Economic Risk Evaluation via Fuzzy Logic

Introduction

The fuzzy logic belongs among soft computing methods. The guiding principle of fuzzy logic means to the tolerance for imprecision, uncertainty, partial truth, and approximation to achieve tractability and robustness.

Fuzzy logic

In classical logic, a theory defines a set as a collection having certain definite properties. Any element belongs to the set or not according to clear-cut rules; membership in the set has only the two values 0 or 1. Later, the theory of fuzzy logic was created by Zadeh in 1965. Fuzzy logic defines a variable degree to which an element x belongs to the set. The degree of membership in the set is denoted $\mu(x)$; it can take on any value in the range from 1 to 0, where 0 means absolute non-membership and 1 full membership. The use of degrees of membership corresponds better to what happens in the world of our experience. Fuzzy logic measures the certainty or uncertainty of how much the element belongs to the set. People make analogous decisions in the fields of mental and physical behaviour. By means of fuzzy logic, it is possible to find the solution of a given task better than by classical methods.

The fuzzy logic system consists of three fundamental steps: fuzzification, fuzzy inference, and defuzzification. See Fig. 1.

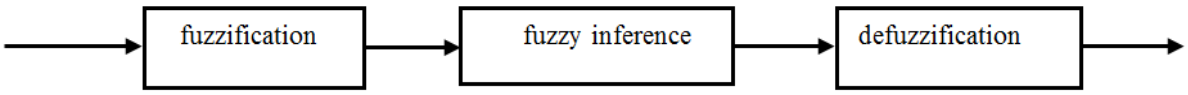


Fig.1: Decision making solved by means of fuzzy logic

The first step (fuzzification) means the transformation of numerical values into ordinary language, if necessary. For example, risk has the linguistic values such as no, very low, low, medium, high, and very high risk. The variable usually has from three to seven attributes (terms). The degree of membership of attributes is expressed by mathematical functions. There are many shapes of membership functions. The types of membership functions that are used in practice are for example Λ and Π. There are many other types of standard membership functions on the list including spline ones. The attribute and membership functions concern input and output variables.

The second step (fuzzy inference) defines the system behaviour by means of the rules such as <IF>, <THEN>, <WITH>. The conditional clauses create this rule, which evaluates the input variables. These conditional clauses have the form

<IF> I_1 is mf_a <AND> I_2 is mf_b . . . < AND R > I_{N-1} is mf_y <OR >I_N is mf_z <THEN> O_1 is mf_{O1} <WITH> s.

The written conditional clause could be described by words: If the input I_1 is mf_a and I_2 is mf_b and . . . and I_{N-1} is mf_y or I_N is mf_z then O_1 is mf_{O1} with the weight s, where the value s is in the range <0–1>. These rules must be set up and then they may be used for further processing.

The fuzzy rules represent the expert systems. Each combination of attribute values that inputs into the system and occurs in the condition <IF>, <THEN>, <WITH> represents one rule. Next it is necessary to determine the degree of supports for each rule; it is the weight of the rule in the system. It is possible to change the weight rules during the process of optimization of the system. For the part of rules behind <IF>, it is necessary to find the corresponding attribute behind the part <THEN>. These rules are created by experts. The <OR> could be instead <AND>.

The third step (defuzzification) means the transformation of linguistic values to numerical ones, if necessary. For example, the linguistic variables for *Risk* are very low, low, medium, high, and very high. During the consecutive entry of data, the model with fuzzy logic works as an automat. There can be a lot of variables on the input.

Case study

The application of the fuzzy logic model is used for evaluation of economic risk to company or firm. The application is solved with ten input variables, three rule blocks and one output variable with three attributes. The inputs and their attributes are: *Gender* (man, woman), *Age* (young, middle, old), *Marital status* (married, single, other), *Number of children* (none, one, more), *Occupation* (short, medium, long term), *Salary* (low, medium, high), *Account* (none, medium, high), *Debt* (none, medium, high), *Number of order*s (one, few, more), *Delayed payment* (none, few, more).

It presents ten inputs where from two to three attributes are selected according to the demand of realization of project. The output from the rule box Personal data evaluates the personality of the client (excellent, good, bad), the rule box Financial data evaluates the financial situation of client (excellent, good, bad), the rule box Business data evaluates the client and its relation consumer - supplier (excellent, good, bad). The output variables are the Qualityy of a client with three attributes (low, medium, high). The model is presented on fig.2. The box Personnel data, Financial data, Business data and Quality of a client is presented on fig.3, a) b) c) d).

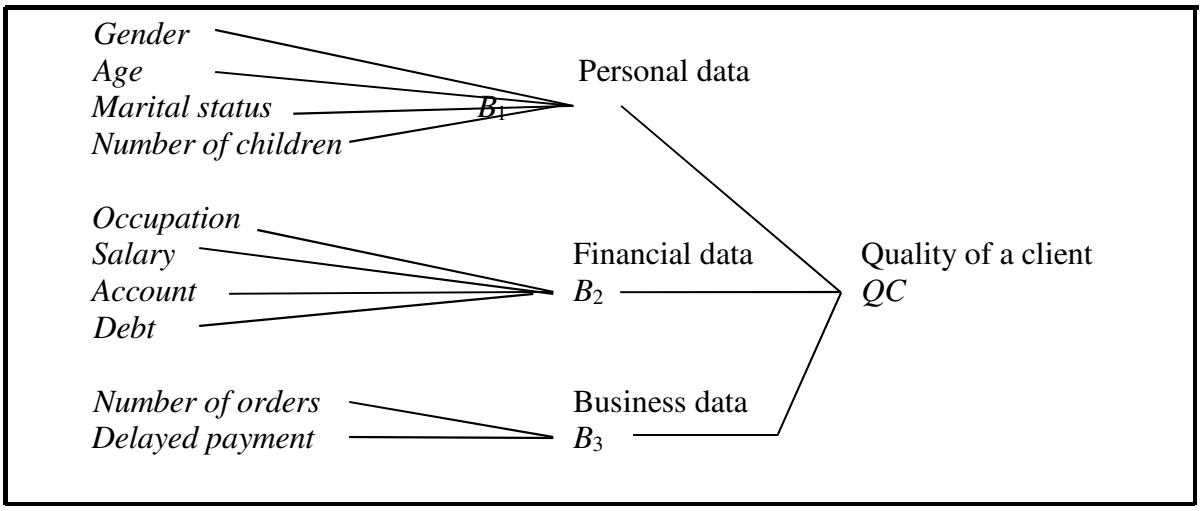
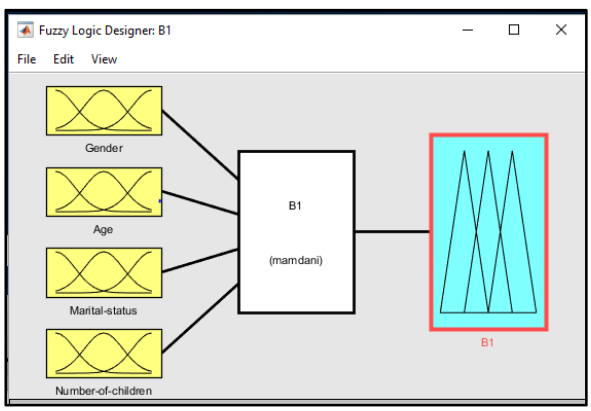
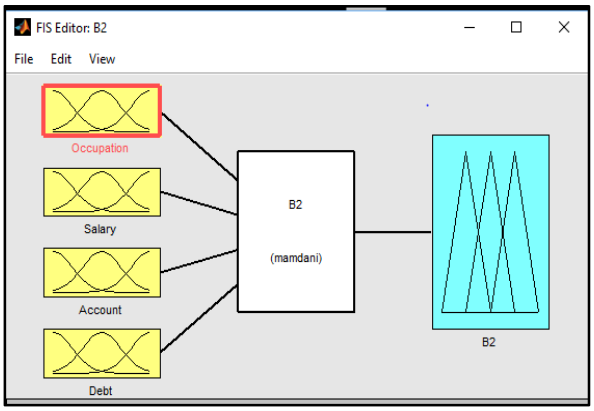


Fig. 2: Fuzzy model



a)



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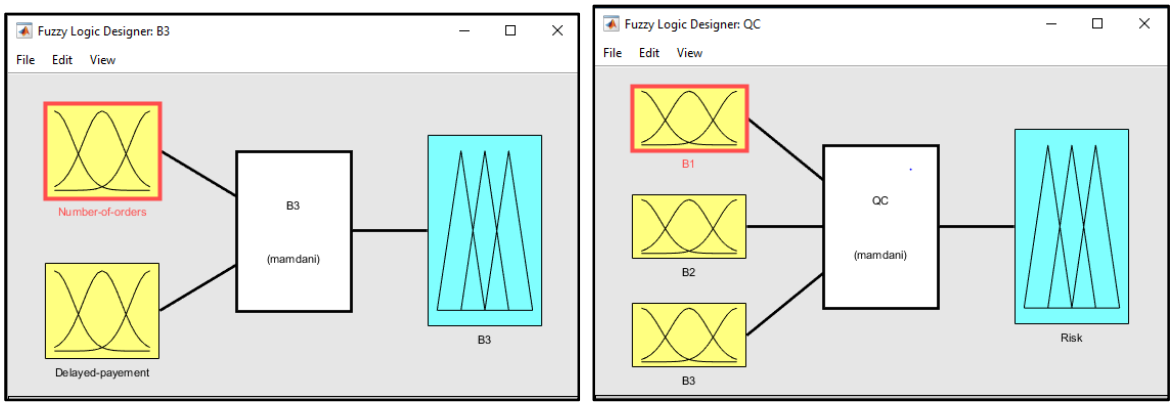

c) d)

Fig. 3 Fuzzy blocks *B*1, *B*2, *B*3, *QC*

It is necessary to set up the membership function for all inputs and outputs. It was used the functions in the shape of Λ, Π, Z, S. The rule box must be set up with rules and their weight among inputs and outputs. The weight of rules can be changed during the process of tuning. The build-up model can be used for the evaluation of risk of client for the firm or company. On the basis of input values, we obtain the information whether the risk of the client is low, medium or high.

The case study is presented by inputs *Gender* = 0.0, *Age* = 0.2, *Marital status* = 0.0, *Number of children* = 0.0, (*B*1 = 0.50), *Occupation* = 0.1, *Salary* = 0.1, *Account* = 0.1, *Debt* = 0.3, (*B*2 = 0.4514), *Number of orders* = 0.1, *Delayed payment* = 0.2, (*B*3=0.3543). The inputs were normalized to be 0.0-1.0. The results *QC* = 0.5 means Low quality of a client and thus high economic risk for the company or firm. See Fig.4.

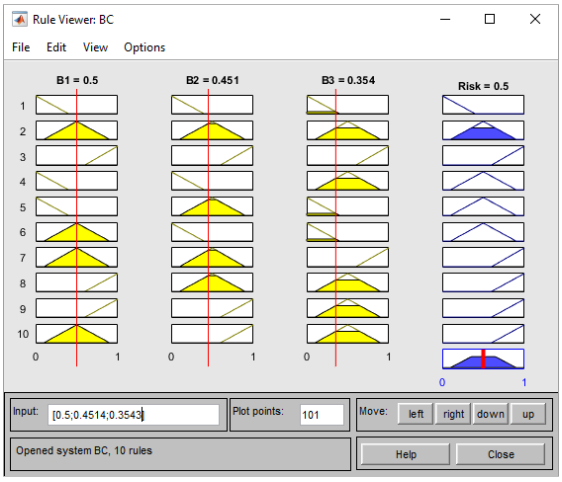

Fig. 4: Economy risk evaluation

Conclusion

The fuzzy logic method plays very important roles in companies and firms because it helps to reduce the risk. The advantage of the use of fuzzy logic is characterized by inputs that are in economy field represented by imprecision, uncertainty, vagueness, semi-truth, approximations, and so forth. The use of theory mentioned above is in the sphere of analyses and simulation. The use of fuzzy logic can lead to higher quality of analyses and simulations and thus to increase the quality of decision-making and reducing the risk.