SOCIETY. INTEGRATION. EDUCATION
Proceedings of the International Scientific Conference. Volume V, May 25th-26th, 2018. 445-454

AN ALGORITHM OF FUZZY INFERENCE SYSTEM FOR HUMAN RESOURCES SELECTION TOOLS

Krasimir Slavyanov
"Vasil Levski" National Military University, Bulgaria

Abstract. *This article offers an original Human Resources selection procedure based on Mamdani fuzzy inference system (FIS) dedicated to compute multiple results each from different type of analyzing criterions. The modeling and information analysis of the FIS are developed to draw a general conclusion from several results each produced by Human Resources selection basic criterion. Simulation experiments are carried out in MATLAB environment.*
Keywords: *human resources, fuzzy inference system, membership function, fuzzy rule, ranking score.*

Introduction

For every Human Resource (HR) Selection tool, high performance technologies are vital for fast and accurate decision after calculations with a specific sophisticated criteria set. These technologies can include a Fuzzy Inference System for implementation of fuzzy rules over a fuzzy variable (Vasileva, 2008; Zadeh, 1973: 28-44; Zadeh, 1988: 83-93). For that purpose, can be used a neuro-fuzzy based agent approach for automatically determining the key skill characteristics defining each expert's preferences and ranking decisions, while handling the uncertainties and inconsistencies in group decisions of a panel of experts (Doctor, 2009b; Hosseininezhad, 2011). The main purpose for these technologies and to this paper is to automate the processes of requirements specification and each applicant's ranking. In this paper, a Fuzzy Inference System has been designed in Matlab environment with considering main effective variables on performance assessment as Inputs variables and level of performance as output. If the system rules are extracted from a specific selection criterion set of a dedicated HR selection methodology the applicant evaluation and ranking can be faster easier and justified process (Doctor, 2008).

Preconditions and means for resolving the problem

Preconditions

Due to the high number of applicants, it is necessary to short-list and rank submitted CVs based on their suitability for the job requirements. To reduce costs,

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http://dx.doi.org/10.17770/sie2018vol1.3311

error and time there is a strong desire from companies towards automating the two processes of: specifying the requirements criteria for a given job (experience, skills, etc.) and matching between the applicants' profiles and the job requirements; to produce an applicants' ranking policy that gives consistent and fair results which can be legally justified (Doctor, 2009a). A specific experimental arrangement is developed for the proposed algorithm of fuzzy inference system for HR selection tool. The arrangement consists of nine key skills that can be produced from an applicant form or site with additional applicant's documentation needed. The HR selection FIS used for example is dedicated in IT sector recruiting. One criterion is designed to classify the applicant's education necessity (computer science, some engineering science or other). Another - analyzing the recommendations for the position (excellent, good or not specific), third – comparing the proper language comprehension level (English, Latin or not proper). Fourth comparison is made for the applicant's job experience (programming, math engineering, computers or other). The fifth criterion from the set is evaluating the level of the corresponding job requirements for the specific job position (full compliance, more important, less important, similar and none). Another criterion is made to be the score from an IQ test (high, above average, average, below average and poor). The same levels are defined and for a psychological test's score. Team work history evaluation (excellent, very good, good, sufficient and poor) and appearance (good and not good) also take part in the FIS. Each applicant criterion indicators can be valued between zero and one. The final result for an applicant is made to be one of five levels: best suitable, suitable, good, average and inappropriate.

The linguistic variable is a main term in the fuzzy logic and is described a variable, witch value defines a set of verbal characteristics of a feature (Doctor 2009b).

Building a system for making a final decision based on fuzzy logic

The tools of fuzzy logic allow the use of two approaches to implement a system for decision. Various membership functions - functional relationships that determine the way in which each point of entrance area (input variables) form the baseline background (degree of affiliation) within the range of zero to one for the membership functions of the output variables.

In this fuzzy inference system, the use of membership functions of Gaussian type is chosen, subject to the following factors: the specificity of level classification; universality of application of Gaussian functions; availability of similarity in many applicants; evenness of the form; pronounced maximum; values other than zero for all points. Gaussian curves are subdivided into two types according to their form: a simple Gaussian curve and the two-way combination of two different Gaussian curves. Similar to them is the function of belonging of type "bell" defined by three parameters (Fig. 1).

The degree of membership of an applicant to the structure of fuzzy membership functions is determined by the value of membership ranging from zero to one. Thus the membership function associated with a fuzzy set of inputs, is used to position the output value in the corresponding area of the membership (Slavyanov, Minchev, 2017: 154-158).

Mamdani's method is commonly used method for decision-making of FIS (Mamdani & Assilian, 1975: 1-13). The method is based on the classic staging of Lotfi A. Zadeh (Zadeh, 1973: 28-44; Zadeh, 1988: 83-93). In Mamdani the output membership functions are expected to be fuzzy sets. After a merging of the different results is necessary fuzzy set for each output variable to be converted to a number. To form a ranking decision for each applicant in the FIS for HR selection tool, the method of Mamdani is chosen.

The aggregation function for the results is selected to be one that would seek the maximum value in each membership function to the input fuzzy variables. Given that demand maximum compliance to a job requirement is characteristic, each of the criterion is selected to form the final result of the type “largest of maximum” as a defuzzification. The Described parameters of demand system for decision making with fuzzy logic are applied in the implementation of fuzzy logic summarizing the results of the nine input variables described before as the key skills evaluated. The system is built with the tools of Matlab and is depicted in Fig. 2.

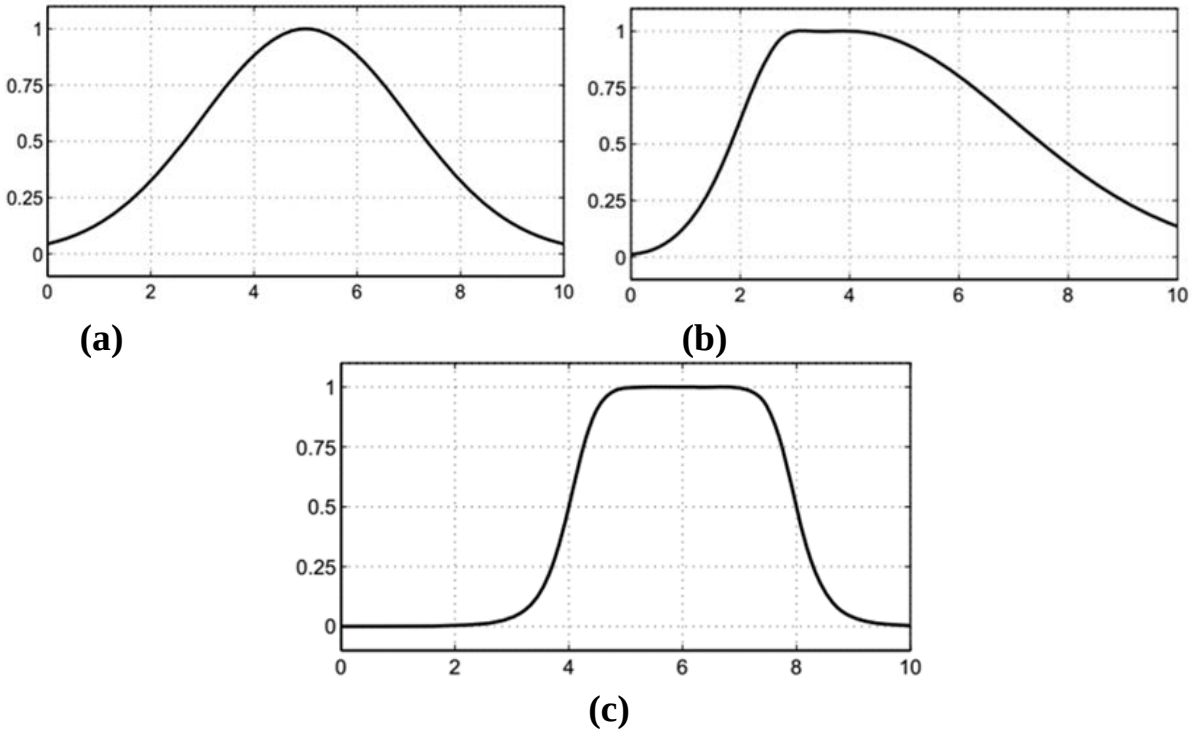

Figure 1. **Graphical description of the functions of belonging to the Gaussian distribution - plain (a) combination (b) and type “bell” (c)**

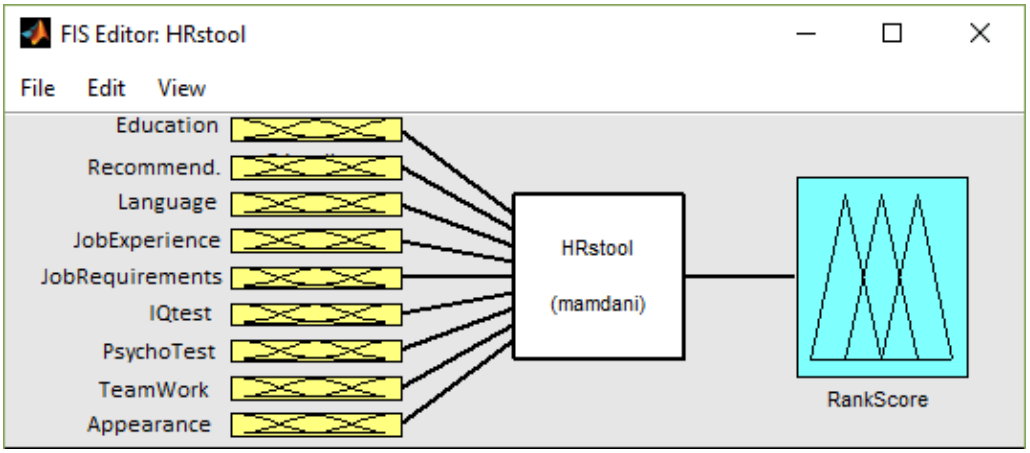

Figure 2. **Block diagram of the system for HR selection decision making by means of the Mamdani method, built in Matlab**

The input variables on the left side of the system are nine, corresponding to each of the criterions used to rank the applicant in the resulting rank score of the HR selection. Each of these input variables is made of membership functions (Fig. 3) named as the levels of the key skills of the applicant form. The output variable is a synthesis of all the rules applied to the input variables and is the rank level that best satisfied these fuzzy rules.

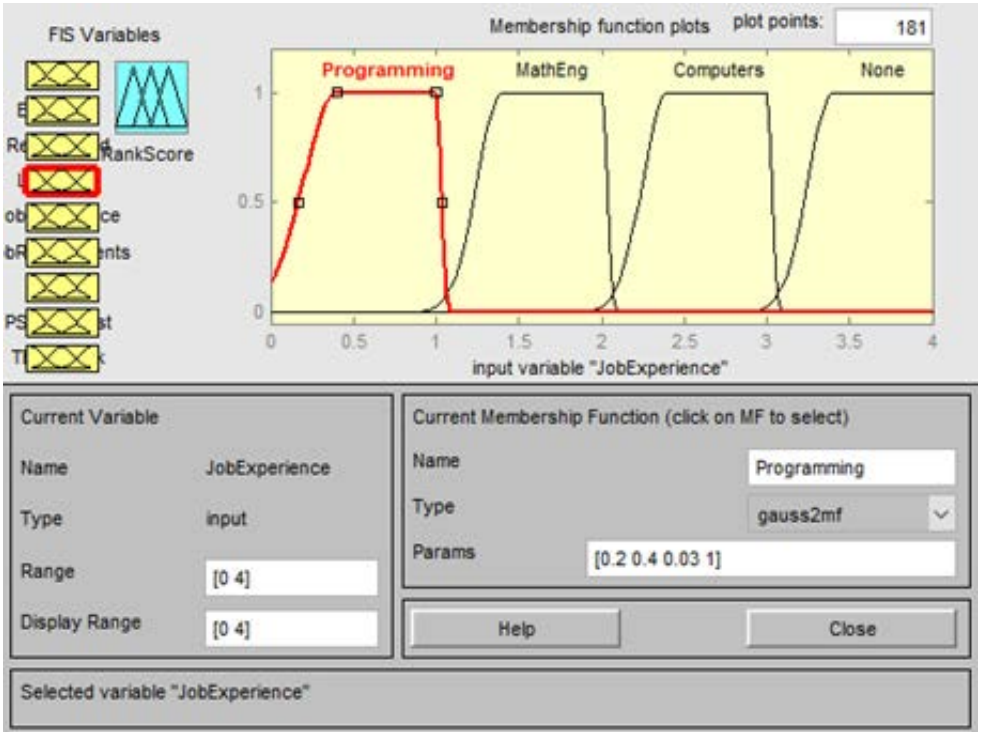

Figure 3. **Graphical expression of membership functions of fuzzy sets corresponding to criterion Job experience**

The chosen shape of the curve membership function to each fuzzy set is Gaussian combination membership function. The results for the key skills *Education* (computer science, some engineering science or other), *Recommendations* (excellent, good or not specific) and *Language* (English, Latin or not proper) should fall within three fuzzy sets defined by the functions of belonging in the range of 0 to 3. Sectors 0-1, 1-2 and 2-3 are distributed in the same sequence as the output values of the criterion indicators.

The specific form of these functions is tailor made to take maximum space in the range 0-3 to fall into the fuzzy sets higher percentage results from the input value. The shape responds to the need with the increase of the coefficient of the indicator to increase the degree of belonging to the elements of the fuzzy set (Fig. 3).

Similar are the parameters of input variable for the results of the other criterion, analyzing the Job Experience (programming, math engineering, computers or other) but here the result is designed to have four values (indicators). In this scientific work they are not described in detail. For input variables with the results of the criterion Job requirements (full compliance, more important, less important, similar and none), IQ test and Psychological test (high, above average, average, below average and poor) and Team work (excellent, very good, good, sufficient and poor) five fuzzy sets are created corresponding to the number of levels in the criterion. For the criterion Appearance, the fuzzy membership functions are only two as mentioned before (Fig. 4).

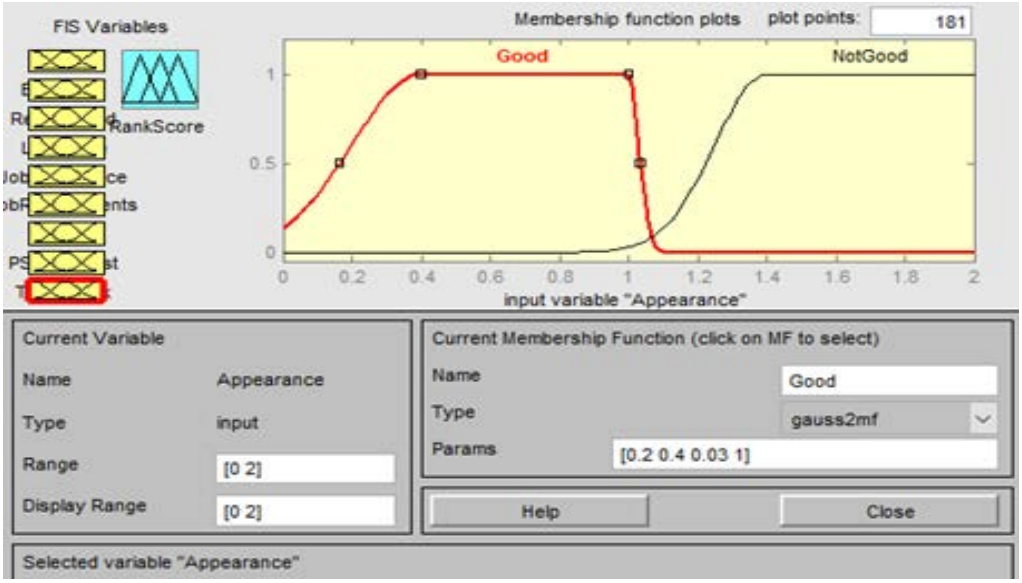

Figure 4. **Diagram describing the membership functions of fuzzy sets corresponding to the variation in criteria Appearance**

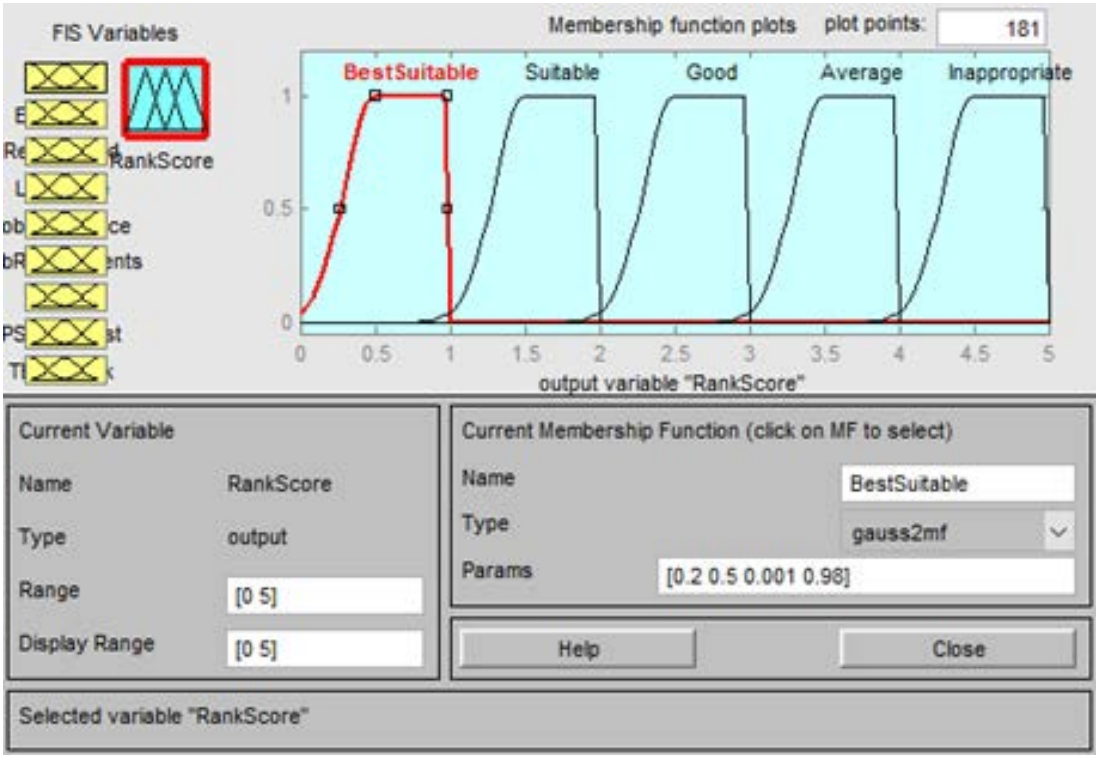

Figure 5. **Diagram of membership functions with Gaussian distribution type "bell" fuzzy sets of the output variable corresponding to the applicant's rank score used in the fuzzy inference system for HR selection tool**

The same logic is applied with Gaussian combination membership function and spaces with a maximum surface area, respectively, membership functions results in ranges 0-1 on the outcome of the first level, 1-2 - the second, etc. filling the interval 0-5 for the criteria with 5 levels (Fig. 5).

The output fuzzy variable is made up of fuzzy sets, broken again in the range 0-5, given the rank of the applicant in order to be placed in a descending list. The membership functions with the Gaussian distribution of type "bell" are aimed to summarize at maximum the results of the input variables, classified by the rules. Membership functions for the fuzzy sets of the output variable are shown on Fig. 5. The particular form aims to distinguish in maximum the membership functions of each criterion indicators for analysis. The shape is consistent with the selected function to summarize the results that is formed by the maximum value in each membership function of the input fuzzy variables.

The set of rules necessary for the operation of the system is composed of 10 rules divided into 2 groups, the weight of every rule of the groups is equal to one (Table 1).

Table 1 **FIS rules for the HR selection tool. Each of the criterion levels are represented with a digit from best to bad indicator in ascending order**

Education	Job Requir.	Job Exper.	Lang.	Recomm.	IQ	Psycho	Team	Appear.	Rank
1	1	1	1	1	1	1	1	1	1
1	1	1	2	2	2	2	2	1	1
2	2	2	2	2	2	2	2	1	2
2	2	2	2	2	3	3	3	1	2
2	2	2	3	3	3	3	3	1	3
2	2	2	3	3	3	4	4	1	3
3	3	3	3	3	3	3	3	1	4
3	4	3	3	3	4	4	4	2	4
3	4	4	3	3	4	4	4	1	5
3	5	4	3	3	5	5	5	2	5

For the first set of rules for each applicant are selected functions of fuzzy sets of input variables that describe it in its relevant characteristics (education, recommendations, language, job experience, job requirements, IQ test, psycho test, team work and appearance) as described classes at the output of each of the criteria (Fig. 6). The operation used for the various fuzzy sets which are obtained for each criterion for evaluation is a logical “AND” to reflect the intersection of these fuzzy sets and to comply thus with the most corresponding result of each rank level. Rules are 5 in number and one of them is used for example:

(1.) (Education==CompSc) & (Recommend==Excellent) & (Language==English) & (JobExperience==Programming) & (JobRequirements==FullCompliance) & (IQtest==High) & (PsychoTest== High) & (TeamWork==Excellent) & (Appearance==Good) => **(RankScore=BestSuitable)**

The second group of 5 rules are designed to treat the results of the applicant form that specify not strong but acceptable results for each rank level. In the rules the logical operator “AND” is used for operation between the selected fuzzy sets, thereby to address potential pass level exceptions allowed by HR selection methodology for applicants with different characteristics in the various indicators of calculation. According the description, the set of 5 rules adopted in that group can be explained, with the example:

(2.) (Education==CompSc) & (Recommend==Good) & (Language==Latin) & (JobExperience==Programming) & (JobRequirements==FullCompliance) & (IQtest==AboveAverage) & (PsychoTest==AboveAverage) & (TeamWork==VeryGood) & (Appearance==Good) => **(RankScore=BestSuitable)**

The described fuzzy inference system is aimed to summarize the results of nine criteria that have output variables of different nature, to put fast result as a digital value corresponding to the combination of degrees of matching the applicant's skills with the different ranking classification levels (Fig. 6).

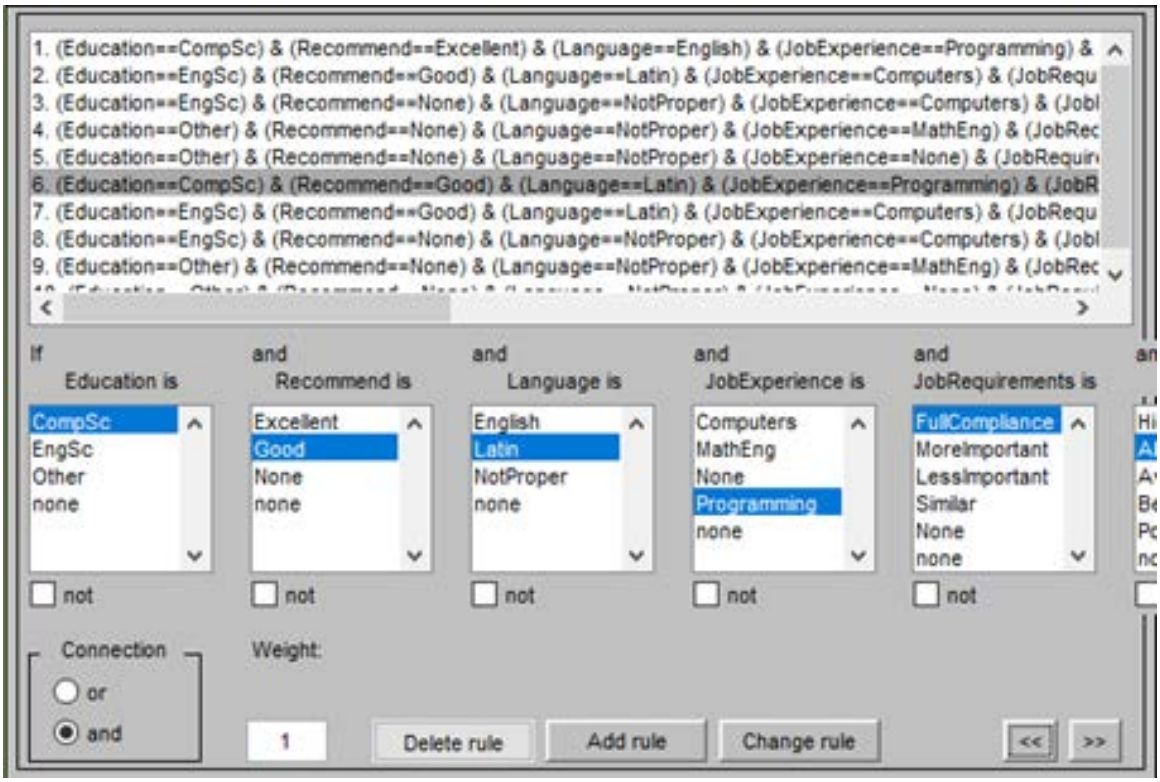

Figure 6. **Fuzzy system rules for HR selection decision-making process of a system with fuzzy logic simulated in Matlab**

Results and discussion

Numerical experimental results in applicant's score assessment on nine criterions. The job applicant placement in the ranking scale is decided upon its classification using fuzzy logic. The results of numerical simulation experiment of applicant placement in the rank scale with FIS result *RankScore* = 0.95 is depicted on Fig. 7.

The result of applicant classification process with FIS is produced with the nine criterion levels as a fuzzy sets and the value of the parameter *RankScore* is used to describe the number corresponding to the FIS decision - 0.95. The result is related to the output variable with this number even if not relevant to any of the defined rules. The applicant is classified as best suitable for the job and is situated in the top of the HR selection ranking scale.

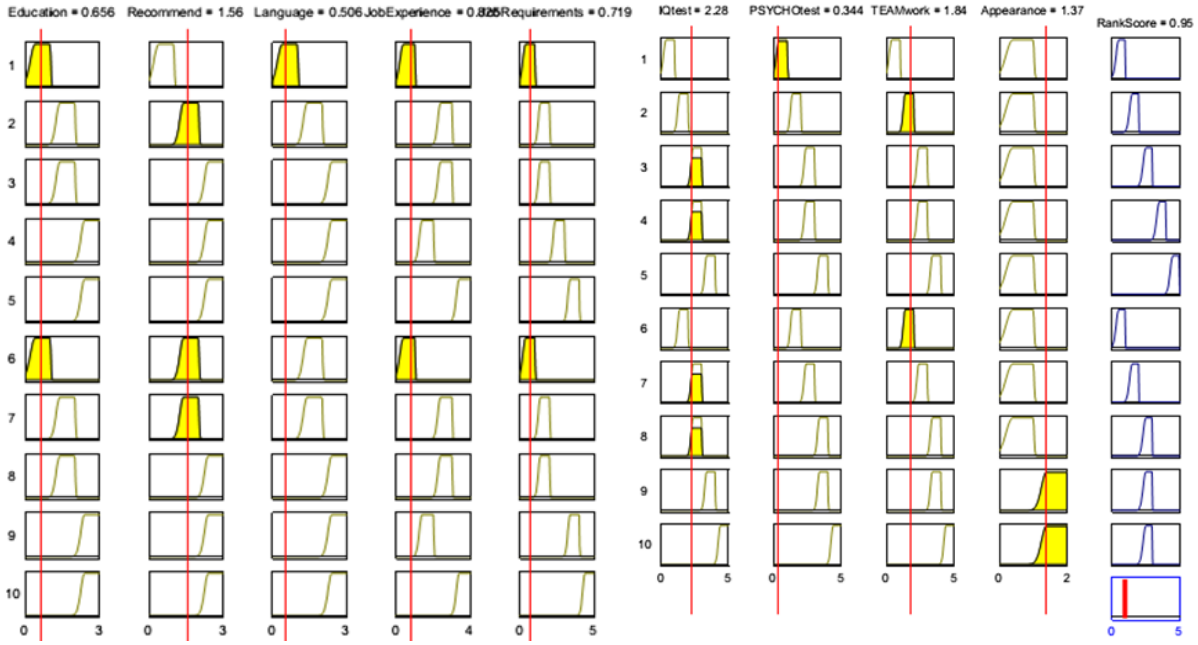

Figure 7. **Graphically expressed results of the procedure (parts "a" and "b") for applicant ranking. The score 0.95 (blue column) is connected to the output variable with the number 1. The applicant in that case is assessed as best suitable**

Conclusion

The fuzzy logic aimed to summarize the results of all predefined criterions in accordance with a system of logical rules is established in MATLAB environment. The membership functions of all input variables are used to formulate a reasoned conclusion, despite the different nature of their dimensions. One of the problems in the summarization of many criterions is permitted. They are able to produce a satisfactory result, but not to formulate a conclusion. The flexible approach in formulating decisions is of particular importance for the possible implementation of the developed HR selection ranking system.

By the implementation of the combination of rules for the operation of the system with fuzzy logic the computational and logical analyses burden in making the final ranking is reduced and the rapid adaptation to changes in the composition and nature of each criterion is allowed. The system can be modified for applicant ranking in HR selection tool processing.

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