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The Use of Artificial Intelligence In Vocational Guidance

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Authors' contributions

This work was carried out in collaboration between all authors. Author AM and AG designed the study, wrote the protocol and supervised the work, carried out performed the statistical analysis. Author AM and AG managed the analyses of the study. Author AM wrote the first draft of the manuscript. Author AG managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The concept of Multiple Intelligences has come out after Howard Gardner redefined intelligence. According to Gardner's theory, human beings have different types of intelligence and based on their respective intelligence types, human beings have different skills in different areas. Human beings can be more successful and productive on areas they are skillful. Therefore, choosing appropriate professions, in accordance with one's intelligence type, is important for individuals as well as for the society. This study aims to develop a technique to help high school students in the profession selection process using artificial intelligence. Questionnaire has been utilized as the research method and the data have been analyzed via Fuzzy Logic Toolbox which is subunit of the software called MATLAB. It was aimed to direct students to appropriate profession and build more successful and productive professions.

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1. INTRODUCTION

The profession is a title of the individuals, which is usually earned after a series of education and a process requiring a special knowledge, skill and labor to have more comfortable life. The meaning of profession may differ from person to person. For some persons it may mean only money; for somebodies earning respect; for someone to generate something new and realize capabilities, for some others it may mean all of them together too.

Satisfaction, feeling of accomplishment and happiness, which are reached in work-life, affect the daily life of a person. In contrast to this condition, dissatisfaction, failure and unhappiness in the work-life may cause some psychological issues. One of the most important reasons of being unhappy at work and therefore in the life is the mismatch between characteristics of jobs that are chosen by the individuals and their own characteristics. In the other words, it is wrong career choice itself. And this condition shows how important vocational guidance is.

Vocational guidance is the process to make the individuals aware of their own personal abilities and characteristics, expectations and to help them to choose the most appropriate profession for themselves by providing information about professions [1].

In today's conditions, it is very hard to get information about professions by observation. In here vocational guidance steps in and gives information about professions that should be known. There are many factors affecting individuals to select a profession. The most important of these factors can line up as the individual's interests, abilities, intelligence, family and community opinion, age, gender, the probability of finding a job, the demands of the profession, the timeliness of the profession and popularity of the profession etc. [2].

In this work, intelligence type of the individuals is determined by using multiple intelligence methods. Questions, which are prepared by considering the individuals' ages, profession of family, expectations of family from the individual, financial possibilities and neighborhood are added to the questionnaire.

The aim of this study is, to guide the formation of productive and successful business areas by helping the individuals to choose right professions. To provide this, in contrast to known and used methods, to get more accurate results at less time, instead of individual opinions, fuzzy logic a branch of artificial intelligence and MATLAB software that is used in artificial intelligence are combined and applied questionnaires are analyzed by using this method. There are going to be more information about multiple intelligence, fuzzy logic and artificial intelligence, which are used in this study.

2. MULTIPLE INTELLIGENCE THEORY

The multiple intelligence theory firstly came out by Howard Gardner learning psychologist in University of Harvard. Multiple intelligence theory was first published in Howard Gardner's book, *Frames Of Mind* [3]. While he was working on "Project 0", which was about brain damaged patients. These patients were able to whistle and able to do sports. However they had lost fewer of verbal and quantitative thinking powers. These facts made Gardner think that there should be more than one types of intelligence [4]. Types of intelligence:

- Verbal - Linguistic Intelligence
- Logical - Mathematical Intelligence
- Spatial Intelligence
- Bodily - Kinesthetic Intelligence
- Musical Intelligence
- Interpersonal Intelligence
- Intrapersonal Intelligence
- Naturalistic Intelligence[5].

In Gardner's view, the aim of school should be to develop all intelligence types and to help people reach vocational goals that are appropriate to their intelligence type [3].

Also King in his work called "*Another Lens: The Theory of Multiple Intelligence in Vocational Assessment*" [6] thinks that for making vocational guidance multiple intelligence gives more accurate results instead of applying IQ tests. He claims that multiple intelligence provides to see with more comprehensive, deeper and broader perspective. In the same work it is claimed that; when individuals choose specific professions, their self-confidences and self-esteems increase,

therefore this condition increases potential compliance between employee and employer. And it is a fact that compliance between employee and employer has a positive effect on development of the country.

3. FUZZY LOGIC

The term of fuzzy logic was firstly mentioned in 1965 by Dr. Lotfi Asker ZADEH Azerbaijani scientist in his article "The Theory of Fuzzy Logic and Fuzzy Sets" [7]. Zadeh defines fuzzy logic as an initiative at formalization of two significant human capabilities: First, the capability to make rational decisions in an uncertainty, incompleteness of information, contradictory information, partiality of truth and possibility, in brief, in an situation of incomplete information. And second, the capability to perform a wide variety of physical and mental mission without any measurements and any calculations [8].

At earlier times classical (crisp) logic was being used, which had been claimed by Aristoteles. According to classical logic, either an object is an element of a set or not. Classical logic defined its boundry with sharp - certain lines. While in classical logic terms of short - tall, beautiful - ugly, fat - thin, smart - not smart, etc... are being present in fuzzy logic terms of very tall - tall - medium - short - very short, so beautiful - not so beautiful - not beautiful, very thin - thin - little fat - fat, very smart - normal - not very smart - not smart are found.

Human logic is said to be fuzzy. Individuals have ability to decide according to conditions. In classical logic there is only black and white. But fuzzy logic claims that there might be thousands of grey tones between black and white. In contrast to classical logic, fuzzy logic is based on uncertainties in traditional logic there is no place for uncertainties. Some technologic areas that fuzzy logic is used can be ordered like that:

- Cameras being controled by fuzzy logic (Sanyo -Fisher, Canon, Minolta)
- Video cameras (Panasonic)
- Washing machines and dish washers (Matsushita)
- The control of Sundai city subway in Japan (Hitachi)
- Breaking system in vehicles (Nissan)
- Vacuum cleaners (Matsushita)
- Elevators (Lift) (Fujitec-Toshiba, Mitsubishi, Hitachi)

- Air conditioners (Matsushita)
- Televisions and computers (Sony)
- Cement industry (Mitsubishi Chem.)
- Steel industry (Nippon Steel)
- Car gearbox systems (Subaru, Nissan)

Also it is used in many other areas such as toaster, microwave oven, handwriting recognition, helicopter flight control system, etc. [9]. Application areas are getting more more by the time.

4. ARTIFICIAL INTELLIGENCE

It is needed to define intelligence before defining artificial intelligence. Intelligence is thinking and reasoning, perceiving and evaluating of perceived things, commenting and concluding them [10]. Artificial intelligence is general name of computer system studies which aim to fulfill the role needing high mental operations like learning from experiences, to reason, to interpret, to generalize. All these abilities belong to only people who are assumed the most intelligence creature in the universe. Also the movements and the behaviors of animals are considered a reference.

Therewithal some scientists defined the artificial intelligence as a system, which can understand the structure of human thinking and can behave similar to them, in other word, developing a computer system that is able to imitate human's behavior.

The aims of artificial intelligence are helping people to decide, to control, to guess and to reach their goals, to solve the complex structure of the human brain, to solve complex problems, which are not able to be solved by people and to understand limits of intelligence [11].

Today, artificial intelligence techniques have found application area in many areas. The most often techniques which are investigated and used, are:

- Artificial Neural Network
- Expert Systems
- Genetic Algorithms
- Fuzzy Logic
- Artificial Life
- Natural Language Processing
- Robotics
- Voice and Face Recognition [11].

Artificial Intelligence Based on Fuzzy Logic

Fuzzy logic is a subject in its own right as a mathematical; also it is a subunit of artificial intelligence. The aim of fuzzy logic is, to draw conclusions closer to life by modelling human's thinking system.

The most important property of fuzzy logic is, in contrast to classical logic's understanding "An object element of a set or not." possibility of an object to be an element is graded between values [0, 1]. Fuzzy logic does not include certain boundaries and this condition made studies closer to everyday language.

Matlab fuzzy logic toolbox

Fuzzy system can be built easily with graphical area by using Graphical User Interface in Matlab software. Matlab Fuzzy Logic Toolbox is used "if – then rules" to describe the behavior of the system.

Fuzzy Logic Toolbox can be reached from the command line by typing "fuzzy". Five main Graphical User Interface tools which are showed in Fig. 1, are used for system to built, to control and to observe in Fuzzy Logic Toolbox. These are:

- ✓ Fuzzy Inference System (FIS)
- ✓ Membership Function Editor

- ✓ Rule Editor
- ✓ Rule Viewer
- ✓ Surface Editor [12].

5. METHODOLOGY

In this study, it is aimed to make vocational guidance by using student's intelligence type, fuzzy logic and artificial intelligence. Questionnaire method was used for data collection. Answers, in the questionnaire were gradated as; never, sometimes, often and always. The survey consists of two parts. There are 40 questions in the first part. These 40 questions were equally prepared from eight types of intelligence. Second part of questionnaire includes information about individual (Appendix).

Questions of prepared questionnaire were answered by 5 different high school's senior students, which are in Bosna Sema Education Institutions, Bosnia and Herzegovina. In total, 160 students completed questionnaires but because of some students did not fill the questionnaire completely, 150 student's questionnaire were evaluated.

The validity of the content and scope of the questionnaire were asked from educators, who are experts in this regard. Also questionnaire questions were prepared with the help of surveys, which are previously used and accepted.

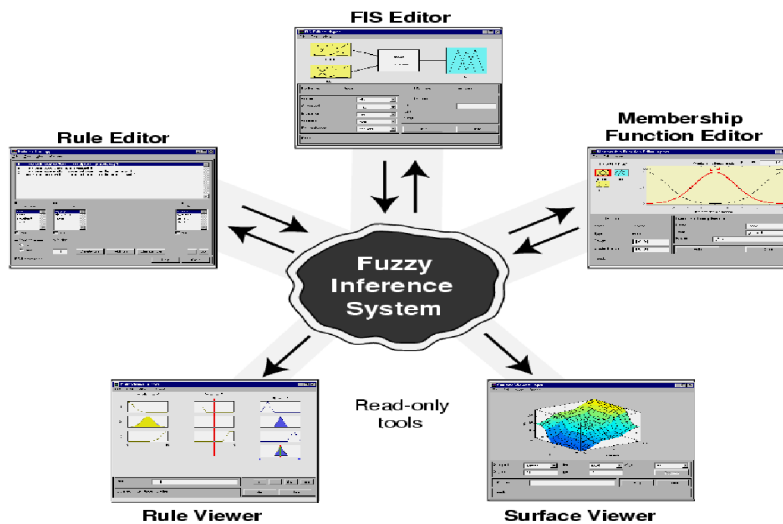


Fig. 1. Fuzzy inference systems

About validity, the questionnaire has been tested by doing pilot application and it has been found that suitable for purpose.

The Cronbach's alpha factor has been determined as 0.83 according to reliability test from Table 1 and it is reliable enough.

Factor analysis was used to group 40 questions that were asked in the questionnaire according to types of intelligence. Firstly for the applicability of factor analysis, According to Table 2 KMO factor value was found as 56% and as a result of this value it was seen that factor analysis could be applied.

The method of principle component analysis has been preferred in factor analysis and factor loadings have been found as 84% which is seen on the Table 3.

As it is seen on the Table 4, 8 factors appeared in the analysis result. Each of these factors has been named as an intelligence type. For instance; the questions from 6th to 10th are defined as the 1st factor, which is named as Logical-Mathematical intelligence.

Table 1. Reliability statistics

Cronbach's alpha	Cronbach's Alpha based on standardized items	N of items
,832	,839	40

Table 2. KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		,564
Bartlett's test of sphericity	Approx. Chi-square	1310,036
	df	780
	Sig.	,000

Just like the 1st factor, all of other factors are named as pointing a type of intelligence and the values are used corresponding to these factors.

The collected data was analyzed by using Matlab Fuzzy Logic Toolbox. Questionnaire data was analyzed by the following steps:

The inputs and the outputs are generated with the help of the mathematical models and rules. In the part of the fuzzy logic, FIS files can be opened by the means of two fuzzy models. These are; Mamdani and Sugeno models.

Mamdani was preferred; because of complex and hard operations, the large number of input and closeness to life. Following FIS file in Fig. 2 was created to evaluate the collected data. This FIS file includes 5 inputs, membership functions of each input, 70 rules, an output and membership functions of this output.

There are some values and options which need to be determined to create the membership function. First of all it is necessary to determine the type of membership function. There is a large number of membership functions, in which fuzzy sets are shown. But generally, triangular, trapezoidal, Cauchy, Gaussian and sigmoidal functions are used. Triangular membership function was used in this study.

Numerical ranges are determined as [1,4]. The reason of determining these ranges is that -as it was mentioned before in multiple intelligence-, individuals have all type of intelligence even with the small amounts. It cannot be said that one individual doesn't have any of intelligence types. So, the value 0 is not taken for intelligence. The minimum value is determined as 1 by considering this for the evaluation of questionnaire.

As it is shown in Fig. 3 membership function parameters were determined in consultation with the experts and naming of set for each parameter was conducted as follows. For inputs; very low, low, medium and high. And for output; unsatisfactory, satisfactory, good and excellent.

Rule editor part is called as "if - then rules". Each input connects to each other with connector "AND" or "OR". Lastly the rule is finished by connecting with connector "THEN". Connector "AND" was used because of using minimum values in this study. Rules were created through results of individuals, who are from various professions and working in occupations according to the type of intelligence, which was determined with the help of questionnaire. In total 70 rules which is shown in Fig. 4 were identified.

In Rule Viwer page, according to defined rules, changes of output based on changes in input values can be observed. In this section, on the model or on the data there can not be any change. Only, rule viwer shows which rule is active and change of the rules. It can be seen in Fig. 5.

Table 3. Total variance explained

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	16,434	41,085	41,085	16,434	41,085	41,085	4,931	12,327	12,327
2	4,780	11,951	53,036	4,780	11,951	53,036	4,775	11,937	24,264
3	3,186	7,966	61,001	3,186	7,966	61,001	4,666	11,665	35,930
4	2,367	5,917	66,918	2,367	5,917	66,918	4,364	10,910	46,840
5	2,041	5,102	72,020	2,041	5,102	72,020	4,244	10,611	57,451
6	2,009	5,022	77,042	2,009	5,022	77,042	3,906	9,766	67,217
7	1,627	4,067	81,109	1,627	4,067	81,109	3,567	8,918	76,135
8	1,276	3,189	84,298	1,276	3,189	84,298	3,265	8,164	84,298
9	,794	1,985	86,284						
10	,672	1,680	87,963						
11	,636	1,591	89,554						
12	,543	1,358	90,912						
13	,451	1,129	92,041						
14	,397	,992	93,033						
15	,353	,882	93,915						
16	,298	,744	94,659						
17	,265	,662	95,321						

Extraction Method: Principal Component Analysis

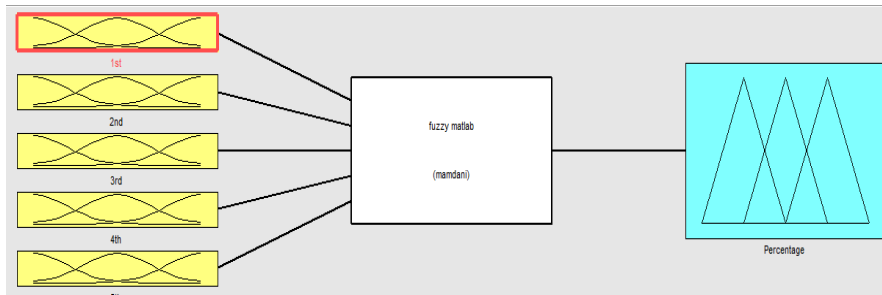


Fig. 2. Fuzzy model

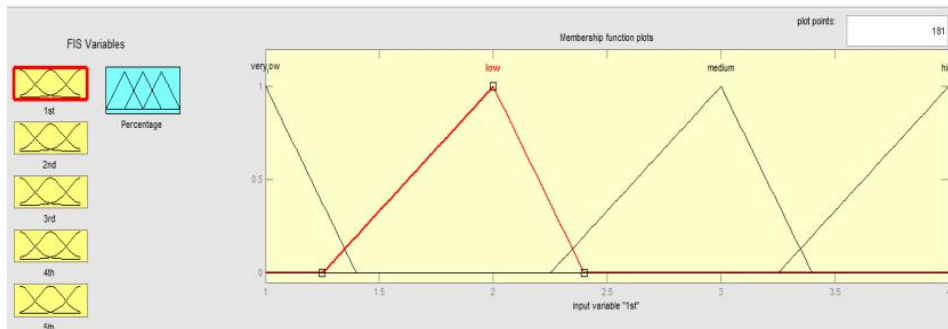


Fig. 3. Membership functions

1. If (1st is high) and (2nd is medium) and (3rd is high) and (4th is high) and (5th is high) then (Percentage is excellent) (1)
 2. If (1st is high) and (2nd is high) and (3rd is high) and (4th is low) and (5th is low) then (Percentage is good) (1)
 3. If (1st is low) and (2nd is high) and (3rd is low) and (4th is medium) and (5th is medium) then (Percentage is good) (1)
 4. If (1st is high) and (2nd is high) and (3rd is high) and (4th is high) and (5th is high) then (Percentage is excellent) (1)
 5. If (1st is medium) and (2nd is very low) and (3rd is medium) and (4th is medium) and (5th is low) then (Percentage is good) (1)
 6. If (1st is medium) and (2nd is high) and (3rd is low) and (4th is very low) and (5th is low) then (Percentage is satisfactory) (1)
 7. If (1st is high) and (2nd is high) and (3rd is high) and (4th is high) and (5th is medium) then (Percentage is excellent) (1)
 8. If (1st is low) and (2nd is high) and (3rd is high) and (4th is medium) and (5th is high) then (Percentage is good) (1)
 9. If (1st is medium) and (2nd is high) and (3rd is high) and (5th is high) then (Percentage is excellent) (1)
 10. If (1st is medium) and (2nd is high) and (3rd is high) and (4th is high) and (5th is medium) then (Percentage is excellent) (1)
 11. If (1st is high) and (2nd is high) and (3rd is high) and (4th is medium) and (5th is high) then (Percentage is excellent) (1)
 12. If (1st is high) and (2nd is high) and (3rd is medium) and (4th is medium) and (5th is high) then (Percentage is excellent) (1)
 13. If (1st is medium) and (2nd is high) and (3rd is high) and (4th is medium) and (5th is high) then (Percentage is excellent) (1)
 14. If (1st is high) and (2nd is medium) and (3rd is medium) and (4th is high) and (5th is medium) then (Percentage is good) (1)
 15. If (1st is medium) and (2nd is high) and (3rd is high) and (4th is medium) and (5th is medium) then (Percentage is good) (1)
 16. If (1st is medium) and (2nd is medium) and (3rd is medium) and (5th is medium) then (Percentage is good) (1)
 17. If (1st is medium) and (2nd is medium) and (3rd is low) and (4th is high) and (5th is medium) then (Percentage is good) (1)
 18. If (1st is low) and (2nd is high) and (3rd is high) and (4th is medium) and (5th is medium) then (Percentage is good) (1)
 19. If (1st is high) and (2nd is high) and (3rd is high) and (4th is high) and (5th is medium) then (Percentage is excellent) (1)

If 1st is and 2nd is and 3rd is and 4th is and 5th is

low medium high very_low none

low medium high very_low none

low medium high very_low none

low medium high very_low none

low medium high very_low none

not not not not not

Connection Weight

or and

1

Delete rule Add rule Change rule << >>

Fig. 4. Rules for fuzzy system

At the same time, according to these entered data, input – output variations can be observed via Surface Viwer. Here, there is possibility to compare relationship between two inputs and outputs in three dimensional graphs. Surface

viewer is not the place to make arrangement. Only the results are observed in this part. The changes between first and fourth inputs and outputs were observed in Fig. 6.

Table 4. Rotated component Matrix^a

	Component							
	1	2	3	4	5	6	7	8
Q-7	,884							
Q-10	,813							
Q-9	,809							
Q-6	,803							
Q-8	,771							
Q-29		,928						
Q-27		,928						
Q-28		,916						
Q-26		,878						
Q-30		,768						
Q-15			,782					
Q-14			,779					
Q-12			,757					
Q-11			,720					
Q-13			,717					
Q-24				,821				
Q-22				,733				
Q-21				,727				
Q-19				,638				
Q-25				,591				
Q-23				,561				
Q-39					,832			
Q-37					,796			
Q-40					,774			
Q-38					,722			
Q-35					,673			
Q-36					,593			
Q-3						,841		
Q-2						,832		
Q-1						,726		
Q-4						,595		
Q-5						,581		
Q-32							,818	
Q-34							,765	
Q-31							,695	
Q-33							,605	
Q-17								,855
Q-20								,709
Q-18								,699
Q-16								,663

Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization, a. Rotation converged in 7 iterations

The code representing properties of the system which are generated in FIS editor are follows:

```
[System]
Name='fuzzy matlab'
Type='mamdani'
NumInputs=5
NumOutputs=1
NumRules=70
AndMethod='min'
OrMethod='max'
```

```
ImpMethod='min'
AggMethod='max'
DefuzzMethod='centroid'

[Input1]
Name='1st'
Range= [1 4]
NumMFs=4
MF1='very low':'trimf', [1 1 1.4]
MF2='low':'trimf', [1.25 2 2.4]
MF3='medium':'trimf', [2.25 3 2.4]
MF4='high':'trimf', [3.25 4 4]
```


[Output1]
 Name='Percentage'
 Range= [25 100]
 NumMFs=4
 MF1='unsatisfactory':trimf, [25 25 35]
 MF2='satisfactory':trimf, [31.25 50 60]
 MF3='good':trimf, [56.25 75 85]
 MF4='excellent':trimf, [81.25 100 100]

While they are continuing the university or starting to the job after graduation, many individuals realise that actually they do not want these professions, which were chosen with different reasons, mostly they do not have any chance to change their professions.

6. RESULTS AND DISCUSSION

In this study, it is aimed to help making vocational guidance for high school senior students before choosing department of the university. The main reasons of choosing this topic are that career choice is very important and is a decision that affects entire life of individuals.

The most important factors that individuals take into consideration before choosing career and that experts mentioned in various researches can be listed as; intelligence types and connected to this interest areas, pressure from family for choosing the profession and financial reasons. The questionnaire, which was prepared by considering these factors, was analyzed by using fuzzy logic technique.

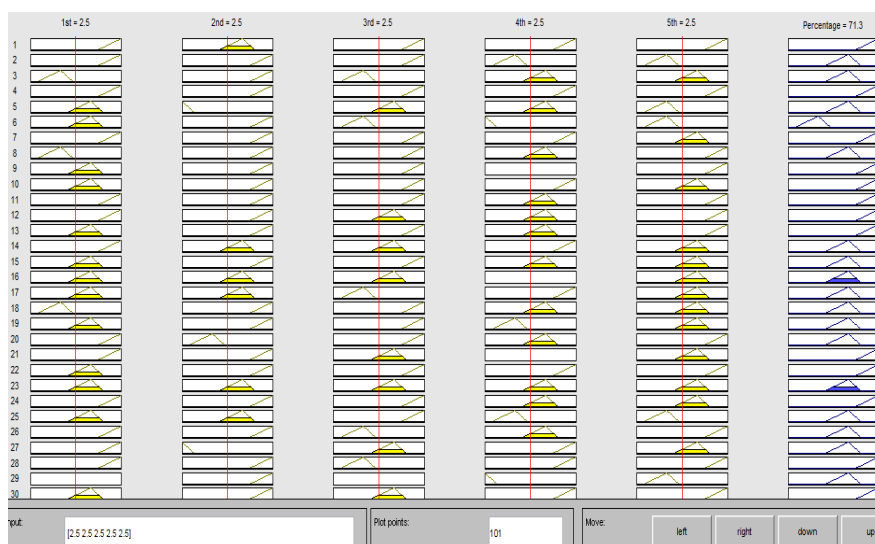


Fig. 5. Evaluation of rule viewer

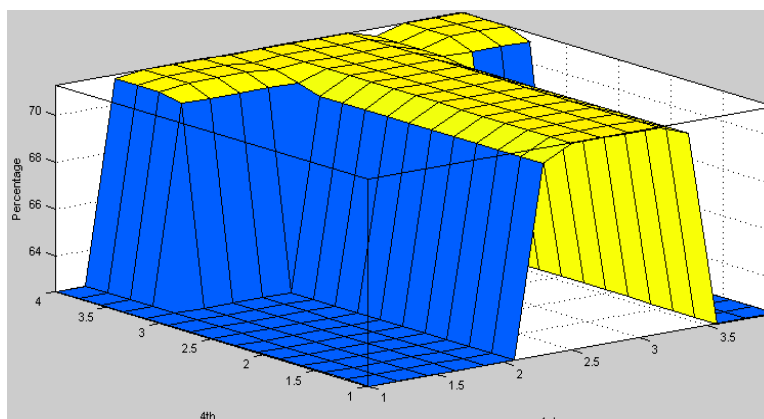


Fig. 6. Correlation between inputs and output

The most important reason for the use of fuzzy logic is being more convenient to human thinking system. In other words, it is being easier to understand data by using everyday language rather than mathematical operations. Thus, individuals, who make vocational guidance, do not need to deal with the mathematical operations. Also, in contrast to classical logic, because of there is no definite boundary between fuzzy logic and data, the fact of that individual may have more than one intelligence type doesn't get ignored.

In today's age of technology, it is important to have the work done in the computer environment. It provides major advantages just like being on computer, not requiring any option or extra time except entering input values, which takes seconds. With the other word the main principle is finding accurate results for the target at a short time. The questionnaire which is applied as a result of reasons above is analyzed with the help of fuzzy logic toolbox in MATLAB software.

During the test, questionnaire was applied to the individuals who are from different professions, have chosen the profession and are satisfied to work in that job and have different intelligence types. Given answers for questionnaire were analyzed in fuzzy logic toolbox. Some of these individuals gave the results as expected and they work in professions appropriate to their intelligence types. But it is also seen that some of the individuals work in professions which were not suggested professions but were close to them. It is considered that the profession was chosen because of factors influencing the choice of career (interest, ability, family, materiality etc.) It means that this study can guide with around 60% success.

In this study, multiple intelligence, fuzzy logic and artificial intelligence were blended. While making fuzzification for crisp inputs and determining rules, some difficulties were encountered. Fuzzification phase should be done by supervision and guidance of an expert. Input, which is added to the model unnecessarily or the rules, which can not be determined accurately, affect result of work negatively or prolong the duration of the study to be analyzed.

With this study, it was aimed to support the studies, which were done and to be base for studies, which will be done. A system can be built by developing this system like expanding

range of functions used in fuzzy logic, increasing the number of input and output, using all questions as input and using all intelligence types as output.

6. CONCLUSION

It should not be forgotten that career is not a facility just for earning money, at the same time; it provides the psychological needs of the individual and also supports the development of society. In this study, a system was built by using fuzzy logic and artificial intelligence together to make vocational guidance that is the most important and difficult to return the decision which is done by individuals for their entire lives.

Also Matlab software was used to analyze data, which was collected by questionnaire technique and questions of survey prepared by using multiple intelligence. As a result, 60% success is a big step towards the objective when the difficulty and importance of vocational guidance were considered. Of course, because of there are many effective factors in guiding for career, the guide who makes vocational guidance should know the individuals requiring vocational guidance, and also the individuals' requests need to be considered.

This study is important for the people to be directed to appropriate professions depending on their abilities and skills from an early age. During the research, not mentioning other influences beside intelligence types could be said to be a limitation. In the future the study in this topic can be more efficient by taking socio-economic factors in consideration. More appropriate career guiding can be made for individuals by using their private socio-economic information.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

VOCATIONAL GUIDANCE QUESTIONNAIRE

The purpose of this questionnaire is to help you determine the best possible profession available for you, which will effect your whole life. I am sure you will show the necessary sensitivity. All information provided will remain confidential. Your data will be incorporated for the study but your participant identification will not be shared.

Thank you for agreeing to share information.

Aydan Meydan

1st PART

Please tick the appropriate box. There is no right or wrong answer. Please choose the answer which represents your opinion.

	Never(1)	Sometimes(2)	Often(3)	Always(4)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
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2nd PART: Please fill out the information below.

Gender : Female Male

Age:

What do you want to study at your graduation level? :

Reason:

What does your family want you to be? :

Father's Occupation:

Mother's Occupation:

Average Monthly Revenues of the Family:

less than 500 KM 500-750 KM 750-1000 KM 1000-1500 KM

1500-2500 KM 2500-4000 KM more than 4000 KM

Additional Comments /

Notes:

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