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The use of virtual reality and fuzzy neural network tools to identify the focus on achieving project results

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The use of virtual reality and fuzzy neural network tools to identify the focus on achieving project results

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Abstract. In the process of making a decision on the inclusion of an applicant in the project team, it is proposed to take into account his project results targeting (PRT). The article describes the conceptual basis for identifying people's focus on achieving the results of significant projects based on the use of virtual reality tools and the capabilities of fuzzy inference systems. At the same time, to configure the parameters of the membership functions of the fuzzy inference system and the values of the individual inferences of the fuzzy rules, the use of a neural-fuzzy network is proposed. To get a training sample, the participants of the teams of implemented projects will need to pass a series of tests using virtual reality tools. According to the proposed concept, persons with high PRT will be primarily recommended for inclusion in the team of project performers.

1. Introduction

State structures and commercial organizations of various sectors of the economy set themselves the task of developing and implementing significant projects. Numerous studies are devoted to improving approaches to the management of state projects and programs. An analysis of publications in this area has shown that in the process of implementing large-scale projects, significant difficulties may arise: a lack of qualified performers, a lack of resources, and the need for additional work [1-4]. These problems, in the context of inefficient management and lack of responsibility on the part of officials, lead to delays, blocking of projects and significant overspending of funds for their implementation [5, 6].

At the same time, employers face difficulties in selecting professional personnel who are able to implement projects and bring their activities to a successful conclusion. It is proposed to make a decision on the inclusion of a person in the project team taking into account their project results targeting [7-10], i.e. the PRT indicator. For this purpose, it is proposed to create and use VR-scenarios that represent problem situations visualized using virtual reality tools.

2. Materials and methods

It is recommended to use two sets of VR scenarios (VR situations) to evaluate the subject's PRT. The scenarios in Set 1 should be designed to evaluate the S – stability of the subject's PRT position. The scenarios in set 2 should be designed to estimate the value of the subject's A – propensity for PRT actions. To calculate the value S, the expression can be used:

$$S = \sum_{i=1}^{I} k_i s_i \,, \tag{1}$$

where I is the number of VR scenarios in set 1; i is the number of the VR scenario in set 1, $i = 1, 2, ..., I$; k_i is the weight coefficient of the VR scenario number i in set 1; k_i can take values from 0 to 1; s_i is the indicator of acceptance by the subject of the PRT position in the VR situation number i in set 1; $s_i = 1$ in the case of acceptance by the subject of the PRT position, $s_i = 0$ otherwise.

The calculation of the value *A* can be performed using the expression:

$$A = \sum_{j=1}^{J} h_j a_j \,, \tag{2}$$

where J is the number of VR scenarios in set 2; j the number of the VR scenario in set 2, $j = 1, 2, ..., J$; h_j is the weight coefficient of the VR scenario number j in set 2; h_j can take values from 0 to 1; a_j is the indicator of acceptance by the subject of the PRT position in the VR situation number j in set 2; $a_j = 1$ in the case of acceptance by the subject of the PRT position, $a_j = 0$ otherwise.

To determine the values of the weight coefficients, it is proposed to apply expert assessments of the specific VR scenarios significance to identify the stability of the subject's PRT position and his propensity for PRT actions. To obtain the resulting estimate of the candidate's (applicant's) PRT, we introduce a generalized indicator *D*, which takes into account the partial indicators of the candidate's PRT-position stability and his propensity to PRT-actions, i.e., the values *S* and *A*.

Perhaps, it is impossible to accurately determine a specific range of S numerical values, at which the PRT position of a person is unambiguously stable. Similarly, it is very problematic to accurately determine *A* numerical values limits, within which a person can be unambiguously attributed to the PRT actions adherents of PRT. In this regard, fuzzy sets (terms) can be used to estimate the values of S and A. In this case, to calculate the exponent *D*, the fuzzy rules of the simplest form, corresponding to the Sugeno fuzzy inference algorithm of zero order, can be used:

$$If\ (S = S^{+})\ and\ (A = A^{+})\ then\ (D = d_1)\,, \tag{3}$$

$$If\ (S = S^{+})\ and\ (A = A^{-})\ then\ (D = d_2)\,, \tag{4}$$

$$If\ (S = S^{-})\ and\ (A = A^{+})\ then\ (D = d_3)\,, \tag{5}$$

$$If\ (S = S^{-})\ and\ (A = A^{-})\ then\ (D = d_4)\,, \tag{6}$$

where S^{+} is the term "high stability of the PRT position"; S^{-} is the term "low stability of the PRT position"; A^{+} is the term" high propensity to PRT actions"; A^{-} is the term" low propensity to PRT actions"; d_1, d_2, d_3 and d_4 are the values of the individual conclusions of the corresponding fuzzy rules.

The values *S* may correspond more or less to the terms S^{+} and S^{-}. To calculate the value of this correspondence, the membership functions $x^{+}(S)$ and $x^{-}(S)$ are used. Their meaning is that the value of the function $x^{+}(S)$ shows with what probability the value of *S* belongs to the term "high stability of the altruistic position", and the value of the function $x^{-}(S)$ shows with what probability the value of *S* belongs to the term "low stability of the altruistic position". Similarly, to calculate the correspondence of *A* values to the terms A^+ and A^- the membership functions $y^+(A)$ and $y^-(A)$ can be used. Piecewise continuous membership functions are widely used in research practice [11, 12].

To find the indicator *D* based on fuzzy rules (3) – (6), it is necessary to perform fuzzification, aggregation and defuzzification. In this case, the parameters of the membership functions and quantities values d_1, d_2, d_3 and d_4 remain unknown, and for their calculation the training capabilities of a multilayer neural network can be used. In this case, a three-layer neural network, in which each layer is designed to perform certain fuzzy inference procedures, should be created. Such a hybrid structure is called a neural-fuzzy network or Adaptive-Network-Based Fuzzy Inference System (ANFIS) [13-19] (Figure 1).

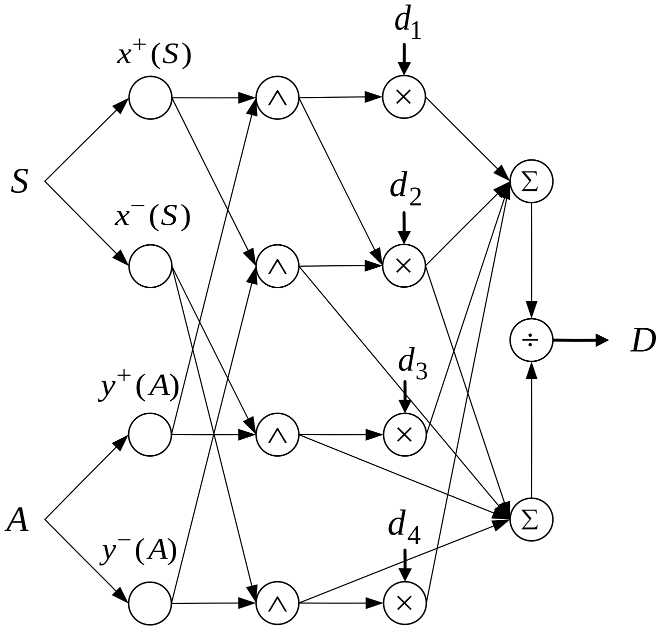

Figure 1. Structure of a neural-fuzzy network designed for PRT estimation

To set up such a neural-fuzzy network, a training sample is needed, for the formation of which it is proposed to involve team members of implemented projects, whose *D* indicator can be evaluated by other members of the same project teams, for example, higher level colleagues. Each such person will need to pass a series of tests using virtual reality tools. The result will be the reactions of each person in each specific VR situation from sets 1 and 2, and then the *S* and *A* scores will be calculated. The training sample obtained in this way can be used to configure a neural-fuzzy network.

ANFIS training is usually performed using a fast error back propagation algorithm or a hybrid algorithm, complicated by the application of the least squares method. During multiple training cycles (epochs), the weights of the neurons of the first and third layers of ANFIS are adjusted. The adjustment must be performed until the value of the training error is stabilized at the minimum level. Once configured, the ANFIS system can be used to support the decision to include a candidate in the project team, taking into account their focus on achieving project results.

3. Conclusion

The indicators of stability of the candidate's PRT position and his propensity to PRT actions calculated by formulas (1) and (2) should be used as input values of the neural-fuzzy network. In the ANFIS layers, calculations will be performed, the result of which will be a *D* score at the network output. This is a generalized PRT indicator of the candidate for inclusion in the project team. Based on the proposed concept, persons with high *D* values will be primarily recommended for inclusion in the project performers team.

The subject of further research will be the development and use of software tools for implementing the conceptual foundations proposed in the article and obtaining experimental results that allow the project team to assess the possibility of identifying a person's focus on results achieving based on the use of VR scenarios and a neural-fuzzy network.

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