance started with examining the abilities of man to make models of things surrounding him and to create strategies with which he can manage to control his environment. The theory of fuzzy logic, one of the rare theories that have fixed such a goal, is certainly one of the most adopted approaches in industry [1].

Unlike the classical logic of Boole, the fuzzy logic is a tool that allows us to manipulate variables considered as fuzzy. This concept is characterized by giving values between 0 and 1. This idea would help computers simulate the vagueness in our thought process and language [2], [3].

In this paper, we are interested in the application of fuzzy logic particularly in decision-making. Indeed, the human decision rests on knowledge of an expert of the concerned domain. For example, a qualified operator controls the quality of a product under manufacture in a factory, whether it is a cake or a piece of foundry. The same thing is in medicine, for example, a physician decides to operate, not only after reaching an objective diagnosis of the state of a patient, but also after a certain sign of interpretation from his experience.

This paper describes a methodology of integration of fuzzy logic in a process of academic orientation in Tunisia [4]. In fact, this methodology enables us to approach a control or classification problem of academic orientation.

In fact, the academic orientation aims, on the basis of merit, to guarantee an affectation to all bachelors wishing to pursue superior studies. All bachelors of the year are considered like candidates to orientation. At the end of the two sessions of the final exam, all bachelors are classified by order of merit (according to the global formula) inside the specialty of the final exam gotten. Then, for every speciality of the baccalaureate, four groups are identified: 1st group is composed of the 25% of the better classified; 2nd group is of the 35% that follow, 3rd group is of the 25% that follow and 4th group is of 15% that are placed last. The chances of candidates to get a path can be valued while basing themselves on the following elements: capacity of welcome in an institute and the results of the candidate [4-7]

This paper can be loosely divided into five parts: first, we present a synthesis of the complexity of introducing fuzzy logic in decision-making and second focus on what the system should do rather than try to model how it works. Then, we present the

issues involved in the application of fuzzy logic, particularly the way to approach a control or classification problem. In order to deal with these issues, we present a case study of a process of academic orientation that we analyze and simplify. The last section concludes the article, presenting the interest of fuzzy logic as an alternative to traditional notions of set membership and logic.

2 Presentation of fuzzy logic

We can introduce basic operations on fuzzy sets. Similar to the operations on crisp sets we also want to intersect, unify and negate fuzzy sets. In his first paper about fuzzy sets, Zadeh [1] suggests the minimum operator for the intersection and the maximum operator for the union of two fuzzy sets. It can be shown that these operators coincide with the crisp unification and intersection if we only consider the membership degrees 0 and 1.

Fuzzy classifiers are an application of fuzzy theory. Expert knowledge is used and can be expressed in a very natural way using linguistic variables, which are described by fuzzy sets. In fact, linguistic rules describing the control system consist of two parts; an antecedent block (between the IF and THEN) and a consequent block (following THEN). Depending on the system, it may not be necessary to evaluate every possible input combination, since some may rarely or never occur.

Table 1 presents a synthesis of the different operators of fuzzy logic.

Tab.1: Different operators of fuzzy logic

N°	Designation	Expression
1	NOT	$\mu_1 = 1 - \mu_i$
2	AND	$\mu_2 = \min [\mu_i]$
3	OR	$\mu_3 = \max [\mu_i]$
4	Product	$\mu_4 = \mu a \, . \, \mu b$
5	Average	$\mu_5 = \Sigma[\mu_i]/N$
6	Fuzzy AND	$\mu_6 = \gamma \min [\mu_i] + (1-\gamma)\Sigma[\mu_i]/N$
7	Fuzzy OR	$\mu_7 = \gamma \max [\mu_i] + (1-\gamma)\Sigma[\mu_i]/N$
8	min – max	$\mu_8 = \gamma \min [\mu_i] + (1-\gamma) \max [\mu_i]$
9	γ	$\mu_9 = \min [\mu a \, \mu b]^{1-\gamma}.\{1-[1-\mu a][1-\mu b]\}^{\gamma}$

By making this type of evaluation, usually done by an experienced operator, fewer rules can be evaluated, thus simplifying the processing logic and perhaps even improving the fuzzy logic system performance [8]. The inputs are combined logically using the AND operator to produce output response values for all expected inputs. The active conclusions are then combined into a logical sum for each membership function. A firing strength for each output membership function is computed. All that remains is to combine these logical sums in a defuzzification process to produce the crisp output.

4 Results

As the dynamic parameter conditioning the academic orientation as well as the diversity of chances for candidates to get a path, it is frequently found in subjective situations. This is why the fuzzy logic approach can contribute to attenuate these situations and to offer a consensual and a more objective support for decision making. So, there is place to proceed to a collection of every intervening parts tendency in the academic orientation process expressed in a natural language and to proceed to its analysis while adopting the fuzzy logic approach.

In order to institute the reflex of adoption of the method, we illustrate a relative application to the academic orientation using some techniques of fuzzy logic. The approach proposed includes the following stages [9], [10]:

- **Stage 1:** Schematizing of the process of the academic orientation and identifying of the various operators.
- **Stage 2:** Listing of the parameters of the academic orientation including those not exploited at present and classify by a hierarchical manner these parameters.
- **Stage 3:** Constituting of a reference database representing various real situations of the academic orientation.
- **Stage 4:** Collecting the various points of view of operators of the academic orientation according to a qualitative appreciation.
- **Stage 5:** Defining consensual criteria and modeling these criteria according to a fuzzy algorithm.
- **Stage 6:** Making simulation according to various situations exploiting the elaborated database.

The problem of academic orientation presents a situation where several candidates must be compared. The variables that determine the situation can be some linguistic variables (fuzzy variables) for

the assessment of candidates at the time of the choice of a path. In the case of this work, we formulated different assessment criteria for the decision making while using fuzzy operators.

The results of a candidate are: ordering according to the average to the baccalaureate (v1), ordering according to the global formula (v2), ordering inside a group (v3) and the score of the candidate (v4).
In order to appreciate the effect of the four variables v1, v2, v3 and v4 on the academic orientation process, we define a membership function: μvi (i=1...4), this function is marked out to a maximal value. For example, the assessment criteria relative to the candidate's results using an AND operator is given by:

$$\mu_{Res} = \mu_{v1} \text{ AND } \mu_{v2} \text{ AND } \mu_{v3} \text{ AND } \mu_{v4}.$$

We proposed to use a multiple criteria approach based on the fuzzy logic in order to offer an objective classification of different candidates.

Tables 2 and 3 present the results of different candidates and their fuzzy image.

Tab.2: Results of different candidates

Variables	Candidates					min	max
	N°1	N°2	N°3	N°4	N°5		
v1	70	70	60	75	85	0	100
v2	65	30	40	65	60	0	100
v3	60	75	60	70	80	0	100
v4	70	65	70	80	75	0	100

Tab.3: Fuzzy image of the different results

	Candidates				
	N°1	N°2	N°3	N°4	N°5
f1	0.750	0.700	0.600	0.750	0.800
f2	0.650	0.300	0.400	0.650	0.600
f3	0.600	0.750	0.600	0.700	0.800
f4	0.750	0.650	0.700	0.800	0.750

Tables 4 and 5 present the assessment of candidates using different fuzzy operators.

Tab.4: Assessment of candidates using some fuzzy operators (without γ)

Criterion	Candidates				
	N°1	N°2	N°3	N°4	N°5
NOT	0.009	0.018	0.029	0.005	0.004
Product	0.220	0.102	0.101	0.273	0.288
Average	0.688	0.600	0.575	0.725	0.738
AND	0.600	0.300	0.400	0.650	0.600
OR	0.750	0.750	0.700	0.800	0.800

Tab.5: Assessment of candidates using other fuzzy operators (with the use of γ)

Criterion		Candidates				
	γ	N°1	N°2	N°3	N°4	N°5
Fuzzy AND	1	0.600	0.300	0.400	0.650	0.600
	0.75	0.622	0.375	0.444	0.669	0.634
	0.5	0.644	0.450	0.488	0.688	0.669
	0.25	0.666	0.525	0.531	0.706	0.703
	0	0.688	0.600	0.575	0.725	0.738
Fuzzy OR	1	0.750	0.750	0.700	0.800	0.800
	0.75	0.734	0.713	0.669	0.781	0.784
	0.5	0.719	0.675	0.638	0.763	0.769
	0.25	0.703	0.638	0.606	0.744	0.753
	0	0.688	0.600	0.575	0.725	0.738
min-max	1	0.600	0.300	0.400	0.650	0.600
	0.75	0.638	0.413	0.475	0.688	0.650
	0.5	0.675	0.525	0.550	0.725	0.700
	0.25	0.713	0.638	0.625	0.763	0.750
	0	0.750	0.750	0.700	0.800	0.800
gamma	1	0.991	0.982	0.971	0.995	0.996
	0.75	0.680	0.558	0.551	0.720	0.730
	0.5	0.466	0.317	0.313	0.521	0.536
	0.25	0.320	0.180	0.178	0.377	0.393
	0	0.219	0.102	0.101	0.273	0.288

Table 6 presents the results of the classification of the candidates using different operators of fuzzy logic.

Tab.6: Results of the classification of the candidates using different fuzzy operators

Criterion		Candidates				
		N°1	N°2	N°3	N°4	N°5
NOT		**3**	**2**	**1**	**4**	**5**
Product		**3**	**4**	**5**	**2**	**1**
Average		**3**	**4**	**5**	**2**	**1**
AND		**2**	**5**	**4**	**1**	**2**
OR		**3**	**3**	**5**	**1**	**1**
Fuzzy AND	1	2	5	4	1	2
	0.75	3	5	4	1	2
	0.5	3	5	4	1	2
	0.25	3	5	4	1	2
	0	3	4	5	2	1
	sum	14	24	21	6	9
	class	**3**	**5**	**4**	**1**	**2**
Fuzzy OR	1	3	3	5	1	1
	0.75	3	4	5	2	1
	0.5	3	4	5	2	1
	0.25	3	4	5	2	1
	0	3	4	5	2	1
	sum	15	19	25	9	5
	class	**3**	**4**	**5**	**2**	**1**

min-max	1	2	5	4	1	2
	0.75	3	5	4	1	2
	0.5	3	5	4	1	2
	0.25	3	4	5	1	2
	0	3	3	5	1	1
	sum	14	22	22	5	9
	class	**3**	**4**	**4**	**1**	**2**
gamma	1	3	4	5	2	1
	0.75	3	4	5	2	1
	0.5	3	4	5	2	1
	0.25	3	4	5	2	1
	0	3	4	5	2	1
	sum	15	20	25	10	5
	class	**3**	**4**	**5**	**2**	**1**

Table 7 presents the results of the final classification of the candidates using the different operators of fuzzy logic.

Tab.7: Result of the final classification of candidates

	Candidates				
	N°1	N°2	N°3	N°4	N°5
Sum of the class	26	35	38	16	16
Final classification	**3**	**4**	**5**	**1**	**1**

4 Conclusion

Fuzzy logic provides a different way to approach a control or classification problem. This method focuses on what the system should do rather than trying to model how it works. One can concentrate on solving the problem rather than trying to model the system mathematically

In this paper, we presented a synthesis of our contribution in proposing an application of the fuzzy on the process of academic orientation in Tunisia. The approach proposed enables not only to contribute to attenuate the contradictory situations but also to lead to a consensual and more objective support. Results of many experiments are presented while using different operators of the fuzzy logic.

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Contribution of individual authors to the creation of a scientific article

Mohamed Najeh Lakhoua wrote and he was responsible for the scientific continuation of this work.
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